British Society of Physical & Rehabilitation Medicine

BSPRM Medical Student Essay Prize 2026 Submissions

The BSPRM Medical Student Essay Prize 2026 attracted an exceptional 27 submissions from medical students across the UK, demonstrating growing interest in Physical and Rehabilitation Medicine (PRM). Following a careful review by the BSPRM judging panel, one winner and three runners-up were selected and recognised at the 2026 BSPRM Annual Scientific Conference.

The competition seeks to engage and inspire medical students by encouraging them to explore the principles, breadth and impact of PRM. By fostering interest at an early stage of medical training, the initiative supports BSPRM's wider mission to advance education, research and clinical excellence in rehabilitation medicine.

The judging panel was greatly impressed by the quality, originality and insight demonstrated across the submissions, which explored a diverse range of topics and perspectives. BSPRM extends its sincere thanks to every student who participated for their thoughtful contributions and enthusiasm, reflecting a promising future for rehabilitation medicine in the UK.

Contents

The Life Within the Living: Rehabilitation Medicine and the Quality of Life 4

Author: *Gabriel Ind* *4*

Medical Student Essay Prize – 2026 Winner *4*

The Half of Rehabilitation We Sleep Through 11

Author: *Eesa Farooqui* *11*

Medical Student Essay Prize – 2026 Runner-Up *11*

Overlooked Dysautonomia: Early Screening with the Nasa Lean Test (NLT) to detect Orthostatic Intolerance Syndromes in Fibromyalgia 16

Author: *Emma Braithwaite* *16*

Medical Student Essay Prize – 2026 Runner-Up *16*

How Can We Improve Cardiac Rehabilitation for Patients with Genetic Dilated Cardiomyopathy? 21

Author: *Ling Gang* *21*

Medical Student Essay Prize – 2026 Runner-Up *21*

More Than A Heartbeat: The Life Beyond Survival 29

Author: *Aayush Pramanik* *29*

Before the Gift: Prehabilitation and the Untapped Potential of Living Donor Kidney Transplantation 35

Author: *Andy Prigg* *35*

Found and Forgotten: The Inequity of Surgical Access in Spasticity Management 41

Author: *Elijah Williams* *41*

Patient Inspiration in Physical and Rehabilitation Medicine 46

Author: *Faiz Bhatti* *46*

History of Spinal Cord Injury Rehabilitation: From Ancient Egypt to Modern Physical Medicine and Rehabilitation 50

Author: *Hana Ghaith* *50*

The Engagement Gap: Why psychological rehabilitation in acquired brain Injury fails before it begins 55

Author: *Igor Pereszczako* *55*

Beyond walking again: the overlooked cognitive deficits in stroke rehabilitation 62

Author: *Ikeola Alao* *62*

A Second Season of Strain: Heatwaves, Functional Safety and Rehabilitation Medicine 67

Author: *Jess Byun* *67*

Introduction to RED-S 72

Author: *Katherine McCabe* *72*

“When Treatment Ends but Recovery Does Not: Rehabilitation After Stoma Formation and the Return to Work” 77

Author: *Kieran Gharti* *77*

From Theatre to Nowhere: The Hidden Bridge Between Neurosurgical Survival and Functional Recovery 83

Author: *Cameron Kumar Pinn* *83*

"I Don't Want to Live Like This": Rehabilitation, Dignity and the Right to a Liveable Alternative 89

Author: *Mohammad Abir Mamun* *89*

A Prescription of Culture: The Missing Dimension of Rehabilitation Medicine 94

Author: *N J Paydar* *94*

When Pain Persists – The Purpose of Rehabilitation Medicine in Chronic Phantom Limb Pain 98

Author: *Nithikka Senthil Kumar* *98*

Advancement of Rehabilitation Medicine: Integrating Veterinary Innovation into Human Healthcare Through the One Medicine Framework 105

Author: *Olivia McCausland* *105*

FND: How Can We Rehab What We Can't Understand? 110

Author: *Rebecca Beardmore* *110*

Beyond the Ward: Wearable Technology and the Unfinished Work of Stroke Rehabilitation 116

Author: *Reece Patterson* *116*

The Current State of Sensor-augmented Digital Health Apps for Remote Physical Rehabilitation: A Narrative Review 120

Author: *Rupert Yeung* *120*

Exercise Without Movement: The Case for Magnetic Mitohormesis in Physical and Rehabilitation Medicine 127

Author: *Sandra Tay* *127*

Should Artificial Intelligence Become a Key Member of the Rehabilitation Multidisciplinary Team? Opportunities, Risks and the Future of Precision Rehabilitation 133

Author: *Shreya Srinivas* *133*

How New Technologies Are Changing Physical and Rehabilitation Medicine 138

Author: *Vishal Vijay Kumar* *138*

Can Physical and Rehabilitation Medicine Solve the World's Leading Cause of Disability? 142

Author: *Yashvardhan Shetty* *142*

Beyond Survival: The Missing Pieces of Physical and Rehabilitation Medicine in Medical Education 147

Author: *Zheqing Zhang* *147*

The Life Within the Living: Rehabilitation Medicine and the Quality of Life

Author: Gabriel Ind

Medical School: King's College London

Medical Student Essay Prize – 2026 Winner

Introduction: Beyond the Mantra

A common mantra I have heard in and around physical and rehabilitation medicine (PRM) is: “We do not save lives, we give people their lives back.” I disagree.

My disagreement is not with the humility behind the phrase, but with the narrow interpretation of what it means to save a life. The phrase reserves saving for resuscitation bays and intensive care units, casting rehabilitation as what happens afterwards. Yet rehabilitation does not only return people to an old life when that is possible; it also helps them preserve, adapt, and enlarge the life that remains.

If life is measured only by pulse and survival curves, rehabilitation will always look secondary. But if life also means agency, dignity, routine, movement, relationships, and self-recognition, preserving quality of life is itself a form of lifesaving. Rehabilitation medicine protects that life by raising what a person can safely do and lowering what daily life unnecessarily demands, preserving the balance on which participation depends.

I began to understand this balance at home, long before I recognised it on clinical placements, because I had the privilege of being raised by my grandparents and watching them grow older. My grandfather is eighty-one, a keen cyclist and British Cycling coach, and still builds his Saturdays around long rides. My grandmother is eighty, has lived with multiple sclerosis (MS) for almost fifty years, and later developed bilateral knee osteoarthritis (OA) and spinal stenosis. For years, her Tuesdays were built around swimming at the public pool, until reaching it began to demand more than her body could repeatedly supply. She no longer swims.

That contrast is painful because it shows how two lives sharing the same home can diverge when one remains scaffolded for participation while the other increasingly has to compensate. Biology was never equal, but much else was: family, routine, and decades under one roof. What differed, beyond disease, was how each life was supported. One had cycling routes, equipment, and a coaching community around him; the other relied increasingly on personal endurance. Structure did not alter biology, but it shaped how far biology could shrink her life. That gap between disease and support shapes ageing everywhere.

Swimming was never only exercise for her. It was independence, routine, and the confidence of leaving the house under her own power. It did not disappear through pathology alone, but through the gap between what her body could repeatedly supply and what an ordinary journey began to demand: transport, steps, and the assurance that she could complete it safely. She did not lose only a sport, but part of the structure that made her week feel like hers. No intervention can restore the body that once swam easily, but PRM asks a more practical question: can the remaining life still contain the ordinary Tuesday she wants to keep?

A Quality of Life, Not a Former Life

That question requires clarity about what PRM protects. The World Health Organization defines health as complete physical, mental, and social well-being, not merely the absence of disease [1], and its quality-of-life framework centres the patient’s own judgement, shaped by goals, expectations, and values rather than

pathology alone [2]. These definitions make quality of life more than an ornament added once survival is secured. It is usually the very thing survival was for.

The disability paradox makes the point sharply. Albrecht and Devlieger found that many people with serious and persistent disability report good or excellent quality of life, confounding observers who assume disability and a worthwhile life cannot coexist [3]. Lives are graded less by tissue integrity than by purpose, control, roles, and participation. When quality of life is poor, the drivers are often pain, fatigue, loss of control, and isolation rather than impairment itself [3]. When I think of what has worn my grandmother down, it was never only the lesions on a scan, but the slow loss of things she had chosen for herself.

The same priority appears when survival itself is at stake. When Fried and colleagues asked seriously ill older patients about life-sustaining treatment, a clear majority would refuse it if the likely outcome was severe physical or cognitive impairment, even when refusal meant death [4]. They were not choosing death, but declining a life they judged no longer their own to live.

The Multimorbidity Bind

No single diagnosis captures my grandmother's difficulty. On paper she has MS, OA, and spinal stenosis; in life these do not wait in separate clinics but arrive in the same morning. Fatigue changes how she walks, knee pain changes how much she moves, and claudication turns distance into uncertainty. The result is not simply more disease, but less room for an ordinary life.

She is not unusual in this. Multimorbidity is now the norm in later life: in a large Scottish cross-sectional study, 23.2% of patients had two or more chronic conditions, a share that climbed steeply with age [5]. Services built around individual diseases struggle when the problem lies in their interactions, which is why the National Institute for Health and Care Excellence (NICE) guidance emphasises personalised plans that reduce treatment burden and fragmented care [6]. The International Classification of Functioning, Disability and Health (ICF) provides rehabilitation with the language for this, locating disability not in any one organ but in the interaction among condition, person, and environment [7]. Read this way, my grandmother's disability does not sit in a brain lesion, a knee joint, or a narrowed spinal canal; it lies in the fit between her functional capacity and the daily world around her.

That is where her conditions collide. MS erodes her reserve through weakness, altered gait, and fatigue [8-10]; OA adds joint pain and lost function [11,12]; stenosis adds claudication, turning each walk into a negotiation with distance and posture [13]. Considered alone, each condition has its own pathway; together, they turn the same advice against itself. Exercise sits at the centre of OA care, backed by trial syntheses and NICE [14-16], and protects function across chronic disease [17], yet "move more" is no longer simple when movement spends the reserve she needs for the rest of the day.

This is the point disease-specific care can miss, and what rehabilitation medicine exists to notice. The task is not to treat the knee, nervous system, and spine as separate problems, but to understand how they combine to make ordinary life harder. Advice that is correct in a guideline can fail at the front door, the bus stop, or the pool entrance without structure, access, and adaptation. What is lost is not a single function, but the rhythm of ordinary life: leaving the house, reaching the pool, seeing family, and returning home with enough reserve for the rest of the day. Protecting that rhythm is the form of lifesaving that the mantra overlooks.

When Daily Life Outruns Capacity

Each of those losses is the same event in different clothing, a demand that has outgrown her capacity. A simple balance captures the problem: functional capacity on one side, task demand on the other (Figure 1). Capacity is what a person can safely and repeatedly supply; demand is what an activity, building, journey, or routine asks. The ICF distinguishes capacity in standardised conditions from performance in real life [7]. People participate when capacity meets demand. They withdraw when demand outruns what they can repeatedly supply. A fifteen-minute walk to the pool raises demand; claudication or MS fatigue lowers capacity. When the balance tips, participation falls away, and with it the routines, choices, and relationships that give survival its purpose.

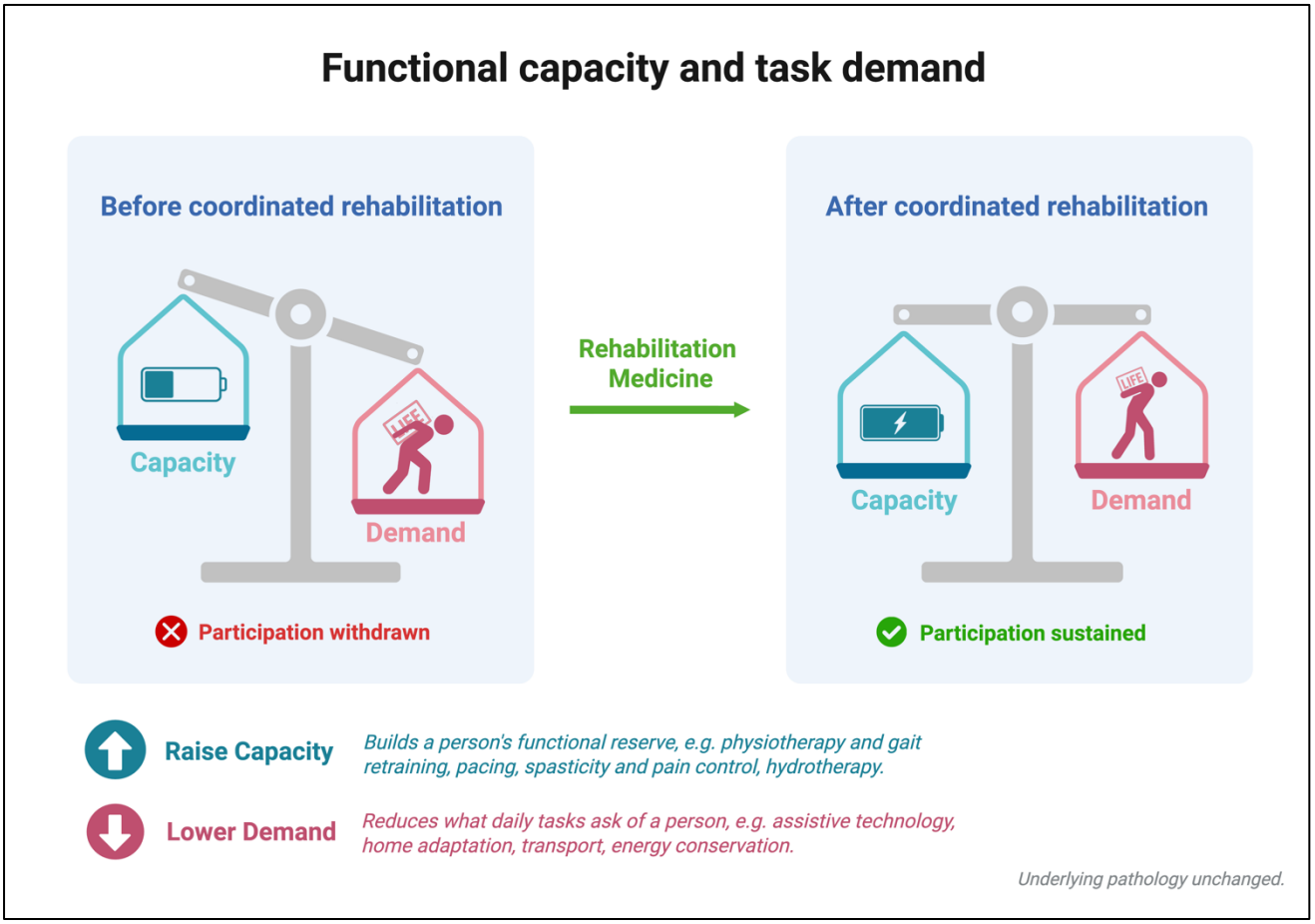


Figure 1. *The capacity and demand model of participation. Participation is sustained when functional capacity meets or exceeds task demand and declines when demand exceeds capacity. Rehabilitation can act on both sides of the balance. Figure designed by the author and created with BioRender.com.*

Once participation is understood as a balance, the rehabilitation physician's task becomes easier to define. Medical optimisation, fatigue and pain management, spasticity treatment, orthotic and exercise prescription, falls-risk review, and goal setting can build capacity. Equipment, transport planning, home adaptation, energy conservation, and community liaison can lower demand. PRM brings these adjustments into one formulation rather than treating them as separate referrals. In progressive disease, capacity may still fall, so the plan keeps adapting demand around personal goals. The diagram cannot capture grief or identity, but it keeps the clinical task visible.

For my grandmother, that task would start with a map of her day, not a generic instruction. When does fatigue peak? How far can she walk before claudication starts? Which activities matter enough to protect? For interacting chronic conditions, the target is not a perfect knee, a cured nervous system, or an unchanged spine, but an ordinary Tuesday made possible again.

Energy conservation and pacing are foundational in MS. NICE places them inside fatigue self-management [18], and Mathiowetz's trial found improvements in fatigue impact, self-efficacy, and in some aspects of quality of life after an energy conservation course [19]. The principle becomes routine: budget effort before exhaustion. For her, a tiring appointment would not follow the weekly shop, and family visits would not be squeezed into mornings already spent on avoidable exertion. The calendar becomes part of the treatment.

Aquatic therapy is one example of how rehabilitation can raise capacity while reducing demand. Buoyancy unloads painful joints, hydrostatic pressure supports balance, and warm water makes movement less daunting. Systematic reviews report modest gains in OA pain and function, with varying certainty because trials are small and hard to blind [20,21]. For my grandmother, the clinical argument is also personal: she already swam, long before anyone called it therapy. The barrier was access: transport, safe pool entry, and supervision that protected without putting her on display.

What Rehabilitation Medicine Offers

If saving a life in this way means keeping capacity above demand, someone must hold the whole picture together. Rehabilitation physicians do not own every intervention; the interdisciplinary team does. PRM adds a physician trained to integrate impairment, comorbidity, prognosis, medication, mental health, and personal goals into one plan, consistent with specialist rehabilitation standards for coordinated, consultant-supported care [22]. Where care is scattered, integration becomes the saving act itself.

For my grandmother, a rehabilitation consultant does not need to replace the clinicians involved. The value lies in one formulation of MS fatigue, knee pain, claudication, mood, medication, deconditioning, and home environment. An offloading knee brace might reduce joint demand [23], but if it is heavy or destabilising, it could raise fatigue and falls risk in MS-related weakness. The integrated decision is not "brace or no brace," but which orthotic, walking aid, or exercise progression reduces joint load without increasing fatigue, instability, or falls risk.

Psychology belongs inside that plan, not beside it. Fear-avoidance, the retreat from activity in anticipation of pain, compounds limitation and predicts poorer function in knee OA [24]. My grandmother's hesitations are not signs of frailty. They are the reasonable preferences of someone determined to stay independent; she would rather not be watched struggling or accept help that turns a capable woman into a patient in public. Rehabilitation that ignores this may rebuild strength while leaving confidence behind. Done well, it supports both and makes movement feel like hers again.

Goals anchor clinical interventions directly to the lives they serve [25,26]. While an instruction to "exercise more" remains abstract, rehabilitation targets outcomes that are concrete and personal: walking from a car park with one planned rest, returning to supervised swimming once a fortnight, or attending a family milestone without paying for it with days of exhaustion. These choices decide what survival becomes.

The Systemic Gap and the Repair

My grandmother has advantages many patients lack: family advocates, a stable home, and a long-standing GP. The problem is that helpful care has never quite added up to a single plan. Each speciality can offer sound advice, but advice becomes brittle when no one tests it against a real day of stairs and fatigue. Her story is personal, but the gap is systemic: services still struggle to organise care around lives with interacting conditions.

The workforce context makes this gap harder to close. The United Kingdom has one of the lowest densities of rehabilitation physicians in Europe, at fewer than 0.3 per 100,000 population [27]. Rehabilitation 2030 frames rehabilitation as an essential health service, and a Lancet analysis estimated that 2.41 billion people could benefit from rehabilitation worldwide [28,29]. For an ageing population defined by multimorbidity, this is not a niche workforce gap. It is a failure to organise services around the lives patients actually live.

Measurement compounds the problem. Rehabilitation is harder to measure and commission than acute care: its outcomes are diffuse and cumulative, and steadier daily life competes with targets that are immediate and visible. But that is an argument for better measurement, not lower priority. Goal attainment can be audited with tools like Goal Attainment Scaling [30], then reported alongside participation, home-time, admissions avoided, carer burden, and community living. These belong beside mortality and length of stay as markers of whether medicine protected the life it saved.

One service-level repair would be consultant-led multimorbidity rehabilitation clinics that act as a point of accountability, linking primary care, community therapists, and the interdisciplinary team around one plan. Such clinics would create a shared formulation, a goal plan, and a named coordinator linking fatigue management, analgesia, orthotics, psychology, transport, and home adaptation. Integrated Care Systems should treat hoist access, transport, and home adaptation as clinical necessities when they determine participation [6,22]. The cultural repair begins earlier: medical students should ask not only what is wrong, but what a patient still wants to do.

Conclusion: What Survival Is For

My grandfather rode eighty kilometres last weekend. My grandmother did not leave the house. The difference between them is not pathology alone. One life has ordinary structures that have kept movement possible across decades. In the other, the supporting structures were never quite assembled; each loss went unanswered until leaving the house itself became the hard part.

So I return to the mantra. “We do not save lives, we give people their lives back” is generous, but it concedes too much. Rehabilitation medicine does not promise to return the old life, because that life may be gone. What it saves is everything that makes a life worth surviving for. It keeps survival from collapsing into mere biology.

In an ageing society, PRM is not a late-stage addition once acute care has done its work. It belongs among medicine’s central purposes, because it resists the slow disappearance of life within the living. My grandmother deserves that kind of saving, and so do the millions whose greatest need is not simply to live longer, but to live the lives they still have as fully as possible.

References

1. World Health Organization. Constitution of the World Health Organization [Internet]. Geneva: World Health Organization; 1948 [cited 2026 Apr 11]. Available from: https://www.who.int/about/governance/constitution
2. The WHOQOL Group. The World Health Organization Quality of Life assessment (WHOQOL): position paper from the World Health Organization. Soc Sci Med. 1995;41(10):1403-1409. doi: 10.1016/0277-9536(95)00112-K.
3. Albrecht GL, Devlieger PJ. The disability paradox: high quality of life against all odds. Soc Sci Med. 1999;48(8):977-988. doi: 10.1016/S0277-9536(98)00411-0.
4. Fried TR, Bradley EH, Towle VR, Allore H. Understanding the treatment preferences of seriously ill patients. N Engl J Med. 2002;346(14):1061-1066. doi: 10.1056/NEJMsa012528.
5. Barnett K, Mercer SW, Norbury M, Watt G, Wyke S, Guthrie B. Epidemiology of multimorbidity and implications for health care, research, and medical education: a cross-sectional study. Lancet. 2012;380(9836):37-43. doi: 10.1016/S0140-6736(12)60240-2.
6. National Institute for Health and Care Excellence. Multimorbidity: clinical assessment and management. NICE guideline NG56 [Internet]. London: NICE; 2016 [cited 2026 Jun 13]. Available from: https://www.nice.org.uk/guidance/ng56
7. World Health Organization. International classification of functioning, disability and health: ICF [Internet]. Geneva: World Health Organization; 2001 [cited 2026 Apr 5]. Available from: https://www.who.int/standards/classifications/international-classification-of-functioning-disability-and-health
8. Filippi M, Bar-Or A, Piehl F, Preziosa P, Solari A, Vukusic S, et al. Multiple sclerosis. Nat Rev Dis Primers. 2018;4(1):43. doi: 10.1038/s41572-018-0041-4.
9. Braley TJ, Chervin RD. Fatigue in multiple sclerosis: mechanisms, evaluation, and treatment. Sleep. 2010;33(8):1061-1067. doi: 10.1093/sleep/33.8.1061.
10. Cameron MH, Nilsagard Y. Balance, gait, and falls in multiple sclerosis. Handb Clin Neurol. 2018;159:237-250. doi: 10.1016/B978-0-444-63916-5.00015-X.
11. Hunter DJ, Bierma-Zeinstra S. Osteoarthritis. Lancet. 2019;393(10182):1745-1759. doi: 10.1016/S0140-6736(19)30417-9.
12. Neogi T. The epidemiology and impact of pain in osteoarthritis. Osteoarthritis Cartilage. 2013;21(9):1145-1153. doi: 10.1016/j.joca.2013.03.018.
13. Lurie J, Tomkins-Lane C. Management of lumbar spinal stenosis. BMJ. 2016;352:h6234. doi: 10.1136/bmj.h6234.
14. Lawford BJ, Hall M, Hinman RS, Van der Esch M, Harmer AR, Spiers L, et al. Exercise for osteoarthritis of the knee. Cochrane Database Syst Rev. 2024;12(12):CD004376. doi: 10.1002/14651858.CD004376.pub4.
15. National Institute for Health and Care Excellence. Osteoarthritis in over 16s: diagnosis and management. NICE guideline NG226 [Internet]. London: NICE; 2022 [cited 2026 Jun 7]. Available from: https://www.nice.org.uk/guidance/ng226
16. Uthman OA, van der Windt DA, Jordan JL, Dziedzic KS, Healey EL, Peat GM, et al. Exercise for lower limb osteoarthritis: systematic review incorporating trial sequential analysis and network meta-analysis. BMJ. 2013;347:f5555. doi: 10.1136/bmj.f5555.
17. Pasanen T, Tolvanen S, Heinonen A, Kujala UM. Exercise therapy for functional capacity in chronic diseases: an overview of meta-analyses of randomised controlled trials. Br J Sports Med. 2017;51(20):1459-1465. doi: 10.1136/bjsports-2016-097132.
18. National Institute for Health and Care Excellence. Multiple sclerosis in adults: management. NICE guideline NG220 [Internet]. London: NICE; 2022 [cited 2026 May 27]. Available from: https://www.nice.org.uk/guidance/ng220

19. Mathiowetz VG, Finlayson ML, Matuska KM, Chen HY, Luo P. Randomized controlled trial of an energy conservation course for persons with multiple sclerosis. Mult Scler. 2005;11(5):592-601. doi: 10.1191/1352458505ms1198oa.
20. Bartels EM, Juhl CB, Christensen R, Hagen KB, Danneskiold-Samsoe B, Dagfinrud H, et al. Aquatic exercise for the treatment of knee and hip osteoarthritis. Cochrane Database Syst Rev. 2016;3(3):CD005523. doi: 10.1002/14651858.CD005523.pub3.
21. Ayan-Perez C, Gonzalez-Devesa D, Montero-Garcia B, Varela S. Effects of aquatic exercise in older people with osteoarthritis: systematic review of randomised controlled trials. Geriatrics (Basel). 2025;10(1):12. doi: 10.3390/geriatrics10010012.
22. British Society of Physical and Rehabilitation Medicine. 2021 BSRM Standards for specialist rehabilitation for community dwelling adults: update of 2002 standards. Summary as at 1 March 2021 [Internet]. London: BSRM; 2021 [cited 2026 Jun 14]. Available from: https://www.bsrm.org.uk/downloads/2021-v9.3-22-3-21-speccommunitystandards-summary-fortheweb-clean.pdf
23. Moyer RF, Birmingham TB, Bryant DM, Giffin JR, Marriott KA, Leitch KM. Valgus bracing for knee osteoarthritis: a meta-analysis of randomized trials. Arthritis Care Res (Hoboken). 2015;67(4):493-501. doi: 10.1002/acr.22472.
24. Scopaz KA, Piva SR, Wisniewski S, Fitzgerald GK. Relationships of fear, anxiety, and depression with physical function in patients with knee osteoarthritis. Arch Phys Med Rehabil. 2009;90(11):1866-1873. doi: 10.1016/j.apmr.2009.06.012.
25. Wade DT. Goal setting in rehabilitation: an overview of what, why and how. Clin Rehabil. 2009;23(4):291-295. doi: 10.1177/0269215509103551.
26. National Institute for Health and Care Excellence. Shared decision making. NICE guideline NG197 [Internet]. London: NICE; 2021 [cited 2026 Jun 3]. Available from: https://www.nice.org.uk/guidance/ng197
27. Sivan M, Cirasanambati M, Okirie E, Jeddi F, Smith M, Basu B, et al. A proposal for expansion of the medical specialty of rehabilitation medicine. Rehabil Process Outcome. 2022;11:11795727221137213. doi: 10.1177/11795727221137213.
28. World Health Organization. Rehabilitation 2030: a call for action [Internet]. Geneva: World Health Organization; 2017 [cited 2026 Jun 3]. Available from: https://www.who.int/publications/m/item/rehabilitation-2030-a-call-for-action
29. Cieza A, Causey K, Kamenov K, Hanson SW, Chatterji S, Vos T. Global estimates of the need for rehabilitation based on the Global Burden of Disease study 2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet. 2020;396(10267):2006-2017. doi: 10.1016/S0140-6736(20)32340-0.
30. Kiresuk TJ, Sherman RE. Goal attainment scaling: a general method for evaluating comprehensive community mental health programs. Community Ment Health J. 1968;4(6):443-453. doi: 10.1007/BF01530764.

The Half of Rehabilitation We Sleep Through

Author: Eesa Farooqui

Medical School: Barts and the London School of Medicine and Dentistry

Medical Student Essay Prize – 2026 Runner-Up

A neurorehabilitation timetable is a precise document. Physiotherapy at nine, occupational therapy at eleven, speech and language after lunch, a goal-planning meeting on Thursday. Every productive hour is booked, costed and audited. The one stretch nobody plans, protects or measures is the seven or eight hours when the brain files away what the day's therapy taught it.

I want to argue something that sounds almost too simple to be a thesis: sleep is not the gap between rehabilitation sessions. It is the part of rehabilitation that makes the rest of it permanent. And inpatient units, by accident rather than malice, spend their nights dismantling the very process they exist to deliver during the day. We would never tolerate a physiotherapist who quietly cancelled half her booked sessions. We tolerate a ward that deletes half a patient's sleep every night and we call it routine.

Rehabilitation is learning, and learning is consolidated in sleep

To see why sleep belongs on the prescription, it helps to be honest about what physical rehabilitation is. After a stroke or a brain injury, recovery of movement depends overwhelmingly on neuroplasticity: the brain relearning, or rerouting, the control of a limb it can no longer move the old way (1). Most rehabilitative practice is therefore a form of motor learning. Reaching for a cup, sequencing the steps of standing up, retraining a swallow, these are procedural skills, and the brain acquires them through the same machinery it uses for any other skill (2).

The part clinicians tend to forget is that skill acquisition has two phases. There is the online phase, the visible improvement during the session itself, and there is an offline phase, the consolidation that happens afterwards, much of it during sleep (3). Healthy adults trained on a motor sequence reliably perform better after a night's sleep than after an equivalent period awake; the gain appears overnight, without further practice (2,3). The mechanism is no longer mysterious. During slow-wave sleep, neocortical slow oscillations couple with thalamocortical spindles, and the neural patterns active during the day's practice are reactivated and stabilised, shifting a fragile memory trace into a durable one (4). Sleep, in other words, is when the day's therapy is written to disk.

There is a second, more recently understood reason the injured brain needs sleep. The glymphatic system, the brain's perivascular waste-clearance pathway, runs at roughly double its waking rate during sleep, flushing metabolic by-products out of the interstitial space (5). For a brain recovering from infarction or trauma, which has a great deal of cellular debris and toxic protein to clear, this nightly housekeeping is not a luxury. So, sleep does two jobs at once for the rehabilitation patient: it consolidates the motor learning therapists work to produce, and it clears the wreckage of the injury itself.

If that is the biology, the clinical implication is uncomfortable. Run an intensive therapy programme on a patient who cannot consolidate it overnight, and you are filling a bath with the plug pulled out. The longitudinal SMiLES work has begun to show exactly this: sleep disruption after stroke is associated with slower functional recovery and worse motor outcomes, and impaired overnight consolidation is a plausible mechanism linking the two (6). Derick Wade's reframing of rehabilitation as a process that changes a person's whole situation, not just their tissues, sits naturally alongside this; you cannot change a situation if the night undoes each day's work (14).

Injury wrecks sleep before the ward gets a chance to

The grim part is that the conditions filling rehabilitation beds are themselves sleep-destroying, so patients arrive already disadvantaged. Across studies, around half of people experience some form of sleep disturbance after traumatic brain injury, and a quarter to a third meet criteria for a diagnosed sleep disorder, rates far above the general population (7). Brain injury can damage the very circuits that generate and time sleep, so the disruption is not simply a reaction to being in hospital.

Stroke is worse in one specific, treatable respect. Obstructive sleep apnoea is present in a large majority of stroke patients, with meta-analytic estimates of sleep-disordered breathing around 70 per cent (8). This matters for recovery, not just for cardiovascular risk. In a study that has aged well, stroke patients with an apnoea-hypopnoea index above ten spent on average around thirteen extra days on the rehabilitation service and were discharged with worse functional and cognitive status, even after adjusting for confounders (9). Apnoea fragments sleep into hundreds of micro-arousals, strips out the deep slow-wave sleep that consolidation and glymphatic clearance both depend on, and layers intermittent hypoxia on top of an already injured brain.

Even where breathing is normal, the injured cortex processes sleep abnormally. Rodent stroke models show that the fine coupling between slow oscillations and spindles, the signature of consolidation, is disrupted after stroke by a pathological rise in isolated local delta waves, and that shifting the brain back towards a more normal sleep pattern is what allows trained motor gains to hold (2). The lesion does not just take a limb; it corrupts the nightly filing system that the limb's recovery depends on. Layered on top is post-stroke fatigue, reported in up to half of survivors and one of the commonest reasons a patient cannot engage with a full therapy programme. Fatigue and fragmented sleep feed each other, and both are routinely treated as background noise rather than as targets.

Here is the part that should embarrass the specialty. Despite this being one of the few directly correctable causes of poor recovery, it is rarely looked for. Screening for snoring or daytime sleepiness, let alone formal testing, happens in only a small minority of stroke patients in the months after their event (8,9). We will scan a patient's brain three times and never once ask whether they stop breathing at night. The omission is not justified by an absence of treatment: continuous positive airway pressure has been trialled in stroke patients and is feasible and beneficial when adherence can be achieved (12). The problem is that nobody is tasked with starting the conversation.

Then the ward finishes the job

If injury sets patients back, the inpatient environment compounds it with almost theatrical efficiency. The World Health Organization recommends night-time noise in wards stay around 30 decibels. Wards run nowhere near that. Objective monitoring on hospital units routinely records overnight levels in the high forties to mid-sixties of decibels, with peaks from alarms, bin lids, drug rounds and conversation that are loud enough to fragment sleep and suppress slow-wave stages (10). To these add the structural insults: bright corridor light bleeding into bays, four-hourly observations that wake patients regardless of clinical need, nocturnal toileting, uncontrolled pain, an unfamiliar bed, and the simple fact that a shared bay contains other unwell people doing the same things at the same hours.

The downstream cost of this is documented well beyond rehabilitation. Disrupted hospital sleep is a recognised driver of the post-hospital syndrome described by Krumholz: a transient state of heightened vulnerability after discharge, associated with delirium, slower recovery and avoidable readmission (11). For a general medical patient that is a problem. For a neurorehabilitation patient whose entire admission is predicated on the brain's capacity to learn and consolidate, it is a contradiction at the centre of the model. We admit people specifically so they can rebuild neural function, and then we run an environment that suppresses the physiological state in which that rebuilding occurs.

What I saw on the ward

On a stroke rehabilitation placement, I followed a woman in her late sixties, a retired teacher recovering from a left middle cerebral artery infarct with a dense right hemiparesis and emerging aphasia. By day she was the model the timetable is built for. She worked hard in the gym, tolerated long sessions, and the therapists were quietly optimistic about her arm. Then her progress flattened. Two good weeks gave way to a fortnight where the same transfer that had been improving simply stopped improving, and her mood went with it.

The therapy assumption in the room was that she had reached a plateau, the polite word for the ceiling of what neuroplasticity will give you. Out of curiosity more than insight, I asked her, slowly, how she was sleeping. She laughed, then mimed someone snoring in the next bed, then pointed at the observations trolley and held up four fingers. Her notes told the rest: she had loud snoring documented by night staff and witnessed pauses in breathing that nobody had actioned, and her drug round and observations were waking her at one and at five. She was being asked to learn complex motor skills by day and then prevented, by noise, by a possible untreated apnoea, and by the ward's own schedule, from consolidating any of them at night.

I am not claiming a single conversation transformed her recovery; that would be a tidy lie. What changed was smaller and more honest. Her snoring was flagged, an overnight oximetry was requested, her non-urgent night observations were spaced out, and she was given eye shades and earplugs that she used. Her notes after that read less like a plateau and more like someone who had started sleeping. The episode taught me that "plateau" is sometimes a diagnosis of the patient when it should be a diagnosis of the night. We had measured her arm every morning after the worst possible night, then concluded her arm was the problem.

That is the original point I keep returning to. Of every input in a rehabilitation admission, sleep is the only one measured by nobody. We score the Barthel and the Functional Independence Measure, we count therapy minutes, we audit length of stay. The eight hours that determine whether any of those numbers move is invisible to the entire apparatus. You manage what you measure, and the ward measures everything except the thing that does the consolidating.

Treating sleep as an intervention, not a comfort issue

None of this requires a new drug or a robot. It requires deciding that sleep is a clinical target with a place in the care plan, and then doing mundane things well.

The first is to look for sleep-disordered breathing. Given a 70 per cent prevalence after stroke and a clear association with longer admissions and worse function, asking every patient about snoring and witnessed apnoeas, and arranging overnight oximetry where indicated, is the highest-yield, lowest-cost screening available on a stroke unit (8,9). Where moderate-to-severe apnoea is found, CPAP is worth attempting early, with realistic effort put into adherence rather than a single failed night written off as intolerance (12).

The second is to protect the environment, which is where most of the cheap wins sit. Clustering observations so a stable patient is not woken at one and again at five, dimming corridors and bays overnight, daytime exposure to natural light to anchor the circadian clock, and routine offering of eye masks and earplugs are all low-risk and supported by the inpatient sleep literature (10,11). A ward that hit even the spirit of the WHO 30-decibel target overnight would be doing something genuinely therapeutic for the brains in its beds.

The third is to treat the things that wake people: pain, nocturia, anxiety. And where insomnia persists, the evidence points away from sedatives, which fragment sleep architecture and raise falls risk in exactly this population, and towards cognitive behavioural therapy for insomnia. Trials are now testing digital CBT for insomnia specifically in stroke survivors, on the logic that better sleep should translate into better consolidation and recovery (13).

The fourth is to use timing as a tool rather than fighting it. If consolidation is sleep-dependent, then the schedule itself becomes therapeutic. Placing a demanding motor-learning session shortly before a protected daytime nap, or before the night, may help the brain capture it, and the literature on sleep-dependent gains gives a rationale for treating "when" as seriously as "how much" (2,3).

There is a service-level point underneath all of this. The United Kingdom has one of the lowest densities of rehabilitation medicine consultants in Europe, and the specialty has argued for expansion to match the rising tide of complex disability (15). When the workforce is that thin, interventions that cost almost nothing and need no new staff are not a footnote, they are the most plausible route to better outcomes. A sleep-protected ward is one of the few upgrades available without a business case for more bodies.

Why a free intervention gets ignored

If protecting sleep is this cheap and this well-grounded, the obvious question is why it is not already standard. Part of the answer is that sleep falls into a gap between professional territories. It is treated as a nursing comfort issue rather than a medical or therapeutic one, so no clinician owns it the way a physiotherapist owns the gym programme. Part of it is the absence of a metric: with no sleep outcome in the standard dataset, poor sleep is literally not on the record that drives improvement. And part of it is cultural. Rehabilitation has spent decades, rightly, asserting that it is active and effortful, the opposite of passive bed rest. Sleep looks like the enemy of that identity even though it is its silent partner.

The reframing I would press for is this. The injured brain does not recover only when a therapist is in the room. It does a great deal of its most important work, the consolidation and the clearance, when nobody is watching, and the lights are out. A rehabilitation prescription that ends at the close of the working day is half a prescription. The patient in front of you has a day plan and, whether anyone has written it or not, a night plan; right now, the night plan is being authored by alarms, observation schedules and an undiagnosed apnoea. None of the fixes are exotic. They are a screening question, a spaced observation round, a dimmer switch, a pair of earplugs and a CPAP machine that someone bothered to titrate. Taking the pen back is one of the cheapest things rehabilitation medicine could choose to do, and it would mean finally taking seriously the half of recovery we currently sleep straight through.

References:

1. Langhorne P, Bernhardt J, Kwakkel G. Stroke rehabilitation. Lancet. 2011;377(9778):1693–702.
2. Gudberg C, Johansen-Berg H. Sleep and motor learning: implications for physical rehabilitation after stroke. Front Neurol. 2015;6:241.
3. Walker MP, Stickgold R. Sleep-dependent learning and memory consolidation. Neuron. 2004;44(1):121–33.
4. Diekelmann S, Born J. The memory function of sleep. Nat Rev Neurosci. 2010;11(2):114–26.
5. Xie L, Kang H, Xu Q, Chen MJ, Liao Y, Thiyagarajan M, et al. Sleep drives metabolite clearance from the adult brain. Science. 2013;342(6156):373–7.
6. Fleming MK, Smejka T, Henderson Slater D, et al. Sleep and motor learning in stroke (SMiLES): a longitudinal study investigating sleep-dependent consolidation of motor sequence learning in the context of recovery after stroke. BMJ Open. 2024.
7. Mathias JL, Alvaro PK. Prevalence of sleep disturbances, disorders, and problems following traumatic brain injury: a meta-analysis. Sleep Med. 2012;13(7):898–905.
8. Johnson KG, Johnson DC. Frequency of sleep apnea in stroke and TIA patients: a meta-analysis. J Clin Sleep Med. 2010;6(2):131–7.
9. Kaneko Y, Hajek VE, Zivanovic V, Raboud J, Bradley TD. Relationship of sleep apnea to functional capacity and length of hospitalization following stroke. Sleep. 2003;26(3):293–7.
10. Buxton OM, Ellenbogen JM, Wang W, Carballeira A, O'Connor S, Cooper D, et al. Sleep disruption due to hospital noises: a prospective evaluation. Ann Intern Med. 2012;157(3):170–9.
11. Krumholz HM. Post-hospital syndrome — an acquired, transient condition of generalized risk. N Engl J Med. 2013;368(2):100–2.
12. Bravata DM, Concato J, Fried T, Ferguson J, Cheng E, Knight S, et al. Continuous positive airway pressure: evaluation of a novel therapy for patients with acute ischemic stroke. Sleep. 2011;34(9):1271–7.
13. Fleming MK, Smejka T, Macey E, et al. Improving sleep and learning in rehabilitation after stroke (INSPIRES2): a randomised controlled trial of digital cognitive behavioural therapy for insomnia. Trials. 2023.
14. Wade DT. Rehabilitation — a new approach. Part four: a new paradigm, and its implications. Clin Rehabil. 2016;30(2):109–18.
15. Sivan M, Cirasanambati M, Okirie E, et al. A proposal for expansion of the medical specialty of rehabilitation medicine. Rehabil Process Outcome. 2022;11.

Overlooked Dysautonomia: Early Screening with the Nasa Lean Test (NLT) to detect Orthostatic Intolerance Syndromes in Fibromyalgia

Author: Emma Braithwaite

Medical School: University of Leeds

Medical Student Essay Prize – 2026 Runner-Up

Introduction

Fibromyalgia (FM) is a highly prevalent condition affecting 2-8% of the global population and around 5% of adults in the UK (Soroosh, 2024). FM is characterised by widespread musculoskeletal pain, diffuse tenderness and diagnosed by pain lasting over 3 months (Mansfield et al., 2017). Fibromyalgia and orthostatic intolerance (OI) syndromes are challenging conditions, additionally, 84% of FM patients have multiple comorbidities adding to this complexity.

FM has been associated with autonomic dysfunction, these patients consistently had more severe symptoms including orthostatic intolerance and significant physical limitations (Salaffi et al., 2025). Salaffi et al reported 64.9% of FM patients were classified as having autonomic dysfunction.

In patients with FM there is often sympathetic overactivity linked to ongoing chronic pain. It has been shown, these patients fail to react to a gravitational stimulus during a tilt table test. This is directly attributed to an absence of an increase in Muscle Sympathetic Nerve Activity (MSNA) (Furlan et al., 2005). MSNA reduction in these patients indicates autonomic dysfunction; this has been associated with increased frequency of syncopal events and symptoms of orthostatic intolerance (Furlan et al., 2005).

Orthostatic Intolerance (OI) syndrome is considered a manifestation of autonomic dysfunction (Magkas et al., 2019). OI syndromes include Postural orthostatic Tachycardia Syndrome (PoTS) and Orthostatic Hypotension (OH) (Isaac et al., 2023). PoTS is defined as an increase in heart rate by 30 beats per minute, during the first 3 minutes, from lying to standing. (Lee et al., 2024). OH is defined as a decrease in systolic and diastolic blood pressure of more than or equal to 20 mmHg or 10mmgHg, respectively (Isaac et al., 2023). When making a diagnosis of PoTS or OH symptoms must have been present during the diagnostic test, common symptoms seen often include light-headedness, dizziness on standing, nausea, and palpitations (Mandel et al., 2017).

Detecting OI syndromes early will allow these symptoms to be managed to improve patient quality of life. The Nasa Lean Test (NLT) is a simple and effective point of care test that can be used as an OI screening tool. (Lee et al., 2024).

This essay will explore the prevalence of OI syndromes in FM patients and the benefits of early detection through screening.

Method and Results: Prevalence of OI syndromes in Fibromyalgia patients

Aim: The study aims to understand the prevalence of OI syndromes in patients with Fibromyalgia and evaluate the significance of performing the NLT in FM patients.

Method: This service Evaluation project was completed using retrospective data collected from Leeds Teaching Hospitals chronic pain clinics. The study included 103 patients all with a formal diagnosis of FM.

All patients in the study completed the NLT from which heart rate and blood pressure changes were recorded, these were analysed to identify autonomic dysfunction and detect OI syndromes. Additional analysis included patient reported symptoms during the NLT, co-morbidities, and current medication.

Results:

From the NLT test, a diagnosis of an OI syndrome or autonomic dysfunction was made in 75 (74.3%) patients, this is demonstrated in Figure 1. OH was diagnosed in 26 (25.7%) patients, 22 patients presented as early phase OH and 4 patients as late phase OH. PoTS diagnosis was made in 10 (9.9%) patients. 22 (21.8%) patients would have been diagnosed with PoTS based on greatest HR alone, however for this study we made diagnoses based on sustained HR only in line with current guidelines. 39 (38.6%) patients showed abnormal results on the NLT but did not meet the OI syndrome diagnostic criteria, this resulted in a diagnosis of autonomic dysfunction. There were no signs of OI syndrome or autonomic dysfunction in 26 (25.7%) patients.

The average change in HR (bpm) during the NLT across all participants was 21.1 ± 11.7, the mean change in HR being abnormal 21.1 demonstrates that the majority of participants had an aspect of dysautonomia.

Symptoms were reported in 95 (94.1%) patients, most common symptoms reported included dizziness (70.9%), pain (33.0%), headache (25.2%) and palpitations (22.3%) being most common. Only 13 (12.9%) patients were unable to complete the full 10 minutes of the NLT.

The Nasa Lean Test

The Nasa Lean Test (NLT) can be used to identify dysautonomia in patients with FM, ME/CFS and LC (Lee et al., 2024).

The NLT is a simple point of care method and extremely accessible in clinic requiring only a blood pressure cuff and wall space. Initially, the Supine heart rate and blood pressure is measured, it is then monitored every minute in standing position with the patients shoulder blades resting against a wall (Lee et al., 2020). The test eliminates the need for expensive equipment for instance in the tilt table test. This ease and accessibility could ultimately improve wait times as the test can be performed in any standard clinic room and only takes 10-15 minutes (Natelson et al., 2021).

Some patients, particularly those with chronic pain, may find the test challenging due to comorbid symptoms such as pain on standing or symptoms of orthostatic intolerance. Abnormalities may be missed in these patients who are unable to tolerate the full 10 minutes (Isaac et al., 2023).

The NLT produces higher heart rate responses and different diastolic blood pressure changes compared to the tilt table test which could impact diagnostic accuracy (Sathaporn et al., 2025). However, through recent studies there is further understanding on normative data for healthy controls, this will help improve interpretation of the NLT (Iftekhar et al., 2025).

Through implementing this test in initial patient consultations, we hope to improve rates of underdiagnosis of OI syndromes in fibromyalgia patients.

Discussion: Clinical Significance of Early Screening and Impact on Patient Care

Detecting OI syndromes in FM patients allows greater understanding of extent of symptoms which can guide targeted clinical interventions.

The impact of OI extends beyond cardiovascular symptoms and has been shown to directly correlate with pain severity and quality of life (Contreras-Merino et al., 2022). Patients with reduced baroreflex involvement during standing show higher fibromyalgia impact scores contributing to increased overall disease burden on day to day life (Zamunér et al., 2017). These patients also report worsening of characteristic widespread pain, fatigue

and syncope (Staud, 2008). Identifying OI can increase understanding of previously unexplained symptoms such as fatigue or dizziness that cannot be attributed to core FM symptoms, including pain and sleep disturbance (Staud, 2008). Such identification supports reducing patient diagnostic uncertainty.

Rehabilitation medicine is a powerful speciality and plays an essential leading role in the management of OI. The most effective approaches for FM often involve MDT rehabilitation programmes. This combines CBT for pain management, sleep improvement relaxation techniques, occupational therapy for energy conservation, exercise and importantly health education (Llàdser et al., 2022). Additional interventions for OI which can be incorporated include physical countermeasures (muscle tensing and leg crossing), use of compression garments, volume expansion (increased fluid and salt intake) and heat therapies (Winslow et al., 2023).

A primary intervention includes structured exercise programmes which can address both autonomic dysfunction and core FM symptoms. Aerobic exercise has been shown to benefit autonomic dysfunction through increasing heart rate variability (Andrade et al., 2019). Exercise in FM patients has demonstrated meaningful improvements in quality of life, pain, physical function and fatigue (Couto et al., 2022). The tailored FM exercise programme often consists of a slow progressive plan, initially starting at a low intensity and low frequency. The PoTS exercise protocol can often then be added for OI symptom management. This begins with cycling or swimming to avoid the upright position and gradually adding upright exercise as tolerated over time (Bryarly et al., 2019).

Lack of curative treatment signifies a more holistic MDT approach for long term management, in which personalised care and patient understanding is essential. Patient health education is crucial to support adherence to effective management plans. Health education on FM pathophysiology alongside autonomic dysfunction will help increase patient understanding of their symptoms.

Earlier detection will allow further appropriate support and guidance to be initiated for patients quickly. Patient support groups have been illustrated to increase engagement, improve motivation, and provide hope for recovery.

Treatment of OI requires good patient compliance with specific lifestyle modifications, this can often be difficult for the patient to implement. Lifestyle changes can often be difficult with patients initially experiencing increased fatigue (Bryarly et al., 2019). However, such changes are extremely beneficial for the patient in the long term. To optimise patient outcomes patient education, support and tailored programmes are essential for treatment. Through earlier detection using the NLT it will help facilitate incorporation of these management strategies to improve quality of life (Lucini et al., 2024).

Conclusion

Distinguishing symptoms from FM related dysautonomia from other conditions is essential for patient outcomes. Detection of OI syndromes in a simple way using the NLT could facilitate this and prevent unnecessary and extensive diagnostic testing.

Incorporating the simple NLT test into clinical practice can allow for early screening of OI. Overall outcomes can then be improved by creating evidence-based treatment plans to directly address these symptoms related to dysautonomia.

References

1. Soroosh, S. 2024. Epidemiology of Fibromyalgia: East Versus West. *International Journal of Rheumatic Diseases*. **27**(12), p.e15428.
2. Mansfield, K.E., Sim, J., Croft, P. and Jordan, K.P. 2017. Identifying patients with chronic widespread pain in primary care. *Pain*. **158**(1), pp.110–119.
3. Salaffi, F., Farah, S., Lommano, M.G., Bianchi, B., Mangiafico, M.C. and Di Carlo, M. 2025. Composite Autonomic Symptom Score 31 (COMPASS-31) for the assessment of symptoms of autonomic dysfunction in fibromyalgia. *Clinical and Experimental Rheumatology*. **43**(6), pp.1054–1061.
4. Furlan, R., Colombo, S., Perego, F., Atzeni, F., Diana, A., Barbic, F., Porta, A., Pace, F., Malliani, A. and Sarzi-Puttini, P. 2005. Abnormalities of cardiovascular neural control and reduced orthostatic tolerance in patients with primary fibromyalgia. *The Journal of Rheumatology*. **32**(9), pp.1787–1793.
5. Magkas, N., Tsioufis, C., Thomopoulos, C., Dilaveris, P., Georgiopoulos, G., Doumas, M., Papadopoulos, D. and Tousoulis, D. 2019. Orthostatic hypertension: From pathophysiology to clinical applications and therapeutic considerations. *The Journal of Clinical Hypertension*. **21**(3), pp.426–433.
6. Isaac, R.O., Corrado, J. and Sivan, M. 2023. Detecting Orthostatic Intolerance in Long COVID in a Clinic Setting. *International Journal of Environmental Research and Public Health*. **20**(10), p.5804.
7. Lee, C., Greenwood, D.C., Master, H., Balasundaram, K., Williams, P., Scott, J.T., Wood, C., Cooper, R., Darbyshire, J.L., Gonzalez, A.E., Davies, H.E., Osborne, T., Corrado, J., Iftekhar, N., Rogers, N., Delaney, B., Greenhalgh, T., Sivan, M., and the LOCOMOTION Consortium 2024. Prevalence of orthostatic intolerance in long covid clinic patients and healthy volunteers: A multicenter study. *Journal of Medical Virology*. **96**(3), p.e29486.
8. Mandel, D., Askari, A.D., J. Malemud, C. and Kaso, A. 2017. Joint Hypermobility Syndrome and Postural Orthostatic Tachycardia Syndrome (HyPOTS). *Biomedical Research and Clinical Practice*. **2**(2).
9. Lee, J., Vernon, S.D., Jeys, P., Ali, W., Campos, A., Unutmaz, D., Yellman, B. and Bateman, L. 2020. Hemodynamics during the 10-minute NASA Lean Test: evidence of circulatory decompensation in a subset of ME/CFS patients. *Journal of Translational Medicine*. **18**(1), p.314.
10. Natelson, B.H., Brunjes, D.L. and Mancini, D. 2021. Chronic Fatigue Syndrome and Cardiovascular Disease: JACC State-of-the-Art Review. *Journal of the American College of Cardiology*. **78**(10), pp.1056–1067.
11. Sathaporn, N., Timinkul, A., Panwong, W., Pipatbanjong, P., Dangwisut, T., Phusabsin, P., Promjun, K. and Kluayhomthong, S. 2025. Comparison of the head-up tilt test and the 10-minute NASA lean test for assessing blood pressure and heart rate responses in young individuals with postacute COVID-19 syndrome. *Blood Pressure Monitoring*. **30**(4), pp.153–160.
12. Iftekhar, N., Wilson, A., Nguty, L., Al-Hilali, H., Al-Hilali, Y., Jain, K., Braka, A., Osborne, T. and Sivan, M. 2025. Normative data for the 10-min lean test in adults without orthostatic intolerance. *Frontiers in Neurology*. **16**, p.1625216.
13. Contreras-Merino, A.M., Davydov, D.M., Galvez-Sánchez, C.M. and Reyes Del Paso, G.A. 2022. Blunted short-term autonomic cardiovascular reactivity to orthostatic and clinostatic challenges in fibromyalgia as an indicator of the severity of chronic pain. *International Journal of Psychophysiology: Official Journal of the International Organization of Psychophysiology*. **175**, pp.61–70.
14. Zamunér, A.R., Porta, A., Andrade, C.P., Forti, M., Marchi, A., Furlan, R., Barbic, F., Catai, A.M. and Silva, E. 2017. The degree of cardiac baroreflex involvement during active standing is associated with the quality of life in fibromyalgia patients. *PloS One*. **12**(6), p.e0179500.
15. Staud, R. 2008. Autonomic dysfunction in fibromyalgia syndrome: postural orthostatic tachycardia. *Current Rheumatology Reports*. **10**(6), pp.463–466.
16. Andrade, A., Vilarino, G.T., Serafim, T.T., Pereira Júnior, A.A., de Souza, C.A. and Sieczkowska, S.M. 2019. Modulation of Autonomic Function by Physical Exercise in Patients with Fibromyalgia Syndrome: A Systematic Review. *PM & R: the journal of injury, function, and rehabilitation*. **11**(10), pp.1121–1131.

17. Couto, N., Monteiro, D., Cid, L. and Bento, T. 2022. Effect of different types of exercise in adult subjects with fibromyalgia: a systematic review and meta-analysis of randomised clinical trials. *Scientific Reports*. **12**(1), p.10391.
18. Bryarly, M., Phillips, L.T., Fu, Q., Vernino, S. and Levine, B.D. 2019. Postural Orthostatic Tachycardia Syndrome: JACC Focus Seminar. *Journal of the American College of Cardiology*. **73**(10), pp.1207–1228.
19. Llàdser, A.-N., Montesó-Curto, P., López, C., Rosselló, L., Lear, S., Toussaint, L. and Casadó-Martín, L.C. 2022. Multidisciplinary rehabilitation treatments for patients with fibromyalgia: a systematic review. *European Journal of Physical and Rehabilitation Medicine*. **58**(1), pp.76–84.
20. Winslow, B.T., Vandal, C. and Dang, L. 2023. Fibromyalgia: Diagnosis and Management. *American Family Physician*. **107**(2), pp.137–144.
21. Lucini, D., Giovanelli, L., Bazzichi, L., Bernardelli, G., Pellegrino, G., Filippou, G. and Sarzi Puttini, P. 2024. Tailored exercise programmes for fibromyalgia: a clinical practical guide. *Clinical and Experimental Rheumatology*. **42**(6), pp.1262–1271.

How Can We Improve Cardiac Rehabilitation for Patients with Genetic Dilated Cardiomyopathy?

Author: Ling Gang

Medical School: University of Liverpool

Medical Student Essay Prize – 2026 Runner-Up

1. Introduction

Dilated cardiomyopathy (DCM) is a complex myocardial disease defined by the presence of left ventricular (LV) systolic dysfunction and LV dilatation in the absence of significant concomitant coronary artery disease or abnormal loading conditions (1, 2). The aetiology of DCM is highly heterogeneous, encompassing genetic mutations, infections, toxins, and neuromuscular, endocrine, and autoimmune diseases (1). DCM pathophysiology involves myocardial eccentric remodelling and fibrosis, associated with excessive activation of the renin-angiotensin-aldosterone system and heightened adrenergic signalling (3). This results in impaired ventricular systolic function, often accompanied by diastolic dysfunction secondary to reduced ventricular compliance (1). Conduction blocks and tachyarrhythmias are also commonly associated with DCM (4).

Clinically, DCM manifests with heart failure symptoms such as dyspnoea, peripheral oedema and fatigue, as well as malignant ventricular arrhythmias causing syncope or even sudden cardiac death (SCD). Clinical presentation can be highly variable; patients may experience arrhythmias and even SCD prior to any HF symptoms (1). Unsurprisingly, these clinical manifestations translate into substantially reduced health-related quality of life (HR-QoL) compared to the general population, comparable to patients with severely symptomatic HF or survivors of myocardial infarction (5). Furthermore, DCM is associated with significant physical and social functioning limitations, poor mental health and leads to significant productivity losses (5, 6). Therefore, DCM should be understood not only in terms of ventricular dysfunction and arrhythmic risk, but also in terms of its effects on daily functioning and psychological well-being (5, 7).

Far from a rare condition, DCM affects 1 in 250 people globally and is rising (8, 9). A genetic aetiology can be identified in approximately 20-35% of DCM patients (10), and is associated with worse prognosis and higher rates of adverse cardiovascular events such as end-stage heart failure and malignant ventricular arrhythmias (11). Although genotype-informed management has strengthened clinical risk management in DCM (12, 13), existing cardiac rehabilitation remains largely HF-centred and insufficiently adapted to genetic DCM (14). This essay argues that current cardiac rehabilitation can be improved through earlier recognition of need, genotype-informed activity guidance, psychological support and patient-directed goal-setting.

2. Current DCM management and the role of cardiac rehabilitation

In the UK, DCM patients are typically managed in specialist cardiomyopathy clinics, where management focuses primarily on pharmacotherapy for HF symptoms, arrhythmic risk assessment and device therapy for high-risk patients (15). For those with suspected genetic etiologies, management also involves genetic testing, counselling and familial cascade screening (8, 15). While effective at improving clinical outcomes, these management strategies remain insufficient to address the broader functional and psychosocial burden of DCM (5, 6).

These management gaps are clearly demonstrated through multiple cross-sectional studies. Steptoe et al. found that DCM patients had significant impairment in physical and social functioning, including difficulty carrying out usual work and daily activities owing to physical or emotional problems (5). Productivity losses are

also significant, as highlighted by a similar study by Wiethoff et al (6). Furthermore, this is accompanied by significant mental health problems, with 52% of all included DCM patients meeting the criteria for possible anxiety disorder and 22% for possible clinical depression (5). In practical terms, this means that patients may struggle not only with exertion and symptoms of heart failure and arrhythmias, but also with daily routines, social participation, work, and confidence in their own bodies (7).

Current cardiac rehabilitation programs partly alleviate this burden. Cardiac rehabilitation is offered to DCM patients primarily through the HF pathway, which includes exercise prescriptions, disease education, and psychological support (16). Evidence extrapolated from general HFrEF populations demonstrates that exercise-based cardiac rehabilitation reduces hospital admissions and improves HR-QoL, functional capacity, exercise tolerance, and fatigue (17). Similar benefits are observed in DCM-related HF (18), in which reduced exercise tolerance and fatigue are common barriers to daily functioning. However, while psychological support can alleviate mental health burden and aid adjustment to chronic disease (19), access remains limited. According to the UK Cardiomyopathy charity's cardiomyopathy care report, only 9% of DCM patients received psychological support during their care (20). This is particularly relevant for DCM patients, as poor disease adjustment is associated with worse physical function, perceived health and higher rates of anxiety and depression (21).

3. Additional rehabilitation challenges in genetic DCM

Management of genetic DCM is further complicated as pathogenic variants differ in penetrance, arrhythmic risk, extra-cardiac involvement and prognosis, resulting in drastically different functional needs (22, 23). Some patients are mainly limited by HF symptoms, while others develop arrhythmias or require ICD implantation prior to pump failure. For example, in Lamin A/C gene (LMNA)-related DCM, which accounts for 4-6% of all DCM cases, conduction disease and arrhythmias frequently precede ventricular dysfunction (22). Patients may experience anxiety about palpitations, ICD shocks and physical activity before they are captured by HF-based rehabilitation pathways, making the current framework incomplete.

This genotype-specific complexity is also evident in exercise-based rehabilitation. Although many DCM patients benefit from it, high-intensity exercise can induce arrhythmia and adverse prognostic implications in patients with high-risk mutations in LMNA or filamin C genes (2). Importantly, this should not lead to complete avoidance of exercise, as low- to moderate-intensity exercise can remain beneficial even in these subgroups (14).

However, genotype-informed exercise rehabilitation remains inconsistently available and largely concentrated in specialist centres, creating a gap between specialist risk assessment and practical exercise guidance.

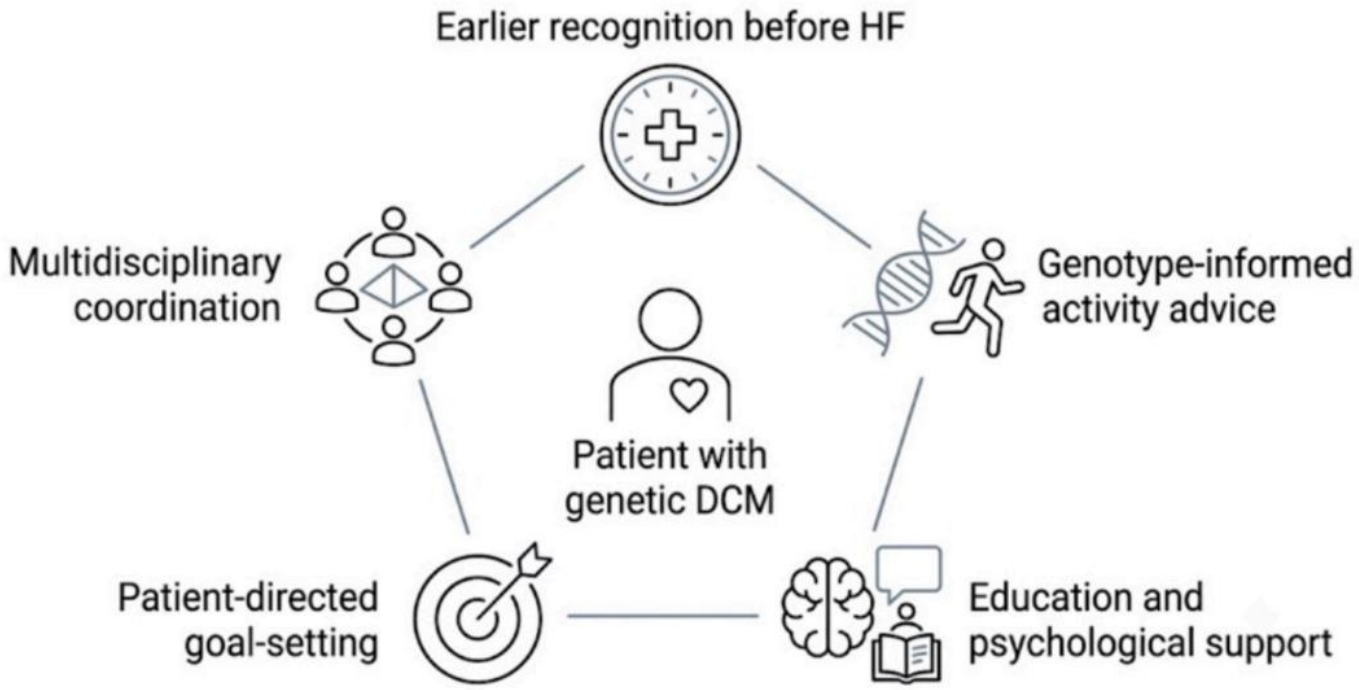
Furthermore, genetic DCM frequently affects younger patients compared to acquired or non-familial DCM (24, 25), who generally face more complex familial, work and societal demands (7). Qualitative reviews from young and middle-aged DCM patients describe disruption to academic and career paths, difficulty fulfilling expected family roles, anxiety about becoming financially or practically dependent on parents or partners, uncertainty about future relationships and children, and difficulty in constructing daily life around the diagnosis (7). Therefore, rehabilitation needs are shaped by life stage just as much as by disease severity. For many younger genetic DCM patients, rehabilitation needs may not be fully captured by HF rehabilitation models shaped around older populations, where frailty, multimorbidity and loss of independence are central concerns (26).

4. The role of rehabilitation medicine in genetic DCM

Rehabilitation medicine focuses on improving functioning and reducing disability by focusing on impairments, activity limitations, QoL, and the personal factors that shape everyday life (27). Applied to genetic DCM, it has the potential to revolutionise DCM rehabilitation by supporting a more individualised approach, with earlier

recognition of need, genotype-informed activity guidance, and rehabilitation goals shaped around patients' own priorities.

Figure 1 – Key rehabilitation principles for improving functional care in genetic DCM.



4.1 Identifying rehabilitation need prior to symptomatic HF

One of the primary potential contributions of a rehabilitation medicine-informed approach is to broaden cardiac rehabilitation beyond the conventional HF pathway, recognising that functional and psychological needs may arise prior to the development of HF among patients with genetic DCM. Key to this would be recognition and early referral for psychological assessment, activity counselling, and arrhythmia and device education. For patients with arrhythmia-prone genotypes, existing conduction diseases or prophylactic ICD implantation, structured psychological support would be vital for addressing shock-related fear and arrhythmia-related anxiety (28, 29, 30). This is evident from the PATHWAY trial, where group metacognitive therapy was shown to significantly improve anxiety and depression symptoms in addition to standard cardiac rehabilitation (31). Similarly, arrhythmia and ICD-targeting group education could promote appropriate symptom monitoring, self-care, and confidence in safe physical activity (32). By reducing uncertainty about symptoms, ICD shocks, and exercise safety, rehabilitation may prevent unnecessary avoidance of activity and deconditioning, with studies demonstrating improved functional capacity and quality of life (33, 34, 35). Together, these interventions are valuable not only as part of standard cardiac rehabilitation but also as vital support for patients with genetic DCM who may benefit prior to symptomatic HF development.

4.2 Translating genotype-informed risk into safe activity advice

Exercise-based cardiac rehabilitation has long been a cornerstone in DCM-HF rehabilitation, with evidence linking individualised exercise prescriptions to improved exercise capacity and QoL (18). However, for some genetic DCM patients, such as those with LMNA or Filamin C mutations, a more cautious and specific rehabilitation pathway is required due to increased arrhythmia and decompensation risk (14, 36). Activity

thresholds can be rigorously assessed using genotype, arrhythmic history, ECG/Holter findings, and Cardiac MRI, while cardiopulmonary exercise testing (CPET) translates this risk profile into practical exercise prescription based on peak VO_2 and ventilatory thresholds (2, 18).

Although these assessments are already available in specialist cardiomyopathy care, their closer integration into cardiac rehabilitation would allow exercise prescription to be guided by both physiological capacity and genotype-informed arrhythmic risk. Furthermore, genotype-informed activity assessment can support patients beyond formal exercise training by providing clearer advice for day-to-day activity, even for whom structured exercise prescription is limited or inappropriate. Clear thresholds can prevent unnecessary activity restriction, particularly in patients concerned about ICD shocks or exertional symptoms, thereby supporting better disease adjustment and improving physical and psychological functioning (18, 5).

4.3 Personalising rehabilitation goals beyond clinical outcomes

Beyond earlier referral and safer activity prescription, genetic DCM also requires rehabilitation goals to be defined by what is important to the patient. This is especially relevant for younger genetic DCM patients whose priorities often differ significantly from traditional rehabilitation goals (37). Patient-directed goal-setting provides a practical mechanism to place the patient's concerns at the forefront of management, such as staying in education or employment, planning pregnancy, parenting, and managing financial and familial responsibilities (7). Furthermore, Patient-directed goal-setting has been shown to strengthen self-efficacy and disease adjustment by giving patients an active role in shaping their own rehabilitation goals and improving motivation while living with an incurable disease (38).

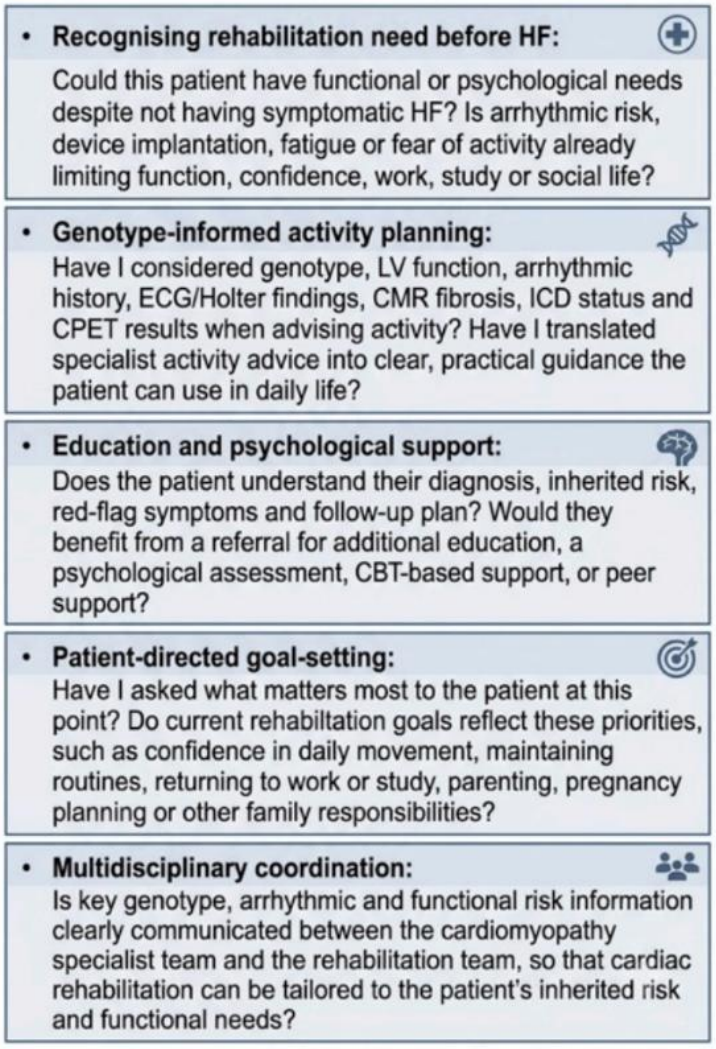
Overall, rehabilitation medicine has the potential to refine cardiac rehabilitation for genetic DCM by improving access, strengthening patient-directedness and making rehabilitation more closely guided by genotype-informed risk. Therefore, it offers a promising route for genetic DCM care to extend beyond classical clinical risk management to support everyday functioning, confidence, and meaningful social and societal participation.

5. Practical notes on implementation

While PRM no doubt has promising potential to improve cardiac rehabilitation for patients with genetic DCM, its implementation remains restrained due to current rehabilitation capacity. The UK has a relatively small rehabilitation physician workforce despite the increase in patients with complex rehabilitation needs, with only 203 consultant posts and fewer than 0.3 rehabilitation medicine specialists per 100,000 population (39, 40). This is substantially lower than many comparable developed countries, with 3.85 specialists per 100,000 in Spain, 2.97 in France and 1.96 in Germany (40). A model that requires direct input from a Rehabilitation Medicine physician for all patients with genetic DCM would therefore be impractical at present.

A more plausible approach would be to embed rehabilitation medicine principles within existing cardiac rehabilitation infrastructure, supported by closer cooperation between specialist cardiomyopathy clinics and cardiac rehabilitation teams. Rather than creating an entirely new pathway, current HF rehabilitation services could be adapted and expanded to include selected genetic DCM patients without symptomatic HF through clinical referral, particularly those with device implantation, arrhythmic risk or activity-related anxiety. Within existing services, this could be supported by practical questions that help clinicians identify rehabilitation needs earlier and tailor cardiac rehabilitation to the specific risks and priorities of patients with genetic DCM, as suggested in Figure 2. This would allow rehabilitation support to be expanded pragmatically by leveraging existing services, while improving functional care for patients with genetic DCM.

Figure 2 - Practical questions to help clinicians identify and address rehabilitation needs for patients with genetic DCM.



6. Conclusion and patient story

Rehabilitation medicine is powerful because it enables patients to rebuild their lives around illness, rather than simply managing their disease. For patients with genetic DCM, it offers a way to translate inherited cardiac risk into practical activity guidance, support for anxiety and adjustment, and opportunities for patient-directed goal-setting, thus enabling meaningful participation in life. To conclude, I will share the story of Jane, whom I had the pleasure of meeting during my clinical placement. Her name and identifiable details have been altered to protect her confidentiality.

Jane is a woman who was diagnosed with LMNA-related cardiomyopathy. She was first investigated after experiencing palpitations, rather than classic HF symptoms. Genetic testing confirmed a pathogenic LMNA variant. She was the first person in her family to receive this diagnosis, making her the proband through whom relatives were offered cascade screening. Although her LV function was relatively preserved, her arrhythmic risk was significant, and she underwent ICD implantation for protection against malignant arrhythmia.

For Jane, ICD implantation was simultaneously reassuring yet frightening. She understood that it was there to protect her, but it also placed a significant burden upon her. She described feeling as though her body could no longer be trusted. Ordinary day-to-day moments became difficult to judge- a faster heartbeat on the stairs, or a moment of breathlessness could raise fears that she was unsafe and that the ICD might fire. Because she had

not developed symptomatic HF, these concerns were initially left unaddressed through rehabilitation. However, they affected how she moved, worked, and imagined her future.

Her care changed after referral to a tertiary inherited cardiomyopathy centre. Here, her arrhythmic risk and ICD follow-up were reviewed alongside the functional concerns that had previously been less visible. Education from the specialist team helped her understand why the ICD had been implanted, which symptoms required urgent review, and which sensations to expect during ordinary exertion. She was also offered support for the anxiety and uncertainty that had followed the diagnosis and device implantation. Together, this helped turn specialist risk assessment into something she could use in daily life: how to pace herself, how to respond to palpitations, and how to rebuild her daily activity without constant stress.

This has revolutionised her care, as now she feels able to live normally again. Through patient-directed goal setting, her priorities such as continuing to work, staying reasonably active and now planning a family, have become an explicit part of her management. Feeling like she is in safe hands, Jane is now preparing for her first pregnancy with coordinated specialist cardiomyopathy and obstetrics support.

This story illustrates how rehabilitation medicine can improve functional care for patients with genetic DCM and, more broadly, for those with other chronic debilitating illnesses. Simple questions about symptoms, activity, psychological support needs, and personal goals can help clinicians translate evidence-based clinical judgement into practical support for patients' daily lives.

References

1. Schultheiss HP, Fairweather D, Caforio ALP, Escher F, Hershberger RE, Lipshultz SE, et al. Dilated cardiomyopathy. Nat Rev Dis Primers. 2019;5(1):32.
2. Arbelo E, Protonotarios A, Gimeno JR, Arbustini E, Barriales-Villa R, Basso C, et al. 2023 ESC Guidelines for the management of cardiomyopathies. Eur Heart J. 2023;44(37):3503-626.
3. De Paris V, Biondi F, Stolfo D, Merlo M, Sinagra G. Pathophysiology. In: Sinagra G, Merlo M, Pinamonti B, editors. Dilated Cardiomyopathy: From Genetics to Clinical Management. Cham (CH)2019. p. 17-25.
4. Zecchin M, Muser D, Vitali-Serdoz L, Buiatti A, Morgera T. Arrhythmias in Dilated Cardiomyopathy: Diagnosis and Treatment. In: Sinagra G, Merlo M, Pinamonti B, editors. Dilated Cardiomyopathy: From Genetics to Clinical Management. Cham (CH)2019. p. 149-71.
5. Steptoe A, Mohabir A, Mahon NG, McKenna WJ. Health related quality of life and psychological wellbeing in patients with dilated cardiomyopathy. Heart. 2000;83(6):645-50.
6. Wiethoff I, Sikking M, Evers S, Gabrio A, Henkens M, Michels M, et al. Quality of life and societal costs in patients with dilated cardiomyopathy. Eur Heart J Qual Care Clin Outcomes. 2024;10(4):334-44.
7. Chen W, Xiao H, Feng C, Li J, Jin J, Mu R. Illness Experiences in Young and Middle-Aged Patients With Dilated Cardiomyopathy on Chinese Social Media: Qualitative Study. J Med Internet Res. 2026;28:e76918.
8. Rosenbaum AN, Agre KE, Pereira NL. Genetics of dilated cardiomyopathy: practical implications for heart failure management. Nat Rev Cardiol. 2020;17(5):286-97.
9. Hershberger RE, Hedges DJ, Morales A. Dilated cardiomyopathy: the complexity of a diverse genetic architecture. Nat Rev Cardiol. 2013;10(9):531-47.
10. Bui QM, Ding J, Hong KN, Adler EA. The Genetic Evaluation of Dilated Cardiomyopathy. Struct Heart. 2023;7(5):100200.
11. Mora-Ayestaran N, Ochoa JP, Gomez-Gonzalez C, Navarro-Penalver M, Gallego-Delgado M, Larranaga-Moreira JM, et al. Arrhythmic genotypes in dilated cardiomyopathy and risk of advanced heart failure. Eur Heart J. 2025;46(48):5222-33.
12. Vissing CR, Espersen K, Mills HL, Bartels ED, Jurlander R, Skriver SV, et al. Family Screening in Dilated Cardiomyopathy: Prevalence, Incidence, and Potential for Limiting Follow-Up. JACC Heart Fail. 2022;10(11):792-803.

13. Wahbi K, Ben Yaou R, Gandjbakhch E, Anselme F, Gossios T, Lakdawala NK, et al. Development and Validation of a New Risk Prediction Score for Life-Threatening Ventricular Tachyarrhythmias in Laminopathies. Circulation. 2019;140(4):293-302.
14. Russo D, Gambardella C, Volterrani M, Lillo R, Volpe M, Autore C. Exercise Participation and Rehabilitation in Cardiomyopathies: An Updated Review. J Clin Med. 2025;14(24).
15. Sorella A, Galanti K, Iezzi L, Gallina S, Mohammed SF, Sekhri N, et al. Diagnosis and management of dilated cardiomyopathy: a systematic review of clinical practice guidelines and recommendations. Eur Heart J Qual Care Clin Outcomes. 2025;11(2):206-22.
16. NHS England, Commissioning standards for cardiovascular rehabilitation [Internet]. England.nhs.uk. 2024. Available from: https://www.england.nhs.uk/long-read/commissioning-standards-for-cardiovascular-rehabilitation/
17. Molloy CD, Long L, Mordi IR, Bridges C, Sagar VA, Davies EJ, et al. Exercise-based cardiac rehabilitation for adults with heart failure - 2023 Cochrane systematic review and meta-analysis. Eur J Heart Fail. 2023;25(12):2263-73.
18. Seo YG, Jang MJ, Lee GY, Jeon ES, Park WH, Sung JD. What Is the Optimal Exercise Prescription for Patients With Dilated Cardiomyopathy in Cardiac Rehabilitation? A SYSTEMATIC REVIEW. J Cardiopulm Rehabil Prev. 2019;39(4):235-40.
19. Wells A, Reeves D, Capobianco L, Heal C, Davies L, Heagerty A, et al. Improving the Effectiveness of Psychological Interventions for Depression and Anxiety in Cardiac Rehabilitation: PATHWAY-A Single-Blind, Parallel, Randomized, Controlled Trial of Group Metacognitive Therapy. Circulation. 2021;144(1):23-33.
20. The State of Cardiomyopathy Care: National Cardiomyopathy Report 2023. Cardiomyopathy UK; 2023. Available from: https://www.cardiomyopathy.org/sites/default/files/State%20of%20cardiomyopathy%20care%202022%20survey%20report.pdf
21. Pavlovic NV, Gilotra NA, Lee CS, Ndumele C, Mammos D, Dennisonhimmelfarb C, et al. Fatigue in Persons With Heart Failure: A Systematic Literature Review and Meta-Synthesis Using the Biopsychosocial Model of Health. J Card Fail. 2022;28(2):283-315.
22. Tayal U, Ware JS, Lakdawala NK, Heymans S, Prasad SK. Understanding the genetics of adult-onset dilated cardiomyopathy: what a clinician needs to know. Eur Heart J. 2021;42(24):2384-96.
23. Wilsbacher LD. Clinical Implications of the Genetic Architecture of Dilated Cardiomyopathy. Curr Cardiol Rep. 2020;22(12):170.
24. Mestroni L, Brun F, Spezzacatene A, Sinagra G, Taylor MR. Genetic Causes of Dilated Cardiomyopathy. Prog Pediatr Cardiol. 2014;37(1-2):13-8.
25. Wong CM, Hawkins NM, Petrie MC, Jhund PS, Gardner RS, Ariti CA, et al. Heart failure in younger patients: the Meta-analysis Global Group in Chronic Heart Failure (MAGGIC). Eur Heart J. 2014;35(39):2714-21.
26. Flint KM, Pastva AM, Reeves GR. Cardiac Rehabilitation in Older Adults with Heart Failure: Fitting a Square Peg in a Round Hole. Clin Geriatr Med. 2019;35(4):517-26.
27. World Health Organisation. Rehabilitation [Internet]; 2024. Available from: https://www.who.int/news-room/fact-sheets/detail/rehabilitation
28. Maia AC, Braga AA, Soares-Filho G, Pereira V, Nardi AE, Silva AC. Efficacy of cognitive behavioral therapy in reducing psychiatric symptoms in patients with implantable cardioverter defibrillator: an integrative review. Braz J Med Biol Res. 2014;47(4):265-72.
29. Ghezzi ES, Sharman RLS, Selvanayagam JB, Psaltis PJ, Sanders P, Astley JM, et al. Burden of mood symptoms and disorders in implantable cardioverter defibrillator patients: a systematic review and meta-analysis of 39 954 patients. Europace. 2023;25(6).
30. Minjie Z, Zhijuan X, Xinxin S, Xinzhu B, Shan Q. The effects of cognitive behavioral therapy on health-related quality of life, anxiety, depression, illness perception, and in atrial fibrillation patients: a six-month longitudinal study. BMC Psychol. 2023;11(1):431.

31. Wells A, Reeves D, Capobianco L, Heal C, Davies L, Heagerty A, et al. Improving the Effectiveness of Psychological Interventions for Depression and Anxiety in Cardiac Rehabilitation: PATHWAY-A Single-Blind, Parallel, Randomized, Controlled Trial of Group Metacognitive Therapy. Circulation. 2021;144(1):23-33.
32. Kuhl EA, Sears SF, Vazquez LD, Conti JB. Patient-assisted computerized education for recipients of implantable cardioverter defibrillators: a randomized controlled trial of the PACER program. J Cardiovasc Nurs. 2009;24(3):225-31.
33. Berg SK, Pedersen PU, Zwisler AD, Winkel P, Gluud C, Pedersen BD, et al. Comprehensive cardiac rehabilitation improves outcome for patients with implantable cardioverter defibrillator. Findings from the COPE-ICD randomised clinical trial. Eur J Cardiovasc Nurs. 2015;14(1):34-44.
34. Kaddoura R, Al-Tamimi H, Abushanab D, Hayat S, Papasavvas T. Cardiac rehabilitation for participants with implantable cardiac devices: A systematic review and meta-analysis. Int J Cardiol Cardiovasc Risk Prev. 2024;21:200255.
35. Berg SK, Svendsen JH, Zwisler AD, Pedersen BD, Preisler P, Siersbaek-Hansen L, et al. COPE-ICD: a randomised clinical trial studying the effects and meaning of a comprehensive rehabilitation programme for ICD recipients -design, intervention and population. BMC Cardiovasc Disord. 2011;11:33.
36. Skjolsvik ET, Hasselberg NE, Dejgaard LA, Lie OH, Andersen K, Holm T, et al. Exercise is Associated With Impaired Left Ventricular Systolic Function in Patients With Lamin A/C Genotype. J Am Heart Assoc. 2020;9(2):e012937.
37. Jetha A, Shaw R, Sinden AR, Mahood Q, Gignac MA, McColl MA, et al. Work-focused interventions that promote the labour market transition of young adults with chronic disabling health conditions: a systematic review. Occup Environ Med. 2019;76(3):189-98.
38. Davies B, Allan KS, Carroll SL, Gibbs K, Roberts JD, MacIntyre C, et al. Perceived self-efficacy and empowerment in patients at increased risk of sudden cardiac arrest. Front Cardiovasc Med. 2023;10:955060.
39. Estimate of workforce needed - British Society of Physical & Rehabilitation Medicine [Internet]. The British Society of Physical & Rehabilitation Medicine. 2022. Available from: https://bsprm.org.uk/articles/estimate-of-workforce-needed
40. Sivan M, Cirasanambati M, Okirie E, Jeddi F, Smith M, Basu B, et al. A Proposal for Expansion of the Medical Specialty of Rehabilitation Medicine. Rehabil Process Outcome. 2022;11:11795727221137213

More Than A Heartbeat: The Life Beyond Survival

Author: Aayush Pramanik

Medical School: Hull York Medical School

Introduction

Cardiac arrests are a leading cause of mortality with a rising global incidence ranging from 52.5% to 97.1% per 100,000 population **(Song, 2024)**. The sudden and unexpected nature of this pathology accounts for roughly 25% of all cardiovascular deaths and results in a critically low out-of-hospital survival rate, approximately 10% **(Tseng et al, 2025)**. Such low survival rates are closely linked to its biological aetiology which is characterized by the sudden cessation of blood circulation to vital organs. Cardiac arrest is centered around a malfunction of the heart's electrical system. This malfunction manifests as either ventricular fibrillation or pulseless ventricular tachycardia. In ventricular fibrillation, the lower heart chambers, including the left and right ventricles, contract in a rapid and uncoordinated manner which restricts perfusion to different parts of the body **(Mayo Clinic, 2022)**. Pulseless ventricular tachycardia follows a similar physiology as ventricular fibrillation, with no detectable pulse **(Cleveland Clinic, 2022)**. The abrupt cessation of blood flow leads to a steep reduction in cerebral and coronary blood supply - cultivating hypoxic ischaemic injury across the body. That said, the current 10% survival rate to hospital discharge has significantly improved through greater use of bystander CPR, faster emergency medical service responses and the increased availability of automated external defibrillators - also leading to one-month survival increasing from 8.0% to 13.3% from 2000 to 2019 **(Yan et al, 2020)**. While this does show success in terms of advancements in the global health landscape, it also creates a new clinical challenge. This essay aims to establish the importance of considering the psychological and neurological consequences of surviving cardiac arrest, the need for increased interventions in these aspects of survivor rehabilitation and a potential framework to do so.

Brain as the hidden organ of injury

Contrary to historical statistics, there is a growing population of survivors emerging from cardiac arrests which warrants the need to shift the focus of healthcare systems from not just restoring circulation around the body but rather towards long-term consequences of surviving such a mentally straining phenomenon. Neurological recovery, psychological state and participation in society have become increasingly important influences in an individual's journey towards true recovery. Although, the heart is the acute organ affected - the brain is often the determinant of long-term outcomes. Cessation of cardiac blood output leads to cerebral ischaemia, which causes neurons to be deprived of essential oxygen and glucose. This leads to rapid depletion of ATP causing oxidative stress, excitotoxicity, as well as ultimately the death of neuronal networks **(Sandroni et al, 2021)**. These neurological adversities continue even after the acute cessation of blood flow is restored, as reperfusion leads to inflammation and dysfunction of neuronal mitochondria - a phenomenon defined as Post-Cardiac Arrest Syndrome (PCAS) **(Nolan et al, 2008).** Such injury to the brain from a neuronal perspective can also manifest into cognitive impairments - targeting specific regions of the brain. PCAS can impact the hippocampus which leads to memory impairment; the prefrontal cortex localized for executive functions of decision-making or planning and the basal ganglia which can lead to slower and even dysfunctional psychomotor function. It is found that approximately 42% to 50% of cardiac arrest survivors face some form of cognitive impairment **(Moulaert et al, 2020)** even after survivors may appear physically recovered. This challenges the assumption that cardiac arrest is objectively a cardiovascular disease and rather promotes the viewing of this phenomenon as an acquired brain injury with potent cardiac origins.

The functional consequences of neurological injury

Neurological deficits as a result of cardiac arrests - if chosen to look into further can be tested through routine examinations. However, the functional impacts or consequences of such neurological injuries are what negatively act upon true rehabilitation of a cardiac arrest survivors. The inability to re-embed themselves into their own lives is the highest cost they pay. A 45-year old teacher David may have experienced ventricular fibrillation while playing basketball. Prompt CPR from bystanders and timely defibrillation led to successful resuscitation. While being discharged from the hospital, cardiac investigations all show positive signs of recovery and his case is considered a clinical "success". However, eight months later he struggles to return back to his job as a teacher due to memory difficulties, suboptimal concentration and a persistent fear of playing basketball or exercising. These somewhat unarticulated struggles a cardiac arrest survivor faces goes much beyond the heart itself which in this case has already clinically "recovered", yet many aspects of his life haven't. From a patient's perspective, they may be lost as to how to deal with these functional consequences as they may blame themselves for their struggles, as medically they have been stated as recovered. The survivor may start taking accountability for not being able to restore participation in their daily lives as personal weakness rather than a proven clinical consequence. This demonstrates the need for functional rehabilitation and the acknowledging of cognitive consequences to become central components of post-cardiac arrest care - to ensure that a patient doesn't just survive a cardiac arrest but also continues to live their lives in an optimal fashion.

The invisible psychological burden

Beyond the neurological injuries - the greatest barriers to recovery for survivors lies in their own psychology. The sudden brush with mortality, uncertainty regarding the future or even the long-drawn intensive care treatment can leave a significant emotional impact on a patient's motivation and intention to reintroduce themselves into daily lives - something which conventional cardiac rehabilitation poorly addresses. Cardiac arrests can manifest into anxiety 3 months post-attack in 30% of survivors while this anxiety is consistently reported in 23% of survivors even after 12 months post-cardiac arrest. Furthermore, 14% of survivors also report clinically significant symptoms of depression 3 months post-attack **(Viktorisson et al, 2019)**. This acts as a testament as to how the damage caused by cardiac arrest goes beyond physiology and that rehabilitation should not just be focused solely on fixing anatomical complexities. Furthermore, the visceral experience of collapsing and feeling helpless during a cardiac arrest itself can manifest into PTSD or post-traumatic stress disorder in 25% of survivors (**Naber et al, 2018),** which, alongside the increased risks of anxiety and depression, can drastically limit an individual from basic life tasks. Furthermore, this psychological impact or sequelae also extends into the family or care-takers of survivors who commonly also face caregiver burden and associated anxiety & post-traumatic stress after possibly witnessing and responding to the initial arrest**.** Partners or caregivers may also develop the need for hypervigilance and a fear of leaving the survivor alone - all of which can negatively infringe upon their own lives but also upon the rehabilitation of the cardiac arrest survivor **(Princip et al, 2023)**

Where current care falls short

Currently, post-cardiac arrest care consists of the standard cardiac rehabilitation framework. This framework does address the cardiovascular impact of cardiac arrest through key components such as supervised exercise training, risk factor management, nutritional counselling and education about heart disease itself **(Tessler et al, 2023),** yet they lack the ability to embrace the heterogeneity that comes with long-term consequences of cardiac arrest as the model focuses only on the heart and was derived from myocardial infarction - an acute condition that is aetiologically different. Psychosocial and stress counselling are also parts of the standard cardiac rehabilitation framework yet their consistency and prevalence of integration are

not always guaranteed or at an optimal level for cardiac arrest survivors. A testament of this is how in a population of 138,018 patients in cardiac rehabilitation - only 59.8% were even just screened for anxiety and depression, let alone given counselling or support in that regard - whilst 40.2% were not screened for any psychological symptoms **(Helmark et al, 2022)**. Furthermore, through association issues with vocational needs are also not very well addressed through standard cardiac rehabilitation, as up to 96% of 368 survivors in an observational cohort study expected not to return to work after cardiac arrest, yet only a small majority received any support from occupational therapists as part of their standard rehabilitation programme **(Salzwedel et al, 2019)**

A broader conceptual issue is also evident within healthcare where rehabilitation pathways are organised traditionally based on the organ system responsible for admission rather than the impairments that manifest long-term post-discharge. This issue can be contextualized by comparing David, a 45- year old teacher who had survived a cardiac arrest as discussed and Emma, a 40-year-old accountant who is recovering from an ischaemic stroke. Both leave the hospital with comparable cardiac baseline indicators and impairments in memory and executive function, limiting both of their abilities in returning to their profession independently. That said, Emma is referred to a multidisciplinary neurorehabilitation team which consists of various key professionals such as occupational therapists and neuropsychologists. This is because a stroke is more commonly recognised as a neurological condition from the outset. On the other hand, David - despite sustaining similar brain-related hypoxic injury is only enrolled into a standard cardiac rehabilitation programme. Although, their impairments are very similar, their rehabilitation pathways differentiate by the location of the initial pathology rather than the functional impairments the patient faces. This discrepancy suggests that rehabilitation frameworks have evolved from a narrow space of clinical specialities rather than patient's lived experiences. This leads to unjustified outcomes for patients as in this clinical context - Emma is able to benefit more from her rehabilitation and return back to work sooner than David solely because her ailments were more aligned with those of a neurological pathology - something that David has no control over. This warrants the shift from a model for rehabilitation that is organ-centred to one that is impairment-led.

From Cardiac Rehabilitation to Cardiac Arrest Survivorship

Although, neurological and psychological assessments are key aspects that need to be incorporated more consistently into post-cardiac arrest rehabilitation - improvements should not simply focus on expanding existing programmes but on redesigning how rehabilitation itself is prescribed to survivors. There is little justification as to why rehabilitation should remain "one size fits all" whilst heterogeneity of recovery is prevalent amongst survivors. Thus, this essay proposes a precision-based cardiac arrest survivorship model where the process of rehabilitation itself is categorized according to functional requirements and consistently adapted throughout an individual's recovery.

The core of this model revolves around creating an individual rehabilitation profile for a cardiac arrest survivor within the first few weeks post-discharge. This survivor profile would rely not just on conventional cardiac assessments but also encompasses a multi-dimensional approach which considers emotional wellbeing, physical capacity, cognition, vocational demands, caregiver burdens and the patient's clearly defined recovery goals. Caregiver burden can be addressed by surveys and interviews to ensure caregiver priorities are considered and accounted for. Furthermore, already validated and widely used measures such as the Hospital Anxiety and Depression Scale (HADS) or the Montreal Cognitive Assessment or MoCA - which is a 10 minute screening instrument based on a 30 point system that detects mild cognitive impairments or early signs of dementia **(Rosenzweig, 2023)**; could be integrated into routine cardiac follow up appointments to foster a holistic rehabilitation profile for cardiac arrest survivors, one that isn't just focused on pathology. These assessments should be repeated one to two months after discharge as most cognitive and psychological deficits emerge significantly once a patient attempts to fully resume education, employment or independent living.

This nuance in the initial assessment of an individual post-cardiac arrest would allow for the rehabilitation pathway or interventions to be suggested or prescribed more strategically to the benefit of the individual's needs. If a survivor demonstrates potent cognitive deficits during the creation of their rehabilitation profile - they would be signposted to early neuropsychological rehabilitation, whereas those facing significant psychological stress post-cardiac arrest could be referred to trauma-specific psychological care. Individuals with minimal neurological sequelae or consequences could continue through traditional cardiac-specific rehabilitation with reassessment at consistent intervals. Crucially, this helps stratify rehabilitation pathways based on individual needs whilst appreciating the quite significant cognitive and psychological impacts cardiac arrest can cause, as proven earlier in the essay through systematic reviews by **Naber et al** and **Viktorisson et al**.

The role of embedding survivorship into the whole rehabilitation process is essential as recovery isn't limited to just being on your two feet or being able to exercise for a few minutes more than usual - it is the process of trying to build a version of yourself that can live your own life to the fullest. A practical step towards embracing this concept would be to establish dedicated post-cardiac arrest survivorship clinics, similarly to those adopted in oncology **(Mayo Clinic, 2023)**. These clinics could help provide the multi-disciplinary support in a structured manner at key recovery milestones such as the three, six and twelve month mark. This continuum would allow clinicians to not just "assign" a rehabilitation plan for maybe 12 weeks and leave the survivor on their own devices. It will allow clinicians to identify evolving cognitive, psychological and vocational priorities - all of which arise not acutely but rather longitudinal/gradually after discharge. This will allow the coordination of timely as well as strategic interventions that are individualised to each survivor, which is necessary given the variety in intention or motivation of survivors to regain independence and practice in their professional or family lives. A survivorship clinic will also help survivors feel more in control of their recovery which will further fuel their desire to return to a life once lived.

This desire to rehabilitate and return back to a life somewhat known to them is also greatly influenced by a survivor's family or support. As established earlier in the essay, cardiac arrest doesn't just affect an individual but their family and support systems as well. This warrants rehabilitation to not be limited to survivors only but also their support systems. The family or caregivers of a survivor should also be educated about cardiac arrest symptoms, trained upon their CPR confidence, screened for PTSD, signposted to support groups which they can attend alongside who they care for and given caregiver fatigue assessments at a regular basis. If a survivor's family is well informed, prepared and mentally at a good place than the survivor themselves also feel more comfortable to take that next step in their rehabilitation and progress in their journey.

Conclusion: The way forward

The aim is not to replace current cardiac rehabilitation pathways but to rather add more of a human dimension to something that has already achieved statistical excellence. A model that focuses on individual journeys, one that differentiates cardiac arrest from similar conditions and one that empowers survivorship over biological recovery is only a start - a constellation of factors that need to be given more attention. This would allow healthcare systems to allocate resources based on objective need, which would avoid both unnecessary interventions and delayed referrals for complex impairments. Through this model, rehabilitation can become adaptive rather than episodic - by making impairment the start point of resource allocation rather than diagnosis - prioritising a proactive rather than a reactive approach that aligns greatly with global healthcare trends. Cardiac arrest is not just a case or pathology - it is a grave experience of almost losing all you have achieved, your hopes and dreams. This understanding is one that is reflected through redefining rehabilitation as the reinvention of a life worth returning to for each and every survivor rather than just a restoration of acute circulation.

REFERENCES

- "Cancer Survivorship Clinics - Overview." Mayo Clinic, 2023, www.mayoclinic.org/departments-centers/cancer-survivorship-clinics/sections/overview/ovc-20556297. Accessed 20th June 2026
- Helmark, Charlotte, et al. "Systematic Screening for Anxiety and Depression in Cardiac Rehabilitation – Are We There Yet?" International Journal of Cardiology, vol. 352, Apr. 2022, pp. 65–71, https://doi.org/10.1016/j.ijcard.2022.02.004. Accessed 20th June 2026
- Mayo Clinic. "Ventricular Fibrillation - Symptoms and Causes." Mayo Clinic, 28 Oct. 2022, www.mayoclinic.org/diseases-conditions/ventricular-fibrillation/symptoms-causes/syc-20364523. Accessed 20th June 2026
- Moulaert, Véronique, et al. "Cognitive Impairments in Survivors of Out-of-Hospital Cardiac Arrest: A Systematic Review." Resuscitation, vol. 80, no. 3, 2020, pp. 297–305, www.sciencedirect.com/science/article/pii/S0300957208007879, https://doi.org/10.1016/j.resuscitation.2008.10.034. Accessed 20th June 2026
- Naber, Dieter, and Monika Bullinger. "Psychiatric Sequelae of Cardiac Arrest." Body-Mind Interaction in Psychiatry, vol. 20, no. 1, Mar. 2018, pp. 73–77, https://doi.org/10.31887/dcns.2018.20.1/dnaber. Accessed 20th June 2026
- Nolan, Jerry P., et al. "Post-Cardiac Arrest Syndrome: Epidemiology, Pathophysiology, Treatment, and Prognostication." Resuscitation, vol. 79, no. 3, 2008, pp. 350–379, www.ilcor.org/data/Post-cardiac_arrest_syndrome.pdf, https://doi.org/10.1016/j.resuscitation.2008.09.017. Accessed 20th June 2026
- Princip, Mary, et al. "Posttraumatic Stress Disorder as a Consequence of Acute Cardiovascular Disease." Current Cardiology Reports, vol. 25, no. 6, 2 May 2023, pp. 455–465, https://doi.org/10.1007/s11886-023-01870-1. Accessed 20th June 2026
- "Pulseless Ventricular Tachycardia: Causes and Treatment." Cleveland Clinic, 2022, my.clevelandclinic.org/health/diseases/23254-pulseless-ventricular-tachycardia. Accessed 20th June 2026
- Rosenzweig, Andrew. "Montreal Cognitive Assessment (MoCA) Test for Dementia." Verywell Health, 17 Aug. 2023, www.verywellhealth.com/alzheimers-and-montreal-cognitive-assessment-moca-98617. Accessed 23rd June 2026
- Salzwedel, Annett, et al. "Patients' Expectations of Returning to Work, Co-Morbid Disorders and Work Capacity at Discharge from Cardiac Rehabilitation." Vascular Health and Risk Management, vol. Volume 15, Aug. 2019, pp. 301–308, www.ncbi.nlm.nih.gov/pmc/articles/PMC6698615/, https://doi.org/10.2147/vhrm.s216039. Accessed 23rd June 2026
- Sandroni, Claudio, et al. "Brain Injury after Cardiac Arrest: Pathophysiology, Treatment, and Prognosis." Intensive Care Medicine, vol. 47, no. 12, 27 Oct. 2021, pp. 1393–1414, pmc.ncbi.nlm.nih.gov/articles/PMC8548866/, https://doi.org/10.1007/s00134-021-06548-2. Accessed 23rd June 2026
- Song, Wei. "Current and Emerging Innovations in Technology, Strategy, and Artificial Intelligence: A New Era in Cardiac Arrest and Cardiopulmonary Resuscitation." Nih.gov, 2024, pmc.ncbi.nlm.nih.gov/articles/PMC12616295/. Accessed 23rd June 2026
- Tessler, Joseph, and Bruno Bordoni. "Cardiac Rehabilitation." PubMed, StatPearls Publishing, 2023, www.ncbi.nlm.nih.gov/books/NBK537196/. Accessed 23rd June 2026
- Tseng, Zian H, and Kosuke Nakasuka. "Out-of-Hospital Cardiac Arrest in Apparently Healthy, Young Adults." JAMA, 20 Feb. 2025, https://doi.org/10.1001/jama.2024.27916. Accessed 23rd June 2026
- Viktorisson, Adam, et al. "One-Year Longitudinal Study of Psychological Distress and Self-Assessed Health in Survivors of Out-of-Hospital Cardiac Arrest." BMJ Open, vol. 9, no. 7, July 2019, p. e029756, https://doi.org/10.1136/bmjopen-2019-029756. Accessed 23rd June 2026

- Yan, Shijiao, et al. “The Global Survival Rate among Adult Out-of-Hospital Cardiac Arrest Patients Who Received Cardiopulmonary Resuscitation: A Systematic Review and Meta-Analysis.” Critical Care, vol. 24, no. 1, 22 Feb. 2020, ccforum.biomedcentral.com/articles/10.1186/s13054-020-2773-2, https://doi.org/10.1186/s13054-020-2773-2. Accessed 23rd June 2026

Before the Gift: Prehabilitation and the Untapped Potential of Living Donor Kidney Transplantation

Author: Andy Prigg

Medical School: Sheffield Medical School

Introduction

In the twelve months before my transplants, a simultaneous kidney and liver, nobody prescribed me an exercise programme. No physiotherapist assessed my functional capacity. No dietician structured a plan to optimise my nutritional status for major surgery. My nephrologist told me to stay as fit as possible. That was it. Good advice, sincerely meant, but not a programme.

So, I made my own. I kept running, kept drinking water by the litre, kept forcing myself through sessions at the gym even as my further declined eGFR falling below ten and the fatigue became something I carried through every waking minute. I had been told that avoiding dialysis would give me the best chance of a good outcome (1,2), and exercise and hydration were the tools available to me. Beyond the physical activity, particularly running kept me grounded. In an emotionally gruelling period of uncertainty, the routine of exercising was the thing that held me together. It gave me something I could control when everything else felt entirely out of my control.

When the call came from the national transplant waiting list for a pre-emptive transplant in June 2024, I arrived at surgery with physiological reserve built through months of deliberate effort, and a psychological resilience that the discipline of exercise had given me. My recovery was not straightforward. I spent five days in intensive care before moving to the ward. But the fitness I had fought to maintain paid dividends. Recovery was gruelling (and pretty painful at times!), I can only imagine how much harder it would've been without my fitness going in.

Pre-rehabilitation

I did not know it then, but what I had done had a name. Prehabilitation 'the systematic optimisation of physical, nutritional, and psychological function' before surgery, is now recognised as a legitimate and effective intervention across surgical specialties (3,4). In colorectal, cardiac, and orthopaedic surgery, structured prehabilitation programmes have demonstrated reductions in post-operative complications, shorter hospital stays, and faster functional recovery (4). Yet in kidney transplantation, prehabilitation remains an emerging concept, confined largely to small feasibility studies and a single landmark randomised controlled trial (5). More critically, almost all of this early work focuses on a single population: the deceased donor waitlist pool. Patients often already on dialysis, deconditioned, waiting months or years for a kidney with no certainty of when, or sadly whether, it will come.

This essay argues that the living donor kidney transplant pathway represents an overlooked and structurally superior setting for prehabilitation. The predictability of surgical timing, the capacity to optimise both donor and recipient simultaneously, and the opportunity to avoid dialysis-related deconditioning entirely through timely pre-emptive transplantation make living donation the ideal context in which Physical and Rehabilitation Medicine can establish itself. Yet this pathway remains almost entirely unstudied. What I did, and more, before my transplant should be available to every donor and recipient by design.

The Emerging Evidence and Its Blind Spot

The case for prehabilitation in kidney transplantation rests on straightforward physiological logic. Chronic kidney disease is a profoundly deconditioning. As renal function declines, patients accumulate uraemic toxins, develop anaemia, lose muscle mass, bones become osteoporotic, alongside experiencing the compounding effects of fatigue, malnutrition, and psychological distress (6,7). Among transplant candidates, the burden is stark: a recent mixed-methods study from Haanstra et al. found that 93% experienced problems with physical functioning, over half had nutritional deficits, and 44% had impairments across all three domains of physical health, nutritional status, and psychological wellbeing. Almost three-quarters reported abnormal fatigue. Most notably, 79% percent wanted a prehabilitation programme. None existed (8).

The FRAILMar trial provided the first robust evidence that exercise-based prehabilitation works in this population (5). An eight-week supervised programme of three sessions per week improved exercise capacity, grip strength, and rectus femoris muscle thickness compared to standard care, including among patients who were frail at baseline. This was the trial the field had been waiting for since Cheng and colleagues first posed the question in 2017: prehabilitation for kidney transplant candidates, is it time? (9). Nearly a decade later, the answer is yes, but the evidence base still remains narrow. The European Society of Organ Transplantation (ESOT) has formalised ten consensus recommendations supporting prehabilitation for solid organ transplant candidates, yet these recommendations acknowledge that clinical data are promising but few, and evidence-based guidance remains scarce (10). The UK Renal Association's clinical practice guideline now includes exercise and lifestyle recommendations spanning the transplant pathway (11). Institutional momentum is building, but it is building around the most common clinical scenario.

The populations studied: are all deceased donor waitlist candidates. The FRAILMar trial recruited patients on the transplant list (5). The Groningen study surveyed waitlisted candidates (8). The ESOT consensus drew on evidence from patients enduring prolonged, unpredictable waits. This matters, because the very unpredictability of deceased donor transplantation creates fundamental barriers to prehabilitation delivery (10). Patients cannot be told when surgery will happen. Programmes cannot be structured around a fixed endpoint. Motivation wanes during the often years of uncertainty. One candidate in the Groningen study described the wait as a "big black hole" of unpredictability (8). A nephrologist noted that fifteen-minute consultations barely allowed time to discuss laboratory results, let alone prescribe exercise (8). These are real barriers. But they are not universal to all kidney transplants.

The Structural Case for Prehabilitation in Living Donor Transplantation

Living donor kidney transplantation offers four structural advantages that make it uniquely suited to implementing prehabilitation, none of which are shared by the deceased donor pathway.

Firstly, timing is predictable. It is not perfectly so, given the realities of surgical capacity, pre-listing workup, and donor assessment, but it is predictable in a way the deceased donor pathway never can be. Living donor transplantation is ‘elective’. A surgical date is planned weeks to months in advance. This transforms the therapeutic relationship with prehabilitation: programmes can be designed with a defined endpoint, intensity can be periodised toward a known surgical date, and progress can be measured against a target rather than sustained indefinitely. The parallel with elective surgical prehabilitation in colorectal or cardiac surgery, where the evidence base is strongest, is direct and compelling (3,4).

Secondly, two patients can be optimised, not one. The living donor is a healthy individual undergoing major surgery for no personal medical benefit. We ask them to accept surgical risk, post-operative pain, recovery time, and the long-term consequences of potentially reduced renal reserve. We owe them the best possible preparation. Yet donor optimisation is understudied. Donor assessment pathways rightly focus on suitability, on ensuring the donor can safely give, but they rarely extend to functional optimisation before the day of surgery. A feasibility trial at the University of Manchester, the only registered study I identified that includes

both live donors and recipients, is currently evaluating a six-week home-based exercise programme monitored by wearable technology. It is a pilot study with an estimated enrolment of forty participants (12).

Moreover, living donation facilitates pre-emptive transplantation, meaning transplantation before the recipient requires dialysis. Pre-emptive transplantation avoids the deconditioning spiral of dialysis entirely and is associated with superior graft and patient survival (1,2). The mechanisms are not fully understood, but reduced co-morbidity burden from uraemia and dialysis avoidance is likely central (1). A recipient who has never been on dialysis arrives at surgery from a higher functional baseline, with more preserved muscle mass, less chronic fatigue, and less of the psychological weight that years of thrice-weekly treatment imposes. Prehabilitation in this context builds on strength rather than attempting to reverse decline. Yet in the United Kingdom, only 35% of living donor kidney transplants are pre-emptive, and only 17% of patients commencing renal replacement therapy are listed for or receive a living donor transplant before starting dialysis (1,13). The median waiting time from dialysis start to deceased donor transplant in the UK exceeds 1,000 days (1). Every one of those days represents lost functional capacity that prehabilitation in the living donor pathway could have preserved.

Finally, the psychological conditions differ fundamentally. Deceased donor candidates face existential uncertainty: the wait, the fear of deterioration, the possibility of never receiving an organ. Living donor recipients navigate a different landscape of gratitude, guilt, relational complexity, and the emotional weight of receiving a gift from someone they likely know (14). Donors themselves manage anxiety about surgical risk, recovery, and long-term health. These are distinct challenges that demand distinct psychological preparation, and they can be addressed through structured intervention precisely because the timeline allows it.

A survey of kidney transplant candidates at University Hospitals Birmingham found that 86% agreed exercise was important for optimising transplant outcomes, but regular exercise participation was far lower (15). The willingness exists. The programmes do not. At a centre where 35 to 40% of candidates are frail or vulnerable to frailty, the transplant community is beginning to recognise the need for prehabilitation (15). The living donor pathway, with its controllable timing and definable patient pairs, is the rational starting point.

Moving Towards a Multimodal Living Donor Prehabilitation Programme

The three pillars of prehabilitation, physical, nutritional, and psychological (3,4), apply to the living donor pathway, but their implementation differs from the deceased donor context in ways that deserve specific attention. The FRAILMar model of supervised, centre-based sessions is not directly transferable to a population that includes healthy donors and pre-dialysis recipients, many of whom are in employment and managing competing demands on their time (5). What follows is an outline of what a living donor prehabilitation programme might look like, drawing on the broader surgical and transplant prehabilitation literature.

Physical optimisation for recipients should begin at the point when a surgical date becomes foreseeable, typically following donor assessment and approval. A graded exercise programme of six to twelve weeks, combining aerobic conditioning and resistance training, could be structured around measurable functional endpoints such as the six-minute walk test, cardiopulmonary exercise testing, or grip strength. For pre-emptive recipients who have not yet started dialysis, the programme builds on preserved baseline fitness rather than attempting to reverse deconditioning. For donors, whose primary risk is post-nephrectomy functional decline, the emphasis shifts to cardiopulmonary reserve and core stability, preparing them for rapid recovery and return to work (3,4,15).

Nutritional prehabilitation must be tailored to each role. Recipients require optimisation of protein intake, correction of the micronutrient deficiencies common in advanced chronic kidney disease, and careful management of fluid balance (16). For those approaching transplant pre-emptively, dietary guidance can shift from the restrictive focus of renal dietary management toward surgical preparation: building reserves rather than managing decline. Donors need pre-operative nutritional assessment to ensure surgical readiness and

post-operative healing capacity, yet the donor workup in most UK centres focuses on immunological compatibility and anatomical suitability rather than functional optimisation. The Groningen study found that even for waitlisted recipients, dietetic input was largely reactive, offered upon request rather than embedded as standard care (8).

The psychological dimension may be the most distinctive feature of the living donor context. Shared psychological preparation that acknowledges the relational dynamics of donation, normalises ambivalence, and builds coping strategies for both parties could be delivered as part of a joint programme. The ESOT consensus explicitly recommended including psychological support alongside physical and nutritional components (10). My own experience confirms the intuition: exercise was my psychological intervention as much as my physical one. Formalising that connection, rather than leaving it to chance, is the opportunity.

Digital platforms offer a pragmatic delivery mechanism. The Kidney BEAM intervention demonstrated that a digital physical activity programme is clinically effective and cost-effective in the broader chronic kidney disease population, improving mental health-related quality of life compared to standard care (17,18). Kidney BEAM is now being adapted for pre-transplant use through a Kidney Research UK-funded doctoral fellowship (19). A living donor prehabilitation programme could use similar digital infrastructure: home-based exercise delivered by video instruction, wearable monitoring of adherence, and remote dietetic and psychological support. This would address the geographical and logistical barriers consistently identified as obstacles to participation (8,15).

The Equity Imperative

There is an uncomfortable truth embedded in my own experience. I had the education, the health literacy, and the socioeconomic resources to prehabilitate myself informally. I understood why exercise mattered. I could afford a gym membership. I had the autonomy to adjust my daily routine around my declining renal function. Not everyone does.

The Birmingham study revealed significant demographic variation in exercise attitudes and practices among transplant candidates, with differences across age, ethnicity, and dialysis modality (15). Older patients and those from South Asian backgrounds were less likely to report regular exercise, despite expressing equally positive attitudes toward its importance. Barriers to living donor transplantation in the United Kingdom are themselves deeply inequitable: patients from socioeconomically deprived backgrounds and ethnic minority communities are less likely to receive a living donor transplant and less likely to receive it pre-emptively (13,20). These disparities compound. A patient who faces barriers to accessing a living donor also faces barriers to the kind of self-directed prehabilitation that patients like me arrange for ourselves. If prehabilitation remains something that motivated, well-informed patients organise independently rather than receive as part of their care, it will entrench existing disparities rather than reduce them.

Physical and Rehabilitation Medicine has a particular responsibility here. The commitment to person-centred, goal-directed care positions it to design programmes that account for individual circumstance rather than imposing a single model. A programme that offers only centre-based sessions will exclude patients who cannot travel. A programme that offers only digital delivery will exclude those without technological access. The answer, as the Groningen participants articulated, is tailored, hybrid provision: professionally guided but home-based where possible, individually designed but enriched by peer interaction (8,15). Prehabilitation should be a leveller, not a privilege.

Claiming the Territory

Rehabilitation medicine occupies the space between acute intervention and sustained recovery. It asks not only whether a patient can survive surgery, but whether they can flourish afterwards. In kidney transplantation, that question has historically been asked after the event: in post-transplant physiotherapy, in return-to-work programmes, in managing the musculoskeletal consequences of long-term immunosuppression. Prehabilitation reverses this sequence. It poses the question before surgery, when intervention has the greatest potential to influence outcomes.

Looking back, I wish I had been offered a structured prehabilitation programme before my transplant. The advice to stay fit was well-intentioned, but advice without structure is aspiration without a plan. A physiotherapist-led exercise programme, a dietician building my nutritional reserves, a psychologist helping me prepare for the reality of what lay ahead: these would not have been luxuries. They would have been clinically appropriate preparation for one of the most physiologically demanding operations a young person can undergo. I managed without them, but I should not have had to.

The case made here centres on kidney transplantation and the living donor pathway specifically, but the principle extends across solid organ transplantation as a whole. The ESOT consensus recognised prehabilitation as relevant to lung, liver, heart, and kidney transplant candidates alike (10). Wherever a surgical date can be anticipated and a patient's functional capacity assessed, there is an opportunity for rehabilitation medicine to intervene before the insult rather than react to its consequences. My own transplant was a combined kidney and liver procedure, and I can say from lived experience that the physiological demands do not respect organ boundaries. The need for preparation is universal.

The economic case reinforces the clinical one. Dialysis costs the NHS between £20,000 and £32,000 per patient per year (1). Every pre-emptive transplant facilitated, every post-operative complication prevented by better functional preparation, represents a saving that extends beyond the cost of the programme itself. What remains is to build the programmes, test them rigorously, and embed them in UK transplant pathways as standard of care. The living donor kidney transplant pathway is the place to start, not because it is the only setting where prehabilitation matters, but because it is where rehabilitation medicine can prove its value most clearly: for both the person who gives and the person who receives.

References

1. Kim I, Maggiore U, Knight SR, et al. Pre-emptive living donor kidney transplantation: A public health justification to change the default. Front. Public Health 11:1124453. doi: 10.3389/fpubh.2023.1124453
2. Azegami T, Kounoue N, Sofue T, et al. Efficacy of pre-emptive kidney transplantation for adults with end-stage kidney disease: a systematic review and meta-analysis. Ren Fail. 2023;45(1):2169618. doi: 10.1080/0886022X.2023.2169618
3. Minnella EM, Carli F. Prehabilitation and functional recovery for colorectal cancer patients. Eur J Surg Oncol. 2018;44(7):919–926. doi: 10.1016/j.ejso.2018.04.016
4. Scheede-Bergdahl C, Minnella EM, Carli F. Multi-modal prehabilitation: addressing the why, when, what, how, who and where next? Anaesthesia. 2019;74(Suppl 1):20–26. doi: 10.1111/anae.14505.
5. Pérez-Sáez MJ, Muñoz-Redondo E, Morgado-Pérez A, et al. Exercise-based prehabilitation for kidney transplant candidates: the FRAILMar randomized controlled trial. Am J Kidney Dis. 2025;86(5):634–645. doi: 10.1053/j.ajkd.2025.07.003.
6. Webster AC, Nagler EV, Morton RL, Masson P. Chronic kidney disease. Lancet. 2017;389(10075):1238–1252. doi: 10.1016/S0140-6736(16)32064-5.
7. Zelle DM, Klaassen G, van Adrichem E, Bakker SJL, Corpeleijn E, Navis G. Physical inactivity: a risk factor and target for intervention in renal care. Nat Rev Nephrol. 2017;13(5):318. doi: 10.1038/nrneph.2017.44.

8. Haanstra AJ, van der Veen Y, Maring H, et al. Factors influencing the development and implementation of a prehabilitation program for kidney transplant candidates: a mixed-methods contextual analysis. Int J Nurs Stud Adv. 2026;10:100558. doi: 10.1016/j.ijnsa.2026.100558.
9. Cheng XS, Myers JN, Chertow GM, et al. Prehabilitation for kidney transplant candidates: is it time? Clin Transplant. 2017;31(8):e13020. doi: 10.1111/ctr.13020
10. Annema C, De Smet S, Castle EM, et al. European Society of Organ Transplantation (ESOT) Consensus Statement on Prehabilitation for Solid Organ Transplantation Candidates. Transpl Int. 2023;36:11564. doi: 10.3389/ti.2023.11564.
11. Baker LA, March DS, Wilkinson TJ, et al. Clinical practice guideline exercise and lifestyle in chronic kidney disease. BMC Nephrol. 2022;23(1):75. doi: 10.1186/s12882-021-02618-1.
12. Kitchen G. Outcomes of a pre-operative exercise programme for live donor and recipient kidney transplant patients. ClinicalTrials.gov Identifier: NCT06858098. 2025.
13. Wu DA, Robb ML, Watson CJE, et al. Barriers to living donor kidney transplantation in the United Kingdom: a national observational study. Nephrol Dial Transplant. 2017;32(5):890–900. doi: 10.1093/ndt/gfx036
14. Van Dellen D, Burnapp L, Citterio F, Mamode N, Moorlock G, van Assche K, Zuidema WC, Lennerling A, Dor FJ. Pre-emptive live donor kidney transplantation: moving barriers to opportunities. World J Transplant. 2021;11(4):88–98. doi: 10.5500/wjt.v11.i4.88
15. Tasleem S, Patel K, Hodson J, et al. Exercise attitudes and practices among adults listed for kidney transplantation: a survey of a diverse patient cohort. Front Sports Act Living. 2025;7:1559322. doi: 10.3389/fspor.2025.1559322
16. MacLaughlin HL, Friedman AN, Ikizler TA. Nutrition in kidney disease: core curriculum 2022. Am J Kidney Dis. 2022;79(3):437–449. doi: 10.1053/j.ajkd.2021.05.024
17. Greenwood SA, Briggs J, Castle EM, et al. Kidney Beam: a cost-effective digital intervention to improve mental health. Kidney Int Rep. 2024;9(11):3204–3217. doi: 10.1016/j.ekir.2024.08.030.
18. Young HML, Castle EM, Briggs J, et al. The development and internal pilot trial of a digital physical activity and emotional well-being intervention (Kidney BEAM) for people with chronic kidney disease. Sci Rep. 2024;14(1):700. doi: 10.1038/s41598-023-50507-4
19. Kidney Research UK. Can prehabilitation help kidney patients preparing for transplant? [Internet]. 2024 [cited 2026 Jun 24]. Available from: https://www.kidneyresearchuk.org/2024/01/29/can-prehabilitation-benefit-kidney-patients-preparing-for-transplant/
20. Udayaraj UP, Ben-Shlomo Y, Roderick P, et al. Social deprivation, ethnicity, and access to the deceased donor kidney transplant waiting list in England and Wales. Transplantation. 2010;90(3):306–312. doi: 10.1097/TP.0b013e3181e346e3.

Found and Forgotten: The Inequity of Surgical Access in Spasticity Management

Author: Elijah Williams

Medical School: Hull York Medical School

Introduction

Spasticity occurs in approximately 25-45% of stroke survivors[1]. It is also highly prevalent in other upper motor neurone conditions such as cerebral palsy, spinal cord injury, and multiple sclerosis. Its consequences range from chronic pain to loss of a functional limb, skin breakdown, carer burden, and then the quieter losses – of identity, confidence, and participation in ordinary life. Management has historically focused on physiotherapy, splinting and botulinum injections with surgery often seen as an intervention of last resort, reserved for those who have already developed fixed contractures.

That position is quickly changing within rehabilitation in the UK. Surgery is becoming an increasingly recognised tool in the rehabilitation pathway, with goals extending beyond purely motor function recovery. I attend a monthly joint spasticity clinic run by a consultant plastic and hand surgeon alongside a rehabilitation consultant – formerly an orthopaedic surgeon - whose background gives him fluency in both the surgical and rehabilitative aspects of spasticity. Two patients I met illustrate both the evolving utilisation of surgical management and the profound inequity in those who currently benefit from it.

Two Patients, One Clinic

Madison is seventeen and in college. She has cerebral palsy and has been under paediatric spasticity services her whole life which has entailed physiotherapy, splinting, botulinum toxin injections, and regular reviews. She presented to clinic wanting to try a surgical approach. The spasticity affecting her hand and wrist was the focus; while she struggled to use her hand spontaneously, she retained good passive assist. She could hook her handbag on her wrist, carry her books between her abdomen and elbow, and was a keen netball player.

Later in the consultation, she reluctantly admitted her motivation for surgery was less about her function and more about the stares, the intrusive questions from her peers, and feeling different. She felt embarrassed wearing her college short sleeved netball t-shirt with the affected arm out in the open. Madison no longer wanted to be defined by her cerebral palsy, instead she wanted to go through school and university with more confidence and to develop an identity that wasn't built around her condition. Her goals – social functioning, self-confidence, participation – were central to her rehabilitation plan. Not motor recovery.

Robert is in his fifties, previously a sergeant in the police force. He attended clinic with his wife, who has been his full-time carer since his stroke. Global aphasia means he can no longer verbally communicate. His wife spoke on his behalf – she described his painful finger contractures, the breaking down skin against his palm and the difficulties she faces providing his care. She told us he had been a strong willed, decisive and confident prior to his stroke; that he would have made the decision to proceed with surgery before he had even walked into the room. But the stroke had stolen that part of his identity from him, and the man sitting beside her could no longer make this decision for himself. This consultation highlighted something which outcome measures rarely express: spasticity does not just reshape the affected limb, it reshapes the lives of everyone around it.

These are just two patients I have had the privilege of meeting and learning from. Throughout this essay, I will use them to illustrate the shifting indications for surgery, the gaps in rehabilitation provision, and a model by

which we could better deliver this care. For rehabilitation physicians this distinction determines whether patients like Madison and Robert ever receive a referral.

Shifting Indications

Spasticity is most commonly defined as a velocity-dependent increase in muscle tone and exaggerated stretch reflexes resulting from an upper motor neurone lesion[2]. Its consequences range from functional loss, pain, skin breakdown and infection, carer burden and deformity. Historically, surgery was reserved as a last resort – once physiotherapy, splinting, and repeated botulinum toxin injections had all failed and a fixed contracture developed.

Two significant shifts are now occurring.

The first is timing. Surgery is now considered earlier in a patient's rehabilitation journey, before a fixed contracture forms. Madison illustrates this. As well as the plateau in her physical rehabilitation, the cumulative burden of conservative management – attending clinic every few months for injections, daily splinting and physiotherapy – had become significant. Earlier surgical intervention also reduces the chance of progression to a fixed contracture. Her surgery is not the last resort, it is a planned step at a stage where it can still shape her trajectory, rather than merely responding to a deterioration.

The second shift is the extension of indications beyond motor function recovery. Reducing finger and wrist flexion to allow for personal hygiene and prevent skin breakdown is now a recognised indication for surgery in its own right – even without improvement in hand function[3]. Surgical correction also offers a more permanent solution compared with dependency on repeated botulinum toxin injections in clinic, which bring their own challenges – transport difficulties, work commitments, or simply the additional burden of an already demanding regime.

Arguably the most important expansion of indications concerns social functioning and identity. The social model of disability is paramount here: it is not necessarily Madison's impaired limb that causes her distress, but a social environment that has not accommodated for it[4]. The stares, the intrusive questions, the visibility of difference are not consequences of her neurological condition alone, they are consequences of an impairment in a world unequipped to accommodate it. Surgery in this context is not simply correcting the deformity, it is reducing a barrier to participation that conservative management couldn't address.

This directly challenges the gatekeeping question which still quietly governs surgical referrals: will this patient be able to use their hand better afterwards? It is not an unreasonable question if motor recovery is the only goal – but alone this is rarely an indication for patients. Issues arise if this is the only question being asked, as it may exclude many patients, including Madison, for whom surgery would meaningfully improve quality of life. Madison would have been excluded by it. NICE guidance spasticity management now supports social participation reflecting the increasing consensus that a purely biomedical framing of surgical success is too narrow[5]. Goal Attainment Scaling (GAS) has reinforced this, allowing outcomes to be assessed against a patients' individual goals rather than generic motor assessments.

Although not a formal indication, identity forms part of the reasoning that makes surgery appropriate. Robert can no longer express his identity through his choices; but the restoration of his physical comfort, the easing of his wife's care burden, and the reduction of his contractures – that is what defines how others see him. These shifts have changed, not just how we measure rehabilitation outcomes, but who we consider eligible in the first place.

Surgical Spectrum

There is no single best surgery for spasticity. Surgical treatment is selected according to the nature and severity of the deformity, the degree of residual volitional control, and most importantly the goals of the patient. In practice, surgical intervention is almost always combined with conservative management – botulinum toxin, splinting, physiotherapy - demonstrating the necessity of multidisciplinary working.

Musculotendinous lengthening is one of the commonly used procedures[3]. It is a relatively straightforward procedure and with lengthening the musculotendinous unit, the effect of the contracture is reduced whilst volitional control (if present) is preserved. Lengthening of the flexor digitorum superficialis and or profundus, for example, can help relieve a clasped hand deformity – reducing the fingernails digging into palmar skin and potentially allowing the patient to pick up objects. The trade-off in this procedure is that the patient may lose the ability to make a full fist due to the reduced excursion (ability to shorten) of the tendons – a consideration weighed against improved hygiene and comfort.

Where lengthening is insufficient, tenotomy – complete tendon transection– may be considered. This definitively removes the deforming force but at the cost of volitional control of the affected body part. Therefore, this procedure is generally reserved for patients where preserving active movement is no longer a realistic or relevant goal for them. Arthrodesis, the surgical fusion of a joint, offers an alternative option – where a joint is permanently fused in a preferable position – though it sacrifices both active and passive movement of the joint.

Motor nerves to muscles can be targeted with either neurotomy or neurectomy (total, selective, or hyperselective). These techniques disrupt the motor fascicles to reduce (selective or hyperselective neurectomy) or abolish (total neurectomy) the motor supply to specific muscles or muscle groups. Hyperselective neurectomy aims to reduce the spasticity of the muscle whilst maintaining volitional control. This technique is commonly indicated when spasticity without contracture is present but can also be used in conjunction with the other procedures outlined above[6].

Functional tendon transfers require thoughtful decision making and at times pre-operative investigations such as EMGs. As well as reducing a deforming force, a tendon transfer redirects it– rerouting a tendon to restore muscle balance. The flexor carpi ulnaris to extensor carpi radialis brevis transfer is a well-established example[3]. Several considerations are specific to spasticity: donor muscles may themselves be spastic and therefore will likely result in the same issue; concurrent dystonia or athetosis presents additional unpredictability; cognitive factors may impair motor relearning required post-operatively; and fixed contractures must be addressed before a tendon transfer can function properly. These are not reasons to avoid tendon transfers – they are reasons why careful planning and the joint surgical and rehabilitative expertise are essential.

Gaps

Physiotherapy, occupational therapy, splinting and botulinum toxin are powerful tools, they are adaptable to the patient and they are iterative. However, they cannot alter the underlying soft tissue and joint pathology. Surgery restores conditions where rehabilitation can be effective again. These are not competing approaches; they are synergistic.

This is the gap which surgery bridges clinically. But there is a second gap – arguably more important –regarding which patients reach surgical assessment.

In 2026, patients should not be developing severe contractures. When presenting to clinic with skin breakdown, pressure sores, and recurrent infections which have been present for months - but more commonly years - it is not merely the natural history of their condition. It is a visible consequence of a system

failing to intervene. Inadequate follow-up, carers who were not equipped nor supported to manage spasticity at home, and a referral pathway that did not exist or was not used. It is unacceptable.

This disparity is only likely to grow. Stroke incidence is rising, driven by an ageing population and the increasing prevalence of modifiable cardiovascular risk factors. More strokes mean more patients with post-stroke spasticity are entering an already failing system.

This disparity becomes most apparent when paediatric and adult services are placed side by side. Children and young people with cerebral palsy, like Madison, are typically known to a multidisciplinary team from early in life. Management is coordinated across paediatric neurology, therapy services, orthopaedics and specialist clinics. The transition to adult services isn't perfect, compliance is a legitimate challenge in adolescence – as Madison's father jokingly hinted – and the continuity of paediatric care is seldom replicated. However, the pathway exists, it is a well-known pathway, and children are found by it.

Adults, on the other hand, are not reliably found. Patients acquiring spasticity following a stroke, or brain injury will usually receive a period of acute rehabilitation with some community therapy, but long-term follow up and access to specialist spasticity services is remarkably inconsistent across the country. Those developing contractures in care homes or under the management of teams without spasticity expertise may wait years, or more concerningly will never receive it. Unfortunately, it is a far too common that by the time a patient reaches clinic, like the one I attend, the question shifts from how to optimise function to how we manage the consequences of a preventable deterioration. The UK has less than 0.3 rehabilitation physicians per 100,000 people – against a European average of 3 per 100,000[7]. Furthermore, half of the major trauma centres across the country have little or no rehabilitation consultant input[8]. As a result, we face a postcode lottery where access to services is determined by geography, which clinician a patient happens to see, and whether that clinician is even aware that surgical options exist at all.

Joint Clinic Model

The clinic I attend runs monthly – a hand surgeon and a rehabilitation physician seeing patients together in the same room. This is not the standard model, most patients with spasticity who receive any specialist review at all will see a rehabilitation physician and a surgeon separately– if they see a surgeon at all that is. The joint assessment streamlines this.

In a single consultation, the rehabilitation consultant brings knowledge of the neurological trajectory, the patient's therapy history and what conservative treatment can realistically deliver. The plastic surgeon brings understanding of the technical options, their respective indications, limitations and risks – as well as the ability to list a patient for surgery directly. Some patients leave with a plan to continue botulinum toxin and optimise physiotherapy and occupational therapy – others are listed that day for surgical management. A decision is made collaboratively, with the patient and with their goals at the centre. No referral letter. No waiting between separate clinics. No fragmented care between these specialties.

There have been discussions around expanding this service; having physiotherapists and occupational therapists present, patients streamed directly into an appropriate management pathway, formal MDT discussions for complex cases. The clinic operates a referral pathway, but the problem is upstream – whether GPs are identifying and referring the right patient. Reducing the long-term care cost, the cost of ongoing physiotherapy and botulinum injections, and the societal costs of not being able to work and contribute to wider society, all need to be formally evidenced. Advocacy alone will not secure its uptake; evidence-based medicine and a systematic approach will.

Conclusion

Madison wanted to wear her netball shirt without people staring. Robert's wife wanted to give her husband the voice his stroke had taken from him. Neither of these goals would have been captured by a referral criterion asking whether a patient would be able to use their hand better afterwards. Both deserved a surgical opinion.

Surgery for spasticity is no longer a last resort. Its indications have developed to include social functioning, quality of life, and restoration of identity – reflecting what patients value. It bridges a gap between what tone management can realistically achieve and what anatomical correction can provide. Its delivery is best achieved through joint services where rehabilitative and surgical thinking are combined in the same room, on the same patient, with the same appreciation of what a patient wants to achieve.

None of this is currently available equitably. Children are largely found by the system. Far too many adults are not – some sitting in care homes with contractures we should have never allowed to develop. The surgeries are available; the supporting evidence is there – a solid referral pathway reaching every patient who needs it does not. What is needed now is the infrastructure, investment, and healthcare professionals who will make it happen.

References

1. Zeng H, Chen J, Guo Y, Tan S. Prevalence and Risk Factors for Spasticity After Stroke: A Systematic Review and Meta-Analysis. Front Neurol. 2021 Jan 20;11:616097. doi: 10.3389/fneur.2020.616097. PMID: 33551975; PMCID: PMC7855612.
2. Lance JW. What is spasticity? Lancet. 1990 Mar 10;335(8689):606. doi: 10.1016/0140-6736(90)90389-m. PMID: 1968597.
3. Hashemi M, Sturbois-Nachef N, Keenan MA, Winston P. Surgical Approaches to Upper Limb Spasticity in Adult Patients: A Literature Review. Front Rehabil Sci. 2021 Aug 31;2:709969. doi: 10.3389/fresc.2021.709969. PMID: 36188802; PMCID: PMC9397894.
4. Oliver, M. (1990) The Politics of Disablement. London: Macmillan Education.
5. National Institute for Health and Care Excellence (2012) Spasticity in under 19s: management (CG145). London: NICE. Updated November 2016. Available at: NICE CG145 Guideline (Accessed: [07.06.2026]).
6. Lam W, Leclercq C, Luria S, Rhee P. Achieving balance in upper limb spasticity management. Journal of Hand Surgery (European Volume). 2026;51(6):737-746. doi:10.1177/17531934261434453
7. British Society of Physical and Rehabilitation Medicine (2024) NHS 10-year health plan for England: BSPRM response. Available at: https://www.bsprm.org.uk/articles/nhs-10-year-health-plan-for-england-survey-bsprm-response/ (Accessed: 7 June 2026).
8. Turner-Stokes, L. et al. (2019) Specialist rehabilitation following major injury: National Clinical Audit (NCASRI) final report. Healthcare Quality Improvement Partnership (HQIP), London. Available at: https://www.kcl.ac.uk/cicelysaunders/about/rehabilitation/national-clinical-audit (Accessed: 7 June 2026).

Patient Inspiration in Physical and Rehabilitation Medicine

Author: Faiz Bhatti

Medical School: University of Buckingham

A person can only do something if they believe it is possible. Doctors tell patients what is and is not possible for them regarding their physical condition. Physical and Rehabilitation Medicine doctors prescribe patients a treatment plan that may include medications and therapy, but they also have the unique role of encouraging and guiding patients on this rehabilitation journey. I believe that the degree to which a physician inspires their patients will improve their ability to recover from injury. In medicine, the effect of one's mind and beliefs on their health and recovery process is severely underestimated. We see some patients make miraculous recoveries from illness and trauma because they have a positive attitude, while other patients struggle with their recovery due to self-doubt. Despite this, there is a great deal of skepticism regarding the impact of one's psychological state on one's ability to recover from a condition. I wish to conduct an examination of contemporary literature to evaluate my assertion.

I began by reviewing a paper studying the correlation between physicians' empathy and clinical outcomes for diabetic patients. The researchers assigned empathy scores to physicians based on a questionnaire. They then measured the outcomes of diabetic patients being treated by these physicians. The first dependent variable they assessed was control of hemoglobin A1c. This paper stated, "Patients of physicians with high empathy scores were significantly more likely to have good control of hemoglobin A1c (56%) than were patients of physicians with low empathy scores (40%, $P < .001$)." [1] Hemoglobin A1c levels are a consistent marker of diabetes severity and the paper established a statistically significant correlation between higher physician empathy scores and lower patient A1c levels. To further substantiate the correlation between physicians' empathy and the effective treatment of diabetic patients, the study tested the association between physician empathy and LDL-C control. The paper asserted, "Similarly, the proportion of patients with good LDL-C control was significantly higher for physicians with high empathy scores (59%) than physicians with low scores (44%, $P < .001$)."[1] The association between LDL-C levels and cardiovascular disease is contained within the NICE (National Institute for Health and Care Excellence) guidelines, based on a large body of research. Therefore, the paper also establishes an association between empathy levels of physicians and reduced risk of cardiovascular disease. This is pertinent to Physical and Rehabilitation Medicine, where many patients have cardiovascular disease that makes their recovery process more difficult. Since the dependent variables of this study are empirical, there is less reason to be concerned about their accuracy. The questionnaire that was used introduced a degree of subjectivity based on one's definition of empathy, but the statistical significance of the results suggests that the questionnaire was constructed logically.

The second paper that I reviewed was concerning the subject of empathy and quality of care. The paper argues that empathy can be correlated with patient satisfaction when both variables are measured using consistent modalities. [2] The researchers did this by reviewing several studies, including surveys comparing levels of empathy to both patient satisfaction and outcomes. In its conclusion, the paper states, "Empathy in the consultation improves outcomes, and empathy can be improved by focused, experiential teaching methods." [2] It was deduced that empathy is a skill, as opposed to a static trait in doctors. This is intriguing because it challenges a popular notion that people are either empathetic or unempathetic. It also emphasizes the importance of incorporating these principles in medical education at all levels. Doctors of the future will have consistently better patient outcomes if they are trained to connect with patients as medical students, but existing doctors would also benefit from focusing on these principles in their continued education.

The third paper I used to find evidence of greater care improving outcomes in patients was a systematic review which included meta-analyses regarding the subject of polymyalgia rheumatica treatment. Polymyalgia rheumatica is a primarily idiopathic rheumatic musculoskeletal disorder consisting of diffuse muscle pain of an autoimmune origin. Upon review of various primary sources and peer-reviewed articles, the researchers describe stages of treatment for a complex illness such as polymyalgia rheumatica. The paper says,

"The studies covered 1 or more phases of the patient journey for people with RMDs." [3] RMDs refers to rheumatic musculoskeletal disorders. The paper goes on to say, "These would be (1) awareness, (2) help-seeking, (3) first encounter, (4) clinical suspicion in primary care, (5) diagnostic tests in primary care, (6) management (outside of rheumatology), (7) rheumatology referral and (8) management in rheumatology." [3]

Conditions such as polymyalgia rheumatica have multiple stages of treatment because they usually require specialized tests for diagnosis and rehabilitation. Without conducting these specialized tests, polymyalgia rheumatica can easily be mistaken for other conditions such as fibromyalgia or rheumatoid arthritis which respond differently to treatment. Polymyalgia rheumatica is treated with low-dose corticosteroids and nonsteroidals, whereas rheumatoid arthritis patients are treated with regular-dose corticosteroids and nonsteroidals. However, fibromyalgia patients do not benefit from anti-inflammatories at all because the condition is caused by a hypersensitivity reaction. Finally, fibromyalgia and rheumatoid arthritis patients experience analgesia from exercise which is not the case for patients afflicted with polymyalgia rheumatica. Polymyalgia rheumatica is an excellent example of the need for all doctors to avoid making assumptions and listen closely to their patient's symptoms before selecting a diagnosis. The stage of help-seeking in polymyalgia rheumatica treatment shows the importance of building a patient's trust, indicating that patients need to trust physicians enough to seek their help in the first place. This applies to all illnesses, of course. When patients have poor experiences with physicians, including the perception of a physician being uncaring, they will be less likely to seek care in the first place. Hence, a dearth of encouragement from a single physician can have negative effects on a patient's health in perpetuity. In addition, the researchers identified the stage of first encounter. [3] If a patient has an unpleasant first encounter, they may not return for another visit. An example of an unpleasant first encounter would be if a patient feels unheard during an initial consultation. If they do not return for another visit, the likelihood of reaching the correct diagnosis and treating it will also decrease. In Physical and Rehabilitation Medicine, we especially require the patient's participation in therapy to achieve full recovery from conditions such as polymyalgia rheumatica which can affect our ability to perform activities of daily living.

When examining the reason that empathy improves outcomes in patients, there are multiple hypotheses that I will propose. Patients report higher levels of both trust and satisfaction when their doctor demonstrates greater levels of empathy.[2] In my own life, I have chosen not to continue my treatment with a physician because I felt that he doubted the severity of my illness, which was psychological in nature. In a circumstance where I had an idiopathic infection, I adhered to the treatment plan given to me closely because I recall the physician stated his desire to help me upon entering the consultation room. Certainly, a patient will be less likely to undergo tests or adhere to a treatment plan if they do not trust the person dictating that treatment. The trust that patients put in us includes their perception of both our morality and competence. If they do not adhere to the prescribed treatment plan, they will be less likely to recover from their illness. There are other explanations proposed by the paper for the link between a physician's empathy and the recovery of their patients, but I find the increased adherence to treatment to be the most compelling. One can apply this principle to Physical and Rehabilitation Medicine where patients are prescribed specific therapy and medications designed to restore their ability to function independently. A more empathetic physician in Physical and Rehabilitation Medicine can therefore assist patients better in being able to return to their baseline physical capabilities.

The fourth study I selected to evaluate the effect of supporting patients on their outcomes assessed mortality in comparison to levels of patient support. The researchers did this by constructing a longitudinal study

following individuals afflicted with HIV over 17 years and assessing their mortality rate. The study also used a self-report questionnaire to assess the level of support being provided to a patient. The study describes the questionnaire as such, “The Montreal-Miami Attitude to Treatment (MMAT-20/HIV) scale is a 20-item self-report questionnaire designed to survey multiple factors that contribute to an overall psychological construct of the treatment process.” [4] The study says this regarding its control of independent variables, “The MMAT-20/HIV predicted survival over 17 years controlling for biomedical (baseline CD4, viral load, antiretroviral medications, age) and psychosocial (race, education, antiretroviral medications) variables.” [4] Upon assessment of the data, the authors write,

“Those in the top half on the MMAT-20/HIV were almost twice as likely to survive as those in the lower half. Scores on the MMAT-20/HIV were significantly but modestly correlated with adherence ($r = .20$, $p < .05$), but adherence was not a mediator of the relationship between the MMAT-20/HIV and survival.” [4]

The finding that patients with HIV lived longer when receiving more psychosocial support, controlling other variables, provides empirical evidence that psychosocial support helps with longevity. This may occur due to patients putting more effort into following their treatment plans as a result of the increased inspiration provided to them. In the field of Physical and Rehabilitation Medicine, patients receive support from the medical team to improve both quality of life and longevity, although the two appear to be positively correlated. Physical and Rehabilitation Medicine patients have many other conditions that may have led to them requiring rehabilitation, even HIV, hence this psychosocial support is an essential part of these patients’ treatment.

The final paper I selected to explore Physical and Rehabilitation Medicine establishes the specific benefits to patients of consulting doctors in Physical and Rehabilitation Medicine. The paper compared the outcomes of traumatic brain injury patients who received treatment from a Physical and Rehabilitation Medicine physician to those patients who did not receive treatment from a consultant in this specialty. The study design was described as follows:

“Data were obtained for 1866 adult patients hospitalized with nonfatal traumatic brain injury. Functional outcome was determined using a modification of the functional independence measure (FIM).” [5] The analysis was conclusive, with the researchers writing “multivariate analysis showed that earlier (<48 hr after admission) physical medicine and rehabilitation consultation resulted in significantly better FIM scores with transfers (odds ratio, 2.61; 95% confidence interval, 1.06-6.40) and locomotion (odds ratio, 3.54; 95% confidence interval, 1.34-9.32) and a significantly shorter acute length of stay ($P = 0.001$).” [5] This source was selected to demonstrate the effect of rehabilitation-focused treatment on a patient’s outcomes. Since doctors in Physical and Rehabilitation Medicine have patient support as a part of their training, they are highly effective at improving patients’ locomotion which reduces their length of stay. It is fascinating that encouraging patients during treatment makes them less dependent on medical treatment after discharge. That encouragement changes a patient's mindset and even has a preventative effect on future illnesses.

My primary reason for studying medicine is to inspire people and make their lives better through this inspiration. This is particularly important to Physical and Rehabilitation Medicine, where doctors must convince patients to participate in activities of recovery by informing them of the benefits and the manner in which they may be conferred. I certainly have a greater interest in this specialty due to the research I conducted in the process of writing this paper. The literature I reviewed supports the concept of encouragement resulting in faster recovery. I postulated that this was due to greater treatment adherence. However, I also believe the body itself responds more effectively to injuries in a state of positive cognition. I am suggesting that markers of chronic inflammation, such as C-reactive protein (CRP), would be downregulated in a patient with a pleasant mood compared to a depressed patient, facilitating more efficient tissue repair. In the future, I hope to collect data that could be used to assess the theory that positive cognition itself facilitates faster healing. We have the responsibility of choosing the most effective treatment for a patient and convincing them to adhere to it, but we may also have the power to change the way patients’ bodies respond to illness after treatment.

References:

1. Hojat M, Louis DZ, Markham FW, Wender R, Rabinowitz C, Gonnella JS. Physicians' empathy and clinical outcomes for diabetic patients. Acad Med. 2011 Mar;86(3):359-64. doi: 10.1097/ACM.0b013e3182086fe1. PMID: 21248604.
2. Mercer SW, Reynolds WJ. Empathy and quality of care. Br J Gen Pract. 2002;52(Suppl):S9-12. PMID: 12389763; PMCID: PMC1316134.
3. Harris GK, Leung JL, Buchanan RRC. Exploring the patient experience in polymyalgia rheumatica. Clin Rheumatol. 2023 Dec;42(12):3421-3422. doi: 10.1007/s10067-023-06752-x.
4. Ironson G, Hylton E, Verhagen R. A new attitude towards treatment measure predicts survival over 17 years. J Gen Intern Med. 2022 Mar;37(10):2351-2357. doi: 10.1007/s11606-021-07245-y. PMCID: PMC9360262.
5. Wagner AK, Fabio T, Zafonte RD, Goldberg G, Marion DW, Peitzman AB. Physical medicine and rehabilitation consultation: relationships with acute functional outcome, length of stay, and discharge planning after traumatic brain injury. Am J Phys Med Rehabil. 2003 Jul;82(7):526-36. doi: 10.1097/01.PHM.0000073825.09942.8F. PMID: 12819540.

History of Spinal Cord Injury Rehabilitation: From Ancient Egypt to Modern Physical Medicine and Rehabilitation

Author: Hana Ghaith

Medical School: University of Sunderland

How have the understanding, management, and rehabilitation of spinal cord injuries evolved from Ancient Egyptian medicine to contemporary Physical Medicine and Rehabilitation (PM&R)?

INTRODUCTION

The spinal cord is an essential communication pathway between the brain and the body, acting as a conduit for neurological signals; a spinal cord injury (SCI) is a disabling neurological condition leading to disruption of motor, sensory and autonomic function. They most frequently occur after high-energy mechanisms of injury, or in select populations like the elderly, due to lower-energy mechanisms too. consequences of SCIs are vast and devasting, ranging from deficits in motor function to significant disability and paralysis.

Throughout time, documents such as the Edwin Smith Papyrus (a unique medical journal from 1600 BCE describing the clinical presentation of spinal cord injuries)[1] have aided in the understanding, classification and management of SCI, which although was limited at the time, it served as a cornerstone in further advancing recovery and quality of life, which is now a specialty more broadly known as physical medicine and rehabilitation (PM&R). PM&R or physiatry is a unique speciality dedicated to improving quality of life and function in those with disabilities by focusing on whole-person functioning rather than the functions of a specific organ, meaning it has a holistic approach which emphasises functioning and participation. It covers a wide range of conditions, such as SCI, which remains one of the most severe conditions managed under its umbrella.[2] Due to the dramatic nature of the condition, further modern advances in technological and surgery will be needed to further maximise function and quality of life, which is the core aim of physical medicine and rehabilitation (PM&R).

This essay will explore the history of SCI, dating from ancient Egypt and referencing important texts such as the Edwin Smith papyrus, and evolve into modern understanding of SCI and how these together have shaped contemporary approaches to the condition.

SPINAL CORD INJURY IN ANCIENT EGYPT

The ancient Egyptians practiced medicine professionally and pioneered the treatment for a wide range of disease, from dental to gynaelogical using plant and animal products, some of which are still used. [3] They also were brilliant diagnosticians, with some of it evidenced in the Edwin Smith papyrus dating from the seventeenth century, which is the oldest surviving trauma text in history. The text is of importance when looking at spinal cord injuries and it contains 6 cases (of the 48 it presents) which relate to injuries of the spine, which it describes in accurate detail. The last clinical case described in the text ends abruptly, hypothesising the writer was going to write more about spinal cord injuries. Unlike other texts, it focuses on clinical observation rather than remedies, further strengthening the viewpoint that the ancient Egyptians were good at diagnosing complex conditions.[4]

Within the text, it can be assumed that the injuries were sustained during battle or in construction, with the average patient being a young, otherwise healthy male, which are assumptions deducted by the time period and choice of language by the author. As mentioned, the papyrus records six SCI injury cases, the first ones ever. The text describes fractures of the spine, and links it to clinical presentations such as paralysis and loss of sensation. Interestingly, the ancient Egyptians linked neck injuries with paralysis of the limbs and further neurological deficits despite having no understanding of neurophysiology or neuroanatomy. This is how the Edwin Smith Papyrus matters to modern PM&R, as its influence on functional assessment and the prognostic links its made allows physicians now to assess motor and sensory function of the limbs, which in turn has helped aid methods in disability management and maximising function in the modern day.

To further assess how documentation of SCI injury in Ancient Egypt has progressed to modern day rehabilitation, it is important to look at how the papyrus recognises SCIs. The papyrus is remarkably structured, using subheadings for introductions, symptoms, diagnosis and recommended treatment. This systematic organisation of the Edwin Smith Papyrus further demonstrates one of the earliest forms of clinical reasoning that remains fundamental to orderly medical practice. For example, it starts with briefly mentioning a mechanism of injury, "fall head-downwards which caused a vertebra to crush its counterpart", and then goes onto symptoms, such as neck stiffness, inability to rotate or flex the neck, painful neck flexion or rotation, pain, and unawareness of both the arms and legs (a term we understand suggests an implication of motor and sensory function). When reading this text, it is important to note none of these are confirmed cases, and that the papyrus does not include differentials at all, which is why with modern medicine we have been able to narrow down specifically what has caused some of these presentations and how the papyrus understandably contains many gaps, with two cases of SCI in the text not describing stiffness and paralysis of the neck as a symptom at all. The text remarkably goes on to contain the first known descriptions of automimic dysfunction due to SCI, such as priapism and urinary incontinence. One of the most important ways the Edwin Smith papyrus aided physical medicine and rehabilitation is through the categorisation of spinal cord injuries, in which it clearly distinguishes between cervical, thoracic and lumbar injuries, and further categorises cervical injuries as open or closed. Furthermore, it distinguishes vertebral body compression fractures from vertebral body burst fractures through post-mortem examinations, which occurred more than 3,500 years before the Watson-Jobes vertebral body classification, therefore highlighting its service to the progression of SCI. [5]

Finally, the text briefly describes prognosis and treatment, which is perhaps its greatest limitation. It humbly recognises severe SCIs an "ailment not to be treated" showing they understood its poor prognosis and limited treatment options available, which can be compared with modern rehabilitation.

Although they lacked the anatomy and neurophysiology to aid them in proper recognising and treating SCIs, their recognition of paralysis and classification of the injuries through systematic clinical assessment laid the foundations for the earliest neurological examinations. Now, modern PM&R has transformed this further to help hone these assessments further to individualise rehabilitation, establish goals and predict long term outcomes.

CLASSICAL AND MEDIEVAL CONTRIBUTIONS TO SPINAL CORD INJURY MANAGEMENT

When looking at how the understanding of SCI has evolved from ancient Egypt, it is easier to periodically assess, from Greek and roman medicine to Islamic medicine and their influences on anatomy and therapeutic exercises, to further ascertain an accurate timeline of how it is now viewed in modern physical medicine and rehabilitation.

Unlike the Egyptians who documented the earliest cases of SCI, important figures, like Hippocrates, or the 'father of medicine' who lived from 460-370 BCE after the decline of the Egyptian Empire, focused more on mechanical interventions; these techniques represent early attempts to improve physical function post injury,

which remains a core principle today. [6]Hippocrates considered knowledge of spinal anatomy, and describes this in his book 'On Nature of Bones' were he describes diseases of the spine and suggests treatments for them. Remarkably, he describes reduction techniques for fractures and underlines the basis of fracture management and fixation which has provided insight into the treatment of modern day spinal diseases. His texts have been further studied now and with each emerging piece of evidence, it confirms that what he was doing during his time carried largely the right foundations although he lacked the necessary means to carry these out, which we now largely have in modern PM&R. [7]

A further important figure to introduce is Galen, a Greek physician who followed after Hippocrates, whose medical theories undermined medicine for a long time, such as the four humours. His role in the evolution of SCI is though the contribution of neurology and linking the level of SCI to paralysis and recognising the higher the injury, the higher disability, which is evidently key today and although it is easily observable through imaging now, it is impressive what was achieved despite the lack of resources. Galen moved the understanding from simply injury equals paralysis to different injuries cause different effects. Modern SCI management still relies on this as the level of injury indicates expected functional outcomes, which links to the rehabilitation a patient will receive. [8]

The next most logical progression would be Ibn Sina and the Islamic age, and how the concepts during this time constructed the rehabilitation we see today. Ibn Sina was a Persian physician whos influence is still seen today through the texts he wrote, such as the Cannon of Medicine, which is a comprehensive medical encyclopaedia which was completed around 1025 CE. [9] It helpfully compiled information from his predecessors like Hippocrates and Galen whilst including his own findings. Ibn Sina once again shaped anatomy today, as he classified the spine into cervical, thoracic, lumbar, sacral and coccygeal regions based on size and shape of each vertebrae.[10] Furthermore, he mentioned spinal nerves and the idea of motor and sensory roots, and how the nerves were also grouped into cervical, thoracic, lumbar, sacral and coccygeal regions. When taking into account that he included the work of Galen, it makes sense as he evidenced that different levels of spinal cord injury would lead to varied severity of motor deficits, as he showed that different levels carried different spinal nerves. One of the main takeaway points from the Canon of Medicine for SCI is its emphasis on the power of exercise, with discussions from massages and therapeutic movement in the management of injuries and these exercise-based interventions are still used as an adjunct to medical or surgical interventions, or used as a sole treatment in more minor injuries. Ibn Sina identified how therapeutic exercise maximised independence and physical function.

To unify the ages, it can be seen how the ancient Egyptians focused on identifying SCI, then the Greek and Islamic scholars focused on anatomy and the earliest forms of therapeutic interventions, with Ibn Sinas interventions foreshadowing principles that are now central to modern rehabilitation.

THE EMERGENCE OF MODERN SCI MANAGEMENT

Although the work during ancient Egypt and ancient Greece helped understand SCI more, it continued to be associated with poor morbidity and high mortality due to complications such as sepsis, highlighting the need for further research into treatment of the condition, research that came with time.

The 19th century became a turning for SCI due to further understanding of neuroanatomy which helped physicians further understand why SCIs lead to paralysis, alongside this, surgical advances further aided treatment options. Furthermore an important improvement during the 19th century was hospital care, which lowered the rate of complications, like sepsis, but also others like pressure ulcers and UTIs. For example, teaching hospitals in London were home to prominent surgeons such as Astley Cooper and Charles Bell who pioneered early surgical treatment options like laminectomies for SCI. Likewise, as SCI management was

advancing in England, Germany was following close behind in the 19th century, with the first successful account of SCI management being done by Wilhelm Wagner. He and his peer wrote a detailed book describing spinal cord injuries from start to end, and even including how to prevent complications, like pressure sores and the importance of post-surgical mobilisation, which are concepts familiar to us now, but showed how their identifician improved mortality rates, and how concepts new to them at the time, are common practice in modern physical medicine and rehabilitation. [11]

As medicine continued advancing, certain world events became turning points, like the world wars, which placed an emphasis on specialised units with better nursing care to improve outcomes, but certain people also revolutionised the care of SCI we see today; one of these people was Ludwig Guttman, who can be regarded as the father of modern SCI rehabilitation as he founded modern treatment of spinal injuries. Accounts of his demeanour as a doctor were astonishingly positive, with his enthusiasm being described as infectious and described as having great empathy, sympathy and charisma. When he came to England from Germany, he built on Wagners ideas, and set up further specialised units, and aided treatment by incorporating physical methods of treatment like exercise and functional training. Overall, Guttmann's philosophy changed the tone from passive to active care, and established rehabilitation principles employed in the modern day, helping birth the modern rehabilitation modern which shifted the focus to independence and patient participation to improve a patients quality of life. (12)

MODERN PM&R AND CONTEMPORARY SCI REHABILITATION

Modern SCI management has evolved considerable since the Edwin Smith Papyrus, with contemporary rehabilitation using a biopsychosocial model to utilise a holistic approach to medicine, unifying the mind and body. Rehabilitation techniques now are vast, and we can assess rehabilitation techniques and their impacts through many ways, such as scoring systems like the Functional Independence Measure Locomotor score. [12] With the emerging care, it is said that 'time is spine', which highlights the importance of acute management interventions to improve outcomes. One of the first methods to improve future success of rehabilitation is stabilisation at the point of injury for the establishment of a definitive airway and paying careful attention to the spine. Alongside this, prompt hospital transfer to aid immediate diagnostic assessments though classifications like the ASIA neurological classification and imaging (usually CT) to determine the extent of the injury and streamline early treatment, that being surgical or medical. After the acute SCI care, traditional rehabilitation strategies aim to improve the range or motion through mobility, strengthening exercises and transfer exercises. Modern examples of PM&R include body weight supported treadmill training, which is evidenced to improve locomotion. More contemporary examples include braces and orthoses. However, this isn't the end of PM&R, emerging therapy include medications like riluzole (a sodium channel blocker aiming to decrease cell death), and systemic hypothermia which has shown clinical success in complications such as cardiac arrest and encephalopathy. There are many more emerging therapies and will continue to be as medicine is progressing as SCI are devasting and will never preventable condition. [13]

CONCLUSION

In conclusion, SCI is a complex condition with devastating outcomes for the patient and their family. From Ancient Egypt which showed early advances in the recognition of SCI, then moving periodically to how important figures like Hippocrates and Galen aided neuroanatomy and understanding of paralysis, to the world wars and now modern-day PM&R were effective treatments and rehabilitation techniques are employed worldwide daily. Today, PM&R focuses on maximising function and quality of life though strategies that have been tried and tested to improve quality of life. While physicians now benefit from advanced technology, the

principles that helped this from the first recorded accounts of injuries of ancient Egypt, or the first time a successful intervention was performed in Germany cannot be ignored.

REFERENCE LIST

1. *Lima R, Monteiro A, Salgado AJ, Monteiro S, Silva NA. Pathophysiology and Therapeutic Approaches for Spinal Cord Injury. International Journal of Molecular Sciences [Internet]. 2022 Nov 10;23(22):13833. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9698625/*
2. *van Middendorp JJ, Sanchez GM, Burridge AL. The Edwin Smith papyrus: a clinical reappraisal of the oldest known document on spinal injuries. European Spine Journal [Internet]. 2010 Aug 10;19(11):1815–23. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2989268/*
3. *Sivan M, Negrini S, Kiekens C, Khan F, Francisco GE, Gimigliano F. The INFORM (International Framework for Rehabilitation Medics) Project to Strengthen the Medical Specialty. Advances in Rehabilitation Science and Practice. 2023 Jan;12.*
4. *Metwaly AM. Traditional Ancient Egyptian Medicine: a Review. Saudi Journal of Biological Sciences [Internet]. 2021 Jun 19;28(10). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8459052/#:~:text=The%20ancient%20Egyptians%20practiced%20medicine,could%20diagnose%20diabetes%20and%20cancer.*
5. *van Middendorp JJ, Sanchez GM, Burridge AL. The Edwin Smith papyrus: a clinical reappraisal of the oldest known document on spinal injuries. European Spine Journal [Internet]. 2010 Aug 10;19(11):1815–23. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2989268/*
6. *Watson-Jones R (1938) The results of postural reduction of fractures of the spine. J Bone Joint Surg Am 20(3):567–586. Available from https://journals.sagepub.com/doi/10.1177/21925682251366981?__cf_chl_f_tk=bQa0WcEH7DFzN1prRxAvXbAZKHAELwvkGeN6u61NpDw-1782818791-1.0.1.1-0fEE3yuYbtyBv3U2zUt0yp0CD_Z3ZUwAByGEuUsoLOg.*
7. *Koutserimpas C, Naoum S, Piagkou M, Alpantaki K, Samonis G. Hippocrates: A Pioneer in Orthopaedics and Traumatology. Surgical Innovation [Internet]. 2024 Feb 1;31(1):123–7. Available from: https://pubmed.ncbi.nlm.nih.gov/37978930/*
8. *Vasiliadis ES, Grivas TB, Kaspiris A. Historical overview of spinal deformities in ancient Greece. Scoliosis. 2009 Feb 25;4(1). Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC2654856/*
9. *Silver JR. History of the treatment of spinal injuries.* Postgrad Med J. *2005;81(952):108-114. doi:10.1136/pgmj.2004.019992. Available from: https://academic.oup.com/pmj/article/81/952/108/7031920*
10. *Bakhtiar L, Gruner OC.* The Canon of Medicine (al-Qānūn fī'l-ṭibb). *Chicago (IL): Great Books of the Islamic World; 1999.*
11. *İBN SÎNÂ [Internet]. TDV İslâm Ansiklopedisi. Available from: https://islamansiklopedisi.org.tr/ibn-sina*
12. *Silver JR. History of the treatment of spinal injuries. Postgraduate Medical Journal [Internet]. 2005 Feb 1 [cited 2019 Nov 1];81(952):108–14. Available from: https://pmj.bmj.com/content/81/952/108*
13. *Burns AS, Marino RJ, Kalsi-Ryan S, Middleton JW, Tetreault LA, Dettori JR, et al. Type and Timing of Rehabilitation Following Acute and Subacute Spinal Cord Injury: A Systematic Review. Global Spine Journal. 2017 Sep;7(3_suppl):175S194S.*
14. *Hachem LD, Ahuja CS, Fehlings MG. Assessment and management of acute spinal cord injury: From point of injury to rehabilitation. The Journal of Spinal Cord Medicine [Internet]. 2017 Jun;40(6):665–75. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5778930*

The Engagement Gap: Why psychological rehabilitation in acquired brain Injury fails before it begins

Author: Igor Pereszczako

Medical School: Anglia Ruskin University

This essay draws on a systematic review of barriers and facilitators to psychotherapy engagement in acquired brain injury that I undertook as a Student Selected Component (SSC) at Anglia Ruskin University School of Medicine. The project consumed several months of work and represented, for me, a genuine attempt to engage with a clinical problem that I found both intellectually compelling and personally important. Submitting it in this form is, in part, an attempt to give it the audience it deserves and to ensure that the findings, however modestly, might reach people who can put them to use.

I am grateful to my supervisor, Sarah McLachlan at Anglia Ruskin University, for her support throughout the project, and to Nora Brennan and the team at Headway East London, whose partnership gave the work its grounding in real clinical experience. I know that Nora will be glad to see these findings reach a wider readership, and it feels fitting that a project which began in collaboration with a patient charity should find its way, eventually, to an audience of rehabilitation clinicians. The poster which helped inform this essay was constructed by me, with help from Sarah, entitled: Engagement with psychotherapy in people with moderate to severe brain injury: a systematic review of barriers and facilitators.

Introduction

In 2019, an estimated 27.16 million individuals sustained a new traumatic brain injury globally.[1] In the United Kingdom alone, 356,699 hospital admissions were attributed to brain injury in the same year.[2] These figures capture only the acute burden. The enduring sequelae of acquired brain injury (ABI, encompassing traumatic brain injury, stroke, and other non-traumatic causes) extend far beyond the initial insult, imposing a chronic, multidimensional burden that rehabilitation medicine is uniquely positioned to address. Memory impairment, emotional dysregulation, behavioural change and the loss of occupational identity collectively define a rehabilitation challenge that is as psychological as it is physical.[3]

Within this context, psychological therapy occupies a critical but persistently underperforming role. Clinical practice guidelines consistently emphasise the importance of psychological intervention in ABI rehabilitation, recognising that depression and anxiety affect approximately 44% and 24% of adults with persistent post-concussion symptoms respectively, whilst behavioural and emotional sequelae complicate recovery across injury severities.[4] Yet in clinical practice, referral to psychology is not equivalent to engagement with psychology. Attrition is high, therapeutic relationships are difficult to sustain, and the conditions that determine whether a patient can meaningfully access psychological care are rarely addressed as a clinical priority.

This essay draws on a systematic review of barriers and facilitators to psychotherapy engagement in adults with moderate-to-severe ABI, undertaken as a Student Selected Component (SSC) at Anglia Ruskin University School of Medicine in partnership with Headway East London and aligned to PRISMA 2020 methodology, to argue that the central problem in psychological rehabilitation is not the quality of available interventions but the structural and relational conditions that precede them. Three barrier domains consistently undermine engagement before meaningful therapy can begin. For Physical and Rehabilitation Medicine (PRM) physicians, who carry

multidisciplinary team (MDT) leadership responsibility, understanding and systematically addressing these barriers is not a peripheral consideration. It is a core clinical obligation.

The rehabilitation paradox

Psychological rehabilitation in ABI exists within a paradox that the specialty has been slow to name. A growing evidence base supports the efficacy of cognitive-behavioural therapy, acceptance and commitment therapy, behavioural activation and adapted group interventions in improving mood, functional disability and quality of life following brain injury.[5,6] Simultaneously, real-world engagement with these interventions remains inconsistently achieved, with high dropout rates, poor between-session adherence and frustrated therapeutic alliances particularly prevalent in patients with moderate-to-severe presentations.[7]

The field's characteristic response to this paradox has been to refine the interventions themselves, developing shorter formats, digitally delivered models and population-specific adaptations.[6,8] This is a valuable endeavour, but it misidentifies the locus of the problem. If patients cannot access, sustain or benefit from psychological therapy because of cognitive, emotional or relational conditions that exist upstream of the therapeutic encounter itself, then refining the therapy will not close the engagement gap. What is required is a systematic understanding of the barriers to engagement, and a clinical commitment to addressing them as a prerequisite to psychological referral rather than an afterthought.

It was this clinical gap that motivated the SSC systematic review, conducted at Anglia Ruskin University School of Medicine in partnership with Headway East London, a brain injury support charity whose frontline experience provided both the intellectual impetus and the real-world grounding for the work.

Methodology

The review was aligned to PRISMA 2020 methodology[9] and searched nine major databases: Cinahl Plus, Embase, MEDLINE, Ovid, PsycINFO, PTSDPubs, SCOPUS, the Cochrane Library and Web of Science. Search terms included combinations of "brain injury," "psychotherapy," "engagement," "barriers" and "facilitators." From 22,296 initial records, 9,083 proceeded to title and abstract screening by two independent reviewers, with a third to potentially resolve conflicts in inclusion and exclusion decisions. Following full-text assessment, 14 sources were included in the final synthesis: ten primary studies, two grey literature sources and two identified through citation screening. Study designs were heterogeneous, encompassing qualitative interview studies, observational feasibility studies, quantitative exploratory designs, single-case experimental studies and a systematic review, reflecting the methodological diversity characteristic of this field. Findings were presented as a poster at institutional level.

Barrier domain one: cognitive impairment

The most consistently cited barrier across included sources was cognitive impairment, particularly memory dysfunction. Judd and Wilson[7] found that 16 of 21 participating psychologists identified memory impairment as the primary obstacle to forming a working therapeutic alliance, reporting that continuity between sessions was persistently disrupted by patients' inability to recall prior content. Morrison and colleagues[10] similarly identified cognitive barriers (including difficulties with executive functioning, concentration and memory) as the predominant rehabilitation obstacle among patients with traumatic brain injury, distinguishable from the physical limitations that characterised stroke survivors' primary concerns.

The clinical implications extend beyond simple session-to-session repetition. When patients cannot retain therapeutic frameworks, consolidate behavioural strategies or recall agreed formulations, the cumulative gains that psychological therapy depends upon cannot accrue. Memory aids, written session summaries and structured between-session materials have demonstrated efficacy in partially mitigating this barrier,[7] yet their systematic provision remains inconsistent. A contemporaneous feasibility study of an adapted acceptance and commitment therapy intervention for stroke survivors found that handbook inaccessibility, difficulty comprehending abstract therapeutic concepts and post-stroke fatigue each constituted active barriers to session engagement,[8] reinforcing that cognitive adaptation is not a refinement but a prerequisite for participation.

For PRM physicians, this domain presents a concrete point of intervention. Cognitive screening prior to psychological referral, calibrated not merely for diagnostic purposes but to inform the specific conditions under which therapy can be meaningfully delivered, should become standard practice. Recommendations to the receiving psychologist regarding session pacing, written support materials and appropriate session length could materially improve the conditions for engagement before the first therapeutic encounter occurs.

Barrier domain two: psychological and identity disruption

The second domain is less tractable and, in many respects, more clinically significant. ABI does not merely alter cognition; it fundamentally disrupts the patient's sense of self. Hoepner and Keegan[11] documented, through qualitative interview analysis of twenty individuals with TBI of varying severity, that loss of identity in its multiple forms, including loss of self-knowledge, loss of comparative self-relative to pre-injury functioning, and loss of self as perceived through others' eyes, constitutes a pervasive and active barrier to healthcare engagement. Critically, their analysis revealed that clinical interactions, including dismissal of ongoing symptoms and failure to validate the chronic nature of TBI, directly exacerbated this identity erosion.

This finding carries profound implications for psychological rehabilitation. If the therapeutic relationship itself, or the broader clinical environment in which it is embedded, communicates disbelief or minimisation of the patient's experience, the foundational condition for any psychological work is undermined before it begins. Patients with mild and moderate TBI in Hoepner and Keegan's cohort described a particular form of clinical ambiguity: being perceived as insufficiently injured to merit ongoing support yet experiencing functional consequences that precluded return to pre-injury life. This limbo actively impeded values-based participation in rehabilitation.

Emotional and behavioural challenges compound this picture. Depression, trauma responses, disinhibited behaviour and the exhausting demands of psychological work felt intensely beyond the therapy room, including significant out-of-session burden reported by behavioural activation therapy participants.[12] Foote's doctoral analysis of an adapted ACT intervention for stroke survivors identified additional psychological barriers including difficulty witnessing others' strong emotions in group settings and self-efficacy deficits in contributing meaningfully to group discussion.[13]

The implications for PRM practice are again concrete. Validation of persistent symptoms as a legitimate and expected consequence of brain injury, delivered consistently by all MDT members rather than by psychologists alone, constitutes a clinical act with measurable consequences for engagement. Training rehabilitation physicians and allied health professionals to recognise and counteract identity-invalidating clinical interactions should be embedded within ABI rehabilitation competency frameworks.

Barrier domain three: family and carer ecosystem

The third domain was simultaneously the most powerful barrier and the most potent facilitator identified in the review: family and carer involvement. Morrison and colleagues[10] demonstrated that family functioning was a statistically stable predictor of perceived rehabilitation barriers, accounting for substantial variance in community participation satisfaction. Guina and Guina[14] illustrated the facilitating counterpart of this relationship in a single-case report: the presence of a family member during an EMDR session for a patient with severe post-stroke expressive aphasia enabled collateral information to be provided that was otherwise inaccessible, fundamentally enabling therapeutic progress that the session format alone could not have achieved.

Stejskal[15] extended this analysis further, arguing that rehabilitation in ABI should be conceptualised as contingent on family involvement across the patient's lifespan, not merely at the point of acute care. Family members themselves frequently require psychological support, in some cases to a greater degree than the patient, and poor family functioning driven by the relational disruption that ABI imposes actively obstructs engagement with all forms of rehabilitation.

Despite this evidence, psychological interventions for ABI are almost universally designed as individual-level treatments. The systemic exclusion of carers from the therapeutic framework removes what the review identifies as both a primary facilitator of engagement and an important source of collateral clinical information. For PRM physicians coordinating MDT care, explicit commissioning of family-inclusive rehabilitation pathways, whether through joint sessions, carer psychoeducation programmes or formalised parallel carer support referrals, represents a structural intervention with meaningful implications for patient outcomes.

The facilitator evidence

The facilitating factors identified in the review are as instructive as the barriers, and they share a notable structural feature: each operates upon the conditions required for engagement rather than upon the content of therapy itself. Adapted and tailored therapeutic models (online delivery, group therapy modifications, communication aids for patients with aphasia, structured written summaries and memory aids) emerged as the most consistently cited facilitator, supported by four sources.[7,8,13,14] Crucially, these adaptations address the cognitive and communication barriers identified above. Barriers and facilitators are not independent phenomena but mechanistically linked: the absence of adaptation creates the barrier; its systematic provision removes it.

Family and community support emerged with equal consistency as a positive engagement factor, reinforced by four sources.[10,11,12,14] This convergence between the barrier and facilitator evidence is not incidental. It strengthens the argument for a pre-engagement framework in which the structural responses to barriers are built into rehabilitation design from the outset, rather than discovered and improvised mid-intervention.

Post-acute care failure

Overlying these individual-level barriers is a systemic failure in post-acute care. Hoepner and Keegan's[11] participants reported near-universal satisfaction with acute and sub-acute care, followed by profound dissatisfaction with the chronic phase, characterised by provider dismissal, unclear referral pathways and inadequate long-term support. This trajectory is a structural feature of UK brain injury services, not a series of individual clinical failures.

Silverberg and colleagues[16] gave this systemic gap a specific institutional face. In semi-structured interviews with eleven family physicians, GPs reported significant uncertainty regarding their roles in managing the neuropsychiatric sequelae of brain injury, limited familiarity with specialist recommendations and considerable difficulty navigating onward referral pathways. If the primary care interface, the point at which patients with persistent post-injury difficulties most frequently present, lacks the capacity to recognise, validate and appropriately refer these presentations, psychological rehabilitation will systematically fail to reach those who need it most.

This is the domain in which PRM has the clearest institutional leverage. Rehabilitation physicians, with established relationships across acute, community and primary care settings, are best placed to develop post-discharge care pathways that include structured primary care liaison, clear referral algorithms and explicit long-term follow-up mechanisms. The alternative, brief high-quality rehabilitation followed by discharge into a care vacuum, is a structurally predictable route to relapse and re-referral.

Synthesis and implications

The evidence synthesised in this review supports a fundamental reconceptualisation of how PRM should approach psychological rehabilitation in ABI. Rather than treating psychological referral as the beginning of the intervention, PRM physicians should treat it as the culmination of a preparatory process, one that systematically addresses the cognitive, relational and social conditions that determine whether engagement is achievable.

This pre-engagement framework has three practical components. First, cognitive screening prior to psychological referral should generate specific recommendations about the adaptations required, not merely a diagnostic label. Second, identity-validating clinical practice across the MDT should be recognised as a therapeutic act in its own right, requiring deliberate attention and training. Third, family and carer assessment should be embedded in rehabilitation protocols as a standard component, generating parallel support pathways that sustain the relational ecosystem in which individual psychological work occurs.

Conclusion

Psychological rehabilitation in acquired brain injury is not failing for want of effective therapeutic modalities. It is failing because the structural, relational and systemic preconditions for engagement are not being systematically addressed. The findings of this SSC systematic review, drawn from nine databases, screened against PRISMA-informed methodology and synthesised in partnership with Headway East London, identified three convergent barrier domains alongside a post-acute care system that routinely allows the engagement gap to widen between hospital discharge and community recovery.

Physical and Rehabilitation Medicine, as the specialty with both the MDT leadership mandate and the longitudinal patient relationship, is best positioned to close this gap, not by developing better therapies in isolation, but by treating engagement itself as a clinical outcome worthy of systematic attention and deliberate design.

Personal reflection

The academic framing of this review belies the moment that gave it its clearest purpose. During a clinical placement at Southend Hospital, I encountered a volunteer from Headway Braintree working with patients on the ward. What struck me was not the clinical encounter itself but the conversation that followed: hearing, at close quarters, what it feels like to navigate a healthcare system that moves on whilst the injury does not. The experience humanised the literature in a way that no database search could. Behind every barrier theme extracted from an included study, there are individuals who cannot always articulate what is obstructing their recovery, not because the experience is absent, but because the language and the opportunity to express it have not been offered to them. That realisation reframed the purpose of the review entirely. It was no longer purely an academic exercise in evidence synthesis. It felt, in some small way, like an attempt to hand back a voice to people who had not lost the experience of their injury, only the means to make others understand it.

References:

1. Guan B, Anderson DB, Chen L, et al. Global, regional and national burden of traumatic brain injury and spinal cord injury, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. BMJ Open 2023;13(10):e075049. doi:10.1136/bmjopen-2023-075049
2. Headway. Statistics. Available at: https://www.headway.org.uk/about-brain-injury/further-information/statistics/ [Accessed 26 April 2025]
3. De Luca R, Calabrò RS, Bramanti P. Cognitive rehabilitation after severe acquired brain injury: current evidence and future directions. Neuropsychological Rehabilitation 2018;28(6):879-898. doi:10.1080/09602011.2016.1211937
4. Riggio S. Traumatic brain injury and its neurobehavioral sequelae. Psychiatric Clinics of North America 2010;33(4):807-819. doi:10.1016/j.psc.2010.08.004
5. Bertisch H, Rath JF, Langenbahn DM, et al. Group treatment in acquired brain injury rehabilitation. Journal for Specialists in Group Work 2011;36(4):264-277. doi:10.1080/01933922.2011.613901
6. Gómez-de-Regil L, Estrella-Castillo DF, Vega-Cauich J. Psychological intervention in traumatic brain injury patients. Behavioural Neurology 2019;2019:6937832. doi:10.1155/2019/6937832
7. Judd D, Wilson SL. Psychotherapy with brain injury survivors: an investigation of the challenges encountered by clinicians and their modifications to therapeutic practice. Brain Injury 2005;19(6):437-449. doi:10.1080/02699050400010994
8. Patchwood E, Foote H, Vail A, et al. Wellbeing after stroke (WAterS): feasibility testing of a co-developed acceptance and commitment therapy intervention to support psychological adjustment after stroke. Clinical Rehabilitation 2024;38(7):979-989. doi:10.1177/02692155241239879
9. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi:10.1136/bmj.n71
10. Morrison B, Patel TA, Brackin M. Family functioning, community participation, and rehabilitation barriers in the acquired brain injury community: an exploratory analysis. Rehabilitation Counseling Bulletin 2024;68(3):168-181. doi:10.1177/00343552241236891
11. Hoepner JK, Keegan LC. “I avoid interactions with medical professionals as much as possible now”: health care experiences of individuals with traumatic brain injuries. American Journal of Speech-Language Pathology 2023;32:846-866. doi:10.1044/2022_AJSLP-22-00103
12. Gertler P, Tate RL. Behavioural activation therapy to improve participation in adults with depression following brain injury: a single-case experimental design study. Neuropsychological Rehabilitation 2021;31(3):369-391. doi:10.1080/09602011.2019.1696212
13. Foote H. Acceptance and commitment therapy to support psychological adjustment after stroke: investigating acceptability, fidelity and measurement [PhD thesis]. University of Manchester; 2024. Available at: https://research.manchester.ac.uk/en/studentTheses/acceptance-and-commitment-therapy-to-support-psychological-adjust
14. Guina J, Guina C. Wants talk psychotherapy but cannot talk: EMDR for post-stroke depression with expressive aphasia. Innovations in Clinical Neuroscience 2018;15(1):45-48
15. Stejskal TM. Removing barriers to rehabilitation: theory-based family intervention in community settings after brain injury. NeuroRehabilitation 2012;31(1):75-83. doi:10.3233/NRE-2012-0776
16. Silverberg ND, Otamendi T, Dulai A, et al. Barriers and facilitators to the management of mental health complications after mild traumatic brain injury. Concussion 2021;6(3):CNC92-0022. doi:10.2217/cnc-2020-0022

Beyond walking again: the overlooked cognitive deficits in stroke rehabilitation

Author: Ikeola Alao

Medical School: University of Nottingham Medical School

Introduction

Rehabilitation after stroke has transformed outcomes for millions of survivors [11, 12]. It has also, in a significant respect, left many of them behind. Stroke is one of the leading causes of acquired disability worldwide [14], while physical recovery is a well-established focus of rehabilitation, cognitive impairment affects approximately half of all stroke survivors [3], encompassing deficits in memory, attention, and executive function with significant consequences for independence, relationships, and daily functioning [6, 7].

Drawing on clinical observation and evidence, this essay examines the disparity between how physical and cognitive rehabilitation are supported after stroke, and contends that the current system prioritises visible motor recovery while under-recognising cognitive impairment, resulting in a definition of recovery that may misrepresent true patient outcomes.

The Man Learning to Walk

Seated in a wheelchair at the end of parallel bars, watching the physiotherapist adjust the equipment, was a man learning to walk. When he stood, it was slow: a careful, deliberate transfer of weight from chair to hands, hands to bars. He moved in small, measured steps, steadying himself with each placement of his feet. The session had a clear structure: a defined distance, a defined goal, a defined end. He completed it.

Watching him, my instinctive thought was simple: this man will recover. The process in front of me was visible, purposeful, and progressive. These were qualities that made recovery feel not only possible but inevitable.

Physical rehabilitation after stroke is effective, well organised, and well understood. A systematic review and meta-analysis of 467 randomised controlled trials involving over 25,000 participants found strong evidence that physical rehabilitation interventions improve motor outcomes after stroke [11]. This evidence is reflected at a policy level: the National Institute for Health and Care Excellence mandates at least three hours of multidisciplinary rehabilitation daily, across five days per week [12].

The progress of physical rehabilitation is also well measured: the Barthel Index provides a standardised, quantifiable assessment of functional independence across activities of daily living, allowing recovery to be tracked [13].

Taken together, the scientific evidence, policy mandate, and standardised measurement framework reflect a domain of rehabilitation that is thoroughly evidenced and comprehensively supported at a policy level. Physical rehabilitation, however, is one component of stroke rehabilitation, not its entirety.

The Man Behind the Helmet

He was sitting upright, wearing a protective helmet, focused on fine motor rehabilitation tasks. His physical function was largely preserved: his movements controlled, his posture steady. From these observations alone, I assumed he was approaching discharge. It was only through conversation that the full extent of his difficulty became apparent.

At times, he was unable to recall the names of his children, where he lived, or other details central to his own identity. The contrast was difficult to ignore: clear physical capability existing alongside equally clear cognitive impairment. This was not a patient with two separate problems; it was a patient whose rehabilitation was visibly addressing only one of them.

When asked about his cognitive progress, a nurse remarked that this might simply be "his new normal." The comment was not unkind, but it was revealing. It suggested an implicit clinical acceptance that cognitive deficits, unlike physical ones, sit outside the boundaries of what rehabilitation is expected to restore.

Post-stroke cognitive impairment (PSCI) is common, though reported prevalence varies considerably: from 22% in population-based cohorts assessed using the Mini-Mental State Examination (MMSE) [1], to over 80% in those assessed with the Montreal Cognitive Assessment (MoCA) [2], with meta-analytic estimates of approximately 53% depending on the tool used [3]. This variation is not arbitrary. Studies reporting the lowest prevalence figures predominantly rely on the MMSE, a tool with well-documented insensitivity to mild cognitive impairment and executive dysfunction [4].

The MoCA, by contrast, incorporates attentional and executive tasks that the MMSE omits, and consistently yields higher detection rates in the same populations [2]. Rather than reflecting genuine differences in the burden of PSCI, the lower estimates may therefore represent a measurement artefact: a floor imposed by a tool designed for a different purpose, applied to a condition it is poorly equipped to detect.

Unlike physical rehabilitation, where the Barthel Index provides a standardised outcome measure to track functional recovery [13], no equivalent tool exists to quantify cognitive rehabilitation progress. Cognitive assessment after stroke relies predominantly on screening tools such as the MMSE and the MoCA, which are designed to detect impairment rather than measure recovery [1,2].

Executive dysfunction is particularly relevant to rehabilitation: the capacity to plan, self-monitor, and adapt is precisely what structured recovery demands. A patient whose executive function is impaired may disengage from therapy, struggle to carry learning between sessions, or appear passive in the face of decisions about their own care, as this patient did [5].

These deficits are also harder to observe than motor impairments. They fluctuate, are context-dependent, and may not manifest within the structured, time-limited environment of a ward review. A patient may appear well-oriented during a morning assessment and yet be unable to hold a familiar conversation by afternoon. However, the more significant problem is not that this inconsistency goes unnoticed; it is that it is simply accepted. This acceptance was evident in the clinical encounter outlined above. The nurse's remark captured this dynamic precisely: not a judgement on the patient, but an implicit lowering of expectation for a domain that rehabilitation had, quietly, stopped trying to reach.

An outlier? Or the system

The man behind the helmet is not an outlier. PSCI is common; its consequences reach beyond the clinical setting, into relationships, autonomy and the capacity to participate in daily life. A patient who can walk but not remember the names of their children is not recovered in any meaningful sense.

PSCI dismantles long-established social networks, which in turn further disrupts self-identity [7]. The consequences extend across the domestic sphere: partners and family members frequently assume carer roles, fundamentally altering relationships that were previously built on mutuality [8]. Intimacy is complicated by newfound dependency and a loss of reciprocation that both parties may struggle to articulate [7,8]. Social participation narrows as cognitive difficulties make previously manageable interactions effortful, and the isolation that follows compounds the initial impairment [7]. The person who returns home after rehabilitation may be physically restored but cognitively diminished; able to inhabit their former environment but no longer

able to fully participate in the life it contained. Yet patients are often left to navigate these consequences without structured support from healthcare providers [6].

The system is structured in a way that allows these consequences to go unnoticed. Cognitive screening tools exist; however, the outcome measures that quantify rehabilitation success prioritise physical function. The Barthel Index is a dominant rehabilitation measure, yet it lacks sensitivity to cognitive and psychosocial domains of recovery [9]. A patient like the man behind the helmet could score highly on discharge, seemingly rehabilitated, yet cognitively and socially diminished.

This imbalance is embedded at a policy level. NICE NG236 dedicates 31 recommendations to movement rehabilitation, specifying interventions, devices, frequencies, and techniques in considerable detail [12]. The cognitive functioning section contains 9 recommendations, most of which instruct clinicians to assess and then apply interventions suited to the impairment, without equivalent specificity [12]. None of these cognitive recommendations were updated in the 2023 revision of the guideline, while movement received multiple new and updated recommendations [12]. The gap reflects a fundamental asymmetry in evidence: physical rehabilitation has developed the outcome measure infrastructure necessary to generate specific, prescriptive guidance; cognitive rehabilitation has not. Where guidance cannot be prescriptive, clinical practice cannot be held accountable, and where accountability is absent, under-prioritisation is the predictable result.

Cognitive rehabilitation must be incorporated alongside physical rehabilitation. Cognitive function directly predicts mobility and functional independence in activities of daily living [10]. The exclusion of cognitive rehabilitation from these frameworks does not merely leave patients cognitively underserved; it undermines the physical outcomes the system is trying to achieve. If the system cannot measure what is lost, it cannot be expected to address it.

Reflection

Initially when looking at the man learning to walk, I made a subconscious observation that he was moderately to severely impaired. That assumption contrasted sharply with my initial impression of the man behind the helmet, whom I had observed as mildly impaired; it was only through conversation with him and the nurse that this impression dissolved. The shift in judgment arose not from visible clinical findings, but from the gap between what I could see and what was actually present, along with the recognition that I had nearly missed it entirely. It unsettled me. I had assessed him as mildly impaired, and I had been wrong in a way that mattered.

Rehabilitation is not uniform, linear or purely physical. It is multidimensional, with aspects that are not equally visible or valued. Physical fluctuation prompts clinical concern; cognitive fluctuation tends to be absorbed into the prognosis. A patient struggling to remember is more likely to be met with accommodation than intervention, as the nurse's remark illustrated. The remark troubled me. Whatever its intention, it signalled that the system had quietly revised its expectations downward, and that this had become unremarkable.

This clinical experience has challenged a subconscious bias, highlighting the multifaceted nature of rehabilitation. If rehabilitation is to address what patients actually lose, it must first be recognised by those delivering it. A clinician who sees only what is visible risks mistaking partial recovery for complete recovery.

Conclusion

Physical recovery is mandated by policy, tracked by validated outcome measures, and reinforced by the visible, progressive nature of motor rehabilitation. Cognitive recovery receives attention, but inconsistently: NICE NG236 illustrates this at a systemic level, with physical rehabilitation recommendations that are specific and prescriptive, while those addressing cognitive function are broader and reliant on clinician discretion [12]. The result is a system in which cognitive impairment is identified but not measurably addressed, creating space for it to be accommodated into the prognosis rather than treated as a rehabilitation target.

The evidence base for physical rehabilitation is strong, and the infrastructure supporting it, from policy mandates to validated outcome measures, reflects this. Cognitive rehabilitation requires equivalent infrastructure: a standardised outcome measure for cognitive recovery progress, equivalent in function to the Barthel Index, without which improvement cannot be tracked and accountability cannot exist. Without this, the dominant metrics of rehabilitation success will continue to favour physical function.

For a patient like the man behind the helmet, the consequences reach far beyond what those metrics record: relationships reshaped by newfound dependency, social networks narrowed as cognitive impairment makes participation effortful, family members absorbing carer roles without structured support. These consequences are not incidental; they are the predictable result of a system that has built comprehensive infrastructure around physical rehabilitation while leaving cognitive rehabilitation without equivalent evidence, measurement, or policy support.

References:

1. *Douiri, A., Rudd, A.G. and Wolfe, C.D.A. (2013). Prevalence of Poststroke Cognitive Impairment. Stroke, 44(1), pp.138–145. doi:https://doi.org/10.1161/strokeaha.112.670844.*
2. *Mahon, S., Parmar, P., Barker-Collo, S., Krishnamurthi, R., Jones, K., Theadom, A. and Feigin, V. (2017). Determinants, Prevalence, and Trajectory of Long-Term Post-Stroke Cognitive Impairment: Results from a 4-Year Follow-Up of the ARCOS-IV Study. Neuroepidemiology, 49(3-4), pp.129–134. doi:https://doi.org/10.1159/000484606.*
3. *Barbay, M., Diouf, M., Roussel, M. and Godefroy, O. (2018). Systematic Review and Meta-Analysis of Prevalence in Post-Stroke Neurocognitive Disorders in Hospital-Based Studies. Dementia and Geriatric Cognitive Disorders, 46(5-6), pp.322–334. doi:https://doi.org/10.1159/000492920.*
4. *Melkas, S., Jokinen, H., Hietanen, M. and Erkinjuntti, T. (2014). Poststroke cognitive impairment and dementia: prevalence, diagnosis, and Treatment. Degenerative Neurological and Neuromuscular Disease, [online] 4, p.21. doi:https://doi.org/10.2147/dnnd.s37353.*
5. *Skidmore, E.R., Whyte, E.M., Holm, M.B., Becker, J.T., Butters, M.A., Dew, M.A., Munin, M.C. and Lenze, E.J. (2010). Cognitive and Affective Predictors of Rehabilitation Participation After Stroke. Archives of Physical Medicine and Rehabilitation, 91(2), pp.203–207. doi:https://doi.org/10.1016/j.apmr.2009.10.026.*
6. *Tang, E.Y.H., Price, C., Stephan, B.C.M., Robinson, L. and Exley, C. (2020). Impact of Memory Problems Post-stroke on Patients and Their Family Carers: A Qualitative Study. Frontiers in Medicine, 7. doi:https://doi.org/10.3389/fmed.2020.00267.*
7. *Pallesen, H. (2013). Body, coping and self-identity. A qualitative 5-year follow-up study of stroke. Disability and Rehabilitation, 36(3), pp.232–241. doi:https://doi.org/10.3109/09638288.2013.788217.*
8. *Kitzmüller, G., Asplund, K. and Häggström, T. (2012). The Long-Term Experience of Family Life After Stroke. Journal of Neuroscience Nursing, 44(1), pp.E1–E13. doi:https://doi.org/10.1097/jnn.0b013e31823ae4a1.*
9. *Quinn, T.J., Langhorne, P. and Stott, D.J. (2011). Barthel Index for Stroke Trials. Stroke, [online] 42(4), pp.1146–1151. doi:https://doi.org/10.1161/strokeaha.110.598540.*
10. *Harini, T., Madushani, P., Munasinghe, D., Maleesha, Y., Vithanage, K. and Wettasinghe, A. (2025). The association of cognitive functions with functional outcomes during post-stroke recovery: A cross-sectional study. Journal of Clinical Neuroscience, [online] 142, p.111667. doi:https://doi.org/10.1016/j.jocn.2025.111667.*
11. *Veerbeek, J.M., van Wegen, E., van Peppen, R., van der Wees, P.J., Hendriks, E., Rietberg, M. and Kwakkel, G. (2014). What Is the Evidence for Physical Therapy Poststroke? A Systematic Review and Meta-Analysis. PLoS ONE, [online] 9(2). doi:https://doi.org/10.1371/journal.pone.0087987.*
12. *NICE (2023). Overview | Stroke rehabilitation in adults | Guidance | NICE. [online] www.nice.org.uk. Available at: https://www.nice.org.uk/guidance/ng236*
13. *Sangha, H., Lipson, D., Foley, N., Salter, K., Bhogal, S., Pohani, G. and Teasell, R.W. (2005). A comparison of the Barthel Index and the Functional Independence Measure as outcome measures in stroke rehabilitation: patterns of disability scale usage in clinical trials. International Journal of Rehabilitation Research, 28(2), pp.135–139. doi:https://doi.org/10.1097/00004356-200506000-00006.*
14. *Feigin, V.L., Stark, B.A., Johnson, C.O., Roth, G.A., Bisignano, C., Abady, G.G., Abbasifard, M., Abbasi-Kangevari, M., Abd-Allah, F., Abedi, V., Abualhasan, A., Abu-Rmeileh, N.M., Abushouk, A.I., Adebayo, O.M., Agarwal, G., Agasthi, P., Ahinkorah, B.O., Ahmad, S., Ahmadi, S. and Ahmed Salih, Y. (2021). Global, regional, and National Burden of Stroke and Its Risk factors, 1990–2019: a Systematic Analysis for the Global Burden of Disease Study 2019. The Lancet Neurology, [online] 20(10), pp.795–820. doi:https://doi.org/10.1016/s1474-4422(21)00252-0.*

A Second Season of Strain: Heatwaves, Functional Safety and Rehabilitation Medicine

Author: Jess Byun

Medical School: Barts/Queen Mary University of London

Introduction

The UK is having a summer it was not built for. For decades, healthcare has thought of winter as its season of strain: flu, pneumonia, falls, cold homes and delayed discharges. However, heat is becoming a second season of strain. At the time of writing this essay, the Met Office had issued its first Red Extreme Heat Warning of the year, with temperatures forecast to approach 40°C across parts of England. That threshold was crossed for the first time in recorded British history in July 2022, during a summer associated with an estimated 2,985 excess deaths in England [1]. What has changed is the trajectory: days above 40°C are now far more likely than they were in the 1960s, and the Met Office estimates a fifty-fifty chance of seeing another 40°C day in the UK within the next twelve years [2]. The UK is heating up faster than its infrastructure, housing stock and healthcare system were designed to tolerate.

Heat does not only kill. It also brings patients into hospital and pushes those already living with chronic illness closer to decompensation. A recent study found heatwaves increase emergency admissions, ischaemic stroke and acute kidney injury [3]. These are not merely acute events: they leave delirium, deconditioning, pressure damage and new dependence in their wake – the functional losses PRM exists to treat.

Healthcare feels this acutely. Wards built for a temperate climate become oppressive by mid-afternoon. During my hospital experience on a Trauma and Orthopaedic ward, I watched staff fan patients with paper folders while fluid charts filled faster than drip bags could be changed. Fridge alarms sound on wards; medicines like insulin pens delivered cold no longer feel quite cold; tablets and capsules in blister packs soften at room temperature, in spaces that were never designed to store treatment safely through heat. The medicines trolley becomes a hazard map: diuretics, anticholinergics, beta-blockers, antipsychotics and sedatives, each capable in different ways of narrowing the body's safety margin in hot weather [4,5]. Watching the ward struggle, I kept returning to the same question: where were these patients going next?

PRM is not immune to heatwaves. It may be uniquely exposed to them.

PRM becomes most visible where acute medicine's question has been answered but the patient's has not: not simply "Am I alive?", but "Can I live? Can I dress, return home, sustain a relationship, and recognise when I need help?" Those questions do not pause during a heatwave. They become harder.

This essay examines heatwaves through the work of PRM, using Sarang and Ada as a lens: Sarang, an ordinary PRM patient, and Ada, her partner and main carer. It considers Sarang's body, the home she returns to, and the PRM team trying to deliver progress in conditions not designed for this. Taken together, this essay argues that being medically stable is not the same as being functionally safe – and that in a heatwave, that gap widens.

Body and home: ordinary complexity, extraordinary risk

Sarang is a 63-year-old woman, ten weeks post-stroke, managing residual left-sided weakness alongside longstanding type 2 diabetes, painful osteoarthritis of both knees, hypertension, persistent fatigue, and a cognitive slowing her family had noticed before the stroke but the acute ward never quite had time to investigate. She is not the most complex patient on the rehabilitation ward. She is, if anything, representative.

She is vulnerable not because of a rare condition, but because she represents the ordinary complexity of rehabilitation medicine. In a heatwave, that ordinary complexity becomes dangerous.

Heat narrows every margin she has. Her therapy tolerance, already limited by fatigue and pain, falls further: her physiotherapist notes that she manages twenty minutes before the session must stop, where previously she managed forty. Her fluid intake, already unreliable, becomes critical rather than advisory. Heat-related vasodilation and dehydration make postural symptoms more likely in someone already unsteady on her best days. Her osteoarthritis pain feels harder to manage when sleep is poor and fatigue is already high. Her skin, particularly over areas of pressure and reduced mobility, carries greater risk of breakdown. And her confidence, which her occupational therapist has spent six weeks carefully rebuilding, takes a quiet hit every time the heat makes a task harder than it was yesterday.

Her medication chart does not help. Her antihypertensive and diuretic burden may narrow the margin between treatment and dizziness, dehydration or falls. Her anticholinergic for bladder urgency can suppress sweating. Sedating medicines may blunt her awareness of thermal discomfort or delay recognition of deterioration. Diabetes complicates the picture further: dehydration, variable appetite and altered activity can all destabilise glucose control [4,5,6]. Reading that chart, a clinician sees a patient whose medication burden has narrowed her thermal safety margin through several mechanisms at once – none individually dramatic, all pointing in the same direction.

Sarang is the most common kind of PRM patient, but she is not the only kind, and the physiological stakes vary with diagnosis. Patients with spinal cord injury, especially higher lesions, may have impaired sweating and cutaneous vasodilation below the lesion, making passive heat exposure particularly hazardous [7,8]. Those with multiple sclerosis may experience worsening neurological symptoms with small rises in core temperature. Amputees may face socket discomfort, sweating, skin breakdown and poorer prosthetic fit. Patients with postural tachycardia syndrome or post-COVID dysautonomia may experience worsened orthostatic intolerance; for frail older adults, dehydration can accelerate into delirium. Each mechanism is distinct. Together, they represent the working material of a specialty that routinely inherits bodies whose thermoregulation, mobility, cognition, skin integrity and confidence have already been altered by the illness or injury that brought them into care.

That body is now going home. For Ada, Sarang's wife and primary carer, discharge is not the end of hospital care. It is the moment clinical risk becomes household responsibility. She has learned the transfer technique, rearranged the flat, memorised the medication schedule. What no one prepared her for is what to do when the flat is thirty-four degrees at 9 pm and Sarang cannot sleep, will not drink, and is more confused than usual.

The home is a clinical variable. It is where Sarang sleeps — and sleep is where neurological recovery happens. It is where she hydrates, attempts her exercises, and where her skin either holds or breaks down under conditions that were never part of the ward assessment.

The flat has no air conditioning – a fact that appeared on no clerking form because no one thought to ask. That absence is not random. Heat vulnerability tracks housing, income, tenure, urban density, shade, transport and the ability to control one's environment [9,10]. Two patients may receive the same outpatient physiotherapy appointment at 2 pm in August but do not make the same journey. One arrives by air-conditioned car, tired but safe. The other waits at a bus stop without shade, transfers twice, and arrives dehydrated and dizzy, expected to perform a session designed as if the journey did not count. In a heatwave, rehabilitation access begins before the clinic door. Ada borrowing a fan from her mother is not incidental; it is a statement about what this household can access. Climate does not create inequality from nothing. It enters the inequalities that are already there and makes them clinically louder.

Heat acts on bodies, on homes, and on the relationships that hold both together. Ada is sleeping badly too. She has not mentioned it.

Carer and the PRM team: a prescription in a different currency

When the rehabilitation physician reviews Sarang's discharge plan, the clinical question is not whether her observations are stable. It is whether she can drink, toilet, transfer, sleep, summon help, manage her medications, and continue therapy in a flat that was thirty-four degrees the night before. Medically stable is not the same as functionally safe. That distinction is the philosophical foundation of the specialty, and in a heatwave it becomes urgent.

Ada is part of that calculation. She is not a passive recipient of the discharge summary; she is a clinical actor, performing manual handling, monitoring cognition, managing medication timing, and making dozens of daily decisions about Sarang's safety and comfort. Heat acts on her too. Her sleep is fragmented. On the day the flat reached thirty-two degrees by mid-morning, she cancelled her own appointment to stay. There is no clinical form that records this. Her physical and emotional reserves are not unlimited. The carer who is exhausted and overheated makes different decisions from the carer who is rested, and those decisions shape directly whether rehabilitation progresses or stalls. The rehabilitation physician's question therefore extends outward from patient to household: can this carer sustain safe care in these conditions?

The physiotherapist's answer begins with reframing the goal. In a heatwave, the aim is not to maintain the same exercise intensity but to preserve progress without turning therapy into harm. This means earlier sessions, shorter duration, modified intensity. Sarang's twenty-minute threshold is not failure; it is the correct physiological response to conditions that have changed. A rehabilitation prescription, like any prescription, must be adjusted when the pharmacokinetics change – and heat changes them. The physiotherapist's dosed exertion schedule, the occupational therapist's functional task progression: this is a prescription in a different currency. The unit is steps, not milligrams; the route is bed to bathroom, not blood to receptor. The consequence of getting it wrong, such as a fall, a skin breakdown, a loss of confidence that takes weeks to rebuild, is as serious as an adverse drug reaction, and considerably harder to reverse. It is undervalued precisely because it does not appear on a drug chart.

For the occupational therapist, the home is not simply where rehabilitation ends; it is part of the prescription. The route from bed to bathroom, the chair Sarang rests in between tasks, the location of drinking water, the safety of the shower, the position of the fan Ada has borrowed – these are not domestic details. They are the conditions in which recovery either continues or fails – what the International Classification of Functioning frames not as background, but as part of functioning itself [11].

The team itself is working in the heat. Research on healthcare professionals confirms what ward staff already know: heat can impair concentration, reaction time, decision-making and wellbeing [12]. In rehabilitation – slow, physical, relational and cognitively demanding – these effects are not abstract. A therapist who is dehydrated and overheated is less able to perform safe manual handling or notice subtle deterioration. In rehabilitation, staff wellbeing is not an HR concern – it is a patient safety argument and one of the conditions that makes safe recovery possible.

Climate as a functional environment

PRM already knows how to think about environment. Every rehabilitation assessment asks about stairs, about finances, about whether there is a carer and what that carer can realistically manage. These are not social footnotes appended to the clinical picture; they are part of it. The staircase Sarang cannot yet climb is a clinical variable; so is what Ada can sustain. Climate belongs in the same category. The argument for climate-resilient PRM is not an expansion into public health; it is that the functional environment now reliably includes thermal conditions that alter rehabilitation outcomes, and PRM has the framework and tools to respond [13,14].

The first shift is that heat enters the rehabilitation assessment itself, not as an afterthought but as a systems question alongside mobility, cognition, continence, skin integrity, housing and carer capacity. For Sarang, this

means asking not only whether she can transfer, but whether she can do so after forty minutes in a flat that has not cooled since yesterday; not only whether her cognition meets the threshold for discharge, but whether heat-related slowing will push her below safe self-management at home; and whether cool water is reachable from her chair without a transfer. These questions do not require a new assessment tool. They require the existing tool to be applied with climate in view.

The second shift is that the rehabilitation prescription adapts to thermal conditions. The medication risks already established in Sarang's chart – diuretics, anticholinergics, sedatives, diabetes agents – require active review against the thermal conditions of the environment she is returning to. A medication review conducted with heat in mind is not a new task for the rehabilitation team; it is the same clinical pharmacology applied to a new environmental stressor. The physiotherapist adjusts session timing; the rehabilitation physician adjusts the medication chart. Both are calibrating a prescription to conditions on the ground — an approach Newman et al. [13] and Amatya and Khan [14] identify as foundational to climate-adaptive rehabilitation practice.

The third shift is in how discharge is judged. A bed freed is not a safe homecoming; the question is whether Sarang's home, at its actual temperature and layout, allows her to sleep, to hydrate, to keep her skin intact, to use her equipment and to reach help if something goes wrong. These have always been functional criteria; heat makes them acute. And the answers are not evenly distributed: they track with income, housing tenure, age, and postcode – a geography of thermal vulnerability that belongs on the rehabilitation assessment alongside grip strength and walking speed [9,15].

Climate-resilient PRM is not about adding weather advice to discharge paperwork. It is about recognising climate as part of the functional environment — and responding with the same rigour PRM already brings to every other barrier between a patient and their recovery.

Conclusion: keeping survival human

Imagine Sarang three months from now. The stroke has not resolved; it has been incorporated. She transfers with one-person assist. She manages her medication with a dosette box Ada fills on Sundays. She walks to the kitchen with a stick, slowly, on a good morning. The journey from the acute ward to that kitchen – the decisions made about her therapy schedule, her home environment, Ada's capacity, her medication chart – is what rehabilitation medicine built. Now imagine that journey in August, in a flat that has not dipped below twenty-eight degrees for a week. The gains are still there. But the margin for error is smaller. She tires faster and each transfer costs more. Ada is doing more than she should and sleeping less than she needs. The heatwave does not undo the rehabilitation. But it tests it – and what makes the difference, in that test, is whether the team anticipated the conditions and built them into the plan.

Heatwaves reveal what rehabilitation medicine is for. They expose the distance between a patient who has been medically optimised and a patient who can actually live – dress, eat, move, sleep, maintain relationships and manage their own health – in the environment they are returning to. Acute medicine saved Sarang's life. PRM is deciding whether it can be lived: in her flat, in her relationships, in summers that are becoming more frequent and more intense.

In a warming world, PRM is not an optional aftercare service. It is the discipline that keeps survival human.

References

1. UK Health Security Agency. Heat mortality monitoring report: 2022 [Internet]. London: UK Health Security Agency; 2022 [cited 2025 Jun]. Available from: https://www.gov.uk/government/publications/heat-mortality-monitoring-reports/heat-mortality-monitoring-report-2022
2. Met Office. Met Office report details rising likelihood of UK hot days [Internet]. Exeter: Met Office; 2025 Jun 18 [cited 2025 Jun]. Available from: https://www.metoffice.gov.uk/about-us/news-and-media/media-centre/weather-and-climate-news/2025/met-office-report-details-rising-likelihood-of-uk-hot-days
3. Bujosa Mateu A, Alegre Latorre L, Villalonga Comas M, Salom J, García Gasalla M, Planas Bibiloni L, et al. Impact of heat waves on human morbidity and hospital admissions in a city of the western Mediterranean area. Int Arch Occup Environ Health. 2024;97(7):757-765. doi:10.1007/s00420-024-02082-y.
4. Wee J, Tan XR, Gunther SH, Ihsan M, Leow MKS, Tan DSY, et al. Effects of medications on heat loss capacity in chronic disease patients: health implications amidst global warming. Pharmacol Rev. 2023;75(6):1140-1166. doi:10.1124/pharmrev.122.000782.
5. Westaway K, Frank O, Husband A, McClure A, Shute R, Edwards S, et al. Medicines can affect thermoregulation and accentuate the risk of dehydration and heat-related illness during hot weather. J Clin Pharm Ther. 2015;40(4):363-367. doi:10.1111/jcpt.12294.
6. Hospers L, Dillon GA, McLachlan AJ, Alexander LM, Kenney WL, Capon A, et al. The effect of prescription and over-the-counter medications on core temperature in adults during heat stress: a systematic review and meta-analysis. E Clinical Medicine. 2024;77:102886. doi:10.1016/j.eclinm.2024.102886.
7. Trbovich MB, Handrakis JP, Kumar NS, Price MJ. Impact of passive heat stress on persons with spinal cord injury: implications for Olympic spectators. Temperature (Austin). 2019;7(2):114-128. doi:10.1080/23328940.2019.1631730.
8. Grossmann F, Flueck JL, Perret C, Meeusen R, Roelands B. The thermoregulatory and thermal responses of individuals with a spinal cord injury during exercise, acclimation and by using cooling strategies: a systematic review. Front Physiol. 2021;12:636997. doi:10.3389/fphys.2021.636997.
9. Stein PJS, Stein MA, Groce N, Kett M, Akyeampong EK, Alford WP, et al. Advancing disability-inclusive climate research and action, climate justice, and climate-resilient development. Lancet Planet Health. 2024;8(4):e242-e255. doi:10.1016/S2542-5196(24)00024-X.
10. UK Health Security Agency. Adverse Weather and Health Plan: protecting health from weather-related harm [Internet]. London: UK Health Security Agency; 2025 [cited 2025 Jun]. Available from: https://www.gov.uk/government/publications/adverse-weather-and-health-plan
11. World Health Organization. International classification of functioning, disability and health: ICF. Geneva: World Health Organization; 2001.
12. Freire K, Green E, Kernaghan L, Castelletto K, Schubert JA. Impact of heat and mitigation strategies on healthcare professionals: a scoping review. Public Health Nurs. 2025;42(3):1408-1420. doi:10.1111/phn.13534.
13. Newman M, Kokame KA, Leochico CFD, Fogarty AE, Burton J, Tenforde AS, et al. Climate change and health through the lens of physical medicine and rehabilitation: a scoping review. J Clim Chang Health. 2024;22:100362. doi:10.1016/j.joclim.2024.100362.
14. Amatya B, Khan F. Climate change and disability: a physical medicine and rehabilitation (PM&R) perspective. J Int Soc Phys Rehabil Med. 2023;6(1):5-9. doi:10.1097/PH9.0000000000000003.
15. Rhim N, Lee S, Choi KH. Adverse health effects of climate change and air pollution in people with disabilities: a systematic review. Epidemiol Health. 2024;46:e2024080. doi:10.4178/epih.e2024080.

Introduction to RED-S

Author: Katherine McCabe

Medical School: University of Nottingham

Young athletes have never had greater access to information about health, nutrition and exercise, yet growing concerns regarding disordered eating and compulsive exercise behaviours have coincided with increasing recognition of Relative Energy Deficiency in Sport (RED-S). RED-S is a syndrome resulting from prolonged low energy availability (LEA) in athletes and was initially introduced as an extension of the Female Athlete Triad by the International Olympic Committee. The Female Athlete Triad is characterised by the three key features of LEA, low bone mineral density, and menstrual disturbances. In 2014, it was expanded in order to recognise the consequences of underfuelling in men and to account for the complexity of energy deficiency beyond these core features. (1)

As rehabilitation professionals increasingly adopt biopsychosocial approaches to athletic health, understanding the sociocultural factors that contribute to RED-S, including the potential role of social media, has become increasingly important. Whilst social media can provide support, community and education for athletes, it can also normalise restrictive eating, compulsive exercise and specific body ideals. This essay argues that social media functions as an emerging digital determinant of health, specifically a sociocultural risk factor for RED-S and needs to be recognised by medical and rehabilitation professionals responsible for the prevention, treatment and management of the condition.

Biological Consequences

RED-S occurs when energy intake is insufficient to meet the combined demands of exercise and normal physiological function. Energy availability refers to the dietary energy remaining for essential physiological processes after accounting for exercise energy expenditure, with LEA defined as less than 30 kilocalories per kilogram of fat free mass (2).

RED-S represents the complex adaptive response to energy deficiency, affecting multiple organ systems. Reduced energy availability is detected by centres within the hypothalamus which suppress non-essential physiological processes through metabolic and hormonal adaptations in order to conserve energy. Although protective in the short term, prolonged adaptation leads to widespread physiological dysfunction, including reduced basal metabolic rate, impaired glycogen restoration and increased reliance on fat stores for energy.

RED-S is characterised by substantial endocrine dysfunction. In an energy deficit, the hypothalamic-pituitary-gonadal axis is suppressed, causing menstrual dysfunction in females and reduced testosterone production in males through decreased luteinising hormone and follicle-stimulating hormone secretion. Over time, these hormonal adaptations lead to impaired bone metabolism, delayed recovery and an increased risk of injury.

The endocrine changes of RED-S also affect the musculoskeletal system. Reduced concentrations of oestrogen and testosterone disrupt normal bone remodelling processes by increasing bone resorption and decreasing bone formation. This reduced bone quality puts athletes with RED-S at an increased risk of stress fractures (3). This is particularly concerning in high impact sports such as running when recurrent bone stress injuries are more likely to occur, resulting in prolonged recovery and increased time away from sport due to rehabilitation. Furthermore, decreased bone mineral density and reduced bone microstructure may increase the risk of osteopenia and osteoporosis in the long term. This is particularly concerning when adolescents and young adults fail to achieve sufficient peak bone mass, as this predicts an increased lifetime fracture and osteoporosis risk (4).

Beyond the health consequences, RED-S also greatly affects performance in athletes. LEA reduces an athlete's ability to recover and adapt to increasing training demands through impaired glycogen restoration and muscle protein synthesis. Consequently, athletes experience reduced strength and endurance and increased fatigue. Furthermore, psychological consequences including reduced concentration, mood disturbance and increased emotional distress may further impair both athletic performance and rehabilitation. Ironically, behaviours promoted and pursued in the name of athletic improvement ultimately impair performance. Rather than enhancing sport, chronically underfuelling prevents athletes from acquiring the full benefits of their training.

Social media and the normalisation of low energy availability

Aesthetisation of athleticism

Social media does not merely expose athletes to underfuelling behaviours, but incentivises them through social and algorithmic conditioning. Historically, athletic success has been determined primarily through performance; who can run the fastest, jump the furthest, or lift the heaviest. However, social media has gradually shifted the focus from performance to appearance, where success is communicated visually. Algorithms preferentially promote content featuring clear abdominal definition, extremely low body fat percentages, and before-after transformations as this generates higher levels of interest and engagement. This has transformed private monitoring behaviours into public performance. As a result, physiques associated with chronic energy deficiency are frequently portrayed as indicators of health, discipline and athletic ability.

Repeated exposure to these ideals normalises restrictive eating and extreme leanness. Recent evidence further supports the role of body image disturbance as a mechanism linking social media use and RED-S; an association has been identified between body image dissatisfaction (including drive for thinness, drive for muscularity, exercise dependence and disordered eating) and low energy availability in both male and female athletes. (8) Whilst these findings demonstrate an important association, causality remains difficult to establish because athletes already vulnerable to body image concerns may preferentially seek out this content. Nevertheless, whether social media acts as a cause or an amplifier is arguably less important clinically than recognising it as a modifiable risk factor within rehabilitation pathways.

This phenomenon can be explained by Festinger's 'Social Comparison Theory' (1954), which proposes that individuals evaluate their own attributes and abilities through comparison with others. In this context, social media repeatedly exposes athletes to a curated abundance of idealised physiques and extreme training behaviours, so there are more opportunities for upward social comparison. A systematic review by Holland and Tiggemann (6) found that social networking use is positively associated with body image concerns and disordered eating, behaviours which overlap with those seen in RED-S. Within online fitness spaces, leanness is aestheticised as athletic performance and often portrayed as a prerequisite for sporting success, reinforcing the belief that lower body weight translates to improved performance.

Furthermore, unlike more traditional thin ideals, contemporary fitness culture has been seen to promote the notion that 'strong is the new skinny' in alignment with recent developments in body positivity and empowerment. Consequently, potentially harmful behaviours remain masked by evidence of fitness and wellbeing.

Clean Eating and Orthorexia Nervosa

Beyond shaping appearance ideals, social media also has the ability to shift athlete behaviour through the promotion of clean eating and wellness culture. These practices are often promoted as evidence-based approaches to health optimisation, but may encourage increasingly restrictive behaviours which place athletes at an increased risk of low energy availability.

Whilst attention to nutrition is essential for athletes' performance, an obsessive focus on dietary purity can become maladaptive, particularly when driven by unregulated online advice rather than by qualified professionals. Bratman (1997) used the term 'orthorexia' to describe the pattern of behaviours characterised by an obsessive focus on perceived food purity, rigid dietary rules and distress associated with deviation from self-imposed dietary standards (7). Whilst not specifically recognised by common diagnostic criteria (DSM-5 or ICD-11), there is growing acknowledgment of the range of behaviours which the disorder describes and their implications.

Within sporting environments, athletes are especially vulnerable to developing orthorexia. Many athletes already monitor their food intake, linking nutrition closely to athletic identity, which can make restrictive dietary practices more difficult to acknowledge. Therefore, orthorexic tendencies such as excessive calorie counting and rigid food rules can appear reasonable. Behaviours that would be concerning in the general population are often normalised or glamorised in sport and may be reinforced by coaches and peers as signs of discipline. Regardless of whether restriction is driven by appearance, performance, or ideals, the physiological outcome remains the same.

Distinguishing between disciplined training and obsessive behaviour can therefore be difficult. While high training volumes may be necessary for progress, they must be balanced with recovery and appropriate oversight. Behaviours associated with RED-S are also frequently interpreted online as commitment, further delaying recognition of harmful patterns until significant damage has occurred.

Algorithmic Reinforcement

Social media algorithms can reinforce athlete vulnerabilities through continuous exposure to appearance-focused and health-related content. Platforms are optimised for engagement and watch time, increasing the likelihood that users are shown content similar to that with which they interact. This can create a curated feed which lacks content diversity. Recommendation systems (such as a 'For You Page') prioritises content similar to that which users have engaged with. An initial interest in health or performance can therefore escalate into sustained exposure to restrictive diet and exercise messaging, creating an echo chamber effect in which content becomes progressively more extreme. In the context of RED-S, algorithms contribute to a self-reinforcing cycle whereby athletes are repeatedly directed towards behaviours that increase the risk of chronic low energy availability.

Many behaviours associated with RED-S are not only tolerated, but receive positive reinforcement online through likes, comments and social validation. Content and programmes promoting unreasonable goals, workout streaks and a 'no days off' attitude can lead to individuals training despite fatigue and training through injury. This increases athletes' energy expenditure without a corresponding increase in energy intake, contributing to low energy availability.

Challenges For Rehabilitation Professionals

The 2023 IOC consensus statement advocates multidisciplinary management involving physicians, dietitians, psychologists and physiotherapists. However, social media introduces a novel challenge, as clinicians must increasingly account for digital environments that reinforce harmful behaviours beyond clinical settings.

The role of social media in RED-S poses unique challenges for rehabilitation professionals. Sports physicians, dietitians, physiotherapists and psychologists must acknowledge its role when recognising, treating and preventing recurrence of RED-S in athletes whose beliefs and behaviours are continually influenced by online environments. Traditionally, social determinants of health include housing, education and socioeconomic status. However, for younger athletes, social media may increasingly represent a digital determinant of health warranting consideration alongside traditional factors.

Firstly, the diagnosis of RED-S is often delayed as many symptoms reinforce traits that athletes and sporting cultures value; weight loss, leanness and amenorrhoea can be viewed as training adaptations rather than warning signs of physiological dysfunction. In reality, these symptoms should prompt medical concern, but athletes may not be prompted to ask for help as they instead interpret them as evidence of commitment and discipline.

Even after recognition has occurred, many athletes show resistance to treatment as the advice given may directly contradict many social media ideals. For example, management of RED-S involves increasing energy intake, rest and reducing training volume in order to compensate for the chronic low energy availability they have experienced. These interventions may cause weight gain and changes in body composition which contradict the idealised body image portrayed by social media. Athletes may perceive appropriate treatment recommendations as a loss of progress as opposed to recovery; weight restoration may be interpreted as failure rather than a form of rehabilitation.

A unique challenge of the rehabilitation of RED-S is that the athlete must reintegrate and use social media after recovery; recovery occurs in the same environment contributing to the illness. Despite adequate energy availability, weight restoration and hormonal recovery, athletes must return to platforms which expose them to extreme leanness, restrictive eating and unrealistic training practices. The social pressures that contributed to the development of RED-S therefore remain present long after physiological recovery has occurred. Therefore, it is important to acknowledge that successful rehabilitation requires more than physiological recovery alone; it also requires consideration of the social and digital environments which contributed to the development of RED-S. This highlights the importance of having a holistic, interprofessional approach involving sports physicians, dietitians, physiotherapists and psychologists to ensure that both the biological and psychosocial contributors to RED-S are addressed.

Future Directions

Primary prevention plays a key role in reducing the incidence of RED-S in athletes. Many athletes are unfamiliar with the disorder and continue to normalise fatigue and amenorrhoea, so education targeting athletes, coaches and healthcare professionals is a pillar in improving RED-S literacy. This can help individuals identify problematic symptoms before significant long-term consequences occur. For example, athletes should be taught that regular menstruation, adequate fuelling and adequate recovery are markers of health and performance capacity rather than barriers to success. This is particularly important in the context of social media where athletes are exposed to information contradicting this.

In diagnosis, social media use should also be considered given its increasing role in shaping athletic behaviour. While energy intake and training load remain primary determinants of energy availability, engagement with fitness-related content may provide useful context for assessing RED-S risk. Asking about exposure to fitness influencers and body-focused content may support earlier identification of at-risk individuals.

It is also important to consider the role of social media platforms themselves in the development of RED-S. There is increasing debate about whether they should be held accountable for algorithmically amplifying specific types of content. Potential strategies such as content moderation, warning labels and reducing visibility of harmful content have all been suggested as countermechanisms in order to reduce misinformation.

Additionally, these platforms also have the potential to support RED-S prevention and education. By promoting evidence based nutrition education, content can mitigate the harmful influences on athletes' behaviour. For example, athlete recovery stories, clinician led content and evidence-based educational content can provide positive counter-narratives within the sports nutrition space. The same platforms that contribute to RED-S may also represent powerful tools for prevention, education and rehabilitation. Overall, whilst social media is a significant risk factor, it may also contribute to the acknowledgement of RED-S and its recovery.

Conclusion

In conclusion, RED-S must not only be understood as a physiological problem, but a sociocultural one. Our culture promotes behaviours which promise health, optimisation and longevity whilst normalising harmful behaviours which hinder performance and the wellbeing of athletes, whilst also having long term effects. Effective prevention and rehabilitation therefore require clinicians to address not only energy availability, but also the digital environments that shape athletes' perceptions of health itself.

References

1. Mountjoy, M., Sundgot-Borgen, J. and Burke, L. (2014). The IOC Consensus statement: beyond the Female Athlete Triad—Relative Energy Deficiency in Sport (RED-S). British Journal of Sports Medicine, 48(7), pp.491–497.
2. von Brackel, Felix N., Munzinger, R., Bartosik, M., Simon, A., Barvencik, F., Oheim, R. and Amling, M. (2025). Impact of Relative Energy Deficiency in Sport (REDs) on Bone Health in Elite Athletes: A Retrospective Analysis. Journal of Cachexia, Sarcopenia and Muscle, [online] 16(5). Available at: https://pubmed.ncbi.nlm.nih.gov/41030229/ (Accessed: 22 June 2026).
3. Hereford, T., Kellish, A., Samora, J. and L. Reid Nichols (2024). Understanding the Importance of Peak Bone Mass. Journal of the Pediatric Orthopaedic Society of North America, [online] 7, pp.100031–100031. https://pubmed.ncbi.nlm.nih.gov/40433296/ (Accessed: 22 June 2026).
4. Lin, W., Cen, Z. and Chen, Y. (2025). The impact of social media addiction on the negative emotions of adolescent athletes: the mediating role of physical appearance comparisons and sleep. Frontiers in Public Health, 12. Available at: https://pmc.ncbi.nlm.nih.gov/articles/PMC11804524/ (Accessed: 22 June 2026).
5. Holland, G. and Tiggeman, M. (2016). A Systematic Review of the Impact of the Use of Social Networking Sites on Body Image and Disordered Eating Outcomes. Body Image, [online] 17(1), pp.100–110. Available at: https://www.sciencedirect.com/science/article/pii/S1740144516300912 (Accessed: 22 June 2026).
6. Dunn, T.M. and Bratman, S. (2016). On orthorexia nervosa: A review of the literature and proposed diagnostic criteria. Eating Behaviors, 21(21), pp.11–17. Available at: https://www.sciencedirect.com/science/article/pii/S1471015315300362 (Accessed: 22 June 2026).
7. Rudin, R., Harris, L., White, H. and Hammond, L. (2025). Exploring different interventions for Relative Energy Deficiency in Sport (REDs): A systematic review. JSAMS Plus, 5, pp.100085–100085. doi:https://doi.org/10.1016/j.jsampl.2024.100085. Available at: https://www.sciencedirect.com/science/article/pii/S2772696724000346 (Accessed: 22 June 2026).
8. Ruscheck, T., Kopp, C., Nieß, A.M. and Haigis, D. (2025). The Athlete's Body Image in the Context of Relative Energy Deficiency in Sport-A Scoping Review. Journal of functional morphology and kinesiology, [online] 10(4), p.413. doi:https://doi.org/10.3390/jfmk10040413. Available at: https://doi.org/10.3390/jfmk10040413 (Accessed: 22 June 2026)

“When Treatment Ends but Recovery Does Not: Rehabilitation After Stoma Formation and the Return to Work”

Author: Kieran Gharti

Medical School: University of Manchester

Introduction:

Before medical school taught me what a stoma meant, I only understood what it looked like. I had seen one long before I stepped onto a colorectal ward: a visible alteration to the body that I observed but did not understand. My uncle lived with a stoma for over a year before passing away from colorectal cancer, and my aunt continues to work as a nurse with a permanent stoma in place. Only through clinical placements and further study did I begin to understand that a stoma is not simply a surgical outcome, but a life-changing adjustment. People living with a stoma, like my aunt, pass through daily life unnoticed - their appliance concealed beneath clothing. With it comes pain, vigilance, and private psychological burden that often remains hidden from view. And even now, clinical exposure and study can only partially illuminate an experience that is lived every day.

Stoma formation is often framed as a necessary technical solution to serious disease, such as malignancy, inflammatory bowel disease, or diverticular pathology. Whilst surgery may remove diseased bowel or relieve life-threatening symptoms, it does not by itself restore confidence, independence, or participation in everyday life. A stoma can reshape how patients eat, dress, work, travel, socialise, and understand their own bodies, making rehabilitation central to recovery rather than secondary to it. This is reflected in the literature: Kovoor et al.’s systematic review and meta-analysis found depressive symptoms in almost half of stoma surgery patients, underlining that the consequences of stoma formation extend far beyond the technical success of the operation.[1]

Recovery after stoma formation is therefore better understood as a process rather than a single postoperative event. Rehabilitation begins before surgery - when patients are first prepared for the possibility of potentially permanent bodily change. It continues through the early shock of waking with a stoma, the learning of self-care, the uncertainties of going home, and the longer effort of returning to ordinary life. This essay traces rehabilitation to shed light on the physical discomfort, psychological strain, and social adjustment that can accompany a stoma – ultimately highlighting the support that can make recovery more than simply survival.

Preparation - the first stage of rehabilitation:

During placement on a gastroenterology ward, one patient described the anxiety that had built toward her follow-up appointment after what she called a ‘dreadful camera test’. What stayed with me was not only the diagnosis of colorectal cancer, but the moment she learned that treatment would require a permanent stoma. That conversation made one thing clear: rehabilitation begins not after stoma formation but much earlier.

Even before any appliance is fitted or any wound is healed, patients are often already anxious. Confronting the prospect of permanent bodily change with a stoma[2], as well as dependence on others and body image disturbance, shape fears associated with unfamiliarity.[3,4] In this sense, the preoperative period is not simply administrative preparation for theatre, but the first stage of adaptation.

At this stage, information and empathy are the treatment. Preoperative stoma education has been associated with reduced anxiety, better postoperative adjustment, and improved self-efficacy, suggesting that patients cope more effectively when they are prepared not only for the operation itself, but for the practical and emotional consequences that follow it.[5,6]

This is supported by randomised evidence. In a trial of 240 patients, those receiving stoma prehabilitation were markedly more likely to achieve independent stoma self-care than those given more limited preparation, with rates of 94.7% compared with 78.5% and 31.2%. The same study found fewer patients with anxiety and depression alongside higher stoma-specific quality-of-life scores, although these psychological benefits were clearer in temporary than permanent stomas.[7] These findings suggest that preparation improves not only technical readiness but also the patient's ability to view the stoma as something manageable.

Similarly, a randomised trial of a single 45-minute preoperative video-based education session found improved self-care knowledge and proficiency, lower anxiety and depression scores, fewer ostomy-related complications, and a shorter hospital stay compared with postoperative-only education.[8] Seeing appliances in advance, discussing likely lifestyle changes, and meeting specialist stoma staff may help transform the stoma from an abstract fear into something more understandable and hence more manageable.[9]

However, preparation depends not only on what is explained, but on how it is explained. In the context of a life-changing operation, patients may only voice fears surrounding dignity, dependency, body image, intimacy, and work when communication is empathetic enough to make those concerns feel legitimate. Empathetic education does not remove the distress of surgery, nor does it eliminate the shock of waking to an altered body, but it may soften the abruptness with which that new reality is encountered.

Recovery after stoma formation depends on far more than surgical success alone. The patient who understands how a stoma functions, what challenges may arise, and what support will be available afterwards is better placed to begin the long work of adjustment than the patient who arrives at that moment unprepared.[10,11] Before any appliance is fitted, rehabilitation has already begun in the work of anticipating bodily change.

Waking up changed:

The early postoperative period is the moment when the stoma becomes inescapably real. What had previously existed as an explanation on a leaflet, or an outlined possibility, is now encountered in the body itself: beneath the dressings, amid pain and the disorientation that follows major surgery. In clinical practice, this stage can be compressed into observations, fluid balance, analgesia, and wound review. For the patient, it can expand into an altered relationship with their own body.

This confrontation is both physical and psychological. In the early aftermath of surgery, patients may be coping with postoperative pain, weakness, restricted mobility, abdominal tenderness, sleep disruption, and the dependence that follows major intervention.[3,12] Additional qualitative work on life after stoma surgery repeatedly identifies themes of altered body image, shame, anxiety, social withdrawal, and loss of confidence, emphasising that the wound is not the only site of recovery.[13] A patient may be medically stable, yet feel profoundly destabilised by the new visibility and unpredictability of bodily function.

Early rehabilitation must be broader than routine postoperative care alone. Mobilisation, pain control, and monitoring remain essential, but so too does sensitive support at the bedside: the first look at the stoma, the first questions, and the first reassurance that fear, disgust, or grief do not represent failure to cope. This is reflected in best-practice recommendations after stoma surgery, which emphasise person-centred recovery, early mobilisation, and a gradual return to activity.[14]

Before confidence can be rebuilt, the new reality must first be faced. The task of this stage is therefore modest but profound: not yet mastery, but recognition - the beginning of understanding that life has changed. Once the altered body has been confronted, the next task is to learn how to live in it.

Learning the body again: self-management as rehabilitation

After the initial shock of surgery, rehabilitation enters a more exacting phase. The stoma is no longer just something to be seen; it must be managed, understood, and gradually integrated into daily life. Emptying the pouch, examining the surrounding skin, learning how an appliance fits, recognising what is normal, and responding when it is not all form part of a new bodily literacy. These tasks may appear routine, even mundane, but they carry psychological weight: each successful repetition offers not merely technique, but a small return of control.

Learning how to care for a stoma is not only a technical achievement, but an important stage in emotional adjustment. Each successful act of self-care helps restore a measure of control to a body that has recently felt unfamiliar and unreliable. In patients with permanent ostomies, structured ostomy-care training has been associated with lower anxiety and better quality of life[15], while a systematic review of self-management interventions found improved self-efficacy and stronger self-management skills, particularly when nurse involvement was present.[16] Taken together, these findings suggest that adaptation depends not only on what patients are taught, but on whether that learning allows them to feel capable in their altered bodies again.

Nevertheless, hospital-acquired confidence can be fragile. It flourishes where guidance is close at hand, but is most vulnerable at the first leakage, the first episode of abnormal output, or the first moment of uncertainty faced without immediate help. The challenge of self-management lies not simply in performing a task correctly, but in sustaining that competence once reassurance is no longer immediate. What seems to matter is not endless instruction, but education that is structured, reinforced, and responsive to the patient's stage of recovery. Marinova et al. found that a small number of focused sessions around discharge were often sufficient to improve self-care abilities. They suggested that the development and maintenance of these behaviours may continue over months and benefit from ongoing support, including telehealth, after discharge.[17] Their findings support the view that self-management is not mastered all at once; it begins in the hospital, but its success is tested most sharply in the everyday life that follows.

Going home: when rehabilitation becomes domestic work

Discharge is often taken as evidence of recovery, but for many patients it marks the point at which rehabilitation becomes less supervised and more precarious. At home, stoma care is no longer carried out in the immediacy of professional reassurance, but in the private space of everyday life - where uncertainty and practical problems must often be solved without immediate help.

What emerges at this stage is a form of hidden labour. The patient is no longer simply repeating a skill learned on the ward but trying to sustain it in the face of leakage, peristomal skin irritation, poor appliance adhesion, supply-related difficulties, and the embarrassment that can magnify each of these problems. Imagine, then, that you have just arrived home from major surgery and your stoma — which you know contains your gut contents - suddenly becomes painful or begins to leak. Where would you go for assistance?

It is precisely in this moment of uncertainty that the limits of discharge teaching become most visible. Patients are often encouraged to seek support through community groups, peer networks, or online resources, and a recent content analysis of user-generated YouTube videos suggests that many do exactly that: leakage, skin complications, inadequate appliance adhesion, and supply-related difficulties were among the most commonly discussed challenges, with users often sharing improvised strategies for managing them outside formal clinical settings.[18] That turn toward peer-generated advice is revealing. It suggests that home

rehabilitation is not simply the continuation of hospital teaching, but an improvisational process in which patients must bridge the gap between professional instruction and the messier realities of everyday life.

Nor is this burden carried by patients alone. Guidance directed at family caregivers has highlighted that those assisting with ostomy care are frequently expected to manage complex tasks without sufficient information or support, suggesting that discharge transfers not only responsibility but also anxiety into the domestic setting.[19] Stoma care can be extended from the hospital to the home by educating not only the patient, but also those more readily available to assist our patients once professional supervision has receded.

The consequences of home management are not only technical. In a study of quality of life among people living with a stoma, 70.3% reported changing their diet because of the ostomy, 58% reported depression after ostomy, and only 34% of those who had been sexually active before surgery had resumed sexual activity afterwards.[20] What stoma patients carry home from the hospital is not only an appliance but also a changed relationship to eating, intimacy, confidence, and their ordinary lives. At this stage, rehabilitation is not just about whether a pouch can be changed correctly, but whether life outside the ward can begin to feel inhabitable again.

For that reason, discharge cannot be treated as the endpoint of recovery. Self-management interventions have been associated with higher self-efficacy, and nurse involvement appears to strengthen both confidence and self-management skills, indicating that outcomes after discharge depend not only on what patients were taught in hospital but also on whether support continues once they return home.[16] Going home is not the conclusion of rehabilitation, but the point at which it becomes ordinary, unspectacular, and deeply private work.

Returning to work: when recovery becomes public again

Returning to work is often treated as evidence that recovery is complete. Work requires that the stoma be managed consistently, discreetly, and with sufficient confidence to withstand commutes, uniforms, fatigue, time pressure, and the risk of leakage in spaces where privacy may be limited. In that sense, work is not an endpoint, but a public test of rehabilitation.

A person may be medically capable of leaving the hospital and managing their stoma at home, yet still feel unready for the workplace, where toilet access may be uncertain, heavier tasks may feel unsafe, and the risk of odour, noise or appliance problems can begin to dominate attention. A 2024 rapid review of workability after stoma formation identified these issues as recurring difficulties stemming from workplace limitations; it also noted the lack of evidence defining reasonable workplace accommodations for people with an enterostomy.[21] In addition, one cross-sectional study found that only 10.9% of participants remained in the same occupation after ostomy creation, while 81.8% changed occupations; among those who did so, two-thirds said that the change was entirely due to the ostomy.[22] These figures suggest that return to work should not be treated as a straightforward marker of convalescence, but rather that the workplace can intensify the very problems that were once negotiated more privately at home.

Despite all of this, work matters for more than financial reasons. It can restore rhythm and identity - the sense of being recognised as more than a patient. Returning to work after stoma formation is an attempt at a second rehabilitation: learning to trust a changed body with unchanged responsibility. That transition cannot rest on patient effort alone; it also depends on follow-up, honest discussion of work-related fears, and workplaces willing to accommodate bodily difference rather than quietly penalise it.

Conclusion

I have spoken to many patients with stomas during medical school. I have rarely asked them what life with a stoma is like once the ward round had ended, or the immediate surgical problem had been solved.

It is easy, as a student, to focus on diagnosis, management, and the satisfaction of reaching an answer. It is harder to remain with what follows: the altered body, the private labour of adaptation, the uncertainty, the effort of entering public life again. These obstacles are not marginal consequences of treatment - they are the very substance of recovery. What we can too easily regard as a surgical success can transform the shape of a patient's life forever.

Rehabilitation after stoma formation unfolds through anticipation, the shock of waking changed, the work of learning self-care, the uncertainties of home management, and the longer effort to return to the most ordinary life possible. Stoma formation reveals something fundamental about rehabilitation itself: what seems to medicine like treatment completed may be only the beginning of recovery.

References:

1. Kovoor JG, Jacobsen JHW, Stretton B, Bacchi S, Gupta AK, Claridge B, et al. Depression after stoma surgery: a systematic review and meta-analysis. BMC Psychiatry. 2023 May 22;23(1):352. doi:10.1186/s12888-023-04871-0
2. Silva C, Santos C, Brito M, Cardoso T, Lopes J. Self-care competence of patients with an intestinal stoma in the preoperative fase. Rev Enf Ref. 2018 Oct 9;IV Série(18):39–50. doi:10.12707/RIV18026
3. Ayaz-Alkaya S. Overview of psychosocial problems in individuals with stoma: A review of literature. International Wound Journal. 2019 Feb;16(1):243–9. doi:10.1111/iwj.13018
4. Thorpe G, Arthur A, McArthur M. Adjusting to bodily change following stoma formation: a phenomenological study. Disability and Rehabilitation. 2016 Aug 27;38(18):1791–802. doi:10.3109/09638288.2015.1107768
5. Latifee R, Saleem FK, Ansari T, Khan MA, Muhammad S. Psychological Impact and Quality of Life in Patients With Intestinal Stoma in Resource-Limited Settings: A Cross-Sectional Study From Pakistan. Cureus. 2025 Jul 19. doi:10.7759/cureus.88292
6. Millan M, Tegido M, Biondo S, García-Granero E. Preoperative stoma siting and education by stomatherapists of colorectal cancer patients: a descriptive study in twelve Spanish colorectal surgical units. Colorectal Disease. 2010 Jul;12(7Online). doi:10.1111/j.1463-1318.2009.01942.x
7. Koc MA, Akyol C, Gokmen D, Aydin D, Erkek AB, Kuzu MA. Effect of Prehabilitation on Stoma Self-Care, Anxiety, Depression, and Quality of Life in Patients With Stomas: A Randomized Controlled Trial. Diseases of the Colon & Rectum. 2023 Jan;66(1):138–47. doi:10.1097/DCR.0000000000002275
8. Yeo H, Park H. Benefits of a Single-Session, In-Hospital Preoperative Education Program for Patients Undergoing Ostomy Surgery: A Randomized Controlled Trial. Journal of Wound, Ostomy & Continence Nursing. 2023 Jul;50(4):313–8. doi:10.1097/WON.0000000000000991
9. Silva NM, Santos MAD, Rosado SR, Galvão CM, Sonobe HM. Psychological aspects of patients with intestinal stoma: integrative review. Rev Latino-Am Enfermagem. 2017 Dec 11;25(0). doi:10.1590/1518-8345.2231.2950
10. Wulff-Burchfield EM, Potts M, Glavin K, Mirza M. A qualitative evaluation of a nurse-led pre-operative stoma education program for bladder cancer patients. Support Care Cancer. 2021 Oct;29(10):5711–9. doi:10.1007/s00520-021-06093-0
11. Essex R, Booth L, Sirois F, Burch J, Dibley L. A scoping review of the qualitative literature reporting experiences of living with a stoma for inflammatory bowel disease. Journal of Advanced Nursing. 2025 Jan;81(1):53–68. doi:10.1111/jan.16254

12. Lupo R, Rubbi I, Barletta A, Mele C, Lezzi A, Triglia C, et al. Quality of Life and Psychophysical Consequences in Individuals with Intestinal Stoma: An Observational Study. IJERPH. 2025 Aug 26;22(9):1327. doi:10.3390/ijerph22091327
13. Black P, Notter J. Psychological issues affecting patients living with a stoma. Br J Nurs. 2021 Mar 25;30(6):S20–32. doi:10.12968/bjon.2021.30.6.S20
14. Association of Stoma Care Nurses UK (ASCN UK). Exercise And Physical Activity After Stoma Surgery: EXPASS Best Practice Recommendations [Internet]. Association of Stoma Care Nurses UK (ASCN UK); 2025. Available from: https://ascnuk.org/wp-content/uploads/2025/10/EXPASS-Best-Practice-Recommendations.pdf
15. Khalilzadeh Ganjalikhani M, Tirgari B, Roudi Rashtabadi O, Shahesmaeili A. Studying the effect of structured ostomy care training on quality of life and anxiety of patients with permanent ostomy. International Wound Journal. 2019 Dec;16(6):1383–90. doi:10.1111/iwj.13201
16. Goodman W, Allsop M, Downing A, Munro J, Taylor C, Hubbard G, et al. A systematic review and meta-analysis of the effectiveness of self-management interventions in people with a stoma. Journal of Advanced Nursing. 2022 Mar;78(3):722–38. doi:10.1111/jan.15085
17. Marinova P, Marinova R. Patient-centred stoma care support: colostomy patients. Br J Community Nurs. 2024 Oct 2;29(10):494–502. doi:10.12968/bjcn.2024.0088
18. Haughey M, Neyens DM, Hopkins CS, Gonzaga C, Harman M. Identifying Strategies for Home Management of Ostomy Care: Content Analysis of YouTube. JMIR Hum Factors. 2025 Mar 6;12:e66634. doi:10.2196/66634
19. Kirkland-Kyhn H, Martin S, Zaratkiewicz S, Whitmore M, Young HM. Ostomy Care at Home. AJN, American Journal of Nursing. 2018 Apr;118(4):63–8. doi:10.1097/01.NAJ.0000532079.49501.ce
20. Wuletaw Chane Zewude, Tilahun Derese, Yisihak Suga, Berhanetsehay Teklewold. Quality of Life in Patients Living with Stoma. Ethiop J Health Sci. 2021 Sep 1;31(5). doi:10.4314/ejhs.v31i5.11
21. Cioffi A, Garzillo EM, Spiteri G, Carta A, De Rosa M, Lourdes Monaco MG. P-045 WORKABILITY AND RETURN TO WORK IN PATIENTS WITH A STOMA: A RAPID REVIEW. Occupational Medicine. 2024 Jul 5;74(Supplement_1):0–0. doi:10.1093/occmed/kqae023.0499
22. Davis D, Ramamoorthy L, Pottakkat B. Impact of stoma on lifestyle and health-related quality of life in patients living with stoma: A cross-sectional study. Journal of Education and Health Promotion. 2020 Nov;9(1). doi:10.4103/jehp.jehp_256_20

From Theatre to Nowhere: The Hidden Bridge Between Neurosurgical Survival and Functional Recovery

Author: Cameron Kumar Pinn

Medical School: Southampton

"Neurosurgery is either complete miracles, or disasters, and never anything in between" (Professor Omar Pathmanaban).

I first heard that remark while watching consultant neurosurgeon Omar Pathmanaban on Channel 5's *The Surgeon*, aired on 4 March 2026 (Channel 5, 2026). It stayed with me because it captured something unsettling about neurological disease: its power to alter a life abruptly, completely, and in ways that reach far beyond the operating theatre. I was reminded of someone I know who suffered a brain bleed and underwent neurosurgery. In the weeks afterwards, they seemed altered: still present, yet not quite themselves. Their eventual recovery was excellent, but the experience sharpened a question that sits at the centre of this essay: what happens to those who survive neurosurgery, but do not return fully to the person they were before?

That question leads directly into the territory of Physical and Rehabilitation Medicine (PRM). In the public imagination, the decisive moment in neurological illness is often the operation itself: the decompression, the clip, the resection, the rescue from imminent catastrophe. Yet PRM asks a different and more enduring question. Not simply: did the patient live? But: what kind of life are they now able to live? The World Health Organization defines rehabilitation as a set of interventions designed to optimise functioning and reduce disability in interaction with the environment (WHO, 2024). The UK Rehabilitation Outcomes Collaborative (UK ROC) similarly describes specialist rehabilitation as coordinated, active care delivered by a trained multidisciplinary team to maximise physical, cognitive, psychological and social participation (UK ROC, 2025). These definitions matter because they challenge a narrow model of success. Neurosurgery may avert death by relieving pressure on the brain, securing an aneurysm, or removing a tumour. None of those achievements, however technically brilliant, automatically restores memory, judgement, agency, employability, relationships, or identity. If surgery provides rescue, PRM ensures restoration. If surgery secures survival, PRM determines whether survival can become meaningful life.

This essay argues that, in the UK, socioeconomic inequity helps determine whether neurosurgical survivors are able to move from technical survival to meaningful functional recovery, because access to timely specialist neurorehabilitation remains both insufficient and unevenly distributed. That argument is particularly important in neurosurgery because the disabilities left behind are often complex, fluctuating, and sometimes difficult to recognise at first glance. Patients with traumatic brain injury (TBI), subarachnoid haemorrhage (SAH), brain tumours, or complex spinal pathology may be medically stable while remaining profoundly impaired in less visible ways: slowed processing, executive dysfunction, disinhibition, fatigue, aphasia, mood disturbance, poor insight, or sensory overload. These are not minor residual symptoms. They are often decisive in determining whether a person can live independently, return to work, sustain relationships, or re-enter education. NICE's 2025 guideline on rehabilitation for chronic neurological disorders is therefore highly relevant. It explicitly includes acquired brain injury and acquired spinal cord injury across all settings, reinforcing the point that neurological recovery is not exhausted by acute intervention alone (NICE, 2025a). In this context, rehabilitation is not an optional add-on after definitive care. It is the bridge between survival in theatre and life beyond it.

To understand why that bridge so often fails, one must begin with what good care ought to look like. NICE guidance on rehabilitation after traumatic injury recommends early identification of rehabilitation need, holistic assessment across physical, cognitive, psychological and psychosocial domains, coordinated goal-

setting, and continuity from inpatient care through discharge and into the community (NICE, 2022). Although developed for traumatic injury, the underlying logic extends naturally to neurosurgical practice. Rehabilitation should not begin when discharge is already looming. It should begin while the acute episode is still unfolding. If likely deficits and discharge barriers are recognised early, teams can plan equipment, involve carers, refer appropriately, and initiate the rehabilitative process before the patient falls into drift. If they are identified late, or not identified at all, disability is confronted reactively rather than anticipated. In effect, the bridge back to ordinary life cannot be built safely if planning only starts when the patient is already standing at the edge of discharge.

The difficulty is that the UK rehabilitation system is structurally too small to deliver that ideal consistently. The British Society of Rehabilitation Medicine recommends a minimum of 60 specialist inpatient rehabilitation beds per million population and 6 whole-time equivalent rehabilitation medicine consultants per million population (BSRM, 2009). Yet UK ROC's six-year report recorded only 959 Level 1 and 2 specialist rehabilitation beds in England in 2020/21 (Turner-Stokes *et al*., 2021). Using England's mid-2021 population of 56.536 million, this equates to approximately 17 beds per million. Workforce data are similarly concerning. The British Society of Physical and Rehabilitation Medicine estimated in 2022 that the UK had 203 consultant posts in rehabilitation medicine and still required an additional 213 simply to achieve equitable provision (BSPRM, 2022). Assuming a UK population of roughly 67 million in mid-2021, that is about 3 consultant posts per million (Turner-Stokes Rehabilitation Medicine estimated in 2022 that the UK had 203 consultant posts in rehabilitation medicine and still required an additional 213 simply to achieve equitable provision (BSPRM estimated in 2022 that the UK had 203 consultant posts in rehabilitation medicine and still required an additional 213 s*et al*., 2021). These figures are not perfectly like-for-like, but they remain revealing. They suggest that the problem is not merely one of local inefficiency or patchy referral culture. The bridge back to function has been built at a scale too small for the number of patients expected to cross it.

National audit evidence shows that this shortfall has real clinical consequences. The National Clinical Audit of Specialist Rehabilitation following Major Injury (NCASRI) concluded that specialist rehabilitation bed capacity in England catered for only around 40% of those who needed such services after major trauma (Turner-Stokes *et al*., 2019). That figure alone is arresting, but the rest of the audit is equally instructive. Among patients who received specialist rehabilitation, 94% showed functional improvement. At the same time, NCASRI identified weak integration of rehabilitation medicine within major trauma pathways and found that many patients who eventually accessed specialist rehabilitation had not had their needs recognised while still in the major trauma centre (Turner-Stokes *et al*., 2019). The implication is difficult to ignore. The problem is not that rehabilitation lacks value. Nor is it that need is uncommon. The problem is that access is constrained and pathway design remains inconsistent. PRM can transform outcomes, but too often it is invited into the patient journey late, contingently, and unevenly.

Within a neurosurgical context, the most persuasive evidence comes from neurosurgical cohorts themselves. Singh, Sinha, Bill and Turner-Stokes (2017) prospectively evaluated neurosurgical inpatients and found that 156 of 223 patients, or 70%, had Category A or B specialist rehabilitation needs. Of 105 patients eligible for admission to the local specialist rehabilitation service, only 20 were referred and just 11 were admitted. Mean transfer time was 70.2 days, well above the cited national standard of 42 days. This matters because it demonstrates that the gap is not hypothetical, nor confined to stroke services or generic trauma pathways. It is visible on neurosurgical wards. The operation may have been technically successful, but the route into recovery remained narrow, delayed, and selective. In other words, the patient survived the acute crisis, yet the system still failed to mobilise the very discipline responsible for converting survival into functioning.

A useful lens through which to examine this problem is deprivation. Glasgow offers one such example. According to Understanding Glasgow, around 29% of the city's population live in Scotland's most deprived national decile, and around 44% live in the most deprived quintile (Understanding Glasgow, 2025a; 2025b). These figures matter not simply as social description, but as clinical context. A discharge pathway that

assumes stable housing, reliable transport, spare space for equipment, digitally confident families, and the ability to navigate fragmented services is not neutral. It is quietly calibrated to advantage. When rehabilitation systems are already constrained by limited beds, workforce shortages, and inconsistent integration, they do not merely operate within social inequality; they risk reproducing it. The bridge may be the same on paper, but the ground on either side is not equally firm.

The empirical literature supports that broader argument. Dunn, Henry and Beard (2003), studying Scottish adults with closed head injury, found important associations between social deprivation, mechanisms of injury and patterns of care. More recent work by Humphries *et al*. (2020) showed that increasing socioeconomic deprivation was independently associated with worse 12-month global outcome after TBI, measured using the Extended Glasgow Outcome Scale. Historical Scottish evidence also points towards inequity within rehabilitation access itself. Macleod and Smith (2005) reported higher rehabilitation admission rates after head injury and SAH among people from more affluent postcode sectors, suggesting that referral and admission pathways may themselves be socially patterned. None of these studies alone proves a complete causal chain. Taken together, however, they support a compelling thesis: deprivation influences not only who is injured and how, but also who is most likely to convert neurological survival into sustained functional recovery. TBI, measured using the Extended Glasgow Outcome Scale. Historical Scottish evidence also points towards inequity within rehabilitation access itself. Macleod and Smith (2005) reported higher rehabilitation admission rates after head injury and SAH among people from more affluent postcode sectors, suggesting that referral and admission pathways may themselves be socially patterned. None of these studies alone proves a complete causal chain. Taken together, however, they support a compelli

One reason this inequity persists is that post-neurosurgical disability is often underestimated when it is least visible. A patient may be walking independently and speaking coherently, yet still be unable to organise medication, assess danger, regulate emotion, sustain attention, or plan a journey home. Such impairments are easy to overlook in hospital, particularly in busy acute environments that are understandably focused on physiological stability and discharge flow. They become much harder to ignore once the patient is back in ordinary life, where cognition, behaviour and judgement matter continuously. NICE is therefore right to emphasise holistic assessment across physical, cognitive and psychological domains (NICE, 2022). Where such assessment is absent or superficial, rehabilitation needs are under-recognised and referral is delayed. Patients from affluent backgrounds may sometimes compensate through family advocacy, paid support, flexible employment and stable housing. Patients from deprived backgrounds are less likely to have those buffers. The same clinical oversight therefore generates unequal downstream harm.

Delay is another mechanism through which inequity operates. When specialist beds are scarce, patients are repatriated, held on non-specialist wards, or discharged while still awaiting appropriate input. This creates a period of drift between acute rescue and active recovery. It is a dangerous period because it coincides with high need, family uncertainty, and potentially time-sensitive rehabilitation gains. Major trauma standards already recognise the importance of early rehabilitation planning, yet NCASRI showed that pathway integration remains weak and that access varies substantially by geography (Turner-Stokes *et al*., 2019). Unlike a delayed scan or delayed theatre slot, delayed rehabilitation rarely triggers urgent alarm. Its harms accumulate more quietly: preventable dependency, reduced vocational recovery, carer burnout, repeated crises, and avoidable readmissions. This is precisely why PRM must be understood not as a downstream luxury, but as time-sensitive medicine.

The discharge environment forms a third mechanism of inequity. NICE's 2025 neurological rehabilitation guideline explicitly advises that people should receive information and support regarding work, education, housing, benefits and legal issues where relevant (NICE, 2025b). That breadth is not bureaucratic excess. It reflects the reality that recovery after neurological injury is shaped by more than brain tissue alone. Abrahamson *et al*. (2017), exploring the experiences of patients with severe TBI and their carers in the first month after discharge from inpatient rehabilitation, found uncertainty, fragmentation and significant support

needs during the transition back to community life. Where services are fragmented, recovery depends partly on whether a patient or carer can chase appointments, understand systems, organise transport and persist through administrative friction. Those capacities are themselves socially patterned. Deprivation therefore does not merely coexist with rehabilitation failure; it intensifies it by making the gaps in the pathway harder to traverse.severe TBI and their carers in the first month after discharge from inpatient rehabilitation, found uncertainty, fragmentation and significant support needs during the transition back to community life. Where services are fragmented, recovery depends partly on whether a patient or carer can chase appointments, understand systems, organise transport and persist through administrative friction. Those capacities are themselves socially patterned. Deprivation therefore does not merely coexist with rehabilitation failure; it intensifies it by making the gaps in the pathway harder to traversesevere TBI and their carers in the first month after discharge from inpatient rehabilitation, found uncertainty, fragmentation and significant support needs during the transition back to community life. Where services are fragmented, recovery depends partly on whether a patient or carer can chase appointments, understand systems, organise transport and persist through administrative friction. Those capacities are themselves socially patterned. Deprivation therefore does not merely coexist withsevere TBI and their carers in the first month after discharge from inpatient rehabilitation, found uncertainty, fragmentation and significant support needs during the transition back to community life. Where services are fragmented, recovery depends partly on whe

Workforce and service coordination sit beneath all of these problems. The BSRM standards emphasise consultant leadership, multidisciplinary expertise and sufficient service scale because specialist rehabilitation requires coordinated clinical judgement, not just generic therapy input (BSRM, 2009). This is one of the defining contributions of PRM: it is not simply about the provision of exercises or discharge equipment, but about synthesising medical, cognitive, functional and social complexity into a coherent plan for recovery. Without adequate rehabilitation medicine staffing, referrals occur late, eligibility thresholds become inconsistent, and community transitions are poorly managed. There is also a strong economic case for getting this right. Turner-Stokes *et al*. (2016) demonstrated the cost-efficiency of specialist hyperacute inpatient rehabilitation for medically unstable patients with complex rehabilitation needs, while Duarte *et al*. (2017) showed that specialist rehabilitation services can reduce hospital length of stay and associated costs. Under-provision is therefore not just a humanitarian failure; it is a systems failure that stores cost, dependency and avoidable morbidity for later.

A more equitable pathway would require several practical changes. First, neurosurgical wards should incorporate mandatory early rehabilitation screening that prompts clinicians to consider cognition, behaviour, communication, fatigue and social circumstances, rather than focusing only on gross physical deficits. Second, rehabilitation medicine should be embedded within neurosurgical and major trauma pathways through routine in-reach rather than optional or late referral. Third, time to rehabilitation review and time to specialist rehabilitation transfer should be tracked as quality indicators, just as acute pathways monitor delay to scan or surgery. Fourth, patients with complex needs should have a named coordinator or navigator at discharge, particularly where social vulnerability is high. Fifth, meaningful community neurorehabilitation and vocational rehabilitation must be available even to those who do not secure scarce inpatient beds. Finally, outcome measurement must move beyond discharge destination and capture participation, return to work or education, carer strain, and sustained community living. A system that records survival but not reintegration has measured only the first phase of care, not whether recovery has truly occurred.

There are, of course, limitations to this argument. The best hard system-capacity data come largely from England-facing sources such as UK ROC and NCASRI, whereas Glasgow is being used here as a Scottish lens. Deprivation indices such as SIMD and IMD can also contain health-related components, creating some risk of circularity when health outcomes are analysed against them. Moreover, not every neurosurgical survivor requires Level 1 or Level 2 inpatient specialist rehabilitation, and some inequity undoubtedly arises upstream in injury exposure rather than only downstream in rehabilitation access. Nevertheless, these caveats do not

undo the core claim. They refine it. The point is not that all poor neurological outcomes are attributable to rehabilitation failure. It is that an under-sized and unevenly distributed rehabilitation system predictably amplifies social inequality in who is able to translate survival into recovery.

Pathmanaban's remark is compelling precisely because it captures the drama of neurosurgery. Yet its limitation is equally important. For many patients, the real story does not end with either miracle or disaster in the operating theatre. It continues elsewhere: in cognition, in mood, in housing, in transport, in work, in family strain, and in access to specialist rehabilitation. This is where PRM enters—not as a peripheral service, but as the medical discipline that determines whether neurological survival can be converted into functional life. In the UK, that conversion remains unequally available. Until specialist neurorehabilitation is treated as part of the core neurosurgical pathway rather than its afterthought, too many patients will survive the operation only to discover that the route back to themselves was never fully built.

References

- Abrahamson, V., Jensen, J., Springett, K. and Sakel, M. (2017) 'Experiences of patients with traumatic brain injury and their carers during transition from in-patient rehabilitation to the community: a qualitative study', Disability and Rehabilitation, 39(17), pp. 1683–1694.
- British Society of Physical and Rehabilitation Medicine (BSPRM) (2022) Estimate of workforce needed. London: BSPRM.
- British Society of Rehabilitation Medicine (BSRM) (2009) BSRM standards for rehabilitation services mapped on to the National Service Framework for Long-Term Conditions. London: BSRM.
- Channel 5 (2026) The Surgeon. Series 1, Episode 3. First broadcast 4 March 2026.
- Duarte, A.I., Bojke, C., Cayton, W., Salawu, A., Case, B., Bojke, L. and Richardson, G. (2017) 'Impact of specialist rehabilitation services on hospital length of stay and associated costs', The European Journal of Health Economics. doi: 10.1007/s10198-017-0952-0.
- Dunn, L., Henry, J. and Beard, D. (2003) 'Social deprivation and adult head injury: a national study', Journal of Neurology, Neurosurgery and Psychiatry, 74(8), pp. 1060–1064.
- Humphries, T.J., Wood, R.L., Phillips, C.J. and Macey, S. (2020) 'The effect of socioeconomic deprivation on 12 month traumatic brain injury outcome', Brain Injury, 34(3), pp. 343–349.
- Macleod, M.R. and Smith, S.J. (2005) 'Gender and deprivation and rates of referral and thereby admission to a national neurorehabilitation service', Clinical Rehabilitation, 19(1), pp. 109–115.
- National Institute for Health and Care Excellence (NICE) (2022) Rehabilitation after traumatic injury (NG211). London: NICE.
- National Institute for Health and Care Excellence (NICE) (2025a) Rehabilitation for chronic neurological disorders including acquired brain injury (NG252). London: NICE.
- National Institute for Health and Care Excellence (NICE) (2025b) Rehabilitation for chronic neurological disorders including acquired brain injury (NG252): Information, advice and learning as part of rehabilitation. London: NICE.
- Singh, R., Sinha, S., Bill, A. and Turner-Stokes, L. (2017) 'Unmet need for specialised rehabilitation following neurosurgery: can we maximise the potential cost-benefits?', British Journal of Neurosurgery, 31(2), pp. 249–253.
- Turner-Stokes, L., Bavikatte, G., Williams, H., Bill, A., Sephton, K. and Ashford, S. (2016) 'Cost-efficiency of specialist hyperacute in-patient rehabilitation for medically unstable patients with complex rehabilitation needs: a multicentre cohort analysis', BMJ Open, 6(9), e012112.
- Turner-Stokes, L., Williams, H., Sephton, K., Bavikatte, G., Burridge, J., Carpenter, I., Duff, J., Hall, K., Judge, S., Bissett, M., Halliwell, D., Nair, A., Newton, D., Price, C. and Rees, S. (2019) National Clinical Audit of Specialist Rehabilitation following Major Injury (NCASRI): report synopsis. London: HQIP.
- Turner-Stokes, L., Williams, H., Sephton, K., Burridge, J., Nair, A., Judge, S., Hall, K., Duff, J. and Rees, S. (2021) UK ROC six-year report 2015–2021. London: King's College London.
- Understanding Glasgow (2025a) SIMD in Glasgow: deprivation trends. Glasgow: Glasgow Centre for Population Health.
- Understanding Glasgow (2025b) Poverty and wealth overview. Glasgow: Glasgow Centre for Population Health.
- UK Rehabilitation Outcomes Collaborative (UK ROC) (2025) Commissioning your specialist neuro-rehabilitation service. London: UK ROC.
- World Health Organization (WHO) (2024) Rehabilitation. Geneva: WHO.

“I Don’t Want to Live Like This”: Rehabilitation, Dignity and the Right to a Liveable Alternative

Author: Mohammad Abir Mamun

Medical School: Brighton and Sussex Medical School

“She had survived.” In hospital, the stroke had not killed her, the infection had settled, the scans were stable, and discharge was appropriate. Yet at home, survival looked different. It looked like a stair she could no longer climb, a bathroom she could not use safely, a spouse too exhausted to sleep, and a body that now required planning, lifting, washing and waiting. When she said, “I don’t want to live like this,” the sentence at first seemed to be about death. But the more important words were “like this.”

This vignette is not a formal assisted dying request, but the clinical grammar of despair: a statement medicine must interpret before deciding what autonomy means. In end-of-life ethics, clinicians often ask whether a patient has capacity, whether their wish is voluntary, and whether their suffering is unbearable. A patient’s autonomy should not be dismissed simply because they are ill, disabled, frightened or dependent. Yet choices are not made in empty space: pain, isolation, inaccessible housing, carer strain, poor symptom control, social care failure and the loss of ordinary roles can all narrow what a patient feels able to choose.

This essay uses “assisted dying” broadly to describe medically assisted death, while recognising that eligibility and practice differ between jurisdictions. It argues that rehabilitation medicine has a distinctive role here. Its purpose is not to override choice or force optimism onto people who are suffering. Rather, rehabilitation asks what “like this” contains, and whether any part of it can still be changed. The ethical question is therefore not only, “Can this person choose death?” It is also, “Has this person been helped to live in a way that still feels human?”

What does “like this” contain?

For some patients, a wish to die may represent a stable and autonomous judgement. However, it should also not be accepted without curiosity. A wish to hasten death is rarely reducible to a simple, fixed wish for death. It may express loss of self, fear, a desire for control, a desire to end suffering, or a desire to live, but not in the present way [1]. It can emerge from suffering that is physical, psychological, social and existential, affecting dignity, meaning and the patient’s sense of self [2]. In patients requesting euthanasia, unbearable suffering has been described across medical, psycho-emotional, socio-environmental and existential domains [3]. Fatigue, pain, decline, dependency, fear of future suffering, loneliness, being a burden, hopelessness and the loss of what made life meaningful can all contribute to suffering becoming unbearable [3].

Clinicians must therefore listen not only to the words “I want to die,” but to the conditions surrounding them. A patient may be saying: I cannot bear this pain; I cannot bear needing help to wash; I cannot bear watching my family suffer; I cannot bear being spoken to as though I have disappeared; I cannot imagine a future that is only decline. The wish to die can therefore be understood as a sentence with a missing clause: “I do not want to live like this.”

For rehabilitation medicine, that missing clause is crucial. “This” may include a bed downstairs, a toilet that cannot be reached, a voice that cannot be understood, a wheelchair that does not fit through the door, or a family member who has become exhausted by care. Not all suffering can be removed, and not every life can be made bearable by rehabilitation. But if suffering is made of many parts, the response must look beyond a single question of capacity.

Autonomy within real conditions

Too often, disabled and dying people have had their choices overruled by professionals who assume that vulnerability necessarily means incapacity. Serious illness, disability and dependence do not erase a person's right to make decisions about their own life. A defensible rehabilitation ethics must therefore avoid replacing abandonment with paternalism. Yet the ability to decide is not the same as the ability to live according to that decision. Rehabilitation theory distinguishes between decisional autonomy (the ability to make choices) and executional autonomy (the ability to act on those choices) [4]. This distinction matters because a person may retain full decision-making capacity while losing the practical means to live as they wish. A patient may choose to remain at home but be trapped by stairs; choose when to eat but be unable to feed themselves; choose to be a spouse, parent or worker but be excluded from those roles by pain, fatigue, inaccessible environments or lack of support. In such cases, the ethical problem is not only whether the patient can decide, but whether the world around them still allows decisions to become real.

A narrow view of autonomy can overvalue physical independence, when in reality human beings are interdependent throughout life and dependence on others need not destroy dignity [4]. The aim of rehabilitation should therefore not be independence at all costs but rather the ability to direct care, shape routines, make informed choices, remain involved in relationships, and keep some authorship over daily life. This reframes the opening vignette: the woman's problem was not simply that she now depended on others, but that her dependence had become unsafe, unsupported and undirected. The question was not simply whether she could express a choice. It was whether her choices still had room to breathe. Could she reach the bathroom, leave the house, sleep without fear, or let her husband be a partner rather than only a carer? Her despair was not located only in her diagnosis. It was spread across the stairs, the missing adaptations, the inaccessible bathroom, the exhausted spouse and the silence after discharge.

Rehabilitation and the parts of "this" that can change

Rehabilitation medicine offers a distinctive response because it is concerned with the conditions that make survival inhabitable; in advanced illness, preserving function becomes one of its most direct ways of protecting dignity and autonomy [5]. Palliative rehabilitation applies this logic when cure or full recovery is no longer possible: its aim is not necessarily restoration to a previous baseline, but maintaining function, slowing avoidable decline, adapting tasks, preparing carers, modifying environments and helping patients pursue goals that remain meaningful within progressive disease [5]. In practice, physiotherapy may address transfers, mobility, breathlessness and fatigue; occupational therapy, toileting, washing, equipment and home layout; speech and language therapy, communication and swallowing; psychology, adjustment and fear; and social work, care packages, housing and family strain.

Because priorities in advanced illness shift with prognosis, symptoms, family dynamics and functional capacity, palliative rehabilitation must be relationship-centred [6]. A rigid model focused only on measurable improvement may miss what matters most: eating with family, praying with dignity, using the toilet privately, sleeping in one's own home, holding a grandchild, or reducing the physical burden on a spouse. Rehabilitation must therefore begin with a practical question: what does this person still need to do, direct or take part in to feel recognisably themselves? Rehabilitation cannot cure terminal illness, reverse every disability or answer every wish to die. But it can sometimes change what "living like this" means. It can turn unmanaged dependence into supported care, isolation into contact, and passive decline into negotiated adaptation. In this sense, rehabilitation is not merely the recovery of movement; it is the work of making altered life more inhabitable.

When “this” is too new to understand

The ethical importance of rehabilitation becomes clearest when disability is severe, sudden and initially unimaginable. After spinal cord injury, suicidal ideation is common in the early period, when the future may appear only as a continuation of hospital dependence. Around half of participants in one qualitative study of people living with spinal cord injury reported suicidal ideation within the first two years after injury, yet none felt they could have made an informed decision about medical assistance in dying during that early period [7]. Immediately after catastrophic injury, the patient may see only loss: walking, continence, work, privacy, status, spontaneity and the previous self. Their distress is real, but their understanding of future life may still be incomplete.

Rehabilitation matters here because it can change not only what a patient can do, but what they can imagine. Views of life after spinal cord injury may change through cognitive and emotional reframing, supported by rehabilitation, peer mentorship and reintegration into community life [7]. Patients may need time to discover what remains possible, learn practical skills, meet others living with disability, and develop a new understanding of independence and identity [7]. Rehabilitation can replace the abstract terror of dependence with practical knowledge: how to transfer, dress, travel, communicate, work, parent, love, worship, socialise and belong differently.

This does not mean that people with spinal cord injury, or other disabilities, should be denied autonomy. The ethical lesson is subtler: a decision made before rehabilitation may not carry the same meaning as a decision made after adaptation, support and lived experience. Rehabilitation cannot guarantee that a person will come to want life, nor should it be used to delay or obstruct every request indefinitely. But where a patient has not yet had a meaningful opportunity to understand life after illness or injury, medicine risks mistaking acute despair for settled judgement.

When “this” means being a burden

A wish to die may also emerge from the fear of becoming a burden. Burden is morally complex: feelings of being a burden can motivate a wish to die, but they can also restrain a person from hastening death because of the harm that death might cause relatives [8]. Some patients may feel trapped between both impulses: wanting to die to release others, yet continuing to live to protect them from the pain of that death [8].

A compassionate clinical response must therefore resist simplistic reassurance. The task is not merely to tell the patient that they are “not a burden,” but to understand what burden means in that family, what practical pressures exist, and what support could alter the relationship between care and love. This fear can be a relational form of suffering, arising when patients feel that their illness has placed physical, emotional, financial or moral strain on those they love [8]. Patients may worry about exhausting a spouse, disrupting family life, causing children distress, consuming resources, or being remembered only as dependent [8]. In this sense, the statement “I am a burden” may not mean “my life has no value.” It may mean “my life is hurting the people I love.”

Rehabilitation is relevant here because it can reduce the lived experience of burden without denying the reality of need. Safer transfers, toileting adaptations, pressure care, communication aids, equipment provision, caregiver education and respite planning can change the emotional texture of care. They may allow a spouse to become a partner again rather than only a carer, or allow a patient to receive help without feeling wholly passive. This is why palliative rehabilitation should be understood not only as functional support, but as preservation of personhood: helping a patient remain a spouse, parent, believer, decision-maker or member of a family, even when illness has altered the body through which those roles are lived [9].

The Liveable Alternative Test

The central question for this essay is not whether assisted dying should be legal, but what rehabilitation medicine should insist upon whenever assisted dying is discussed. Safeguards are often framed around prognosis, capacity, voluntariness and coercion. These are essential, but incomplete. A person may have capacity and still be choosing within conditions shaped by uncontrolled symptoms, inaccessible housing, carer exhaustion, fragmented social care or absent rehabilitation.

International data show why this matters. In Oregon's 2025 Death with Dignity Act report, the three most frequently reported end-of-life concerns among patients who died after ingesting prescribed medication were loss of autonomy, decreasing ability to participate in activities that made life enjoyable, and loss of dignity [10]. These figures do not prove that rehabilitation would alter every assisted dying request, nor can they be directly transplanted into the UK context. They do, however, show that many concerns cluster around domains rehabilitation medicine is designed to address: autonomy, participation, dignity, bodily function and burden. In England and Wales, assisting suicide remains illegal, while recent parliamentary and professional debate has shown that assisted dying remains legally and ethically contested [11–14]. Rehabilitation medicine should not pretend to settle that debate. It should insist that choice is evaluated alongside the conditions that make life feel liveable or unliveable.

This could be understood as a liveable alternative test. Before an assisted dying request is treated as settled, clinicians should ask whether the patient has had a serious opportunity to live differently before death is understood as the only remaining form of control. This would include palliative care review, rehabilitation assessment, mental health assessment, carer burden assessment, housing and social care review, communication support, peer support where relevant, and a community follow-up plan. It would also document what matters to the person: valued roles, acceptable dependence, preferred place of care, spiritual or cultural priorities, and remaining life goals. A patient cannot meaningfully choose home if there is no ramp, no care package and a spouse already beyond capacity. They cannot meaningfully choose dignity if continence care, communication aids or professional advice are inaccessible. NICE guidance on end-of-life care already recognises the importance of active decision-making, communication needs, coordinated care and access to professional advice across settings [15]. Rehabilitation guidance similarly emphasises assessment, goal-setting, service coordination, participation and support after discharge into community rehabilitation services [16]. The liveable alternative test therefore does not add a paternalistic veto. It asks whether medicine has done enough to ensure that an informed choice is not simply the final shape taken by abandonment.

Conclusion

When a patient says, "I don't want to live like this," medicine must not rush to correct, dismiss or romanticise the statement. It must ask what "this" contains. Sometimes it will contain suffering that cannot be sufficiently relieved, even by excellent care. Sometimes it will contain a settled autonomous judgement that deserves serious moral attention. But often it will also contain modifiable realities: unmanaged symptoms, avoidable dependence, inaccessible homes, exhausted carers, loneliness, fear, poverty, fragmented care and the loss of roles that made life feel recognisable. Rehabilitation medicine belongs in this ethical space because it asks a different question from cure. It asks what can still be changed, supported, adapted, preserved or made possible. Its work may be practical and ordinary: a ramp, a transfer board, a communication aid, a fatigue strategy, a family meeting, a peer mentor, a care plan. Yet these ordinary interventions can alter whether life is experienced as passive survival or as a continuing, if changed, form of human life.

The argument is not that rehabilitation can answer every wish to die, nor that autonomy should be denied in the name of care. It is that choice should not be narrowed by abandonment. Before medicine accepts death as the only remaining expression of control, it must ask whether rehabilitation could restore any other form of agency. Rehabilitation cannot promise that every life will feel liveable, but it can prevent medicine from mistaking an unsupported life for an informed choice.

References:

1. Monforte-Royo C, Villavicencio-Chávez C, Tomás-Sábado J, Mahtani-Chugani V, Balaguer A. What Lies behind the Wish to Hasten Death? A Systematic Review and Meta-Ethnography from the Perspective of Patients. PLoS ONE [Internet]. 2012 May 14;7(5). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3351420/
2. Rodríguez-Prat A, Balaguer A, Booth A, Monforte-Royo C. Understanding patients' experiences of the wish to hasten death: an updated and expanded systematic review and meta-ethnography. BMJ Open [Internet]. 2017 Sep;7(9):e016659. Available from: https://bmjopen.bmj.com/content/bmjopen/7/9/e016659.full.pdf
3. Dees MK, Vernooij-Dassen MJ, Dekkers WJ, Vissers KC, van Weel C. "Unbearable suffering": a qualitative study on the perspectives of patients who request assistance in dying. Journal of Medical Ethics. 2011 Sep 24;37(12):727–34.
4. Cardol M, Jong BAD, Ward CD. On autonomy and participation in rehabilitation. Disability and Rehabilitation. 2002 Jan;24(18):970–4.
5. Chaudhary MA. Beyond Cure in Advanced Cancer: Preserving Function, Dignity, and Participation Through Palliative Rehabilitation. Palliative Medicine Reports. 2026 Jan;7.
6. Wilson CM, Papadimitriou C. Palliative rehabilitation is relationship-centered care. Annals of Palliative Medicine. 2023 Jan;0(0).
7. Tchajkova N, Ethans K, Smith SD. Inside the lived perspective of life after spinal cord injury: a qualitative study of the desire to live and not live, including with assisted dying. Spinal Cord. 2021 Mar 31;59(5):485–92.
8. Gudat H, Ohnsorge K, Streeck N, Rehmann-Sutter C. How palliative care patients' feelings of being a burden to others can motivate a wish to die. Moral challenges in clinics and families. Bioethics [Internet]. 2019;33(4):421–30. Available from: https://rdcu.be/bVn9l
9. R Krishna LK, Yong CYL, Koh SMC. The role of palliative rehabilitation in the preservation of personhood at the end of life. Case Reports. 2014 Jul 9;2014(jul09 1):bcr2014204780–0.
10. Oregon Health Authority. Oregon Death with Dignity Act. The Lancet [Internet]. 2024 Mar 20;342(8886-8887):1543–4. Available from: https://www.oregon.gov/oha/PH/PROVIDERPARTNERRESOURCES/EVALUATIONRESEARCH/DEATHWITHDIGNITYACT/Documents/year26.pdf
11. Crown Prosecution Service. Suicide: Policy for Prosecutors in Respect of Cases of Encouraging or Assisting Suicide | The Crown Prosecution Service [Internet]. Cps.gov.uk. 2025. Available from: https://www.cps.gov.uk/prosecution-guidance/suicide-policy-prosecutors-respect-cases-encouraging-or-assisting-suicide
12. UK Parliament. Terminally Ill Adults (End of Life) Bill - Parliamentary Bills - UK Parliament [Internet]. Parliament.uk. 2024. Available from: https://bills.parliament.uk/bills/3774
13. British Medical Association. The BMA's views on legislation on physician-assisted dying [Internet]. 2025. Available from: https://www.bma.org.uk/media/jribiniu/summary-of-the-bmas-views-on-pad-legislation-updated-january-2025.pdf
14. Royal College of General Practitioners. Assisted Dying [Internet]. www.rcgp.org.uk. 2020. Available from: https://www.rcgp.org.uk/representing-you/policy-areas/assisted-dying
15. National Institute for Health and Care Excellence. Overview | End of Life Care for adults: Service Delivery | Guidance | NICE [Internet]. Nice.org.uk. NICE; 2019. Available from: https://www.nice.org.uk/guidance/ng142
16. National Institute for Health and Care Excellence. Overview | Rehabilitation after Traumatic Injury | Guidance | NICE [Internet]. www.nice.org.uk. 2022. Available from: https://www.nice.org.uk/guidance/ng211

A Prescription of Culture: The Missing Dimension of Rehabilitation Medicine

Author: N J Paydar

Medical School: University of Leicester

Three 48-year-old men experience an identical stroke. The scans are similar; the treatment is comparable. Their physical recovery follows remarkably similar trajectories. Shortly before discharge, each patient meets with their rehabilitation team to discuss their recovery goals and priorities. Mr Smith, an office worker in Britain, will head back home to his wife and children. He tells his rehabilitation team that he wants to drive again, manage his own shopping and avoid becoming a burden on his family. Mr Rahimi, a shopkeeper in Iran, will return home to his wife and elderly parents. He tells his rehabilitation team his priority is not simply to regain physical function, but to reconnect with his community. Meanwhile, just east of Iran, Mr Tanaka, an onion farmer in rural Japan, mutters the word 'ikigai'. These contrasting goals expose a tension at the heart of rehabilitation medicine - what constitutes successful rehabilitation when patients themselves define success in fundamentally different ways?

The 1977 introduction of the biopsychosocial model transformed physical and rehabilitation medicine (PRM) by recognising that recovery extends beyond pathology. However, it largely overlooks the cultural frameworks through which patients understand illness and judge the success of their recovery. This essay explores whether culture is a neglected fourth dimension of PRM - one that influences not only how patients recover, but what they are recovering for.

Through parallel journal entries of three fictional stroke survivors from Britain, Iran and Japan, this essay critically examines how cultural values shape perceptions of disability and successful recovery. These fictional narratives are not intended to represent entire cultures, but to illustrate how cultural values can shape individual rehabilitation goals. The journal format intentionally mirrors the longitudinal nature of rehabilitation, following recovery as it unfolds across different lives and cultural practices. By juxtaposing these experiences, the essay argues that successful rehabilitation extends beyond the restoration of physical function, challenging the notion that recovery can be defined by a single universal standard.

Journal entry from 15th April: The Goal-Setting Meeting

Mr Smith (United Kingdom): "The physiotherapist asked me what I wanted most. I told her I wanted to drive again. I hate relying on my daughter to take me shopping. I just want to be independent again."

Mr Rahimi (Iran): "I told the physiotherapist I wanted to return to Friday prayers at the village mosque. She asked how I plan on getting there. I smiled and told her my daughter would drive me. Getting there isn't what worries me - I'm worried my friends won't see me as the same man they knew before my stroke."

Mr Tanaka (Japan): "What do you want the most? The physiotherapist asked. I paused and thought for a long time before answering. 'Ikigai… a reason for being'. The harvest matters, but what matters more is knowing that each morning there is work worth doing."

Reconstructing Identity: Beyond Functional Recovery

Although PRM is frequently framed around restoring mobility and strength, patients often describe their greatest loss in terms of their identity rather than impairment. This reflects Bury's 1982 concept of biographical disruption, which suggests that a chronic illness leads to a fundamental rethinking of a person's self-identity [1]. Subsequent scholars have since argued that leaving the sick role does not necessarily mark the end of biographical disruption, but instead, it continues throughout the liminal state – a transitional period situated between acute illness and recovery [2]. Through this lens, PRM can be understood as a process of reconstructing identity, rather than simply restoring physical function. However, as illustrated by the three stroke survivors presented in this essay, the same clinical impairment may produce fundamentally different forms of biographical disruption across a range of cultural contexts. As such, it may be argued that patients ultimately experience two strokes - the first results in brain damage; the second arises when individuals are no longer able to perform their culturally valued roles that give their lives meaning. Consequently, the challenge for PRM is no longer simply restoring function, but deciding what restored function is ultimately for.

The differing definitions of successful rehabilitation illustrated by the three patients also raise an important question: can the assessment tools used by clinicians to evaluate successful recovery be applied universally? Scales such as the Barthel Index (BI) and the Functional Independence Measure (FIM), have transformed PRM by providing reliable measures of functional recovery, primarily through the assessment of independence. However, they only capture what patients can do, rather than the identities it allows them to reclaim. For some, this may mean independence; for others, it may mean reconnecting with the community or simply, rediscovering a sense of purpose.

As such, these narratives demonstrate that culture shapes rehabilitation in two distinct ways: first by defining what recovery means to patients, and second by shaping the frameworks through which clinicians evaluate whether this has been achieved. Consequently, this creates a disconnect between what patients perceive as successful rehabilitation, and what clinicians can measure using conventional outcome tools. Bridging this disconnect requires more than cultural competence; it requires a shift towards cultural humility, whereby clinicians can recognise that their own beliefs about successful rehabilitation are shaped by culturally specific values rather than universal principles [3]. The question is therefore not whether rehabilitation has been successful, but whose definition of success it has fulfilled.

Journal entry from 20th July: Three Months Later

Mr Smith (United Kingdom): "It has been three months since I had my stroke. My wife has been encouraging me to walk to the local shops with her. I still must stop and rest, but every now and then I make it there on my own. Yesterday I made my wife a cup of tea instead of the other way round. It was only a cup of tea but for the first time since my stroke, it felt like I was giving something back."

Mr Rahimi (Iran): "Last Friday, my daughter drove me to the village mosque. My occupational therapist has been helping me practise climbing the mosque steps, and I was pleased to manage them without needing to stop this time. I worried my friends would see me differently, but after prayers we sat together and drank chai, just as we always had. At home, my elderly parents now try to look after me, though for so many years it was my responsibility to care for them. I still catch myself reaching to help before remembering that things have changed."

Mr Tanaka (Japan): "Three months have passed since I had my stroke. The physiotherapist tells me I am walking further every week. My family is pleased. But my happiest mornings are not the ones when I walk without my stick, they are the mornings my son waits for me so we can walk to the fields together. I realise now that recovery is not only about walking, but also about having somewhere worth walking to."

The Hidden Destination of Rehabilitation

PRM traditionally celebrates improvements in function, yet the journal entries reveal a more profound observation: Although all three patients demonstrate identical levels of functional improvement, none of them describe the action of walking as the achievement. Instead, they value what walking makes possible. Mr Smith walks to regain his role within his marriage, Mr Rahimi climbs the mosque steps to reclaim his place within the community, and Mr Tanaka walks to the fields because they restore his sense of ikigai. Rehabilitation, in this sense, is not merely a means for restoration of function, but instead, the restoration of possibility.

This distinction closely aligns with Sen's 1980s Capability Approach, which argues that wellbeing should be understood in terms of the opportunities people have to live meaningful lives [4]. Conventional rehabilitation outcomes largely evaluate achieved function; however, the Capability Approach suggests that clinicians should instead consider the opportunities that restored function creates. Although all three stroke survivors have achieved comparable levels of physical improvement, they may experience profoundly different recoveries if their capabilities to pursue meaningful lives differ.

Journal entry from 1st March: One year later

Mr Smith (United Kingdom): "The driving assessment finally came through. It confirmed what I had quietly been suspecting. I filed the letter away and found myself looking forward to walking to the shops with my wife on Saturday."

Mr Rahimi (Iran): "My daughter still helps me with the mosque steps. I still pause halfway up, but I no longer find myself looking around to see who is watching. I simply look forward to seeing who is already waiting inside."

Mr Tanaka (Japan): "This year I missed the onion festival for the first time in thirty years. I thought I would feel as though I lost a part of myself. Instead, I spent the afternoon planting the first onions of next season with my son. Only then did I realise that the fields had always grown far more than onions."

The Rehabilitation Paradox

All three patients achieved an identical Barthel score at their one-year review. According to the physiotherapist progress notes, each recovery remains incomplete: Mr Smith still can't drive, Mr Rahimi still needs help climbing the mosque steps, and Mr Tanaka still walks with a stick. By every conventional measure, full recovery has not been achieved. However, their journal entries tell a different story. Although each patient fell short of their original functional goal, each patient ultimately achieved the outcome they valued most. These narratives therefore challenge the assumption that functional recovery and successful rehabilitation are synonymous. If rehabilitation enables patients to reclaim the aspects of life they themselves consider meaningful, should it be regarded as unsuccessful simply because residual physical limitations remain? Or does this simply reflect a mismatch between culturally defined patient goals and western-defined clinical measures of success?

It is important to recognise that although our three patients achieved identical Barthel scores and each achieved the goal they valued most, we cannot conclude that they experienced *equally* successful rehabilitation. Recovery remains a deeply personal and culturally situated experience that cannot be fully captured by either functional outcomes or goal attainment alone. Similarly, if all three patients obtained different Barthel scores, we cannot conclude that they have *not* achieved equally successful rehabilitation. Therefore, rehabilitation outcomes should be evaluated using a combination of standardised functional measures, patient-centred goals, and an understanding of each individual's personal and cultural context, rather than relying on any single outcome measure.

The Fourth Patient

Throughout this essay, three patients have been recovering from a stroke: Mr Smith, Mr Rahimi, and Mr Tanaka. Yet, there has in fact, been a fourth patient all along. The fourth patient is rehabilitation medicine itself. Over the course of these narratives, PRM has undergone its own rehabilitation. At the beginning, PRM sought to restore physical function. However, through the experiences of these three men, it encountered something far more challenging; it came to recognise that functional improvement alone cannot explain why three patients with almost identical physical impairments pursued fundamentally different goals, nor why three patients with incomplete physical recovery ultimately described their rehabilitation as successful. Just as stroke compelled the patients to reconstruct their identities, it compelled rehabilitation medicine to reconstruct its own understanding of recovery. And so, perhaps the greatest rehabilitation required was not that of the three patients, but that of rehabilitation medicine itself.

A New Prescription For Rehabilitation

If rehabilitation medicine is to complete its own recovery, it must embrace culture as an integral dimension of rehabilitation rather than a contextual afterthought. Functional measures will always remain valuable, however they should be interpreted alongside patient values and identities. Just as clinicians prescribe exercise, therapy, and assistive devices, they must also prescribe curiosity - a willingness to understand the cultural values and identities that shape what recovery truly means for each individual patient.

References

1. Engman A. Embodiment and the foundation of biographical disruption. Social Science & Medicine. 2019 Mar;225(1):120–7.
2. Trusson D, Pilnick A, Roy S. A new normal?: Women's experiences of biographical disruption and liminality following treatment for early stage breast cancer. Social Science & Medicine. 2016 Feb;151:121–9.
3. Lekas HM, Pahl K, Fuller Lewis C. Rethinking cultural competence: Shifting to cultural humility. Health Services Insights. 2020 Dec 20;13(13).
4. Bloemen B, Pijpers E, Cup E, Groothuis J, van Engelen B, van der Wilt GJ. Care for capabilities: Implementing the capability approach in rehabilitation of patients with neuromuscular diseases. Study protocol of the controlled before-after ReCap-NMD study. Phillips T, editor. PLOS ONE. 2021 Dec 21;16(12):e0261475.

When Pain Persists – The Purpose of Rehabilitation Medicine in Chronic Phantom Limb Pain

Author: Nithikka Senthil Kumar

Medical School: University of Leeds

Introduction

With an estimated 70,000 amputees in the UK (Bones, 2026), and pain affecting 95% of individuals following amputation (Hanyu-Deutmeyer et al., 2023), pain management often takes centre-stage in the long-term management considerations for patients facing life-changing physical disability.

But beyond symptomatic management, there are multi-fold aspects to a person's care that evolve long after the initial injury. Restoration of function, individual autonomy and identity are some of the considerations pertinent in the holistic care of patients with amputations. By bridging priorities of medical treatment and restoration of meaningful living, rehabilitation medicine seeks to address the questions often unanswerable by medical specialties in isolation.

The lived experience of an older man living with phantom limb pain and chronic neuropathic pain illustrates the potentials of rehabilitation medicine when pain cannot be eliminated. Our conversation on an acute admission to treat a flare of chronic pain served as a microcosm for the potentials of coordinated, multi-modal approaches to rehabilitation care and address delicate ethical quandaries.

The patient's rehabilitation journey

Identifying patient details have been anonymised to preserve confidentiality while maintaining the educational value of this case.

I am grateful for the time this patient was able provide, and his candid expressions of his health journey. His account of personal struggles, triumphs and experiences with his health elucidated how his greatest challenges extended beyond the physical pain that was immediately apparent.

On initial observation, his wheelchair, mobility aids and supported position in bed offered preliminary insight into limitations in function, mobility and independence; but the complexities of navigating multiple chronic conditions would only be revealed through conversation.

Following a traumatic road traffic collision many years ago, the gentleman sustained multiple injuries, culminating in a lower-limb amputation that was later revised more proximally due to symptomatic neuromas. Although the initial trauma occurred decades earlier, its consequences continued to unfold throughout his life. Alongside phantom limb pain, musculoskeletal conditions including osteoarthritis and arthropathies and cardiovascular co-morbidities impacted his mobility and independence – not as individual diagnoses but cumulative complexities to his rehabilitation journey. His story epitomises a reality for many individuals living with disability, where rehabilitation becomes a lifelong process of navigating and adapting to continually fluctuating health states.

Pain was an unspoken but persistent presence throughout our conversation, influencing not only what the patient shared, but how he shared it. He had kindly agreed to speak with me while waiting for his next dose of morphine, explaining that the conversation was a welcome distraction. This encounter provided a snapshot into a longer experience of managing chronic pain, which had become intertwined into the rhythm of his daily life, organised around symptomatic relief. Managing his physical pain with long term use of high-dose fentanyl

lozenges, gabapentin, and ibuprofen gel reflected an effortful balance between alleviating daily pain, and longer-term rehabilitation aspirations. Tensions between priorities of preserving independence and reducing medication reliance with immediate relief composite a significant challenge for his ongoing and future care.

The emotional burden of living with chronic disability became apparent as the conversation developed, and the patient shared his feelings of guilt for relying on his family; often declining visitors while in hospital. The consequences of limb loss extended deeper than the physical pain he was admitted for - increasing social isolation, persistent low mood and increasing fatigue were significant challenges stemming from the collective impact of injury upon his personhood and identity. He expressed frustration with navigating fragmented healthcare services, moments of fractured continuity in his care, and disappointment in surgical approaches alone to effectively manage his complex health. This patient's account elucidated how multi-modal rehabilitation approaches may strive to care for the intertwined challenges of chronic illness, psychological health and social well-being.

Difficulties for rehabilitation for phantom limb pain

Of the many physical, emotion and social challenges that follow post-amputation, chronic pain is a frequent and debilitating consequence that may hinder rehabilitation. Post-amputation pain is broadly categorised into residual limb pain (RLP) and phantom limb pain (PLP), each arising from distinct but overlapping cortical, spinal, and peripheral mechanisms.

Residual limb pain

Residual limb pain refers to peripheral mechanisms at the amputation site, driven by soft tissue inflammation or infection, bone pathology such as osteomyelitis, and the formation of neuromas. Following injury to a peripheral nerve, Wallerian degeneration occurs. The distal axon and myelin sheath degenerate, macrophages and Schwann cells act locally, and the proximal nerve undergoes disorganised proliferation. In the absence of distal nerve targets, a neuroma is formed: a bundle of nerve fibres is embedded in connective and adipose tissue with a lower threshold for activation.

The pathophysiology of neuromas can be targeted in the treatment for resulting symptomatic pain - where peripheral nerve blocks reduce hyper-activity of neuromas, reducing the pain felt at the amputation site (Buch et al., 2020). These treatments were provided for this patient, who experienced both types of post-amputation pain.

Phantom-limb pain

PLP affects 40-80% of amputees but remains less precisely understood due its heterogenous pathology (Spezia et al., 2024). The underling cortical mechanism involves somatosensory re-mapping of the region corresponding to the denervated limb post amputation. Following amputation, a loss of sensory input from the amputated limb causes neighbouring cortical representations to expand into the deprived region, altering the somatosensory homunculus. As a result, aberrant sensory inputs from neighbouring regions are mis-interpreted as being propagated from the missing limb (Makin and Flor, 2020).

However, cortical representation of the lost limb is not fully erased, and persistent phantom limb representations combined with new sensory inputs may contribute to PLP. Prosthesis and compensatory movements may also influence cortical re-mapping, elucidating how the underlying pathophysiology may demonstrate varied pain experiences individual to individual, highlighting the need for personalised rehabilitation.

At the dorsal root of the spinal cord, loss of afferent input reduces inhibition of sensory transmission, leading to hyper-active autonomous signalling and central sensitisation where minor signals are amplified as intense pain (Erlenwein et al., 2021).

Implications for management

Clinical treatments aim to reduce the propagation of pain signals and alleviate the experience of pain. However, as seen in this patient case, the heterogenous nature of the underlying mechanisms present a challenge for effective treatments, requiring multi-disciplinary rehabilitation approaches beyond pharmacological focus.

Safety considerations for rehabilitation

Safety considerations for this patient can be categorised into immediate risks and longer-term concerns, each with the potential to compromise functional recovery, independence and quality of life.

Falls in the elderly population

In the short-term, the acute risk of falls was a pertinent concern, due to marked differences in gait, balance and physical activity associated with lower-limb amputation (Stefanacci and Wilkinson, 2025). Among individuals with lower limb loss, the estimated incidence of annual falls ranges from 40 to 80%, and increases further with advancing age, highlighting the importance of preventative measures for patients with diminished physiological reserves (Hunter et al., 2016).

For this patient, the recovery following a fall would likely be complicated by impaired wound healing, functional limitations and chronic pain. Although in our encounter the patient did not appear markedly frail, a fall in an older adult with co-morbidities could precipitate a stepwise decline in independence. The unfamiliar hospital environment further increases risk, requiring attention to environmental hazards, the patient's mobility and situational factors such as unhurried mobilisation to the bathroom (NICE, 2025).

Long-term opioid therapy – a temporary treatment with long-term consequence

The optimisation of analgesia for the patient's chronic neuropathic pain while balancing the risks of long-term opioid therapy is a key safety consideration, particularly given the patient's opioid dependency and psychiatric co-morbidity. Although oral morphine has demonstrated the ability to reduce pain in the short term for phantom limb pain (Alviar et al., 2016), longer-term use increases the risk of fractures, falls, endocrine and immune dysfunction, and adverse cardiac events – magnified in older patients and at higher medication doses (Faculty of Pain Medicine of the Royal College of Anaesthetists, 2024). The risk of opioid-induced hyperalgesia, a state of abnormal pain sensitivity, would additionally hinder the combined clinical and patient effort towards tapering morphine therapy, becoming barriers to rehabilitation.

Co-existence of psychiatric conditions

Psychiatric illness is more prevalent in amputees than in the general population, and the co-existence of depression and opioid dependency in this patient required additional consideration (Urits et al., 2019). Overlaps between neural limbic pathways and the endogenous opioid system may explain how mood disorders and chronic pain reinforce one another, complicating management. Additionally, the blurred

boundaries between physical pain and emotional pain can lead to clinical circumstances where opioid therapy is used to treat a combination of both, raising safety concerns (Sullivan, 2018).

Considerations for patient care

The layered complexities emphasise the need for patient-specific approaches beyond the general opioid treatment guidelines (NICE, 2020). Determining treatment priorities involves the careful deliberation of weighing safety risks against the alleviation of suffering. Such deliberation requires a multi-disciplinary approach and clear communication between pain specialists and rehabilitation teams to ensure consistent prescribing while focussing on functional goals.

The ethics of rehabilitation when 'cure' is impossible

Multi-fold ethical reflections represent wider considerations for the purpose of rehabilitation medicine for the alleviation of suffering and meaningful recovery.

Historical influences

A historical under-treatment of pain led to pain being reframed as the '5th vital sign' in the 1990s, initiating aggressive management approaches with limited safety evidence (Mandell, 2016). While these initiatives paved the way for increased attentiveness to patient experience, they arguably overshot in their focus on pharmacological therapies. Compounded by shifting cultural ideologies, increasing emphasis on patient satisfaction, and the expanding pharmaceutical industry – initially well-intentioned goals for public health precipitated longer-term harms (The Lancet Public Health, 2022).

Ethical tensions in opioid prescribing

The nature of opioid therapies exists as a paradox; concomitant with the provision of pain relief are the risks of iatrogenic harm, suspending the responsible clinician in an ethical limbo between caring for patient's immediate wishes and facilitating longer-term rehabilitation goals. The balance between a patient-led treatment model and clinician-guided approach becomes an active consideration in this case, where avoiding paternalistic practices and facilitating patient autonomy is complicated by underlying opioid dependence, which may compromise decision-making capacity (Yan and Kuo, 2019).

Distinctions between pain and suffering

Deliberating the ethics of pain relief management raises the question of what the prescribed treatment aims to alleviate - pain or suffering?

While pain is understood to have primarily physiological origins, suffering composites a more multi-dimensional experience: impacting an individual's 'personhood', threatening their sense of identity, and ability to live meaningfully (Duffee, 2019). In this patient's testimony, he expressed moments of suffering distinct from his experience of pain; his loss of independence and bodily integrity - were an ongoing challenge to his sense of self, regardless of any pain he was feeling.

This case illustrates two predominant ethical challenges to treatment: the difficulty of defining pain in the absence of nociceptive stimulus, and the difficulty in distinguishing pain from suffering. A paucity of definitive clarity to these concepts adds to the complexity of caring compassionately, safely and holistically for this patient.

Patient experiences such as his, elucidate the importance of not conflating measurable pain with suffering, as purely analgesic approaches would likely fall short in addressing the multiple contributors of his suffering. Adopting a multi-faceted approach to care, including social care, mental health support, and regularly reviewing the patient's priorities may increase the chance that the patient can be cared for in a way that is individually meaningful and necessary.

Future directions of rehabilitation

Current management approaches

Ongoing advancements in management approaches are necessary to bridge the uncertain efficacy of pharmacological treatments (Erlenwein et al., 2021).

Non-invasive therapies such as mirror therapy have indicated potential to reduce the intensity and duration of daily pain episodes, however evidence is limited in this area, underscoring the need for larger trials investigating mirror therapy (Campo-Prieto and Rodríguez-Fuentes, 2020). Similarly, neuro-modulation techniques that aim to reverse maladaptive neuroplasticity require further evaluation, limited evidence shows it may demonstrate similar efficacy to mirror therapy (Spezia et al., 2024).

Surgical innovations

Amongst limited effective treatment options, surgical interventions indicate potential for long-term management. Targeted Muscle Reinnervation (TMR) is a nerve-transfer procedure, originally developed for prosthetic control but found to reduce amputee pain by correcting underlying pathophysiological mechanisms (Aternali and Katz, 2019). The process involves surgically re-routing free nerve ends at the amputation site to provide a physiological target for regenerating axons. A single-institution cohort study found that 71% of below-knee amputees with co-morbidities were pain free following TMR, demonstrating reduced opioid use, and markedly improved ambulation outcomes (Chang et al., 2021). The efficacy of this therapy in highly co-morbid patients and elderly patients indicates real-world applicability. Importantly, the potentials of TMR to improve mobility-limiting neuropathic pain is a meaningful outcome of novel research, as it may facilitate functional recovery and restore independence.

Regenerative Peripheral Nerve Interfaces (RPNI) is a surgical technique demonstrating similar success, providing a preventative strategy for chronic neuropathic pain. RPNI involves harvesting muscle to create a graft around major nerve ends at the amputation site, leading to re-vascularisation and re-innervation of transected nerve endings. A systematic review evaluating pain outcomes after TMR and RPNI demonstrated improved neuroma pain in 75%–100% of patients and phantom limb pain in 45%–80% of patients (Mauch et al., 2023). Despite a small incidence of complications of delayed wound healing, both techniques were considered safe and well-tolerated.

Advances in surgical techniques indicate potential for improved wider rehabilitation efforts for chronic neuropathic and phantom limb pain.

Concluding reflections

Learning of this patient’s experience brought into focus the intertwined ethical and safety components involved with the management of PLP and chronic neuropathic pain, where there are rarely binary answers. The use of opioids for long-standing pain management prompts recognition that pain relief alone may not constitute meaningful rehabilitation. Similarly, while emerging surgical innovations may offer hope for future patients, they may not be feasible for this individual – emphasising the importance of a multidisciplinary approach.

Ensuring that a patient's beliefs, values and priorities are understood by all responsible clinicians is pivotal to person-centred rehabilitation. Although preventing pain may not always be possible, integrated rehabilitation approaches offers the opportunity to alleviate suffering while enabling individuals to live meaningfully with disability.

Reference list

- Alviar, M.J.M., Hale, T. and Lim-Dungca, M. 2016. Pharmacologic interventions for treating phantom limb pain. Cochrane Database of Systematic Reviews. **10**(10).
- Aternali, A. and Katz, J. 2019. Recent advances in understanding and managing phantom limb pain. F1000Research. **8**, p.1167.
- Bones, S. 2026. 12 Key Facts About Amputation in the UK - Steel Bones. Steel Bones - Dedicated to civilian amputees. [Online]. Available from: https://steelbone.co.uk/12-key-facts-about-amputation-in-the-uk/ .
- Buch, N.S., Qerama, E., Brix Finnerup, N. and Nikolajsen, L. 2020. Neuromas and postamputation pain. PAIN. **161**(1), pp.147–155.
- Campo-Prieto, P. and Rodríguez-Fuentes, G. 2020. Effectiveness of mirror therapy in phantom limb pain: a literature review. Neurología (English Edition). **37**(8).
- Chang, B.L., Mondshine, J., Attinger, C.E. and Kleiber, G.M. 2021. Targeted Muscle Reinnervation Improves Pain and Ambulation Outcomes in Highly Comorbid Amputees. Plastic and Reconstructive Surgery. **148**(2), pp.376–386.
- Duffee, C.M. 2019. Pain versus suffering: a distinction currently without a difference. Journal of Medical Ethics. **47**(3), pp.175–178.
- Erlenwein, J., Diers, M., Ernst, J., Schulz, F. and Petzke, F. 2021. Clinical updates on phantom limb pain. PAIN Reports. **6**(1), p.e888.
- Faculty of Pain Medicine of the Royal College of Anaesthetists 2024. Long term harms of opioids | Faculty of Pain Medicine. fpm.ac.uk. [Online]. Available from: https://fpm.ac.uk/opioids-aware-clinical-use-opioids/long-term-harms-opioids .
- Hanyu-Deutmeyer, A.A., Cascella, M. and Varacallo, M. 2023. Phantom Limb Pain. Nih.gov. [Online]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK448188/.
- Hunter, S.W., Batchelor, F., Hill, K.D., Hill, A.-M., Mackintosh, S. and Payne, M. 2016. Risk Factors for Falls in People With a Lower Limb Amputation: A Systematic Review. PM&R. **9**(2), pp.170-180.e1.
- Macpherson, C. 2009. Undertreating pain violates ethical principles. Journal of Medical Ethics. **35**(10), pp.603–606.
- Makin, T.R. and Flor, H. 2020. Brain (re)organisation following amputation: Implications for Phantom Limb Pain. NeuroImage. **218**(1), p.116943.
- Mandell, B.F. 2016. The fifth vital sign: A complex story of politics and patient care. Cleveland Clinic Journal of Medicine. **83**(6), pp.400–401.
- Mauch, J.T., Kao, D.S., Friedly, J. and Liu, Y. 2023. Targeted muscle reinnervation and regenerative peripheral nerve interfaces for pain prophylaxis and treatment: A systematic review. PM&R. **15**(11), pp.1457–1465.
- NICE 2025. Overview | Falls: Assessment and Prevention in Older People and in People 50 and over at Higher Risk | Guidance | NICE. Nice.org.uk. [Online]. Available from: https://www.nice.org.uk/guidance/ng249 .
- NICE 2020. Recommendations | Neuropathic pain in adults: pharmacological management in non-specialist settings | Guidance | NICE. www.nice.org.uk. [Online]. Available from: https://www.nice.org.uk/guidance/cg173/chapter/Recommendations .

- Spezia, M.C., Dy, C.J. and Brogan, D.M. 2024. Phantom Limb Pain Management. The Journal of Hand Surgery. **50**(2).
- Stefanacci, R. and Wilkinson, J. 2025. Falls in Older Adults - Geriatrics. MSD Manual Professional Edition. [Online]. Available from: https://www.msdmanuals.com/professional/geriatrics/falls-in-older-adults/falls-in-older-adults .
- Sullivan, M. 2018. Depression Effects on Long-term Prescription Opioid Use, Abuse, and Addiction. The Clinical Journal of Pain. **34**(9), p.1.
- The Lancet Public Health 2022. Opioid overdose crisis: time for a radical rethink. The Lancet Public Health. **7**(3), p.e195.
- Urits, I., Seifert, D., Seats, A., Giacomazzi, S., Kipp, M., Orhurhu, V., Kaye, A.D. and Viswanath, O. 2019. Treatment Strategies and Effective Management of Phantom Limb–Associated Pain. Current Pain and Headache Reports. **23**(9).
- Yan, E. and Kuo, D.J. 2019. 'I just need an opiate refill to get me through the weekend'. Journal of Medical Ethics. **45**(4), medethics-2018-105099.

Advancement of Rehabilitation Medicine: Integrating Veterinary Innovation into Human Healthcare Through the One Medicine Framework

Author: Olivia McCausland

Medical School: University of Nottingham

The boundary between human and animal medicine has never been clear cut. Ancient healers treated humans and animals alike, and civilisations from the Egyptian Papyri to the Zhou Dynasty recognised that anatomical and physiological knowledge transcends species. An 18th-century Chinese text reads "the foundations of veterinary and human medicine are equally comprehensive, and neither can be placed above the other". This philosophy has since been formalised as "One Medicine" — the principle that pooled knowledge of anatomy, pathology, physiology, and disease across species creates a broader, more capable healthcare system than either discipline could develop alone.[1]

One Medicine is primarily focused on infectious disease. Approximately 60% of human infectious diseases are zoonotic, and outbreaks of Ebola, Avian Influenza, and COVID-19 are reminders of how intimately human and animal health are intertwined.[2] However, the argument extends far beyond epidemiology. Veterinary medicine has made clinical advancements in physical rehabilitation, which human medicine has been slow to adopt — not because of lacking evidence, but because the structural mechanisms for the transfer of cross-species knowledge are not there.[1]

This essay examines two areas within Physical and Rehabilitation Medicine. First, multimodal neurological rehabilitation following Spinal Cord Injury (SCI), where canine clinical trials have produced controlled outcome data to a higher level than the equivalent human evidence base, in both scale and protocol specificity. Second, mesenchymal stem cell therapy for musculoskeletal rehabilitation. This will look at spontaneously occurring disease in dogs which has generated translational data now being considered for human application. In both cases, the veterinary evidence preceded and, this essay will argue, exceeds the human clinical standard. The work of Professor Noel Fitzpatrick, whose pioneering surgical and rehabilitative approach catalysed the modern One Medicine movement in the UK, provides key support for this argument.[14 17]

Scenario 1: If you and your beloved dog were to undergo an equivalent spinal cord injury, your dog would be walking before you.

The injury: SCIs are highly comparable between humans and canines. Intervertebral Disc Extrusion (IVDE) in dogs — a slipped disc — occurs when the degenerate inner core of a spinal vertebra extrudes and compresses the spinal cord, directly mirrors an acute Herniated Nucleus Pulposus (HNP) in humans. Even the injury classifications closely resemble each other: canine patients are categorised as Deep Pain Perception (DPP) positive or negative by assessing preservation of pain in the distal limbs, while the human equivalent — the ASIA Impairment Scale — assesses Deep Anal Pressure. The neurobiological mechanism, Intensive Neurorehabilitation (INR), is identical in both. Triggering central axon pathways crossing the lesion, and stimulating propriospinal connections that avoid the injury site, INR drives autonomous locomotion and afferent feedback.[3] This model, known as the Central Pattern Generators (CPG) model, is the shared foundation of both veterinary and human locomotor rehabilitation.[3 4] Where the species diverge is not in theory, but in the rigorous regimes put into practice.

The protocol: Canine post-surgical rehabilitation is initiated within 2–7 days, with an intensive programme covering a range of domains.[3] In human SCI, rehabilitation is typically aimed to commence 7–14 days post-operatively, with vast variation between establishments. This timeframe may be extended in some for up to 8 weeks post-surgery, involving strict bed-rest.[4] The veterinary field has moved toward immediate, protocol-driven rehabilitation as the standard, whereas human SCI rehabilitation pathways still show substantial variation in start times for active rehabilitation. The evidence surrounding early initiation in humans is less consolidated than its veterinary equivalent.[3 4]

There are also major differences in how the protocol is integrated. The veterinary INR model combines three simultaneous electrostimulation approaches: Functional Electrical Stimulation (FES) targeting neuromuscular activation; Interferential Electrical Stimulation (IES) for symptomatic management of pain and oedema; and Transcutaneous Electrical Spinal Cord Stimulation (TESCS) for neuromodulation of the lumbar locomotor network.[3] Each of these domains exist in human rehabilitation medicine, and evidence supports their individual use for gait, limb coordination and muscle activation.[4] However, no equivalent combined trimodal protocol has been established in human SCI rehabilitation guidelines. The components are recognised separately, yet there is no standardised integration. Additionally, there is inclusion of pharmacological management (4-aminopyridine) in DPP negative dogs who had not shown improvement after 3–4 weeks, but did begin to demonstrate a flexion-extension locomotor pattern.[3] In human medicine, 4-AP is used in Multiple Sclerosis to improve gait,[6] but has not been incorporated into acute SCI rehabilitation protocols in the novel combined approach that veterinary medicine has adopted. The veterinary management of the most severely injured patient is not just better-executed human medicine, it's fundamentally different.

The last resort: In animals for whom land-based rehabilitation still results in undetectable improvement, the Underwater Treadmill (UWTM) provides an advantage, both therapeutically and for assessment. A 2023 study by Linder et al. demonstrated that dogs unable to complete the land assessment were significantly more likely to generate a recordable score on the UWTM.[5] This revealed motor recovery that land assessment would have missed. This has a direct implication to humans. If an aquatic environment exposes motor function in the most severely injured SCI patients, human rehabilitation medicine may be systematically underestimating neurological recovery in this cohort by not incorporating equivalent aquatic assessment into standard pathways.[5]

Scenario 2: How your pet may be the cure of your osteoarthritis.

The background: Spontaneous diseases arise due to genetic dispositions, environment, and the natural aging process. Diabetes Mellitus, Osteoarthritis (OA), and Cancer are just a few of the life-changing conditions which may be developed throughout a lifetime, and often the direct cause is unknown. Just like humans, companion animals are equally at risk of developing these conditions, and for all species finding a cure is complex and time-consuming.

The naturally occurring disease in species could become a fundamental research aid for society. Traditional preclinical testing involves the induction of autoimmune diseases or injuries in laboratory animals, particularly rodents. However, these models often fail to achieve accurate replicas of the complex therapies translating to humans, which is where the Spontaneous Disease Model can be applied.[10]

Rodent OA models are invariably chemically or surgically induced. However, these models have been proven to be poor predictors of numerous aspects of drug management when converted to humans.[10] Despite providing genetic information, as currently logged in the International Mouse Phenotyping Consortium's (IMPC) comprehensive catalogue of mammalian gene functions, the efficacy or toxicity of pharmaceutics do not translate easily to humans.[11] It has been shown that the pathophysiology of induced diseases diverges substantially: mice do not spontaneously develop OA as humans do, whereas dogs do.[7] This methodological difference is the main driver in developing a new research pathway.

The heterogeneity of companion animals — varying genetics, ages, and environments — mirrors the multiplicity of human disease in ways laboratory animals cannot.[7] The clinical real-world reflection of natural disease progression is far superior to induction of diseases, and it also addresses the ethical issues associated with enforced induction of disease. Not only are many animals saved from having chronic diseases thrust upon them, but the chronic nature of human illness is mimicked. The longitudinal outcomes of companion animal disease are ideal models for human treatment, assessing long-term safety, dosing, and allogeneic therapy efficacy.[7] The common traits shared between companion animal and human, such as obesity, living into old age, and shared environments and activities, sets a prime foundation. This is further developed by the effort and finances put into providing them with almost identical treatments to what we would expect humans to be given. This extends from long-term anti-inflammatory treatment to physio and joint replacements.

The treatment: The most actively developed therapeutic area in this field is Mesenchymal Stem Cells (MSC). This is a process reliant on adult stem cells which modulate the immune system, reduce inflammation, and encourage tissue repair.[9] Key biological mechanisms of the process involve immunomodulation (through interaction with immune cells to suppress an amplified inflammatory response), secretome production (which prevents cell death of the native cells, whilst stimulating local tissue repair), whilst having a homing ability to the injury site.[9] These immunomodulatory properties enable MSCs to be used for degenerative or immune-mediated conditions.

Dogs have numerous comparable spontaneous diseases which have the outcome of end-stage osteoarthritis, and the pathogenesis of this spontaneously occurring disease is the closest resemblance of human pathology.[7] Anatomical likeness, disease progression and heterogeneity closely align. A prime example of this is the proteoglycan deterioration in the articular cartilage of dogs matching that in humans, whereas disease induced by cruciate ligament transection differs vastly in pathogenesis.[7] As a result of the wide variety of breed disposition, coupled by a larger proportion of inbreeding, the genetic associations with these diseases are often more identifiable.[7] Known risk factors, such as size and weight, show evident disease increase in distinctive breeds, and the assessment of independent risk factors, such as dietary reduction, have had an immense increase in research conducted through inbred canine colonies. In addition, the subclassification of OA in dogs is well distinguished. This enables extensive specific research which can be placed on a parallel to human disease and subtype, offering a way to align dog models with corresponding human OA phenotypes.[7] However, one of the most important selling points of spontaneous disease models, particularly in dogs, is the compressed timeframe they offer. The progression and onset of a disease over months mirrors the process occurring in humans over years, and treatment will show effects on a similar compressed timeframe, allowing for veterinary longitudinal studies which would take decades in the human research field.[7]

MSC therapy is not speculative. It is already deployed across species, making knowledge transfer a matter of clinical urgency.[8] The paracrine activity of MSCs is well understood, although the restricted application of the therapy (due to it currently being available as an emerging elective therapy, rather than an offered treatment) limits awareness of future possibilities.[9]

In the human research field, clinical trials show promising short-term results and excellent safety profiles, although optimal cell dosage, the best source of cells, and long-term restorative effects are still being researched. However, the current evidence for canine MSC therapy has excelled beyond this. It is not merely observational or anecdotal; it meets the Randomised Controlled Trials (RCT) standard that human medicine itself demands for clinical guideline development.[8] MSCs have been shown to statistically improve disease symptoms (for example, a 42.6% reduction in pain on movement when compared to the placebo group in a 2016 study by Harman et al.[8]), whilst not causing any increase in adverse reactions or negative health. A significant improvement in multiple independent outcome measures, which is being replicated by numerous other veterinary studies,[15] [16] would provide a strong basis for guideline development in the human clinical field. This raises the question, why has this not been the case for human musculoskeletal rehabilitation? Harman et al. explicitly address the translational prospects this paper offers, as it provides valuable animal clinical safety

and efficacy outcome data to those developing human stem cell therapy.[8] Similarly to the study by Martins et al., the veterinary trials are stated to be foundational in the human clinical field. The current FDA Investigational New Animal Drug Application establishes this veterinary data as being submitted for regulatory consideration in human medicine, supporting just how translational the data is, and how key it is in the safety and development of therapy in mankind.[8]

Limitations

Whilst this essay, and the many studies it supports, show strong support for the collaboration between specialties, there are limitations. One limitation of the veterinary evidence base, for example, is the inconsistency in study paradigms, and incomplete reporting on trials.[9]

The species translation gap is still a limitation. Even spontaneously occurring canine disease, whilst superior to rodent models, is not an exact match for human disease. This is compounded by anatomical differences, quadrupedal vs bipedal gait differences, and cartilage thickness and turnover variation.[7] This essay works to argue not that dogs are identical to humans, but that they are sufficiently similar to warrant formal collaboration in research.

Additionally, some of these studies involve populations skewed towards certain breeds, limiting the true representation in translation. Martins et al. (2021) skewed towards Dachshunds and other chondrodystrophic breeds predisposed to IVDE, limiting generalisability to broader SCI aetiologies such as trauma, tumour, and vascular injury.[3] The retrospective design of the Martins et al. (2021) study further limits causal inference, as it cannot fully distinguish INR-induced recovery from spontaneous resolution.[3]

Finally, there may be aspects of commercial bias in many of the veterinary MSC trials. Harman et al. (2016) was funded by VetStem Biopharma, the company providing the stem cell product used in the trials.[8] Whilst this does not invalidate the trials, a conflict of interest should be acknowledged.

Conclusion

Both areas examined in this essay illustrate that veterinary protocols preceded, and in some respects exceed, the human clinical standard. This may be attributable to the structural freedom to trial aggressively, early, and at scale in spontaneously occurring disease, rather than due to superior funding or resource. In both SCI rehabilitation and MSC therapy, the authors of the veterinary papers themselves explicitly identify human medicine as the intended beneficiary of their findings, whilst also acknowledging the simultaneous benefit to animal practice.[3 8] It is the institutional mechanism which is not there to act on the transference.

Sociological barriers may exist. The informal nature of knowledge transfer is driven by system deficits, such as regulatory fragmentation, segregated research funding, institutional resistance to change, and the absence of standardised joint clinical trial frameworks.[1] Ultimately, the restriction is organisational, and professional, rather than scientific. Previous cross-species research has failed to provide adequate knowledge for transference. The rodent models have persisted despite displayed inadequacies,[10] exemplifying resistance to new research pathways. The canine spontaneous disease model, though available and validated, has not universally been adopted into conventional preclinical channels.[7]

The formalisation of One Medicine, from Schwabe's foundational text in 1964[14] to the One Health Initiative in 2006 and the Humanimal Trust in the UK by Professor Noel Fitzpatrick in 2014, reflects growing recognition that these barriers are structural rather than scientific. These organisations have highlighted the need not solely for awareness, but for formal cross-species research infrastructure — obtainable through joint ethics approval pathways, shared clinical trial registration, and multidisciplinary rehabilitation protocol development groups. The work of Fitzpatrick demonstrates this is clinically achievable when institutional boundaries are removed.[14]

Ultimately, the removal of these barriers is not only advantageous to companion animals but is hugely impactful to the human patient. It is costly to thousands every year that MSC remains outside the guidelines for OA management in humans, and every SCI patient who begins their rehabilitation so much later than their canine equivalent. This represents a direct and preventable harm that the One Medicine framework exists to address. Companion animals in these trials have a genuine welfare interest of their own — one that One Medicine is able to benefit alongside humans, rather than exploiting veterinary patients for human gain.

References

1. Zinsstag J, Schelling E, Waltner-Toews D, Tanner M. From "one medicine" to "one health" and systemic approaches to health and well-being. *Prev Vet Med*. 2011;101(3–4):148–156.
2. Taylor LH, Latham SM, Woolhouse ME. Risk factors for human disease emergence. *Philos Trans R Soc Lond B Biol Sci*. 2001;356(1411):983–989.
3. Martins Â, Gouveia D, Cardoso A, et al. A controlled clinical study of intensive neurorehabilitation in post-surgical dogs with severe acute intervertebral disc extrusion. *Animals (Basel)*. 2021;11(11):3034.
4. Martins Â, et al. A comparison between body weight-supported treadmill training and conventional over-ground training in dogs with incomplete spinal cord injury. *Front Vet Sci*. 2021;8:597949.
5. Linder JE, et al. Adaptation of land treadmill scoring system for underwater treadmill in dogs with thoracolumbar intervertebral disc extrusion. *Vet Surg*. 2023. DOI: 10.1016/j.vsu.2023.00904.
6. Goodman AD, Brown TR, Krupp LB, et al. Sustained-release oral fampridine in multiple sclerosis: a randomised, double-blind, controlled trial. *Lancet*. 2009;373(9665):732–738.
7. Meeson RL, Todhunter RJ, Blunn G, Nuki G, Pitsillides AA. Spontaneous dog osteoarthritis — a One Medicine vision. *Nat Rev Rheumatol*. 2019;15(5):273–287.
8. Harman R, Carlson K, Gaynor J, et al. A prospective, randomized, masked, and placebo-controlled efficacy study of intraarticular allogeneic adipose stem cells for the treatment of osteoarthritis in dogs. *Front Vet Sci*. 2016;3:81.
9. Brondeel C, Pauwelyn G, de Bakker E, Saunders J, Samoy Y, Spaas JH. Review: mesenchymal stem cell therapy in canine osteoarthritis research: "Experientia Docet." *Front Vet Sci*. 2021;8:668881.
10. Little CB, Zaki S. What constitutes an "animal model of osteoarthritis"? The need for consensus. *Osteoarthritis Cartilage*. 2012;20(4):261–267.
11. Brown SDM, Moore MW. The International Mouse Phenotyping Consortium: past and future perspectives on mouse phenotyping. *Mamm Genome*. 2012;23(9–10):632–640.
12. Dobkin BH, Apple D, Barbeau H, et al. Weight-supported treadmill vs over-ground training for walking after acute incomplete SCI. *Neurology*. 2006;66(4):484–493.
13. Field-Fote EC, Roach KE. Influence of a locomotor training approach on walking speed and distance in people with chronic spinal cord injury. *Phys Ther*. 2011;91(1):48–60.
14. Schwabe CW. *Veterinary Medicine and Human Health*. 3rd ed. Baltimore: Williams & Wilkins; 1984.
15. Vilar JM, Batista M, Morales M, et al. Assessment of the effect of intraarticular injection of autologous adipose-derived mesenchymal stem cells in osteoarthritic dogs using a double blinded force platform analysis. *BMC Vet Res*. 2014;10:143.
16. Cuervo B, Rubio M, Sopena J, et al. Hip osteoarthritis in dogs: a randomized study using mesenchymal stem cells from adipose tissue and plasma rich in growth factors. *Int J Mol Sci*. 2014;15(8):13437–13460.
17. Fraser, M., Bailey, J., Short, A., Hauptmannova, I., Fitzpatrick, N., Marshall, B. and La Ragione, R. (2025), Value of a One Medicine approach. Veterinary Record, 196: 362-363.

FND: How Can We Rehab What We Can't Understand?

Author: Rebecca Beardmore

Medical School: Barts and the London

Prior to becoming a medical student, I trained and spent 3 years working in the NHS as a physiotherapist. I was able to experience first-hand the huge impact that rehabilitation had on the quality of life of those who needed it; from brain injuries to geriatrics, from palliative care to major trauma. In many of these groups, there are robust rehabilitation pathways, supported by extensive evidence-based literature that can be used to inform clinical decision making. However, there are certain patient groups who do not easily fit into an existing rehabilitation model. One such group is those with functional neurological disorder (FND).

FND describes symptoms related to the impaired functioning of the nervous system with no clear organic cause, and encompasses motor, sensory, cognitive and perceptual symptoms. Current evidence suggests there are 50,000-100,000 people with FND in the UK (1), although this is likely to be much higher due to missed diagnoses. The quality of life for these individuals is markedly worse than the general population (2) and their prognosis is generally poor (3). As a result, both direct and indirect costs to the individual, the healthcare service and the social care system are very high (4). Despite increasing research in recent years, the aetiology of FND remains poorly understood. As a result, FND is underrepresented in the medical curriculum, as well as in NHS resource allocation. There is a scarcity of specialist services available for patients with FND (5). In many cases, patients are not able to access any services at all, as they do not meet the inclusion criteria of any one service. Furthermore, there is enormous heterogeneity within FND, presenting a significant challenge to rehabilitation in itself.

FND exposes a hidden assumption in medicine; that we struggle to treat what we don't understand. Physical and rehabilitation medicine (PRM) has always focused on function, rather than underlying structural pathology. This is the key to effective FND rehabilitation; based on function and engagement. Evidence shows that the greatest challenge in the management of FND is not the condition itself, but the lack of rehabilitation services and robust clinical pathways.

The following is an account of one patient with FND who had a profound effect on me. This essay will explore the barriers to rehabilitation she faced at each stage, and what the evidence suggests we could do differently.

Katherine

The Accident and Emergency department is particularly busy today. A young woman, Katherine, is lying on a trolley. She is 30 years old; she has 2 young children and is self-employed as a nail technician. At 6am this morning, Katherine woke to find that she couldn't feel her legs, and she couldn't move them either.

Every test is performed; lumbar punctures, blood tests, MRIs of her brain and spinal cord. All the results are negative. While investigations are ongoing, the multi-disciplinary team (MDT) agree that Katherine needs to be admitted. The hospital has a stroke unit, but Katherine hasn't had a stroke, so she can't go there. There is no specific neurology ward. There is an older adult rehabilitation ward, but Katherine is 30 so she doesn't meet the criteria to be admitted. Eventually, a bed is found on an endocrinology ward.

1: Whose problem is this?

FND sits at an intersection between neurology and psychiatry, and does not fit entirely into either category (6). As a result, patients can find themselves in a medical 'no-man's land', where no speciality will take responsibility for their care. It is often the case, as with Katherine, that individuals are admitted to general medical wards, which are often not equipped for rehabilitation. The input of relevant specialists is then dependent on referrals by the medical team, which are often rejected (7). As the volume of research regarding FND grows, it is becoming increasingly clear that these patients require co-ordinated, multidisciplinary care, rather than episodic input from different specialties. Unlike medical specialties that focus on structure and pathology, PRM places the patient's function, participation and quality of life at the forefront. In FND, the study of structure and pathology alone is rarely able to grasp the extent of an individual's rehabilitation needs. PRM is uniquely positioned to integrate physical, psychological and functional approaches to rehabilitation that FND requires (8).

On the 3rd day of her admission, Katherine's symptoms had not changed. For the first time, FND was mentioned as a possible diagnosis during an MDT meeting. This created a number of new issues. Katherine was being seen by an endocrinology consultant, who didn't feel he had the necessary expertise to diagnose FND. There was no neurology or psychiatry team at the hospital, so a referral to a larger hospital nearby was made. She was diagnosed with FND via email by a neurologist later that week, and she was not reviewed by psychiatry at any point during her 24-week admission.

Katherine was told that she had been diagnosed with FND during the daily ward round. The medical registrar who communicated this to her had not received any education or training on FND, and as a result could not adequately explain the diagnosis to her. She had to learn what her condition was from a google search. When we tried to commence rehabilitation, she was unable to engage fully. She did not understand her condition, and so our therapy input made no sense to her.

2: What is going on?

The current recommendations make it clear that FND should not be a diagnosis of exclusion, but rather based on specific examination findings and clinical assessment (9). Despite this, FND is often not initially considered as a differential, resulting in delayed diagnoses. This can have far-reaching implications for an individual's rehabilitation. Unnecessary medical interventions can worsen FND symptoms, and a delay in diagnosis often results in delayed commencement of appropriate rehabilitation (10).

Once a diagnosis is made, it is critical that this is explained clearly to the patient by a professional with good understanding of FND. There is growing evidence providing guidance for doctors having this conversation, and which information is important to include (11). These include highlighting positive signs, validating the patient's symptoms, and explaining that they are potentially reversible (12). It is very difficult for a patient to improve if they do not have a good understanding of what is causing their symptoms to begin with. As with any skill in medicine, regular practice improves proficiency and confidence. The ownership of FND by PRM would ensure patients are seen by professionals with experience and confidence in explaining and discussing their diagnosis.

The challenges associated with providing a timely diagnosis and adequate explanation to the patient can also be addressed by improving education of medical professionals on FND. Providing practical training on how to identify and discuss FND would ensure doctors feel better equipped to do so. Despite the prevalence of FND, it is rarely included in formal medical education or as part of specialty training (13). Given the significant disease burden of FND and the relatively large impact a clear diagnosis and explanation can have on rehabilitation trajectory and outcomes, this should be a priority in medical education programmes.

Katherine's condition continued to worsen during her admission. She developed functional seizures, and experienced no improvement in her motor or sensory function. As a physiotherapist, I had the capacity to see her 3 times a week for a therapy session. This was limited by a lack of specialist equipment or access to a gym. The occupational therapy (OT) team at the hospital only had the staffing to see discharge-dependent patients, which at this stage, Katherine was not. As a result, she did not have any OT input until the final 2 weeks of her admission. Psychiatry had no capacity to see inpatients; Katherine could be seen as an outpatient once she had been discharged home.

3: Where is the MDT?

The benefits of structured rehabilitation for individuals with FND have now been clearly established (14). Evidence shows that MDT rehabilitation programmes provide benefit to patients with FND across a number of domains. These include a reduction in symptom severity, an improvement in function and perception of function among others (15). These benefits were sustained across inpatient and outpatient settings. Often one specialty cannot be successful without the input of another; physiotherapy is unlikely to be as beneficial without psychology input. Equally, psychiatry input alone is unlikely to demonstrate significant improvement.

Although Katherine was able to access some physiotherapy, the benefits of this were limited significantly by the lack of parallel psychological support. This highlights the need for a robust FND pathway, where patients are able to access physical and psychological therapies simultaneously. The Exeter model is an integrated FND pathway within the NHS. It provides a structure for how an MDT service would operate, with the principle that the assessment and treatment of FND should be through clear pathways and defined roles (16).

As seen in Katherine's case, currently this MDT approach is rarely achieved in NHS settings. In part, the lack of MDT integration is likely due to the aforementioned lack of ownership of the management of FND. No department currently oversees the management of FND in such a way that they could create a functioning pathway. The skills and experience to create a rehabilitation pathway are core to PRM, demonstrating the potential value of their role in FND management.

A few weeks into her admission, Katherine's relationship with some members of staff began to break down. Katherine felt that they did not believe her symptoms or diagnosis, and were providing worse care as a result. The situation became a cycle, with Katherine refusing care by certain members of staff, and staff members becoming increasingly disengaged from her care.

During MDT meetings, I heard members of staff express outdated, often negative opinions about FND. It was clear that they lacked a meaningful understanding of the disorder, or how it presents. This was prevalent in some degree through all professions, at all levels.

4: Why don't you believe me?

As discussed, the lack of training and therefore understanding of FND amongst healthcare professionals remains an ongoing barrier to the effective management of patients. Further to this, negative perceptions and stigma from medical professionals towards patients with FND are widespread (17). The prevalence of this stigma may originate from the belief that a patient is 'feigning' their symptoms, particularly as FND was once seen as a purely psychiatric disorder. The clinical implications of this stigma can be wide-reaching. Initially, it can result in delayed diagnosis and appropriate management, which can negatively impact patient outcomes. The perception that FND is not a 'real' condition results in poor communication of the diagnosis to patients. As previously explored, effective communication and explanation of the diagnosis is a crucial first step in a positive trajectory for patients. Patients report feeling that their concerns are minimised and their symptoms are invalidated by professionals (18). This can damage the relationship between the patient and professional,

as well as creating internalised shame and reduced self-confidence in the patient. These factors will both be significant barriers to successful rehabilitation.

As a medical student, we learn a great deal from doctors and healthcare professionals in clinical practice. In the absence of formal teaching, the entirety of our exposure to FND comes from clinical practice. The perceptions and stigma towards FND patients often demonstrated in practice is therefore role-modelled for medical students (19). This creates a self-perpetuating cycle, where stigma is inadvertently taught to students, in the absence of formal, evidence-based education.

The literature clearly suggests that effective education of healthcare staff can significantly improve stigma and perceptions, and improve the quality of care provided (20). A crucial part of the education programme was sharing of patient stories, which highlights how stigma can be broken down when patients are seen as people, rather than just as their diagnosis. Where a negative cycle of stigma currently exists, evidence-based education and training can produce a positive cycle of improving understanding.

There is an intersectional aspect to FND stigma, which may have played a role in Katherine's care. Women are disproportionately affected by FND, with evidence suggesting that gender bias may contribute to both the stigmatisation of FND, as well as the reduced representation of this population in research and education (21). This reflects a wider pattern in healthcare, where women's symptoms are more likely to be dismissed or minimised. In FND, where negative perceptions are already so prevalent, existing gender bias can compound these issues significantly. This is particularly important in rehabilitation, which is fundamentally based on a therapeutic relationship between a patient and their clinical team. If a patient feels they are being ignored or dismissed, this can have a negative impact on their rehabilitation. An educational programme on FND for healthcare professionals must therefore also address unconscious biases and how these can negatively impact care and rehabilitation.

---

24 weeks after she presented to A&E, Katherine was discharged back to her own home. During this period, her functional status had continued to decline. She was ultimately discharged as a full-time wheelchair user, dependent on a full sling hoist for transfers, and with carers 3 times per day. This will have a huge impact on her quality of life and independence, as well as the lives of her young children and family.

Katherine's story is not a unique one, but it is a tragedy nonetheless. We have no way to know if Katherine's outcome could have been different. We do know that she did not receive the rehabilitation and care that might have allowed it to be. She was admitted to the wrong ward, under the wrong team, with no psychological support and facing stigma perpetuated by staff who did not understand her condition. These are not inevitable failures; they can be addressed. The ownership of FND by PRM would be an important step towards providing interdisciplinary and patient-centred care. The foundational aspects of PRM; goal-directed rehabilitation, MDT working and a biopsychosocial approach are the exact elements that were absent in Katherine's care.

Katherine's case was pivotal in my decision to study medicine. In the months I spent as her physiotherapist, I saw repeated missed opportunities in her care. Not by individuals, but by a system that could not understand or adequately meet the needs of a person with FND. FND is a disorder of function; PRM as a specialty is dedicated to improving function above all. The question is not whether we fully understand FND, but whether we are willing to attempt rehabilitation despite that uncertainty.

Specific details relating to Katherine and her case have been changed to protect her identity and confidentiality.

References:

1. Finkelstein, S.A., Diamond, C., Carson, A. and Stone, J., 2025. Incidence and prevalence of functional neurological disorder: a systematic review. Journal of Neurology, Neurosurgery & Psychiatry, 96(4), pp.383-395.
2. Bailey, C., Agrawal, N., Cope, S., Proctor, B., Mildon, B., Butler, M., Holt, K., Edwards, M., Poole, N. and Nicholson, T.R., 2024. Illness perceptions, experiences of stigma and engagement in functional neurological disorder (FND): exploring the role of multidisciplinary group education sessions. BMJ Neurology Open, 6(1), p.e000633.
3. Gelauff, J. and Stone, J., 2016. Prognosis of functional neurologic disorders. Handbook of clinical neurology, 139, pp.523-541.
4. Espay, A.J., Aybek, S., Carson, A., Edwards, M.J., Goldstein, L.H., Hallett, M., LaFaver, K., LaFrance Jr, W.C., Lang, A.E., Nicholson, T. and Nielsen, G., 2018. Current concepts in diagnosis and treatment of functional neurological disorders. JAMA neurology, 75(9).
5. O'Keeffe, S., Chowdhury, I., Sinanaj, A., Ewang, I., Blain, C., Teodoro, T., Edwards, M. and Yogarajah, M., 2021. A service evaluation of the experiences of patients with functional neurological disorders within the NHS. Frontiers in Neurology, 12, p.656466.
6. Mavroudis, I., Kazis, D., Kamal, F.Z., Gurzu, I.L., Ciobica, A., Pădurariu, M., Novac, B. and Iordache, A., 2024. Understanding functional neurological disorder: Recent insights and diagnostic challenges. International Journal of Molecular Sciences, 25(8), p.4470.
7. FND Hope UK. (2023) Freedom of Information project aimed to explore issues reported by NHS clinicians and the FND community regarding accesses to treatment for people with FND. Available at: https://www.fndhope.org.uk/freedom-of-information-project-aimed-to-explore-issues-reported-by-nhs-clinicians-and-the-fnd-community-regarding-accesses-to-treatment-for-people-with-fnd/ (Accessed: 23 June 2026).
8. Stone, J. and Milburn-McNulty, P., 2025. Reclaiming Functional Neurological Disorder for Rehabilitation Medicine. Advances in Rehabilitation Science and Practice, 14, p.27536351251408021.
9. Galenchik-Chan, A., Ren, T., Cohen, D. and Maurer, C.W., 2025. Recognising and managing functional neurological disorder in the acute healthcare setting. Emergency Medicine Journal, 42(11), pp.758-763.
10. Greenfield, M.J., Fobian, A.D., Fargason, R.E. and Birur, B., 2024. Optimizing outcomes when treating functional neurological disorder in acute care settings: case reports depicting the value of diagnostic precision and timely and appropriate psychological interventions using an interdisciplinary framework. Frontiers in Psychiatry, 15, p.1288828.
11. Bennett, K., Diamond, C., Hoeritzauer, I., Gardiner, P., McWhirter, L., Carson, A. and Stone, J., 2021. A practical review of functional neurological disorder (FND) for the general physician. Clinical Medicine, 21(1), pp.28-36.
12. Stone, J., 2016. Functional neurological disorders: the neurological assessment as treatment. Practical Neurology, 16(1), pp.7-17.
13. De Liège, A., Carle, G., Hingray, C., Lehn, A., Autier, L., Degos, B. and Garcin, B., 2022. Functional neurological disorders in the medical education: an urgent need to fill the gaps. Revue Neurologique, 178(8), pp.788-795.
14. Keatley, E.S., Cairncross, M., Raman, S., Molton, I.R., Choi, E., O'Kane, K., Buchholz, A.S., LaFaver, K. and Aaron, R.V., 2026. Rehabilitation therapies for functional neurological disorder: a systematic review and meta-analysis of clinical trials. The Journal of Neuropsychiatry and Clinical Neurosciences, pp.appi-neuropsych.
15. Guy, L., Caceres, G.A., Jackson, T., Gorman, S., Wilson, J., Hsieh, Y., Petty, D., Harrison, S. and Pick, S., 2024. Routine outcomes and evaluation of an 8-week outpatient multidisciplinary rehabilitative therapy program for functional neurological disorder. Journal of Neurology, 271(4), pp.1873-1884.

16. Russell, L., Butler, L., Lovegrove, C., Owens, C., Roberts, L., Yates, P., Carrick, R., Amoako, A. and Price, C., 2022. Developing a multidisciplinary pathway for functional neurological disorders in a UK National Health Service: The Exeter model. ACNR, Advances in Clinical Neuroscience and Rehabilitation.
17. LaFaver, K., Lang, A.E., Stone, J., Morgante, F., Edwards, M., Lidstone, S., Maurer, C.W., Hallett, M., Dwivedi, A.K. and Espay, A.J., 2020. Opinions and clinical practices related to diagnosing and managing functional (psychogenic) movement disorders: changes in the last decade. European Journal of Neurology, 27(6), pp.975-984.
18. Bailey, C., Tamasauskas, A., Bradley-Westguard, A., Gilli, P., Poole, N., Edwards, M.J., Agrawal, N. and Nicholson, T., 2025. What are the experiences of people with motor and sensory functional neurological disorder? A systematic review and thematic synthesis of qualitative studies. Disability and rehabilitation, 47(1), pp.1-15.
19. Garris, J., Ryan, M., Snow, E., Mildon, B. and Bradley, E., 2025, April. Medical Student Perspectives on Stigma in Functional Neurologic Disorder: A Qualitative Study (P8-5.004). In Neurology (Vol. 104, No. 7_Supplement_1, p. 1906). Hagerstown, MD: Lippincott Williams & Wilkins.
20. Lehn, A., Navaratnam, D., Broughton, M., Cheah, V., Fenton, A., Harm, K., Owen, D. and Pun, P., 2020. Functional neurological disorders: effective teaching for health professionals. BMJ neurology open, 2(1), p.e000065.
21. McLoughlin, C., Hoeritzauer, I., Cabreira, V., Aybek, S., Adams, C., Alty, J., Ball, H.A., Baker, J., Bullock, K., Burness, C. and Dworetzky, B.A., 2023. Functional neurological disorder is a feminist issue. Journal of Neurology, Neurosurgery & Psychiatry, 94(10), pp.855-862.

Beyond the Ward: Wearable Technology and the Unfinished Work of Stroke Rehabilitation

Author: Reece Patterson

Medical School: Brighton and Sussex Medical School

During my placement in geriatric medicine last year, I spent time on the stroke ward, a high-turnover environment where patients were admitted and discharged daily against a standardised pathway of medication, physiotherapy and occupational therapy. What stayed with me was not the patients who recovered but those who were swept through the protocol and sent home before they were whole: people who had regained enough function to be deemed safe, yet not enough to feel independent. For many, particularly older adults, that loss of independence weighed as heavily as the stroke itself. The alternative the system tended to offer was escalating medication rather than continued therapy, carrying on a polypharmacy burden of its own with constipation, falls and further admissions following close behind. The ward worked exactly as designed. The question it left me with was whether the design itself was the limitation, and whether rehabilitation could continue beyond the hospital walls at the intensity that recovery actually demands.

That question is more pressing than it once was. The Global Burden of Disease Study 2021 found that over a third of the world's population lives with a neurological condition, and that such disorders have now overtaken cardiovascular disease as the leading contributor to global disease burden (1). Stroke sits at the centre of this picture, and its rehabilitation is unusual in that prolonged inpatient stays are frequently driven by therapy needs rather than acute medical instability. Those extended stays are not benign. They expose patients to infection and deconditioning, and in older adults, they invite delirium, a complication associated with a 2.5-fold rise in short-term and a 3.2-fold rise in six-month mortality (2). Set against a system in which the Darzi review counted more than a million people awaiting community services, over fifty thousand of them for longer than a year, the case for moving rehabilitation safely into the home is both clinical and structural (3).

Wearable technologies have emerged as a plausible bridge across that gap. My interest in them is not incidental: my academic supervisor, whose background is in the engineering of such devices, challenged me to interrogate them from the perspective I am being trained in. Where an engineer sees an elegant feedback loop, a clinician has to ask a harder question. Can these devices actually be used in practice, and will patients adhere to them, or will they be discarded as just another gadget? It is a question of acceptability as much as efficacy, and it is precisely the question that the functional-outcomes literature has tended to neglect. Several systematic reviews have examined wearables for gait, limb function, and fall risk, but they pool heterogeneous devices and focus on biomechanical performance, consistently omitting adherence, patient experience, and quality of life (4-6). Whether patients find these technologies meaningful remains poorly characterised.

Reviewing the trial literature with those patient-centred outcomes in mind is revealing. Across five randomised controlled trials enrolling 238 adults after stroke, spanning device types from passive exoskeletal orthoses and wrist-worn activity monitors to a wearable myoelectric interface and a smartwatch self-management platform, the most consistent signal is engagement. In the UPBEAT feasibility trial of the OnTrack smartwatch system, participants used the device an average of 6.3 days per week, with 90.7 per cent adherence sustained over 12 weeks (7). The MINT myoelectric trial reported that 91 per cent of completers trained for at least sixty minutes daily, performing roughly 300 repetitions a day, far above the volumes typical of supervised home programmes (8). Preference data points the same way: every participant in the T-WREX exoskeleton trial preferred the device to conventional exercise, and four in five felt more likely to complete it independently at home (9). For a field long frustrated by the poor uptake of home exercise, this is not a trivial finding.

Engagement, moreover, translates into function. In the Virtual Arm Boot Camp trial, participants achieved 368 additional daily reach-to-grasp counts compared with a waitlist control, a 30 per cent increase from baseline, with corresponding gains on the REACH scale and the Arm Capacity and Movement Test (10). The MINT intervention improved Wolf Motor Function Test times by 6.8 seconds at six weeks, approaching the gains seen in constraint-induced movement therapy and doing so in a substantially more impaired population (8). These results matter beyond their effect sizes because they unsettle a long-standing assumption that patients in the chronic phase, or those with severe hemiparesis, have exhausted their capacity for recovery (11). High-dose, home-based, wearable-mediated training appears able to reach residual neuroplasticity in people whom conventional services have tended to write off.

And yet the evidence contains a discord that I think is the most important thing the literature has to teach. The functional gains were rarely matched by improvements on formal quality-of-life measures. In the V-ABC trial, neither the Stroke Impact Scale hand subscale nor its strength subscale shifted significantly between groups, even as objective arm use rose markedly (10). In MINT, the Motor Activity Log, a self-report of everyday arm use, barely moved despite clear gains on timed testing (8). UPBEAT's EQ-5D-5L improved in both arms, leaving the wearable's specific contribution indistinguishable (7). It would be easy to read this as evidence that the devices do not really help. I would argue the opposite, that the instruments are looking in the wrong place. The Motor Activity Log is weighted towards fine finger dexterity, a capacity largely absent in the severely impaired patients MINT enrolled, while the EQ-5D is too coarse to register the incremental changes in arm use that nonetheless reshape a patient's day. A measure that cannot see the improvement patients feel is not neutral, it actively understates the value of the intervention.

If that argument holds, it carries a clear methodological implication. Future trials should stop treating quality of life as a generic afterthought and adopt instruments with demonstrated responsiveness in stroke, such as the Stroke Impact Scale, which resolves hand function, mobility, emotion and participation separately and has established clinically important differences (12), or the PROMIS Upper Extremity bank, which adapts to a wide range of severity and has shown sensitivity to change in upper-limb rehabilitation (13). Choosing the right ruler is not a technicality. It determines whether the things that matter to patients are ever recorded as mattering at all.

A second lesson from the trials is that the device is never the whole intervention and is rarely the active ingredient on its own. The more effective programmes embedded wearable feedback within a wider structure of exercise, behavioural support and human contact. V-ABC paired its TENZR wrist sensor with a home curriculum and six virtual therapist sessions. Its authors were candid that feedback in isolation is unlikely to sustain behaviour once it is withdrawn, a caution borne out by earlier work in which wristwatch feedback raised arm use only while the feedback continued (14). OnTrack wrapped its smartwatch in a self-management coaching protocol built on goal-setting and problem-solving rather than on data alone. Most tellingly, UPBEAT achieved a therapist fidelity score of just 53.9 per cent against a 75 per cent target despite six hours of training, a reminder that even in a trial, the human delivery cannot be assumed (7). The implication for practice is uncomfortable but important. A wearable rehabilitation system is only as good as the clinician supporting it, and therapist training must be treated as a core component of the intervention rather than a logistical afterthought. The risk, if commissioners forget this, is that devices are prescribed as a cheaper replacement for therapist contact, hollowing out the very multicomponent model that the evidence shows is effective.

If technology and a therapist together constitute the intervention, biology helps determine who responds to it. The MINT trial made an unusually thoughtful contribution here by treating lesion location as a predictor of outcome. Participants whose strokes involved the posterior limb of the internal capsule, a proxy for corticospinal tract integrity, improved significantly less than those whose tracts were spared, implying that some preserved descending motor pathway is a prerequisite for the mechanisms a myoelectric interface recruits (15). This dovetails with neuroimaging-based prediction models such as PREP2, which stratify likely upper-limb recovery from biomarkers of corticospinal function, and gestures towards a future in which the

choice of wearable modality is matched to a patient's neurological profile rather than offered uniformly (16). Crucially, severity alone did not preclude benefit: ninety-five per cent of the MINT sample had Fugl-Meyer scores below 25, yet this severely impaired group still gained more than sham. Impairment and prognosis are not the same thing, and access to rehabilitation should not be rationed on first impressions of severity, a temptation I saw at work on the ward, where the most disabled patients were often the quickest to be moved towards a purely medical pathway.

This is where the sociological dimension becomes unavoidable. The interventions reviewed all assumed access to a smartphone, tablet or home broadband, and MINT explicitly identified computer illiteracy as a barrier for some participants (8). Patients without digital access or confidence, disproportionately older, poorer or from minority communities, stand to be excluded from precisely the technology promoted as widening access, unless device-loan schemes and digital-skills support are built in from the outset. There are data questions too. Continuous monitoring of movement and physiological signals, often routed through third-party platforms, demands robust governance and genuinely informed consent, which cannot be presumed in a vulnerable post-stroke population still adjusting to disability. A technology adopted without attention to equity and privacy risks deepens the inequalities it claims to address.

One further feature of the evidence deserves comment, because it is itself a finding. Although the search that underpinned this review was deliberately broad, encompassing multiple sclerosis, spinal cord injury and traumatic brain injury, every trial that met the criteria concerned stroke. The absence is not an accident of searching but a map of where the research effort has gone, and it suggests that the lessons being learned in stroke have yet to be tested in other lifelong neurological conditions that might benefit just as much.

Taken together, the evidence supports a measured optimism. Wearable technologies that combine objective monitoring, personalised goals and therapist-supported coaching can extend rehabilitation intensity beyond the clinic, sustain engagement at levels home programmes have struggled to reach, and even narrow geographical inequities, as in V-ABC's recruitment across rural Canadian provinces (10). Their clearest system-level promise lies in supporting earlier discharge. Early Supported Discharge already reduces length of stay without sacrificing outcomes, but its success depends on patients maintaining adequate therapy intensity at home, exactly the gap wearables are positioned to fill (17). UPBEAT's preliminary cost data, lower mean costs in the intervention arm at £7,338 against £14,064, with inpatient care the dominant driver, hint at what might follow, though the authors rightly treat such small-sample figures with caution (7).

I return, in the end, to the stroke ward. The patients who troubled me were not failed by the acute care they received but by the assumption that rehabilitation ends at the hospital door. What this evidence has taught me, and what I expect to carry into practice, is that the decisive factor in recovery is often the maintenance of contact after discharge, whether through outpatient review, primary care, or the digital tools examined here. A wearable device is not a substitute for that relationship, and treating it as one would repeat the original error in a more modern form. Used well, as one carefully supported element of a continuing therapeutic relationship, it offers a way to keep the unfinished work of recovery going for patients who would otherwise be left behind.

References

1. Global, regional, and national burden of disorders affecting the nervous system, 1990-2021: a systematic analysis for the Global Burden of Disease Study 2021. Lancet Neurol. 2024;23(4):344-81.
2. Cavallazzi R, Saad M, Marik PE. Delirium in the ICU: an overview. Annals of intensive care. 2012;2:1-11.
3. Darzi A. Independent Investigation of the NHS in England. Online. London: Department of Health and Social Care; 2024 12 September.
4. Li X, Chen Z, Yue Y, Zhou X, Gu S, Tao J, et al. Effect of Wearable Sensor-Based Exercise on Musculoskeletal Disorders in Individuals With Neurodegenerative Diseases: A Systematic Review and Meta-Analysis. Frontiers in Aging Neuroscience. 2022;14.
5. Tseng KC, Wang L, Hsieh C, Wong AM. Portable robots for upper-limb rehabilitation after stroke: a systematic review and meta-analysis. Annals of Medicine. 2024;56(1).
6. Bonanno M, Ielo A, De Pasquale P, Celesti A, De Nunzio AM, Quartarone A, et al. Use of Wearable Sensors to Assess Fall Risk in Neurological Disorders: Systematic Review. JMIR Mhealth Uhealth. 2025;13:e67265.
7. Fusari G, Coleman S, Davies J, Dearling J, Findlay J, Goddard M, et al. UPBEAT Trial: a randomised feasibility evaluation of a digital system for UPper limB rEhabilitation After sTroke. Pilot and feasibility studies. 2025;11(1):136.
8. Khorasani A, Gorski CM, Hung NT, Hulsizer J, Paul V, Tomic G, et al. Wearable Myoelectric Interface for Neurorehabilitation (MINT) to Recover Arm Function: a Randomized Controlled Trial. medRxiv: the preprint server for health sciences. 2025.
9. Housman SJ, Le V, Rahman T, Sanchez RJ, Reinkensmeyer DJ, editors. Arm-training with T-WREX after chronic stroke: Preliminary results of a randomized controlled trial. 2007 IEEE 10th International Conference on Rehabilitation Robotics, ICORR'07; 2007.
10. Simpson LA, Barclay R, Bayley MT, Brasher PMA, Dukelow SP, MacIntosh BJ, et al. A Randomized Control Trial of a Virtually Delivered Program for Increasing Upper Limb Activity After Stroke. Neurorehabil Neural Repair. 2025;39(3):179-89.
11. Page SJ, Gater DR, Bach-y-Rita P. Reconsidering the motor recovery plateau in stroke rehabilitation¹. Archives of Physical Medicine and Rehabilitation. 2004;85(8):1377-81.
12. Duncan PW, Wallace D, Lai SM, Johnson D, Embretson S, Laster LJ. The stroke impact scale version 2.0. Evaluation of reliability, validity, and sensitivity to change. Stroke. 1999;30(10):2131-40.
13. Hung M, Saltzman CL, Greene T, Voss MW, Bounsanga J, Gu Y, et al. The responsiveness of the PROMIS instruments and the qDASH in an upper extremity population. Journal of Patient-Reported Outcomes. 2017;1(1):12.
14. Schwerz de Lucena D, Rowe JB, Okita S, Chan V, Cramer SC, Reinkensmeyer DJ. Providing Real-Time Wearable Feedback to Increase Hand Use after Stroke: A Randomized, Controlled Trial. Sensors. 2022;22(18):6938.
15. Shelton FdNAP, Reding MJ. Effect of Lesion Location on Upper Limb Motor Recovery After Stroke. Stroke. 2001;32(1):107-12.
16. Stinear CM, Byblow WD, Ackerley SJ, Smith M-C, Borges VM, Barber PA. PREP2: A biomarker-based algorithm for predicting upper limb function after stroke. Annals of Clinical and Translational Neurology. 2017;4(11):811-20.
17. Jee S, Jeong M, Paik N-J, Kim W-S, Shin Y-I, Ko S-H, et al. Early Supported Discharge and Transitional Care Management After Stroke: A Systematic Review and Meta-Analysis. Frontiers in Neurology. 2022;13 755316.

The Current State of Sensor-augmented Digital Health Apps for Remote Physical Rehabilitation: A Narrative Review

Author: Rupert Yeung

Medical School: Barts and The London

Introduction

Being able-bodied is a lifelong objective for participation in meaningful roles such as work and education. Yet, about 2.4 billion people live with a reversible condition that hinders this.[1] Rehabilitation is defined as "a set of interventions designed to optimize functioning and reduce disability in individuals with health conditions in interaction with their environment".[1] Physical rehabilitation to improve muscle strength and movement patterns increases physical capacity, reduces pain and provides an improved quality of life through greater independence and self-confidence.[2] Rehabilitation is a crucial investment to avoid costly hospital admissions and reduce length of stay.[3]

However, global rehabilitation needs continue to be unmet from the lack of accessibility, trained professionals, and adherence.[1] To tackle this, outpatient rehabilitation services have begun to integrate tele- and remote rehabilitation such as PDFs, videos and emails in between inpatient appointments. These have already seen some success in the specialties of gait, balance and postural assessment.[4,5,6] Still, these methods, much like traditional rehabilitation, fail to meet individual needs[1] and cause a loss of interest due to the repetitive nature of the exercises and low technique confidence from lack of personalised feedback and staff communication.[8]

To address this issue, digital health apps have been upgraded with sensors such as cameras on smartphones, accessories e.g. smartwatches. These can collect information on the patient and is then packaged into feedback, which enhances engagement and distract from the repetitiveness of the task.[8] One way is through visual feedback which communicates concepts such as range of motion (ROM) or exercise technique via. pictures, videos and graphs.[9] These have potential in home exercise programmes with targeted exercises particularly in early-stage post-operative rehabilitation and musculoskeletal disorders.[10]

It is thus necessary to provide a review of relevant existing and future apps to implement digital health apps and technology into the physical rehabilitation programme, examine how these have addressed clinical barriers to traditional physical rehabilitation delivery and consider future research pathways to enhance home-based personalised care.

Types of Rehabilitation Apps

Based on the current landscape of rehabilitation apps augmented with sensors, these apps used either wearable sensors[12,13,16,17,18,20,21,28,29] or cameras[1,14,15,19,22,23,24,25,27] with the aim to track joint positions and angles to measure the timing and ROM of rehabilitation exercises.[11,12] One paper used a tablet as both the sensor and the display.[26] Camera-based systems were simpler to set up, with the most widely used being the Kinect device chosen for its portability and ease of use.[19] However, it was found that single camera systems only recognized the anterior joint when the position of 2 different joints coincided on the x,z axis (e.g. arm located behind the user's chest).[19] Kinect cameras also had a hard time tracking patients on walkers or wheelchairs.[27] To tackle this, some camera systems used multiple cameras at once,[11,19,27] or were aided with markers on the body.[27] Tang et al.[27] demonstrated that multiple cameras with markers were more accurate than no makers multiple

cameras (p<.001) and no markers one single camera (p<0.005). Yet, multiple camera systems were found to take longer to set up, and there were occasions where data had to be excluded due to technical difficulties experienced during set-up.[11] This suggests that the "best" technologies were not universally superior; rather, its suitability depended on whether the user prioritised accuracy or simplicity.

Wearable sensors were accurate in measuring orientation, velocity and gravitational forces of the joint using accelerometers and gyroscopes.[16] Wang et al 2024 offered better accuracy than traditional means, showing a 39% and 42% improvement.[29] Still, careful placement and calibration of sensors, similarly to multiple camera systems, meant lost time and additional worries for the patient.[11,16] According to the developers of the re.flex system, it was challenging for the patient to accurately place the sensors when over the injury. The sensors were also not comfortable to wear and were inaccurate when the patient had different sized limbs than the standard.[16,23] Thus, wearable sensors too sacrificed usability for accuracy.

Joints and Planes

The most common body part measured was the shoulder with 9 papers[15,19,22,23,24,25,27,28,29], due to the freedom of range of movement in all three axes.[20] Some papers measured the shoulder on one plane[15,19,23] while others papers examined all 3 axes using exercises that used a combination of planes.[22,25,27,29] Simple movements such as the shoulder lateral raise[19] were preferred in some papers as their main objective was to see the efficacy of the chosen system. Still, two papers: one testing a combination of shoulder movements[27] and another testing multi-system movements such as jumping and throwing[24], demonstrated the potential for digital health apps use in more realistic movements. 9 papers measured the lower limb, defined as the knee, hip, or both.[11,13,14,16,17,18,20,21,24] Out of these 9 papers, more papers looked at the knee joint[16,17,18] than other joints such as the hip[13,14] while for the commonality of injuries such as ACL tears, which make up 50% of sport knee injuries.[18] Some papers were found to expand the available joints measured to the hand/wrist[26] and the head/neck.[12]

Feedback Methods

Feedback was given in three main categories: visual, audio and haptic. While all papers had visual biofeedback, 5 papers were supplemented with audio cues.[16,19,21,22,25] 2 papers combined wearable sensors with vibrators[16,23] to provide haptic feedback to the participant. Only one paper combined all three.[16] Visual was the most used feedback form, usually by representing the patient's movement with a video or ball along a path.[21] Visual and audio were combined by having visual cues overlaid on the video feed of the participant plus auditory prompts within the user interface.[25] One system produced a verifying high-pitched sound for every correct attempt so that the participant was not distracted by the visual feedback during the exercise.[19] This led to a 90% or bigger improvement by the feedback group in this particular audio/visual feedback digital health app.[19] 100% of participants in another study reported vibro-haptic feedback as intuitive since it gave perfect timing.[23] Thus, one can argue that the more types of feedback integrated into the app, the greater confidence which enhances motivation and adherence.

Tackling traditional rehabilitation barriers

To recap, barriers from traditional rehabilitation include low levels of accuracy and personalised feedback during home exercises, as well as a lack of usability/accessibility, trained professionals, and motivation/adherence.[1] All papers found gave personalised feedback and 15[11,12,14,15,16,17,18,19,21,22,24,25,26,27] studies reported better accuracy than their traditional counterparts. 7 papers[11,13,15,20,21,23,28] measured high usability scores and 6 papers[13,16,18,20,21,28] saw an increased motivation and adherence to rehabilitation. Finally, 2 papers[18,26] had features that tackled the barrier of lack of access to staff. *(see Figure 1 for evidence map)*

Figure 1: Evidence Map to highlight which traditional rehabilitation barriers were tackled

Barriers	Personalised feedback	Better accuracy than traditional	Usability	Adherence, motivation	Lack of staff access
Bell 2019[11]					
Buzcu 2024[12]					
Gu 2019[13]					
Horng 2022[14]					
Hou 2025[15]					
Ianculescu 2019[16]					
Jarungvittayakon 2025[17]					
Kordatos 2018[18]					
Kritikos 2019[19]					
Lin 2022[20]					
Nuevo 2024[21]					
Pereira 2024[22]					
Rajanna 2016[23]					
Sanesi 2019[24]					
Sharma 2024[25]					
Suero-Pineda 2023[26]					
Tang 2015[27]					
Vasconcelos 2018[28]					
Wang 2024[29]					

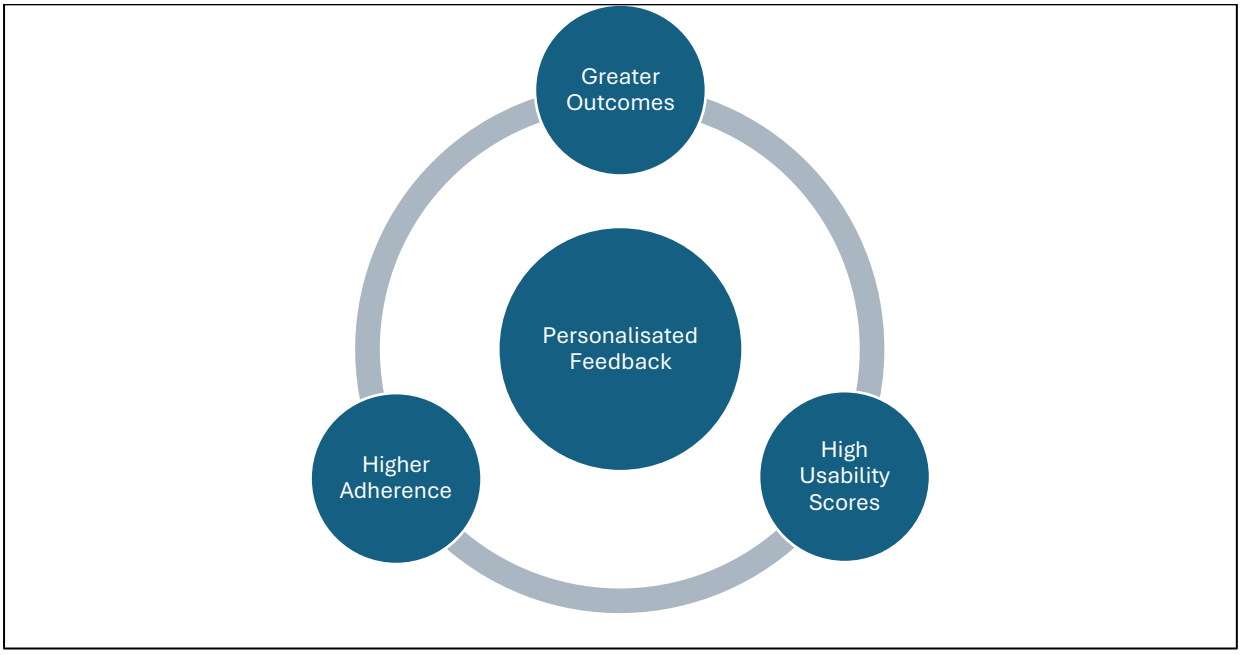
(Green = randomised control trial, Orange = observational study, Red = protocol)

Every digital health app found used the information gathered to give personalised exercise feedback. One exemplary example used daily calibration to the patient's pain-free ROM to dynamically adjust exercise regimens and feedback rather than in weekly sessions.[26] 15[11,12,14,15,16,17,18,19,21,22,24,25,26,27] of the 19 apps reported better outcomes than their controls; one example being DeepPhysio coaching patients to an accuracy of between 84.38–87.88%, compared to control's accuracy of 57.52%.[24] This adaptability and accuracy led to significant outcome improvements in limb ability such as the Patient Rated Wrist Evaluation ($p=0.001$)[27] or complex movements as shown by a 36% error reduction in shoulder rotation.[15] The higher outcome score may be caused by the high marks on usability (as evidenced by a high 83/100 System Usability Score[21] and high 4.56/5 Likert Score)[15] from increased accessibility, enhanced care and satisfaction by both participants and staff.[20] Although one may assume that these apps only thrive in laboratory/controlled conditions, 7 studies[13,14,16,22,24,27,28] were trialled at home and gave equally encouraging results.

The higher satisfactory scores can be argued to responsible for the higher adherence, such as the 31% higher adherence in the re.flex system despite control patients marking extra sessions during the trials.[16] This may be because patients forget to do the exercises, struggle with motivation or are less disciplined in following their prescribed exercise routines without the direct supervision of a physiotherapist.[16] The apps also further

motivated those who wanted to do the exercises but did not have the guidance to do it unsupervised. Participants who cared about performance and accuracy were noted to repeat the same exercise to obtain better scores.[13] The higher adherence loop back to greater outcomes, ultimately aiding those with mobility challenges or from remote areas by reducing the rate of face-to-face referrals by 41%.[26] (*see Figure 2 for a summary of the Outcome-Usability-Adherence Loop)*

Figure 2: The Outcome-Usability-Adherence Loop, brought together by personalised feedback



Future Research

There are still some steps that current digital rehabilitation apps and sensors can take to improve. All these apps come with the assumption that participants are familiar using smartphones and internet, which may not be possible for some elderly/disadvantaged patients.[20] On top of this, better automation is required as patients are unlikely to have a companion present. One problem encountered was participants taking several steps to click the stop button, which introduced noise in the data of the exercise and made performance measurement inaccurate.[13] Participants have also noted the overwhelming amount of information, such as trying to match the speed of the reference exercise while looking at the repetition counter[13] or interpreting depth from the visual feedback.[27] An improvement display of information is therefore required, such as overlaying a "ghost" reference over the user to compare speed and motion or a side view option for better visualisation.[13] One way to achieve this is to gamify the exercises. By turning exercises into games, such as a flight pilot simulation game app[17] or games creating bridges, passing through labyrinths or opening gates,[28] these apps increased patient satisfaction significantly ($p<0.0001$ satisfaction score compared to control).[17] However, it is important to note that these gamified systems only make up 2 out of the 19 apps, and one paper[28] required the game to be controlled by one of the facilitators.

In the pursuit of higher accuracy digital health apps, these systems have been found to be too strict for real-world use, especially when there was ROM compensation. Physio@Home had guides that appeared whenever there was the slightest misalignment and did not disappear until they were corrected.[27] Moreover, when cameras were obstructed by low lighting or multiple objects/people in frame, the camera failed to recognise the participant's posture.[25] The camera also needed to be placed at the same height for recording both reference and practice exercises.[13] Future research must look at relaxing restrictions such as camera height and make systems more forgiving to small changes in exercise execution. Moreover, incomplete or incorrect

repetitions that are usually excluded from sessions should be logged as valuable indicators of user progress, enabling longitudinal tracking and adaptive feedback during rehabilitation.[15]

Looking at the evidence map (figure 1), only 2 papers[18,26] tackled the lack of patient-clinician communication. These digital health apps had additional features included for patient-physiotherapist ease. One example had separate app versions; the patient version focused on personalised exercise recommendations based on patient preferences and adaptive difficulty levels.[18] Physiotherapists could use the app to personalise adjustments, show exercises, see live feedback for degrees, and see the patient's progress activity.[18] One paper[26] linked these apps with a chat that could be used for questions about topics like pain, allowing a 31% higher adherence compared to the control group. Social features enabling peer support and competition, regular progress celebrations and milestone achievements, and integration of motivational messaging tailored to individual patient profiles improved adherence.[27] Thus, more research like these are required for improving communication between staff and patients.

In terms of innovation, one can consider expanding current systems to allow for multiple limb systems[24] or customisations such as pressure sensors[14], strain gauges to measure forces exerted by resistance bands attached to the sensor[21], multiple limb systems such as the hip, shoulder and spine[11], supporting more complex compound movements[15] or adding more features such as blood pressure and heart rate.[20] However, this should be balanced with cost effectiveness analyses, as none of the included studies evaluated economic impact despite cost being a major barrier to rehabilitation access.

Limitations

12 of the 19 papers found were single-armed, non-randomised pilot studies such as observational[13,14,15,18,19,23,27,28,29] or questionnaire studies[20] with the intention of testing the system on human participants. Others were protocols[12,24,25] with the aim to detail the system's mechanism without the need for participant data. Only 4 out of the 19 papers were randomised controlled trials[16,17,21,25] that compared traditional physiotherapy with the digital health app, thus the benefits remain to be confirmed in larger prospective studies.[19] The participants included were also healthy which does not reflect typical outpatient populations with comorbidities, low digital literacy or limited access to technology.[27] There was also significant variability in sample sizes (n=4 to n=60)[14,18], study populations (both injured[23] and non-injured[15]), and outcome measures, making it difficult to give clear app recommendations for specific patient groups or conditions. The range of measured outcomes, joint system and complexities also make these systems not directly comparable, as seen by one paper having statistically significant differences between three different types of measurements for different exercises.[22] The papers were also only English-language peer-reviewed publications, introducing geographical bias and an underestimation of current technological capacities. Finally, these studies were short in duration, often completed in less than a month. Therefore, effects durability on long term benefits is still unclear and its impact on post-surgical physical therapy outcomes such as cost-saving, adherence and quality of life is yet to be seen. It is also important to note that while most studies improved accuracy and adherence, this was not universal. For example, Nuevo et al.[21] found greater quadriceps strength (p=0.028) but not ROM (P=0.535) or walking ability (p=0.523), suggesting that certain motor outcomes may be enhanced over others. Similarly, Pereira et al.[22] demonstrated that different computational methods (cosine similarity vs dynamic time warping) produced significantly different accuracy results for the same exercises. These discrepancies may indicate that digital health app feedback depends on approach and intended outcome.

Conclusion

This narrative review shows that multiple camera-based or wearable sensor-based systems are more accurate but fall short in accessibility compared to single camera setups. Current apps focus on simple shoulder/lower limb movements. While digital health apps are generally beneficial, there needs to be caution in picking algorithms and objectives. Personalised feedback to users in a remote settings and 15/19 papers reporting better feedback accuracy than traditional methods made making users generally stronger and more able, causing high usability scores and therefore a high adherence. Future research pathways should look at simpler set ups, more intuitive feedback through tactics such as gamification, balancing accuracy with leniency, better patient-clinician communication strategies such as chats and social features and finally systems that measure multiple limbs and outcomes while being cost-effective.

Reference List

1. World Health Organization. Rehabilitation [Internet]. World Health Organisation. World Health Organization: WHO; 2024. Available from: https://www.who.int/news-room/fact-sheets/detail/rehabilitation
2. Sivan M, Philips M, Baguley I, Nott M. Oxford Handbook of Rehabilitation Medicine [Internet]. Google Books. 2019 [cited 2026 Feb 13]. Available from: https://books.google.co.uk/books?id=15OzDwAAQBAJ&lpg=PA1&pg=PT19#v=onepage&q&f=false
3. Turner-Stokes L. Efficiency of specialist rehabilitation in reducing dependency and costs of continuing care for adults with complex acquired brain injuries. Journal of Neurology, Neurosurgery & Psychiatry. 2006 May 1;77(5):634–9.
4. Chamorro-Moriana G, Moreno A, Sevillano J. Technology-Based Feedback and Its Efficacy in Improving Gait Parameters in Patients with Abnormal Gait: A Systematic Review. Sensors. 2018 Jan 6;18(2):142.
5. Ma C, Wong D, Lam W, Wan A, Lee W. Balance Improvement Effects of Biofeedback Systems with State-of-the-Art Wearable Sensors: A Systematic Review. Sensors. 2016 Mar 25;16(4):434.
6. Wang Q, Markopoulos P, Yu B, Chen W, Timmermans A. Interactive wearable systems for upper body rehabilitation: a systematic review. Journal of NeuroEngineering and Rehabilitation. 2017 Mar 11;14(1).
7. Giggins OM, Persson U, Caulfield B. Biofeedback in rehabilitation. Journal of NeuroEngineering and Rehabilitation. 2013;10(1):60
8. Jack K, McLean SM, Moffett JK, Gardiner E. Barriers to Treatment Adherence in Physiotherapy Outpatient clinics: a Systematic Review. Manual Therapy [Internet]. 2010 Jun;15(3):220–8. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC2923776/
9. Univeristy of Exeter. Digitherapix | [Internet]. Digitherapix.co.uk. 2024 [cited 2026 Feb 13]. Available from: https://digitherapix.co.uk
10. Sheth N, Foran J. Total Knee Replacement Exercise Guide - OrthoInfo - AAOS [Internet]. www.orthoinfo.org. Available from: https://orthoinfo.aaos.org/en/recovery/total-knee-replacement-exercise-guide
11. Bell KM, Onyeukwu C, McClincy MP, Allen M, Bechard L, Mukherjee A, et al. Verification of a Portable Motion Tracking System for Remote Management of Physical Rehabilitation of the Knee. Sensors (Basel, Switzerland) [Internet]. 2019 Feb 28 [cited 2020 Feb 20];19(5). Available from: https://www.ncbi.nlm.nih.gov/pubmed/30823373
12. Buzcu B, Calvaresi D, Anuraj B, Calbimonte JP. Demo: Towards Dynamic Self-Organizing Wearables for Head and Neck Digital Rehabilitation. 2024.
13. Gu Y, Pandit S, Saraee E, Nordahl T, Ellis T, Betke M. Home-Based Physical Therapy with an Interactive Computer Vision System [Internet]. IEEE Xplore. 2019. p. 2619–28. Available from: https://ieeexplore.ieee.org/document/9022034

14. Horng HC, Chao WT, Chen JF, Chang CP, Wang PH, Chang PL. Home-based non-invasive pelvic floor muscle training device to assist women in performing Kegel exercise in the management of stress urinary incontinence. Journal of the Chinese Medical Association. 2021 Nov 9;85(4).
15. Hou K, Khan MMR, Rahman MH. An Accessible AI-Assisted Rehabilitation System for Guided Upper Limb Therapy. Sensors. 2025 Oct 8;25(19):6239.
16. IANCULESCU M, ANDREI B, ALEXANDRU A. A Smart Assistance Solution for Remotely Monitoring the Orthopaedic Rehabilitation Process Using Wearable Technology: re.flex System. Studies in Informatics and Control. 2019 Oct 9;28(3).
17. Jarungvittayakon C, Sa-ngasoongsong P, Chockchaisakul D, Bamrungchaowkasem J, Wongsak S. Effectiveness of Mobile Exergaming with Sensor-Based Visual Feedback as an Adjunct Therapy for Home-Based Quadriceps Exercise Training in Knee Osteoarthritis: A Prospective Randomized Controlled Trial. Life. 2025 Nov 12;15(11):1738–8.
18. Kordatos G, Stavrakis M. Preliminary design of a wearable system to increase adherence to rehabilitation programmes in acute Cruciate Ligament (CL) rupture. In: ACM Goodtechs Conference. ACM; 2018. p. 277–82.
19. Kritikos I, Mehmeti A, Nikolaou G, D. Koutsouris. Fully portable lowcost motion capture system with realtime feedback for rehabilitation treatment. In: 2019 International Conference on Virtual Rehabilitation (ICVR). p. 1–8.
20. Lin WTM, Lin BS, Lee IJ, Lee SH. Development of a SmartphoneBased mHealth Platform for Telerehabilitation. IEEE Transactions on Neural Systems and Rehabilitation Engineering. 2022;30:2682–91.
21. Nuevo M, Rodríguez-Rodríguez D, Jauregui R, Núria Fabrellas, Zabalegui A, Conti M, et al. Telerehabilitation following fast-track total knee arthroplasty is effective and safe: a randomized controlled trial with the ReHub® platform. Disability and Rehabilitation. 2023 Jul 5;46(12):2629–39.
22. Pereira B, Cunha B, Viana P, Lopes M, Melo ASC, Sousa ASP. A Machine Learning App for Monitoring Physical Therapy at Home. Sensors [Internet]. 2024 Jan 1;24(1):158. Available from: https://www.mdpi.com/1424-8220/24/1/158
23. Rajanna V, Vo P, Barth J, Mjelde M, Grey T, Oduola C, et al. KinoHaptics: An Automated, Wearable, Haptic Assisted, Physio-therapeutic System for Post-surgery Rehabilitation and Self-care. Journal of Medical Systems. 2015 Dec 11;40(3).
24. Sanesi G, Bagdanov AD, Bertini M, Del Bimbo A. DeepPhysio. In: Proceedings of the 27th ACM International Conference on Multimedia. New York, NY, USA: ACM; 2019. p. 2219–20.
25. Shama B, Shetty G, Pereira J, K. P, Pai P. HerAlly: AI Physiotherapy Assistant for Breast Cancer Patients. In: 2024 Third International Conference on Artificial Intelligence, Computational Electronics and Communication System (AICECS). p. 1–5.
26. Suero-Pineda A, Oliva-Pascual-Vaca Á, Durán MRP, Sánchez-Laulhé PR, García-Frasquet MÁ, Blanquero J. Effectiveness of a Telerehabilitation Evidence-Based Tablet App for Rehabilitation in Traumatic Bone and Soft Tissue Injuries of the Hand, Wrist, and Fingers. Archives of Physical Medicine and Rehabilitation. 2023 Feb;104(6).
27. Tang R, Tang A, Yang XD, Bateman S. Physio@Home: Exploring visual guidance and feedback techniques for physiotherapy exercises. In: ACM SIGCHI. 2015.
28. Vasconcelos A, Nunes F, Carvalho A, Correia C. Mobile, Exercise-agnostic, Sensor-based Serious Games for Physical Rehabilitation at Home. 2018. p. 271–8.
29. Wang HD, Khan N, Chen A, Sarkar N, Wisniewski P, Ma M. MicroXercise: A Micro-Level Comparative and Explainable System for Remote Physical Therapy. arXiv (Co rnell University). 2024 Aug 6;

Exercise Without Movement: The Case for Magnetic Mitohormesis in Physical and Rehabilitation Medicine

Author: Sandra Tay

Medical School: University College London

Introduction: The Rehabilitation Paradox

During an internship at the Biolonic Currents Electromagnetic Pulsing Systems (BICEPS) Laboratory at the National University of Singapore, I came across a question I hadn't expected to find in a research setting: what do you do for a patient who needs physiotherapy, but simply cannot do it? The lab was developing a device that used brief pulses of low-energy electromagnetic fields to stimulate muscle; not to make it contract and move, but to trigger the underlying biology that exercise normally provokes. At the time, I was still early in my medical education and understood only fragments of what I was seeing. Yet the clinical rationale for this approach was clear, and its practical implications were hard to ignore.

Rehabilitation medicine is built on a deceptively simple premise: movement heals. Structured mobilisation after surgery, illness, or injury restores function, prevents deconditioning, and drives recovery in ways that medication alone cannot. The conventional answer is physiotherapy, and it works when it can be delivered. The problem is that the patients who most need it are frequently those least able to perform it; someone recovering from major abdominal surgery, spending weeks in an ICU, or too frail to safely stand. These patients deteriorate precisely because the therapeutic tool they need requires a capacity they have lost.

Sarcopenia sits at the heart of this problem. The progressive loss of skeletal muscle mass and function with age affects between 10% and 27% of adults over 60, rising to over half of older patients [1, 2]. In the UK, it costs the health service an estimated £2.5 billion annually [3]. In critical care, sarcopenia is found in a third of ICU patients and is associated with nearly a fourfold increase in one-year mortality [4]. This statistic does not just reflect muscle weakness, but the cascade of complications that immobility sets in motion.

For these patients, a therapy that could deliver the biological benefits of exercise without requiring movement would represent something genuinely new in rehabilitation medicine. That is the promise of magnetic mitohormesis: the use of pulsed electromagnetic fields to activate the mitochondrial pathways that muscle normally engages during exercise. This essay examines how that technology works, what the evidence currently shows, and where it might fit within Physical and Rehabilitation Medicine; not as a replacement for physiotherapy, but as a tool for the patients physiotherapy cannot yet reach.

Biological Foundations: Why Muscle Mitochondria Are the Target

To understand why pulsed electromagnetic fields might help a post-surgical patient recover, it helps to first appreciate what exercise does to muscle at a cellular level.

When muscle contracts during exercise, it experiences mechanical stress and a transient rise in intracellular calcium, which triggers a cascade of signalling events. At the centre of this is PGC-1α (peroxisome proliferator-activated receptor gamma coactivator 1-alpha), a transcriptional regulator that acts as a master switch for mitochondrial biogenesis [5]. Its activation leads to the proliferation of mitochondria within muscle fibres, a shift toward more oxidative metabolism, enhanced fat oxidation, and the release of myokines (signalling proteins secreted that exert systemic anti-inflammatory and metabolic effects) [6]. Thus, the systemic reach of the muscle secretome is why regular exercise is protective against many conditions that seem unrelated to fitness.

The concept of mitohormesis sits within this framework. Hormesis is the well-established biological phenomenon in which low-level stress triggers an adaptive, protective response [7]. Mitohormesis specifically describes this at the level of the mitochondria: a controlled, modest rise in reactive oxygen species (ROS) during oxidative phosphorylation acts not as damage, but as a signal, activating downstream pathways that improve mitochondrial efficiency and cellular stress resistance [8]. Exercise is one of the most potent natural inducers of mitohormesis. The question the BICEPS laboratory was trying to answer is whether the same mitochondrial response could be triggered non-mechanically.

The answer lies in a property of skeletal muscle that makes it unusual among tissues: its sensitivity to electromagnetic fields via calcium-permeable mechanosensitive channels, particularly TRPC1. During exercise, mechanical deformation of the muscle membrane opens these channels, allowing calcium influx that initiates PGC-1α signalling. Research from the BICEPS group demonstrated that extremely low-frequency pulsed electromagnetic fields can activate the same calcium-mitochondrial axis without any mechanical stimulus at all [9, 10]. Moreover, the mitochondrial network in skeletal muscle appears to be particularly sensitive to this type of stimulation compared to other cell types, ensuring a relatively tissue-specific effect rather than a systemic electromagnetic exposure.

Critically, this is not electrical muscle stimulation in the conventional sense. Traditional neuromuscular electrical stimulation (NMES) passes current through tissue to elicit a motor nerve response and force contraction. The Pulsed Electromagnetic Field (PEMF) paradigm used here operates at field strengths too low to cause contraction. Instead, it targets the metabolic and regenerative biology of muscle. The distinction matters clinically as patients with surgical wounds, implanted hardware, or too little muscle mass can potentially receive this stimulation safely.

Clinical Evidence: From Cells to Patients

Like most therapies that earn clinical credibility, the evidence base for magnetic mitohormesis began in cell cultures and animal models before reaching humans. That human evidence remains early-stage, but it has shown consistent and wide-ranging applications that prove to be promising.

The first controlled human study to examine this specific PEMF paradigm in a surgical rehabilitation context was a randomised pilot trial by Stephenson et al. published in 2022 [11]. Twenty patients underwent an anterior cruciate ligament reconstruction, a procedure that predictably triggers systemic metabolic disruption through enforced immobility. These patients were randomised to receive either weekly PEMF exposure or placebo post-surgery. The PEMF group showed improvements in high-energy phosphate metabolism on MRI spectroscopy, reductions in circulating ceramide species (lipotoxic metabolites that accumulate during muscle disuse), and favourable changes in plasma biomarkers of muscle regeneration. The implications of these findings are significant as they suggest that intervention delivered during a period when patients cannot exercise was shifting muscle metabolism in a direction that mirrors what exercise normally achieves. The sample size was small, and the authors were appropriately cautious, but the biological signal was clear enough to justify larger investigation.

The largest human dataset to date came in 2023, when Venugobal et al. published results from 101 participants across a wide age range of 38 to 91 years [12]. Eighty-seven percent had pre-existing mobility dysfunction. After 12 weeks of weekly 10-minute PEMF sessions, all three mobility tests used (Timed Up and Go, Five Times Sit-to-Stand, and 4-metre Normal Gait Speed) showed statistically significant improvements across every age group. The oldest participants, those between 76 and 91, saw their TUG time fall from an average of

15.35 to 13.14 seconds; a clinically meaningful change given that scores above 14 seconds in this age group are associated with materially higher fall risk. Body composition data from a subgroup also showed a 1.2%

increase in lean muscle mass and a reduction in visceral fat of 3.7% without any change in body weight, suggesting genuine metabolic recomposition rather than weight loss.

Independent replication has followed outside of Singapore. A randomised controlled trial involving 60 patients with end-stage knee osteoarthritis was conducted in Hong Kong [13]. Patients that were randomised to PEMF alongside home-based exercise showed significantly greater improvements in knee extensor and flexor strength compared to exercise alone, as well as superior pain reduction, with the greatest gains seen in patients over 70. The literature consistently shows that older, deconditioned patients respond more strongly to PEMF than younger, healthier individuals. This has major implications for rehabilitation medicine: the patients who benefit most from PEMF are exactly those who struggle with conventional therapies.

A further independent signal came from Auburn University in the United States in 2024, where a double-blind crossover pilot trial was conducted in pre-frail and frail residents of long-term care facilities [14]. Despite the small sample and short duration, participants who received active PEMF showed improved gait speed and overall Short Physical Performance Battery scores by the end of the study, with those who received treatment in the second half of the crossover still demonstrating gains at 24 weeks.

From Laboratory to Clinic: Translation and Its Challenges

The translation of PEMF technology from laboratory to clinical practice has progressed systematically. Unlike many rehabilitation modalities that suffer from inconsistent protocols, this research program has maintained a standardized exposure protocol and mechanistic model. This consistency has yielded a cohesive body of clinical data across diverse patient populations, including independent replication in Hong Kong, US frailty trials, and ongoing studies involving chronic ankle instability and prolonged hospitalisation in haematology patients [13, 14, 15]. The transition into active clinical care is further demonstrated by the 2025 opening of the QuantumTx–NUH MitoCharge Centre at the National University Hospital Singapore, a dedicated facility for post-surgical, sarcopenic, and deconditioned patients [16].

That said, honest appraisal of where the field stands require naming what the evidence does not yet fully answer. The Venugobal community study provides the most compelling mobility data but lacked a placebo-controlled arm. The Stephenson ACL trial with its concrete biological endpoints in MRI phosphate spectroscopy and plasma ceramide levels, enrolled only 20 patients. What is needed, and what several ongoing trials are beginning to address, is a large adequately powered placebo-controlled RCT in a clearly defined rehabilitation population. That is not a criticism of what has been done; it is simply the natural next step for any therapy approaching mainstream clinical adoption.

There is also a question of generalisability. Most human data comes from Singapore and Hong Kong, in populations that differ from UK patients in comorbidity burden, baseline muscle mass, and habitual activity levels. Whether effects of similar magnitude would be seen in an older NHS patient with multiple comorbidities is genuinely unknown. This is arguably the most important translational question this field now needs to answer.

Cost presents a further and distinctly British challenge. In Singapore, a single 10-minute session costs SGD $50 (approximately £30) with recommendations of one to three sessions per week [17]. Even at its most economical, that represents a meaningful financial burden for individuals, and an obvious barrier in a publicly funded healthcare system where any new intervention must demonstrate not just clinical benefit but cost-effectiveness relative to existing alternatives, as required by NICE [18]. A health economic analysis would be an important next step, and one that could make or break the case for NHS commissioning.

Because the device is simple to operate, requires no consumables, and can be administered in 10-minute outpatient sessions, it has the potential to become highly cost-effective at scale, despite its current private clinic pricing.

Current Landscape and Future Directions

The value of PEMF in rehabilitation medicine lies in its broad applicability rather than any single intervention. It addresses a fundamental clinical challenge: stimulating muscle activation in patients who are physically unable to exercise. This specific barrier is central to many conditions, including post-surgical recovery, frailty, prolonged hospitalisation, ICU-acquired weakness, and stroke. Consequently, PEMF has the potential to address some of the most common and costly burdens facing UK rehabilitation services today.

Moreover, the NHS physiotherapy workforce is under sustained pressure. Waiting lists for musculoskeletal services have grown by 27% in recent years, the Chartered Society of Physiotherapy (CSP) has called for a 7% annual increase in physiotherapy positions just to keep pace with demand from an ageing population, and 15% of physiotherapy staff leave the NHS each year, many within their first five years [19, 20]. In this context, a technology that could deliver meaningful muscle-metabolic benefit in ten minutes, without requiring a trained

therapist to be present for every session, starts to look not just clinically attractive but operationally relevant. It is unable to replace physiotherapy as nothing about PEMF addresses the motor relearning, coordination, and functional task practice that skilled physiotherapy delivers. Instead, it could extend the reach of rehabilitation into the gaps that the workforce cannot fill.

Several trials now underway suggest the field is thinking along exactly these lines. The National University Hospital Singapore is actively recruiting haematology patients undergoing prolonged hospitalisation into a case-matched control study examining whether PEMF can prevent or slow the deconditioning that typically accumulates during extended inpatient stays [15]. A parallel trial in Cairo is investigating PEMF for dysphagia in elderly post-stroke patients, reflecting an interest in neurological rehabilitation applications that goes beyond the musculoskeletal focus of earlier work [21]. The Brazilian study published in 2025 by Leonardo et al. demonstrated significant improvements in knee extensor strength and TUG performance in sarcopenic older adults after just 12 PEMF sessions, adding to the growing body of independent replication across different continents and healthcare systems [22].

Looking further ahead, there are plausible applications that have not yet been formally tested but follow logically from what is already known. Cancer-related sarcopenia, the profound muscle wasting that accompanies chemotherapy and prolonged treatment, is a growing rehabilitation priority for which exercise is often simply not feasible during active treatment.

Another example is cardiac rehabilitation, where deconditioning post-acute coronary syndrome or cardiac surgery can be severe and the window for exercise-based recovery is narrow. These applications are a logical extension of mechanisms already supported by human clinical data.

While PEMF does not yet have the evidence base for routine NHS adoption, the clinical trials defining its future are happening now. PRM is the specialty with the most relevant patient populations, the clearest clinical questions, and the most to gain from being part of that process early rather than late.

Conclusion

Magnetic mitohormesis is not a finished story. The trials completed so far are promising but small, the evidence base is geographically narrow, and the economic case for NHS adoption has not yet been made. Acknowledging this is not a reason to be dismissive, it is simply an accurate description of where a young and genuinely interesting area of research currently stands.

What the evidence does show, consistently across independent groups and clinical contexts, is that brief weekly exposure to low-energy pulsed electromagnetic fields can produce meaningful changes in muscle biology and physical function in people who are unable to exercise. Given that PRM's core objective is restoring function in patients who cannot tolerate conventional therapy, the potential of this technology merits rigorous clinical investigation.

The next steps are clear: larger placebo-controlled trials, a UK-based population study, and a health economic analysis that speaks to NHS commissioners rather than research journals. Regardless of whether future studies confirm early findings or reveal new complexities, the underlying research objective remains sound. Rehabilitation medicine requires innovative interventions for its clinically complex patients, and PEMF represents a highly promising candidate to fill this gap.

References:

1. Yuan S, Larsson SC. Epidemiology of sarcopenia: prevalence, risk factors, and consequences. Metabolism. 2023;144:155533.
2. Cruz-Jentoft AJ, Bahat G, Bauer J, Boirie Y, Bruyère O, Cederholm T, et al. Sarcopenia: revised European consensus on definition and diagnosis. Age Ageing. 2019;48(1):16–31.
3. National Institute for Health Research Birmingham Biomedical Research Centre. Sarcopenia and multimorbidity [Internet]. Birmingham: NIHR; 2024 [cited 2026 May]. Available from: https://www.birminghambrc.nihr.ac.uk/our-research/sarcopenia-and-multimorbidity
4. Bai T, Xiao Y, Liu Y, Peng X, Deng L. Assessment of sarcopenia in the intensive care unit and 1-year mortality in survivors of critical illness. Nutrients. 2021;13(8):2726.
5. Kang C, Li Ji L. Role of PGC-1α signalling in skeletal muscle health and disease. Ann N Y Acad Sci. 2012;1271(1):110–117.
6. Pedersen BK, Febbraio MA. Muscles, exercise and obesity: skeletal muscle as a secretory organ. Nat Rev Endocrinol. 2012;8(8):457–465.
7. Ristow M, Schmeisser K. Mitohormesis: promoting health and lifespan by increased levels of reactive oxygen species. Free Radic Biol Med. 2014;73:371–374.
8. Yun J, Finkel T. Mitohormesis. Cell Metab. 2014;19(5):757–766.
9. Franco-Obregón A, Tai YK, Wu KY, Iversen JN, Wong CJK. The developmental implications of muscle-targeted magnetic mitohormesis: a human health and longevity perspective. Bioengineering. 2023;10(8):956.
10. Tai YK, Abdul Rahum MS, Ng JJ, Koh APF, Lim JY, Tay HK, et al. Magnetic fields modulate metabolism and gut microbiome in correlation with Pgc-1α expression: follow-up to an in vitro magnetic mitohormesis mechanism. FASEB J. 2020;34(8):8322–8340.
11. Stephenson MC, Krishna L, Pannir Selvan RM, Tai YK, Wong CJK, Yin JN, et al. Magnetic field therapy enhances muscle mitochondrial bioenergetics and attenuates systemic ceramide levels following ACL reconstruction: Southeast Asian randomized-controlled pilot trial. J Orthop Translat. 2022;35:99–112.
12. Venugobal S, Tai YK, Goh J, Teh S, Wong C, Goh I, et al. Brief, weekly magnetic muscle therapy improves mobility and lean body mass in older adults: a Southeast Asia community case study. Aging. 2023;15(6):1768–1790.
13. Wang Q, Ong MT, Man GC, Franco-Obregón A, Choi BC, Lui PP, et al. The effects of pulsed electromagnetic

field therapy on muscle strength and pain in patients with end-stage knee osteoarthritis: a randomized controlled trial. Front Med. 2024;11:1435277.
14. Sagong H, Tsai PF, Wang CH, Brown L, Edison J. Enhancing muscle function in frailty: findings from a pilot study on magnetic mitohormesis therapy. Innovation in Aging. 2024;8(Suppl 1):igae098.2758.
15. ClinicalTrials.gov. Pulsed electromagnetic fields in preventing physical deconditioning in patients undergoing prolonged hospitalization [NCT06744764]. Bethesda (MD): National Library of Medicine (US); 2024 [cited 2026 May]. Available from: https://clinicaltrials.gov/study/NCT06744764
16. Yong Loo Lin School of Medicine, National University of Singapore. From science to strength: QuantumTx–NUH MitoCharge Centre transforming muscle health for all. NUS Medicine News [Internet]. 2026 [cited 2026 May]. Available from:
17. Singapore General Hospital. More seniors should have access to Bixeps to strengthen muscles and stay active for longer. SGH News [Internet]. 2025 [cited 2026 May]. Available from: https://www.sgh.com.sg/news/patient-care/more-seniors-should-have-access-to-bixeps-to-strengthen-muscles-
18. National Institute for Health and Care Excellence. About technology appraisal guidance [Internet]. London: NICE; 2024 [cited 2026 May]. Available from: https://www.nice.org.uk/about/what-we-do/our-programmes/nice-guidance/nice-technology-appraisal-guidance
19. Chartered Society of Physiotherapy. MSK waiting times and the physiotherapy staff shortage [Internet]. London: CSP; 2024 [cited 2026 May]. Available from: https://www.csp.org.uk/news/2024-06-05-msk-waiting-times-physiotherapy-staff-shortage-may-media
20. Chartered Society of Physiotherapy. New NHS workforce report highlights government's under-ambitious increase in physio roles [Internet]. London: CSP; 2024 [cited 2026 May]. Available from: https://www.csp.org.uk/news/2024-02-13-new-nhs-workforce-report-highlights-governments-under-ambitious-increase-physio
21. ClinicalTrials.gov. Effect of pulsed electromagnetic therapy on chronic dysphagia in elderly post-stroke patients [NCT07100262]. Bethesda (MD): National Library of Medicine (US); 2025 [cited 2026 May]. Available from: https://clinicaltrials.gov/study/NCT07100262
22. Leonardo PS, Sá Filho AS, Inacio PA, França PR, Aprigliano V, Teixeira F, et al. The effects of pulsed electromagnetic field (PEMF) on muscular strength, functional performance and depressive symptoms in elderly adults with sarcopenia: a short-term intervention. Life. 2025;15(7):1111.

Should Artificial Intelligence Become a Key Member of the Rehabilitation Multidisciplinary Team? Opportunities, Risks and the Future of Precision Rehabilitation

Author: Shreya Srinivas

Medical School: University College London

The Hardships of Rehabilitative Medicine

Physical and rehabilitation medicine involves working with a holistic approach in neurorehabilitation, musculoskeletal rehabilitation, amputee medicine, spinal rehabilitation and trauma rehabilitation to optimise the recovery of patients and preserve function to enable patients to participate in all aspects of society. (1) These areas of medicine are responsible for improving the quality of life of countless patients. Furthermore, this specialty carries a burden of disease that is ever-increasing as the UK population ages, chronic disease becomes more prevalent, and the interlinking of scientific research, technological advances and public health awareness increase the rate of stroke and trauma survival. Despite growing recognition that recovery trajectories can vary considerably between patients, rehabilitation programmes continue to be directed by diagnostic pathways and evidence-based guidelines. In addition to this, due to staffing constraints, patients may receive therapy as it is available with intermittent assessment rather than in the optimal time frame for their recovery. This use of standardised treatment protocols with limited capacity to cater to heterogenous patient needs can have a detrimental impact on quality of life for many patients as it may prolong their recovery period. This was illustrated by a study which used stratification of patients based on their stroke severity to compare recovery trajectories at 1, 3, 6 and 12 months follow-up post-stroke. It highlighted that a multitude of factors including stroke severity, underlying medical conditions such as diabetes mellitus or anaemia, prior cerebrovascular events, gender and age had an influence on post-stroke functional recovery trajectories. (2) This demonstrates that there is a pressing need for therapy that can be continuously monitored and adapted based on patient response as recovery is rarely uniform.

Artificial Intelligence Explained

In an evolving digital world, the issue of person-centred treatment within medicine can be tackled with increasing success. Artificial intelligence is at the forefront of new approaches to make rehabilitation more precise by adapting ongoing therapy informed by continuous monitoring of each patient's physiology, behaviours and goals. However, the promise of the future of artificial intelligence within healthcare is accompanied by issues of bias, equity and patient trust that must be addressed prior to implementation. Whilst artificial intelligence is often quickly cited as an emerging solution to many problems within the medical field, it is a broad term which encompasses an entire field of computer science. It is important to understand which sections of the field can introduce meaningful change to patient care. The main areas of artificial intelligence of interest within physical rehabilitation healthcare are supervised and unsupervised machine learning models, deep learning models, computer vision, natural language processing and predictive analytics. Supervised machine learning models work by analysing 'training' cases alongside their desired output labels to generate an algorithm that can correctly label a new case. Unsupervised learning differs in that it uses unlabelled data and infers patterns to sub-group the original data, identify outliers or represent the data. Machine learning allows the generation of a data sorting algorithm without having to manually input specific

decision rules or account for interactions between each confounding variable. (3) Deep learning models are an advanced subset of machine learning which involves training a multi-layered artificial neural network with huge data sets to deal with more complex patterns with a reduced need for manual input engineering as the model learns which input features are important directly from the raw data. (4) Convolutional neural networks are a particular type of neural network used in deep learning for grid-like data such as images and videos which is integral in the field of computer vision (5); computer vision is the process by which artificial intelligence models allow computers to recognise aspects like people, writing or objects in an image or video, reconstruct them to identify their 3D characteristics and reorganise them to infer relationships between them. (6) Natural language processing is a branch of artificial intelligence that allows computers to recognise, understand and generate human text or speech. (7) Predictive analytics uses neural networks and decision trees to enable a computer to use historical data and statistical modelling to predict future outcomes. (8) Artificial intelligence is a novel tool that, if understood and correctly applied, can be used by clinicians to transform patient recovery outcomes with increasingly personalised care.

Opportunities For Artificial Intelligence

For any patient undergoing physical rehabilitation, their care is a journey through which their multidisciplinary team help guide them. This journey begins with their initial assessment of baseline functionality. Currently, this assessment can be biased as clinicians only see patients in a snapshot of their day and self-report methods of activity and clinician analysis of this can both be unreliable at times. (9) Artificial intelligence could provide a solution here with computer vision to analyse gait, wearable devices (10) for continuous measurement of movement and function, natural language processing to analyse speech and machine learning models to help interpret electromyograms. Using artificial intelligence as assistance, under the supervision of clinicians, in these tasks would provide more objective outcome measures, more sensitive detection of deterioration and continuous monitoring of patients. The next step in a patient's journey is gathering information to inform the formulation of a therapeutic plan. This step is vital as conditions such as strokes which require rehabilitation are extremely heterogenous; any two patients with the same injury are likely to recover with drastically different outcomes. Artificial intelligence, particularly predictive analytics, could solve this problem and take patient care one step further by adding the step of prediction. For example, machine deep learning models could be used to interpret subtler details in brain MRI scans to predict walking and limb use recovery as well as the risk of subsequent falls and readmission. This would allow a multidisciplinary team to set goals that are more achievable for the patient, tailor patient counselling to their calculated risk and allocate resources with more certainty. Once the multidisciplinary team has the patient's risk information and a prediction of their outcomes, this can be used to inform a personalised therapeutic plan. Currently, guidelines ensuring a good standard of care can mean that patients are given equal treatment rather than equitable treatment, for example, patients with varying aphasia in the acute phase of post-stroke recovery may both be given speech therapy in hour-long sessions which may not be optimal for their recovery. The process of integrating the best available scientific research with each patient's holistic circumstance to alter therapeutic approaches involves trial and error and can prolong the patient's recovery journey. Therefore, using artificial intelligence as a tool to expedite this process could improve patients' quality of life. For example, natural language processing could be used in continuous analysis of speech outside of hospital appointments. It could be designed to recognise quantitative linguistic features within spontaneous speech, allowing early detection of improvement or deterioration which could influence recovery trajectories. This information could then be fed to speech therapists who could make timely adjustments to therapy ahead of their next session. This precision rehabilitation would ensure that there is no time wasted in management, a principle that has been shown to be vital in the first three months of post-stroke recovery. (2) Moreover, this method of remote rehabilitation would reduce waiting lists, increase accessibility to treatment for those living in rural areas, increase adherence to treatment plans and decrease the burden on the already stretched workforce. Administration underpins all

aspects of the patient journey; however, it is often overlooked. Improving administration could mean inequalities are addressed and better care is promoted (11). The efficiency of administrative tasks could be improved by implementing generative artificial intelligence that uses patient summary notes to create a GP discharge summary letter which is then reviewed by a clinician or combining speech recognition, natural language processing and large language models to convert the audio of a multidisciplinary team meeting into text, organise it into a problem list, management plan, responsibilities and follow-up actions whilst retrieving any relevant past medical history from the patient database. This will make clinical documentation faster, allowing more time for clinicians to spend one-on-one with rehabilitation patients, improving the quality of care. This is vital to recovery trajectories as I saw whilst shadowing on a stroke ward; a patient re-learning how to walk following an ischaemic stroke told me that the progress she had made was more reliant on the support and encouragement of her multidisciplinary team as they motivated her to get up and try each day. Therefore, it is important to remember that whilst artificial intelligence may benefit many avenues of physical and rehabilitation medicine, it must not be used with a view to replace clinicians as human touch and empathy works symbiotically with science to garner better outcomes for patients.

The Overall Benefit of Artificial Intelligence

By digesting and transforming vast amounts of physiological, behavioural and clinical data into actionable insights, artificial intelligence has the potential to improve patient care from initial assessment to long term follow-up. At the centre of all healthcare, is the patient's experience. Artificial intelligence would enable patients to receive care that is specifically tailored to their needs and delivered increasingly in a home setting, allowing them to have greater independence with increased motivation through the feedback of continuous monitoring. Additionally, the use of artificial intelligence would benefit clinicians as more sensitive and objective measurements push care towards better patient outcomes due to earlier detection and, therefore, intervention which is a major point in the NHS 10-year Health Plan. (12) Finally, artificial intelligence would help relieve partly the burdens of workforce efficiency and cost in the NHS, which would allow for a greater capacity and a better working environment for healthcare professionals.

Drawbacks of the use of Artificial Intelligence

Whilst artificial intelligence may seem like an ideal fix for many logistical problems within the healthcare system, it is far from perfect. A consistent issue arising in many of the studies regarding the use of artificial intelligence in rehabilitative medicine is that of dataset input bias. (10) In order to infer patterns and generate an algorithm, machine learning models rely entirely on the dataset they are given. Hence, this dataset must be able to represent the entire population to be effective for all patients. Bias within the input dataset, such as using patient data from a wealthier post code area, can widen existing disparities in healthcare. For example, if artificial intelligence were used to analyse gait and the input dataset consisted of diverse patients with similar Body Mass Index (BMI) scores, it may fail to correctly identify gait problems in a patient of lower or higher BMI or may even identify problems that are unrelated to rehabilitation, causing false fear. Another key issue is explainability, particularly when using deep machine learning models. (10) Explainability is the task of comprehending and retracing an artificial intelligence algorithm to understand why it made a certain decision or gave a certain result. This is vital to wider implementation of artificial intelligence as people cannot trust the algorithm if they do not understand its reasoning. Moreover, it ensures the model is not relying on prejudiced data nor acting on unethical principles, which is integral when being used for patient care. In addition to this, there is currently very limited clinical evidence for the use of artificial intelligence in physical and rehabilitation medicine, with majority of studies being in post-stroke care alone. Consequently, before implementing artificial intelligence in rehabilitation medicine, we should increase efforts to assess the physical and psychological impacts of this technology on patients in real-life scenarios. (14) Another key problem with the

use of artificial intelligence to aid physical rehabilitation, is whether it is an equitable approach. Stroke, a major cause for patients needing rehabilitation, is also ‘the largest global cause of adult neuro-disability'. (15) Therefore, digital exclusion may hamper the ability of patients to engage with artificial intelligence-led at- home monitoring, especially as patients are likely to be elderly and may have cognitive impairment post-stroke. In addition to this, engagement with at-home monitoring technologies may be obstructed if patients feel as though their privacy is not respected. Whilst continuous monitoring may improve their outcomes, it may also cause them to feel anxious or unable to relax which would reduce their quality of life, partly negating the positive impacts the technology may have had. Finally, and perhaps most importantly, patient recovery is driven by empathy, support and encouragement from the people surrounding them. As humans, we rely on the trust and hope fostered by our interpersonal relationships to motivate ourselves. This human connection is a part of rehabilitative medicine that could never be automated or replaced by artificial intelligence.

The proposed solution

Step 1 – artificial intelligence assisted comprehensive assessment

Artificial intelligence uses multiple sources to build a comprehensive patient profile, identifying complex relationships between variables to produce a detailed baseline assessment which is then reviewed by healthcare professionals before starting the multidisciplinary team meeting.

Step 2 – recovery prediction

Machine learning models estimate probabilities of different outcomes for an individual patient. This informs goal setting and resource allocation.

Step 3 – shared decision making

The multidisciplinary team considers the holistic needs of the patient combined with generated predictions to inform a management plan.

Step 4 – personalised rehabilitation programme

A shift from a protocol-driven management plan to one centred around the patient’s own data.

Step 5 – continuous at-home rehabilitation

Wearable technology and smartphone applications allow continuous monitoring of rehabilitation between appointments.

Step 6 – dynamic progression with intelligent alerts

Artificial intelligence continuously suggests changes to the personalised management plan corresponding to the patient’s response and changes in their recovery trajectory. These optional changes would be alerted to the multidisciplinary team, as artificial intelligence would not be making any independent treatment decisions.

Step 7 – continuous human review

To ensure patient safety, clinical judgement would always override artificial intelligence recommendations.

Conclusion

To conclude, whilst artificial intelligence holds an immense amount of promise for the future of physical and rehabilitation medicine, none of these improvements can be implemented unless artificial intelligence becomes transparent, equitable, validated and seamlessly integrated into the multidisciplinary teams with appropriate education and training for healthcare professionals.

References

1. Rehabilitation Medicine Training Is Divided into Five sub-specialities [Internet]. Hee.nhs.uk. 2026 [cited 2026 Jun 30]. Available from: https://heeoe.hee.nhs.uk/Sub-specialties
2. Lin CJ, Huang HC, Tsai JY, Liu TC, Liu HY, Chi NF, et al. Heterogeneous Recovery Trajectories and Prognostic Factors After Ischemic Stroke. Cerebrovascular Diseases. 2026 Jan 22;1–21.
3. Yu KH, Beam AL, Kohane IS. Artificial Intelligence in Healthcare. Nature Biomedical Engineering. 2018 Oct;2(10):719–31.
4. Google. Deep Learning Vs Machine Learning [Internet]. Google Cloud. [cited 2026 Jun 30]. Available from: https://cloud.google.com/discover/deep-learning-vs-machine-learning
5. Staff C. Deep Learning vs. Neural Network: What's the Difference? [Internet]. Coursera. 2025 [cited 2026 Jun 30]. Available from: https://www.coursera.org/articles/deep-learning-vs-neural-network
6. IBM. What Is Computer Vision? [Internet]. Ibm.com. 2021 [cited 2026 Jun 30]. Available from: https://www.ibm.com/think/topics/computer-vision
7. Stryker C, Holdsworth J. What Is NLP (natural Language processing)? [Internet]. IBM. 2024 [cited 2026 Jun 30]. Available from: https://www.ibm.com/think/topics/natural-language-processing
8. IBM. What Is Predictive analytics? [Internet]. IBM. 2022 [cited 2026 Jun 30]. Available from: https://www.ibm.com/think/topics/predictive-analytics
9. Reiman MP, Manske RC. The Assessment of function: How Is It measured? a Clinical Perspective. Journal of Manual & Manipulative Therapy [Internet]. 2011 May [cited 2019 Nov 20];19(2):91–9. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3172944/
10. MORONE G, Group R, CARBONETTI R, CINNERA AM, MALFITANO C, Alessio BISIRRI, et al. Artificial Intelligence in rehabilitation: a Living Systematic Mapping Review - First Release. European Journal of Physical and Rehabilitation Medicine [Internet]. 2025 Dec 1 [cited 2026 Jan 28];61(5):694–708. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC12824600/
11. Ewbank L, Lamming L, Cream J, Wenzel L. Admin Matters: the Impact of NHS Administration on Patient Care [Internet]. The King's Fund. 2021 [cited 2026 Jun 30]. Available from: https://www.kingsfund.org.uk/insight-and-analysis/long-reads/admin-matters-nhs-patient-care
12. NHS England. NHS Long Term Plan [Internet]. NHS. 2019 [cited 2026 Jun 30]. Available from: https://www.england.nhs.uk/long-term-plan/
13. IBM. Explainable AI [Internet]. IBM. 2023 [cited 2026 Jun 30]. Available from: https://www.ibm.com/think/topics/explainable-ai
14. Sumner J, Lim HW, Chong LS, Bundele A, Mukhopadhyay A, Kayambu G. Artificial Intelligence in Physical rehabilitation: a Systematic Review. Artificial Intelligence in Medicine [Internet]. 2023 Dec 1;146:102693. Available from: https://www.sciencedirect.com/science/article/pii/S0933365723002075
15. Stockley RC, Hirst Y, Hayes C, Watkins KE, Goodwin PC. How Equitable Is Digital Rehabilitation for People after stroke? a Systematic Review Using an Equity Approach. Frontiers in Digital Health. 2025 Jun 24;7.

How New Technologies Are Changing Physical and Rehabilitation Medicine

Author: Vishal Vijay Kumar

Medical School: Imperial College London

Modern medicine is often celebrated at its most dramatic moments: the resuscitation of a collapsing patient, the precision of emergency surgery, the stabilisation of catastrophic injury. These are the scenes in which healthcare appears most visibly heroic. Yet the true test of medicine often begins after the operating theatre empties and the monitors fall silent. Survival, though essential, is not the same as recovery. For many patients, the aftermath of trauma or neurological illness is marked by a different kind of crisis: the loss of movement, independence, ability to work, identity, and social belonging. It is within this gap between biological survival and meaningful living that Physical and Rehabilitation Medicine (PRM) finds its purpose.

Unlike acute specialties, which focus on immediate physiological rescue, PRM asks a different question: not simply how a life can be saved, but how that life can be rebuilt. Its concern is with function, adaptation, participation, and most importantly, dignity. In this sense, it is one of the most quietly important areas within medicine, because it refuses to mistake bodily survival for full recovery. Today, that mission is being reshaped by a wave of technological innovation. Virtual reality, functional electrical stimulation, robotic devices, brain-computer interfaces, and tele-rehabilitation are changing not only how rehabilitation is delivered, but what clinicians can reasonably hope to achieve. These tools are expanding the reach of therapy beyond maintenance and compensation, towards active retraining, neural reorganisation, and reintegration into social life. At the same time, they expose a difficult truth: the effects of technological progress in rehabilitation are not the same everywhere. It is shaped by systems of funding, workforce, geography, and unequal access to care.

This makes PRM a unique lens through which to examine medical progress. Rehabilitation has long challenged the reductionist assumption that health is simply the absence of pathology. A patient may survive a spinal cord injury, a stroke, or major polytrauma with stable observations and well-healed tissues, and yet remain unable to dress independently, return to work, communicate effectively, or participate in family life. The World Health Organization's International Classification of Functioning, Disability and Health reflects this broader understanding by framing disability as not only in bodily impairment, but also in the relationship between the body, activity, and environment (World Health Organization, 2001).[1] New technologies have embraced this philosophy, seeking to improve not merely clinical metrics, but function as well.

One of the clearest examples of this digital transformation is immersive virtual reality (VR). Conventional rehabilitation often depends on repetition, and repetition can easily become exhausting, monotonous, and psychologically draining. VR changes that by placing patients in visually rich, responsive, and motivating environments in which tasks can be repeated with purpose. In neurological rehabilitation, VR has shown promise in improving upper limb recovery, mobility, balance, and activities of daily living, particularly after stroke.[2] More importantly, it changes the character of therapy itself. Rather than asking patients to perform isolated, decontextualised exercises, VR can simulate walking through environments, reaching for meaningful objects, or navigating tasks that resemble life beyond the clinic. This makes rehabilitation not only more intensive, but more immersive and functionally useful to the patient.[2]

Its value is especially striking in conditions where conventional interventions offer only partial relief. Neuropathic pain after spinal cord injury, for example, can be profoundly debilitating and often remains resistant to medication.[3] In such cases, VR-based mirror feedback and embodied visual illusions may help reduce pain by altering distorted body representation and recalibrating sensory processing.[4] This marks an

important shift in how technology is used in PRM. It is no longer merely compensating for disability; it is increasingly being used to intervene in the brain's own perception of the injured body. Rehabilitation, in other words, is becoming not only mechanical but neurocognitive as well.

Functional electrical stimulation, or FES, similarly illustrates how technology is changing the therapeutic landscape. By applying controlled electrical impulses to peripheral nerves, FES can generate purposeful muscle contraction in weakened or paralysed limbs.[5] In practice, this can assist grasp, stepping, cycling, or transfer training, turning rehabilitation into a more active process. A systematic review by Eraifej et al. found that upper limb FES can improve activity after stroke, especially when incorporated into structured rehabilitation programmes.[5] In spinal cord injury, FES-assisted cycling and stepping have also shown promise in supporting conditioning and functional practice.[6] The significance of FES lies not only in the movement it produces, but in the model of rehabilitation it represents: one in which the patient participates in meaningful, assisted action rather than receiving purely passive therapy.

Robotic rehabilitation extends this approach. Robotic gait trainers, exoskeletons, and upper-limb devices allow patients to perform highly repetitive, task-specific exercises that may be difficult to sustain through conventional therapy alone. This is particularly relevant in neurological rehabilitation, where recovery is influenced by the intensity and specificity of training. For example, a recent Cochrane review suggests that electromechanical-assisted gait training combined with physiotherapy increases the odds of regaining independent walking after stroke, especially in the first three months after stroke and in people who are initially non-ambulatory.[7] Robotics in this field do not replace physiotherapists, but augment what they can do. They provide consistency, data, and endurance, while the clinician remains responsible for interpretation, adaptation, encouragement, and goal-setting.

Brain-computer interfaces, or BCIs push the horizon even further. These systems translate neural activity into commands for external devices such as communication aids, robotic limbs, or stimulators. For patients with severe paralysis, this offers the possibility of bypassing damaged motor pathways and allowing intention to be expressed through alternative interfaces. Many applications remain experimental, but electrical stimulation and neurotechnology research in spinal cord injury and stroke continues to suggest meaningful possibilities for restoring function and modulating neural plasticity.[8] Their significance for PRM lies in the way they redefine rehabilitation itself. If technology can create new routes between thought and action, then recovery is no longer simply about restoring damaged systems, but about engineering new possibilities for function.

For all their sophistication, however, these technologies are only meaningful when they serve goals that matter to the patient. During a clinical placement, I found myself initially captivated by the machinery of rehabilitation, especially futuristic-looking robotic training devices that gave the sense that innovation might somehow outpace neurological loss. What altered my understanding was not a machine, but a conversation. I was observing a goal-setting session with a patient I will call Richard, who was living with a spinal cord injury. The team discussed entirely reasonable targets: improving transfers, increasing trunk control, preserving respiratory function, etc. Richard listened, then gently pointed out that he was an artist, and that if rehabilitation only taught him how to move from bed to wheelchair without helping him stabilise himself well enough to hold a paintbrush, then it was preserving his body while neglecting his identity.

That remark taught me something very important about PRM. The discipline is not defined by the novelty of its technologies, but by the depth of its listening. Rehabilitation should be a process of collaborative problem-solving, dependent on meaningful goal setting and patient participation.[9] Richard made that principle vividly real. A device matters because of what it allows a person to become again: a worker, a parent, an artist, a student.

This is also why tele-rehabilitation may prove one of the most important changes in the field, even if it appears less dramatic than robotics or BCIs. Through video consultations, remote monitoring, app-based exercise platforms, and home-based digital support, tele-rehabilitation extends care beyond specialist centres and into

the spaces where people actually live.[10] Evidence suggests that, in selected settings, tele-rehabilitation can offer outcomes comparable to in-person care while improving continuity and reducing travel barriers.[10] For PRM, this matters because function is not ultimately tested in a therapy gym, but in kitchens, workplaces, streets, and homes. By moving rehabilitation into everyday environments, telemedicine brings the specialty closer to its true objective, enabling patients to achieve their personal goals.

Yet if technology has expanded the possibilities of PRM, it has also thrown longstanding inequalities into sharper focus. Advanced rehabilitation tools are not distributed evenly, either globally or domestically. Their availability depends on infrastructure, specialist staffing, local commissioning, and political priorities. In theory, a health system may celebrate innovation; in practice, access to that innovation may be highly selective. Rehabilitation therefore reveals a persistent fault line within modern healthcare: acute intervention is often treated as indispensable, while long-term recovery is too often viewed as secondary, discretionary, or geographically variable.

Even in an advanced economy such as the United Kingdom, where there is the promise of universal healthcare, it coexists with marked regional variation in rehabilitation access. Rehabilitation inequities persist across the UK, particularly for marginalised communities and those living with long-term conditions or deprivation.[11] In some areas, patients move from acute trauma care into coordinated specialist rehabilitation supported by multidisciplinary teams and modern assistive technology. In others, they face delayed discharge, fragmented follow-up, and inconsistent access to community rehabilitation. The inequality here is not abstract. It shapes how far recovery can proceed, how quickly complications are addressed, and whether a patient is supported back into education, employment, and family life.[12]

This uneven resource allocation matters because rehabilitation outcomes are cumulative. The benefits of technology depend not only on the device itself, but on the system surrounding it: trained staff to operate it, therapists to integrate it into care, clinicians to review progress, and community services to sustain gains once hospital-based treatment ends. A robotic trainer is of limited value if there is no specialist team to select appropriate patients. Tele-rehabilitation is of limited use if a patient lacks internet access, digital literacy, or follow-up support. Even established interventions can remain inaccessible if local services are under-resourced or poorly integrated. As a result, inequality in PRM is not simply a matter of who receives cutting-edge innovation. It is a matter of who is offered the chance to convert survival into meaningful recovery.

New technologies have undoubtedly changed PRM. VR is making therapy more immersive and, in some settings, more neurologically responsive. [8] FES is restoring visible movement to limbs once thought functionally silent and may improve conditioning and muscle health in spinal cord injury. [3 5] Robotics are increasing the volume and precision of task-specific practice and can improve the likelihood of regaining independent walking after stroke. [6 7] BCIs are beginning to create new pathways between intention and action, though they remain largely experimental. [11] Tele-rehabilitation is extending specialist care into the home and can offer outcomes comparable to in-person care in selected circumstances. [2] Together, these developments are shifting rehabilitation medicine away from a narrow model of maintenance and towards one of active retraining, adaptation, and participation.

And yet the final hurdle of PRM is not technological but moral, a question of equitable access. A rehabilitation system should not be judged only by the sophistication of its devices, but by how fairly it distributes them and how fully it supports the people who need them. The future of PRM will depend not merely on invention, but on allocation: on whether societies are willing to invest in recovery as seriously as they invest in rescue. To save a life and then ration the means of rebuilding it is not a neutral act; it is a statement about whose recovery is valued. In that sense, rehabilitation medicine forces a broader reckoning with modern healthcare itself. The measure of progress is not simply whether patients survive catastrophe, but whether they are given a genuine opportunity to live well after it.

References

1. World Health Organization. (2001). *International Classification of Functioning, Disability and Health (ICF)*. Geneva: WHO
2. Laver KE, Lange B, George S, Deutsch JE, Saposnik G, Chapman M, et al. Virtual reality for stroke rehabilitation. Cochrane Database Syst Rev. 2025 Jun 20;2025(6):CD008349. doi:10.1002/14651858.CD008349.pub5 PubMed PMID: 40537150; PubMed Central PMCID: PMC12178777.
3. Shiao R, Lee-Kubli CA. Neuropathic Pain After Spinal Cord Injury: Challenges and Research Perspectives. Neurotherapeutics. 2018 Jul;15(3):635–53. doi:10.1007/s13311-018-0633-4 PubMed PMID: 29736857; PubMed Central PMCID: PMC6095789.
4. Austin PD, Siddall PJ. Virtual reality for the treatment of neuropathic pain in people with spinal cord injuries: A scoping review. J Spinal Cord Med. 2021 Jan;44(1):8–18. doi:10.1080/10790268.2019.1575554 PubMed PMID: 30707649; PubMed Central PMCID: PMC7919871.
5. Eraifej J, Clark W, France B, Desando S, Moore D. Effectiveness of upper limb functional electrical stimulation after stroke for the improvement of activities of daily living and motor function: a systematic review and meta-analysis. Syst Rev. 2017 Feb 28;6(1):40. doi:10.1186/s13643-017-0435-5
6. Sanna N, Nossa R, Biffi E, Guanziroli E, Diella E, Ferrante S, et al. Evaluating the health and fitness benefits of a 6-month FES-cycling program on a recumbent trike for individuals with motor complete SCI: a pilot study. J NeuroEngineering Rehabil. 2025 Mar 10;22(1):55. doi:10.1186/s12984-025-01585-0
7. Mehrholz J, Kugler J, Pohl M, Elsner B. Electromechanical-assisted training for walking after stroke. Cochrane Central Editorial Service, editor. Cochrane Database of Systematic Reviews. 2025 May 14;2025(5). doi:10.1002/14651858.CD006185.pub6
8. Cervera MA, Soekadar SR, Ushiba J, Millán JDR, Liu M, Birbaumer N, et al. Brain-computer interfaces for post-stroke motor rehabilitation: a meta-analysis. Ann Clin Transl Neurol. 2018 May;5(5):651–63. doi:10.1002/acn3.544 PubMed PMID: 29761128; PubMed Central PMCID: PMC5945970.
9. Wade DT. Goal setting in rehabilitation: an overview of what, why and how. Clin Rehabil. 2009 Apr;23(4):291–5. doi:10.1177/0269215509103551 PubMed PMID: 19293289.
10. Laver KE, Adey-Wakeling Z, Crotty M, Lannin NA, George S, Sherrington C. Telerehabilitation services for stroke. Cochrane Stroke Group, editor. Cochrane Database of Systematic Reviews. 2020 Jan 31;2020(1). doi:10.1002/14651858.CD010255.pub3
11. Hui A, Latif A, Hinsliff-Smith K, Chen T. Exploring the impacts of organisational structure, policy and practice on the health inequalities of marginalised communities: Illustrative cases from the UK healthcare system. Health Policy. 2020 Mar 1;124(3):298–302. doi:10.1016/j.healthpol.2020.01.003
12. Wenzel ARJ, Cowan C, Parchini P, Azhdar M, Perreault K, Breedt E, et al. (In)Equitable Access to Rehabilitation Services: A Scoping Review with Implications for Rehabilitation Researchers and Administrators. Archives of Physical Medicine and Rehabilitation. 2026 Jun 4. doi:10.1016/j.apmr.2026.05.022

Can Physical and Rehabilitation Medicine Solve the World's Leading Cause of Disability?

Author: Yashvardhan Shetty

Medical School: University of Edinburgh

"What's your biggest fea-"

"Chronic back pain."

"What?"

"Chronic back pain," I repeated with the embittered conviction of someone who had just recovered from a dreadful month of intermittent lower back pain. Judging from my date's laugh, she'd credited my answer to my incredible wit. I returned the laugh with a dead-eyed smile. For that laugh escaped the lips of someone evidently devoid of any empathy for or experience with lower back pain. Somebody wasn't getting a call back from me.

It is easy, as a 22-year-old, to dismiss chronic pain as folklore, whose fables are only grumbled about by our parents. There's no way that simply bending over, walking, running, or even just sitting could ever be painful? Especially for me: a clean-eating, calorie-tracking, weight-lifting, occasionally-stretching, serial watcher of Instagram fitness influencers. My one-month free trial of back pain, however, had me thinking that perhaps this chronic pain hullabaloo is not a matter of "if", but of "when". And the mere thought of having to live every day of my life with that insufferable twang was enough to spur me into a desperate investigation to understand it. This essay compiles my findings into three questions:

1. What exactly causes chronic back pain?
2. Why is it so hard to solve?
3. How can we solve chronic back pain?

The folklore I had so arrogantly dismissed is, in fact, the single largest source of human disability on the planet. Last week, I entered the kitchen to my mother bending down to pick up a spoon off the floor. There is a small sound to listen for, a short inward breath of the kind you take when cold water hits. One hand finds the small of her back, the other braces against the counter, and for a moment she simply waits, folded over a most ordinary task, negotiating with her own back for permission to stand. Multiply that moment by 619 million. That is how many people lived with low back pain in 2020, the largest contributor to global years lived with disability of any condition. That figure is projected to reach 843 million by 2050 (GBD 2021 Low Back Pain Collaborators, 2023). As many as eight in ten of us will feel it at some point (Balagué et al., 2012).

So, what causes it? The intuitive answer seems too obvious to be worth asking. We carry the assumption that pain always marks damage, and you feel it where you are broken. Sprain an ankle and the heat, swelling, and ache all point helpfully at the torn tissue beneath. If we apply the same logic to the back, then the conclusion writes itself. The pain is there because something there has worn, slipped, bulged or degenerated. This story makes sense for most people, but for most people it is wrong.

In around 85 to 95 percent of people who see a doctor for back pain, no specific structural cause can be found at all (Hartvigsen et al., 2018). Even when you scan the spines of people in no pain whatsoever, the supposed culprits are everywhere to be found. Disc degeneration appears in 37 per cent of symptomless twenty-year-olds and 96 per cent of symptomless eighty-year-olds. Disc bulges, the very finding used to usher patients towards surgery, sit silently in 30 per cent of pain-free twenty-year-olds and 84 per cent of pain-free eighty-

year-olds (Brinjikji et al., 2015). Reading this, it seems like the abnormal spine is, statistically, the normal one. We have spent decades and fortunes treating the photographs rather than the patient. In the United States alone, back and neck pain consumed roughly $87.6 billion in a single year, the third largest bill of any health condition (Dieleman et al., 2016).

If pain does not reliably mark damage, what is it? The answer the evidence keeps pointing towards is that pain is not a measurement taken from the tissues but a protective output generated by the nervous system. It is the brain's verdict on how much danger the body is in, assembled from far more than the state of a disc. Load, sleep, mood, stress, fear and the meaning we attach to a twinge all feed into that verdict (Vlaeyen and Linton, 2000). Back pain is therefore rarely one thing in one place. It is a whole, sensitised, often frightened person living a whole life, and roughly two-fifths of its global burden is driven by ordinary modifiable factors such as how we move, work and sit (GBD 2021 Low Back Pain Collaborators, 2023).

You cannot cut out a fear or operate on a deconditioned life. If the problem is a person rather than a part, the response must be aimed at the person: at what they can no longer do, at the fear and the disuse the pain has bred, at function rather than structure. That points quietly towards the one corner of medicine built around exactly that question: physical and rehabilitation medicine. Which now leaves a distinctly uncomfortable one of our own. If we have known for years that the back is usually not the problem, why have we proved so spectacularly unable to solve it?

The first obstacle is that chronic back pain denies us a working feedback loop. Most fields that make progress rely on a fundamental feedback loop. You try something, you see clearly what it did, and you adjust. Back pain breaks that cycle twice over. It breaks it at the start, because for most people there is no identifiable cause to aim treatment at. And it breaks the cycle at the end, because even after treating, you cannot cleanly read the result. There is no blood test for suffering and no scan that shows how much something hurts, and most back pain rises and falls on its own regardless of what is done to it (Hartvigsen et al., 2018). The consequence is that almost any treatment can appear to work. Rest the patient and the pain recedes, so rest looks effective. Inject the patient and the pain recedes, so the injection looks effective. Maybe the pain was receding anyway. Unable to aim with confidence or to measure the result honestly, the field cannot tell its successes from its accidents, and a discipline that cannot reliably tell what is working cannot reliably get better.

The second obstacle is that "chronic back pain" is not one condition but many wearing a single name. A small minority have a genuine and findable cause, a fracture, an infection, a tumour, a trapped nerve, and for them the structural tools are exactly right (Hartvigsen et al., 2018). The vast remainder do not, and among them the drivers differ from person to person, mixing load, deconditioning, sleep, mood, stress and fear in proportions unique to each life (Vlaeyen and Linton, 2000). A single treatment cannot fit a problem that is really a crowd of different problems, and a trial that averages across the crowd can easily conclude that nothing works very well, because the thing that helps one person is cancelled by the thing that helps another.

The third obstacle is the most troubling, because here the standard treatment does not merely fail, it can actively deepen the problem. The structural story is not told in silence. It is told to a frightened patient, and the telling has consequences. Inform someone that their spine is degenerating or crumbling, and you give them a powerful reason to protect it, to move less, to brace and to avoid. Yet reduced movement and fear of movement are themselves among the best-established drivers of pain becoming chronic (Vlaeyen and Linton, 2000). The explanation meant to account for the pain becomes a cause of its persistence. The same pattern shows in how the condition is medicated. Around four in ten people with back pain are prescribed opioids, yet in a placebo-controlled trial a short course of opioids relieved acute back pain no better than a dummy pill, while carrying a measurable risk of misuse (Jones et al., 2023). A treatment that does not outperform a sugar pill, but does carry its own dangers, is not a neutral act. Each of these is an intervention that a patient experiences as care and that can leave them worse placed than before, which makes the wrong approach unusually hard to abandon, because it arrives wearing the costume of help. I have watched this play out in my own family. My mother had, by the time her back seized up in that kitchen, done everything she was ever told to

do. She had lost the weight, taken up exercise, cleaned up her diet and remade her body in the image of every health leaflet she had read. The pain stayed. She had changed the supposed cause, and the effect had not followed, which is about as close to a clean experiment as ordinary life allows, and it quietly refutes the cruellest explanation of all, that she had simply not tried hard enough. But a hard problem is not an impossible one.

It is, rather, a set of bottlenecks, and bottlenecks can be taken apart one at a time. Engineering offers the discipline: first clear away whatever is making things worse, then build, piece by piece, what is missing.

The clearing-away is already underway in the UK, where national guidance advises against routine imaging for non-specific low back pain and against prescribing opioids for it (NICE, 2016). The first thing to build is the feedback loop we never had. By combining brain imaging with machine learning, researchers have begun to read objective signatures of pain from neural activity itself. This work is young, shown so far on pain provoked in the laboratory rather than the chronic pain of the clinic (Wager et al., 2013), but it is the first faint outline of a measurement where none has ever existed. A measurement, once it matures, is the thing against which a mistaken treatment can finally be tested.

The other half is the loop itself. Rather than wait years for a single trial to rule on a single question, the real-world outcome of every treated patient can be fed into a system that learns continuously, so that the field corrects itself in something closer to real time and at the scale of whole populations.

With a real signal in hand, the second obstacle yields. If chronic back pain is a crowd of different conditions wearing one name, no single treatment will ever serve it, and the answer is to stop treating the crowd as one. The same machine learning that reads the data can sort patients into meaningful subgroups and match each to the approach most likely to help it, instead of giving everyone the same averaged therapy. This is not entirely new. Simple stratification tools already do a crude version, sorting patients by their risk of a poor outcome and adjusting care to match (Hill et al., 2011). What richer data and sharper algorithms promise is to turn that crude sorting into genuine precision, dissolving the very heterogeneity that has quietly defeated every one-size-fits-all trial.

That leaves the third obstacle, and the most human. Once the right treatment for a given person is known, it must reach them, and the treatment that works is stubbornly hard to deliver. Its leading form is cognitive functional therapy, in which a professional helps the patient understand that their pain does not signal a damaged back, identifies the specific movements they have learned to dread, and then coaches them gently back through those movements until the nervous system relearns that they are safe. In the largest trial to date, of 492 patients, it produced large and lasting gains in pain and function at lower cost than usual care (Kent et al., 2023). The catch is that it is skilled, personal and slow.

Here technology earns its place, not as ornament but as the lever that scales a treatment which is otherwise skilled, personal and slow. Consider the delivery of the therapy itself. Virtual reality can carry this kind of psychologically-informed care into a patient's own home, immersing them in pain education, relaxation and the skills to calm a frightened nervous system. This is no longer speculation. An in-home virtual-reality programme for chronic low back pain has been authorised by the United States Food and Drug Administration, having produced clinically meaningful reductions in pain across randomised trials of more than a thousand patients, even if its margin over a convincing placebo was modest (Garcia et al., 2021; Maddox et al., 2023). Consider the load itself. For the workers whose pain is driven by heavy lifting, robotic exosuits worn on the back already cut activity in the spinal muscles by a tenth to two-fifths during repetitive lifting, easing the very forces that feed their pain (Kermavnar et al., 2021). And consider the parts of care that are language rather than hands. The education and the daily coaching can be carried by conversational artificial intelligence, tirelessly, in any tongue, at almost no marginal cost, stretching one scarce specialist across thousands of patients. A purpose-built therapy chatbot has already outperformed a waiting list in a randomised trial for depression and anxiety, the close companions of chronic pain, though the same researchers were careful to note that generic

chatbots are not yet fit for clinical care (Heinz et al., 2025). None of this replaces the clinician. It multiplies them. These tools are the weakest they will ever be and will be met by a public growing more fluent in them by the month. The honest boundary must be drawn in bright ink: each of these advances scales or sharpens a treatment, and none has yet been shown, by itself, to cure. But to take a therapy that already works and carry it to the millions who cannot currently reach it is still solving a great part of the problem.

When we can build the feedback loop we never had, the field can finally separate what works from what merely seems to. When we use it to tell the many conditions apart, treatment can at last be aimed. When we scale the human cure with machines, we distribute access to those who were previously deprived of it. Each of these, quietly, is the same idea: that you mend a back by tending to the whole person who carries it. I began my research fearful of a near-inevitable life of pain and ended it a little less afraid. In the kitchen, my mother still straightens slowly from a dropped spoon. She was never failing a test of will, and she is not beyond help. She is waiting for a medicine willing to treat the whole of her rather than the photograph of her spine, armed now with tools worthy of the task. That medicine has a name, and an unglamorous reputation it is about to outgrow: physical and rehabilitation medicine.

References

1. Balagué, F., Mannion, A.F., Pellisé, F. and Cedraschi, C. (2012) 'Non-specific low back pain', *The Lancet*, 379(9814), pp. 482–491.
2. Brinjikji, W., Luetmer, P.H., Comstock, B., Bresnahan, B.W., Chen, L.E., Deyo, R.A., Halabi, S., Turner, J.A., Avins, A.L., James, K., Wald, J.T., Kallmes, D.F. and Jarvik, J.G. (2015) 'Systematic literature review of imaging features of spinal degeneration in asymptomatic populations', *American Journal of Neuroradiology*, 36(4), pp. 811–816.
3. Dieleman, J.L., Baral, R., Birger, M. et al. (2016) 'US spending on personal health care and public health, 1996–2013', *JAMA*, 316(24), pp. 2627–2646.
4. Garcia, L.M., Birckhead, B.J., Krishnamurthy, P., Sackman, J., Mackey, I.G., Louis, R.G., Salmasi, V., Maddox, T. and Darnall, B.D. (2021) 'An 8-week self-administered at-home behavioral skills-based virtual reality program for chronic low back pain: double-blind, randomized, placebo-controlled trial conducted during COVID-19', *Journal of Medical Internet Research*, 23(2), e26292.
5. GBD 2021 Low Back Pain Collaborators (2023) 'Global, regional, and national burden of low back pain, 1990–2020, its attributable risk factors, and projections to 2050: a systematic analysis of the Global Burden of Disease Study 2021', *The Lancet Rheumatology*, 5(6), pp. e316–e329.
6. Hartvigsen, J., Hancock, M.J., Kongsted, A., Louw, Q., Ferreira, M.L., Genevay, S., Hoy, D., Karppinen, J., Pransky, G., Sieper, J., Smeets, R.J. and Underwood, M. (2018) 'What low back pain is and why we need to pay attention', *The Lancet*, 391(10137), pp. 2356–2367.
7. Heinz, M.V., Mackin, D.M., Trudeau, B.M. et al. (2025) 'Randomized trial of a generative AI chatbot for mental health treatment', *NEJM AI*, 2(4)
8. Hill, J.C., Whitehurst, D.G.T., Lewis, M., Bryan, S., Dunn, K.M., Foster, N.E., Konstantinou, K., Main, C.J., Mason, E., Somerville, S., Sowden, G., Vohora, K. and Hay, E.M. (2011) 'Comparison of stratified primary care management for low back pain with current best practice (STarT Back): a randomised controlled trial', *The Lancet*, 378(9802), pp. 1560–1571.
9. Jones, C.M.P., Day, R.O., Koes, B.W., Latimer, J., Maher, C.G., McLachlan, A.J., Billot, L., Shan, S. and Lin, C.-W.C. (2023) 'Opioid analgesia for acute low back pain and neck pain (the OPAL trial): a randomised placebo-controlled trial', *The Lancet*, 402(10398), pp. 304–312.
10. Kent, P., Haines, T., O'Sullivan, P., Smith, A., Campbell, A., Schutze, R., Attwell, S., Caneiro, J.P., Laird, R., O'Sullivan, K., McGregor, A., Hartvigsen, J., Lee, D.-C.A., Vickery, A. and Hancock, M. (2023) 'Cognitive functional therapy with or without movement sensor biofeedback versus usual care for chronic, disabling low back pain (RESTORE): a randomised, controlled, three-arm, parallel group, phase 3, clinical trial', *The Lancet*, 401(10391), pp. 1866–1877.
11. Kermavnar, T., de Vries, A.W., de Looze, M.P. and O'Sullivan, L.W. (2021) 'Effects of industrial back-support exoskeletons on body loading and user experience: an updated systematic review', *Ergonomics*, 64(6), pp. 685–711.
12. Maddox, T., Garcia, H., Ffrench, K., Maddox, R., Garcia, L., Krishnamurthy, P., Okhotin, D., Sparks, C., Oldstone, L., Birckhead, B., Sackman, J., Mackey, I., Louis, R., Salmasi, V., Oyao, A. and Darnall, B.D. (2023) 'In-home virtual reality program for chronic lower back pain: a randomized sham-controlled effectiveness trial in a clinically severe and diverse sample', *Mayo Clinic Proceedings: Digital Medicine*, 1(4), pp. 563–573.
13. National Institute for Health and Care Excellence (2016) *Low back pain and sciatica in over 16s: assessment and management. NICE guideline NG59.* London: NICE.
14. Vlaeyen, J.W.S. and Linton, S.J. (2000) 'Fear-avoidance and its consequences in chronic musculoskeletal pain: a state of the art', *Pain*, 85(3), pp. 317–332.
15. Wager, T.D., Atlas, L.Y., Lindquist, M.A., Roy, M., Woo, C.-W. and Kross, E. (2013) 'An fMRI-based neurologic signature of physical pain', *New England Journal of Medicine*, 368(15), pp. 1388–1397.

Beyond Survival: The Missing Pieces of Physical and Rehabilitation Medicine in Medical Education

Author: Zheqing Zhang

Medical School: University of Oxford

Medical students are trained to recognise catastrophe. We learn the choreography of trauma: airway, breathing, circulation, disability, exposure. We practise cervical-spine immobilisation on plastic mannequins and search for reversible conditions: hypoxia, hypovolaemia, acidosis, hypoglycaemia, tension pneumothorax, and so on. In those moments, medicine feels heroic because the stakes are visible and urgent.

Yet some of medicine's most important questions begin only after the monitor has stopped alarming. What does it mean to survive with a brain injury that steals speech but not understanding? What happens after spinal trauma, when pain gives way to uncertainty? Is a life worth living if it is "ruled" by disability? My brief encounters with Physical and Rehabilitation Medicine (PRM) during medical school have made me suspect that the last question is not one to invite a simple "yes" or "no". It says more about the assumptions of the able-bodied observer than about the lives of disabled people themselves.

Rehabilitation is often misimagined as an epilogue: a set of exercises after the "real" medicine has finished. The World Health Organization (WHO) defines rehabilitation as interventions that optimise functioning and reduce disability in interaction with a person's environment [1]. The International Classification of Functioning, Disability and Health similarly reframes disability not simply as impairment within a body, but as a dynamic relationship between health condition, activity, participation and context [2]. Globally, at least one in three people live with a condition that could benefit from rehabilitation [3]. PRM is therefore not a niche afterthought. It is the medicine of consequences: biological, psychological and social.

I first understood this not through a lecture, but through three glimpses: a woman rushed to the emergency department after a rail incident, a day following a patient with traumatic brain injury through neurorehabilitation, and the sight of parasports near the National Spinal Injuries Centre. Together, these encounters shifted my understanding of recovery from "will this person survive?" to "what would allow this person to live meaningfully?"

The Spine in Resus

She arrived by air ambulance after a rail incident: a Priority 1 trauma patient with facial lacerations and suspected multiple spinal injuries. Around her neck were blocks and straps I recognised from simulation teaching. The textbook image had become painfully human, sending through me a rush of adrenaline no mannequin could reproduce. It was the end of a long emergency medicine shift, but no part of me wanted to leave. Her screams alternated with the beeping of monitors. She cried that her back and legs hurt. The team moved with practised calm, completing the primary survey, arranging urgent bedside imaging and a CT trauma series. The scans revealed multiple cervical and thoracic spine fractures, as well as bilateral femoral shaft fractures.

I remember the strange inadequacy of my knowledge. I knew why the blocks were there. I was familiar with C-ABCDE, prompt imaging, and the danger of secondary cord injury. But watching her grimace, the question that rose in me was not anatomical but existential: will she walk again?

NICE guidance on rehabilitation after traumatic injury emphasises that assessment for rehabilitation needs should begin early and include physical, cognitive, communication, emotional and social domains [4]. BSRM

standards similarly describe specialist rehabilitation as a critical component of the trauma pathway and advise early rehabilitation medicine involvement for patients with complex needs [5]. However, availability and timeliness of such services are not guaranteed. The National Clinical Audit for Specialist Rehabilitation following Major Injury found that only 57% of patients with complex needs were assessed within the standard of 10 days from referral, and average time from assessment to admission was 20 days [6]. In trauma care, every minute matters; in rehabilitation, every missed day or week may matter too.

That encounter forced me to confront a gap in my education. I had been taught how to prevent neurological deterioration, but not how to discuss neurological uncertainty. I had learned dermatomes, but not how someone rebuilds identity after paralysis. I had memorised motor levels and reflexes, but not the practicalities of functional impairment: bladder and bowel care, sexuality, wheelchair skills, home adaptations, employment, pain, spasticity, fatigue or grief. Medical school had prepared me to ask, "Can this patient move their legs?" PRM asks, "What does this person need to live, participate and belong?"

The Brain in Rehab

This question returned to me at the Oxford Centre for Enablement (OCE), a multidisciplinary neurorehabilitation facility, where I followed a patient recovering from traumatic brain injury. He wore a protective helmet after cranial surgery and used a wheelchair. His comprehension seemed far better preserved than his speech. What struck me most was his visible frustration: he appeared to know what he wanted to say, but only a few disjointed words emerged. I had met aphasia and dysarthria as clinical signs in examination stations. In real life, communication difficulty was not a sign; it was a form of imprisonment.

The speech and language therapy session was not merely about articulation. It championed agency. The therapist waited longer than felt natural, resisting the urge to rescue his sentences. She used gesture, writing, pictures and yes-no scaffolding. He practised reading from and discussing stories about his hometown, a personal touch that made therapy feel less intimidating. I realised how often clinical conversations reward speed. Ward rounds move briskly; silence feels inefficient. In eight-minute OSCE stations, strategic pauses for "communication skills" are inserted only when useful. But for this patient, silence was not empty. It was the space in which autonomy could form.

Traumatic brain injury is increasingly understood not as a single acute event but as a condition with long-term and sometimes evolving consequences [7,8]. Cognitive, behavioural, communicative and emotional impairments may shape participation long after the initial injury. Evidence supports coordinated multidisciplinary rehabilitation after acquired brain injury, particularly when therapy is goal-directed and adapted to the person's needs [9]. The lesson here was that neurological recovery is not simply the return of damaged function. It is the construction of alternative routes into personhood.

The Body in Recovery

Later that day, in physiotherapy, I watched the same patient attempt to stand from his wheelchair. It took two therapists, repeated verbal cues, a gait belt, pauses for fatigue, and immense concentration. From the outside, the achievement looked small: hips forward, weight through feet, knees supported, rise. But the effort in the room was enormous. I recalled previously seeing phrases like "mobilising slowly" in patients' notes, without realising that slowness may not indicate deficiency, but diligent attempts in the dawn of recovery.

The literature on goal setting in rehabilitation explains why such moments matter. Wade argues that goals provide structure, motivation and a shared language for patients and teams [10]. At the OCE, goals were repeatedly mentioned and re-evaluated in physiotherapy and occupational therapy sessions, always as a collaboration between patient and therapist. Standing from a wheelchair may be a step towards transferring to a toilet, returning home, reducing care needs, or simply inhabiting one's body differently. In acute medicine,

success can feel binary: alive or dead, stable or unstable, bleeding or controlled. In rehabilitation, success is incremental, personal and deeply contextual.

Occupational therapy made this even clearer. The patient moved from clinical exercises into a woodworking workshop. The atmosphere changed: less hospital-like, more normality and possibility. There was the smell of timber, the concentration of measuring and sanding, the quiet dignity of making something. A "simple" birdhouse took hours longer than it might for a person without disabilities, yet the feeling of accomplishment seemed far greater. For someone whose body is recovering, the execution of every tiny task can be a triumph. Initially, I wondered whether this was "therapy" in the medical sense. Then I recognised the task's complexity: posture, fine motor control, attention, sequencing, tool selection, communication and patience. The workshop was rehabilitation disguised as life.

This is perhaps PRM's most radical insight: function is meaningful only when attached to living. A muscle grade of 4/5 is less important than whether someone can cook, parent, work, study, pursue hobbies, or hold conversations without difficulty. The UK Rehabilitation Medicine training curriculum describes the specialty as addressing the wider consequences of illness through holistic, patient-centred care [11]. Unfortunately, these wider consequences are often left at the margins in undergraduate medical training. We learn diseases by organ system; patients live them across homes, workplaces and relationships.

Life Beyond Disability

My third glimpse came at the National Spinal Injuries Centre at Stoke Mandeville Hospital. I saw the rehabilitation gym: parallel bars, mats, wheelchairs, hoists, weights, therapists, and patients with varying degrees of paraplegia and tetraplegia. From my accommodation window, I also witnessed a parasport event featuring wheelchair racing and para-cycling. I remember the exhilarating accelerations, sharp turns, competitors striving and spectators cheering with the same fervour that characterises any other tournament. It unsettled the quiet pity that can attach itself to disability in medical settings. These were not bodies waiting to be restored to a previous norm before life could resume. Life was already happening.

Spinal cord injury can cause profound physical, autonomic, sensory and psychosocial consequences, but WHO's international report stresses that it need not preclude good health or social inclusion when rehabilitation, assistive technology and accessible environments are available [12]. Physiotherapy after spinal cord injury has increasingly focused not only on impairment but also on participation and quality of life [13]. Adaptive sport is one expression of that shift: not a sentimental symbol of "overcoming" disability, but a practical route to fitness, mastery, community and identity.

This matters because clinicians may underestimate the quality of life of disabled people. Albrecht and Devlieger described the "disability paradox": many people with serious and persistent disabilities report good or excellent quality of life, contrary to external assumptions [14]. The paradox dissolves when we recognise that quality of life is not reducible to physical capacity. It is shaped by relationships, autonomy, environment, meaning, access and social attitudes. Disability may impose real losses, pain and barriers, and romanticising it would be dishonest. But assuming disability diminishes a life worth living is also a failure of imagination.

At the same time, acknowledging the possibility of flourishing must not minimise psychological suffering. Life after major trauma or neurological injury may involve grief over physical changes, fear of dependence, and uncertainty about the future. Depression and anxiety are common after spinal cord injury, and psychological morbidity can persist long after inpatient rehabilitation [15,16]. Following traumatic brain injury, mood disorders, personality change, fatigue and reduced insight may complicate recovery, relationships and return to work [17]. Life beyond rehabilitation therefore requires not only mobility aids and therapy goals, but also skilled psychological and psychiatric support. In line with PRM's multidisciplinary ethos, clinical psychology, neuropsychology, psychiatry, peer support and family work can all be crucial to rebuilding agency.

The social model of disability sharpens this point by distinguishing impairment from the disabling effects of inaccessible environments and exclusionary systems [18]. PRM sits productively between models. It does not deny biology: traumatic axonal injury, spinal cord lesions, paralysis, spasticity and neuropathic pain are real. But neither does it stop at biology. It asks how medicine, technology, family, housing, education, employment and social policy can convert survival into participation.

What Medical School Leaves Unseen

Looking back, I am struck by how little formal exposure to PRM I received compared with the frequency of rehabilitation needs in every specialty. On surgical placements, I saw amputations and limb-saving operations, but less often the prosthetic, psychological and occupational journey afterwards. In emergency medicine, I saw injuries arrive, but rarely the months of rehabilitation that followed. In neurology and stroke medicine, I learned localisation, but not always the long work of adaptation.

Without a standardised PRM curriculum, medical students' exposure is highly variable. Rehabilitation medicine in the UK also faces workforce constraints; the specialty has been described as substantially smaller than equivalent PRM workforces in many European countries (0.27 compared with the average of 3 per 100,000) [19]. In Germany, the Hannover model formally incorporated PRM into the medical school curriculum [20]. Elsewhere, limited undergraduate exposure may both reflect and reinforce invisibility in the system. If students rarely see PRM, they may underestimate its complexity and importance. Worse, they may inherit a model in which rehabilitation is an afterthought rather than a priority.

Not every medical student will become a rehabilitation physician. But every doctor needs PRM literacy. We should learn to ask about baseline function, personal goals, carers, housing, communication needs, continence, sexuality, work, transport and fatigue as naturally as we ask about smoking or drug allergies. We should understand the roles of physiotherapists, occupational therapists, speech and language therapists, psychologists, nurses, social workers, prosthetists, orthotists and rehabilitation consultants. We should spend time not only in resus, theatres and clinics, but also in rehabilitation units, therapy sessions and community visits.

More importantly, we should adopt a balanced mindset. Acute medicine often requires doing things quickly. Rehabilitation necessitates doing things with individuals over time. It demands humility from doctors because progress may depend less on a prescription than on a therapist's patience, a family's adjustment, or a patient's redefinition of what matters. It is scientific and technical, but also narrative and deeply human.

What Makes Life Worth Living?

The woman in the emergency department may or may not have walked again. I do not know. That uncertainty still troubles me. But I now think my first question — "Will she ever walk?" — was incomplete. Walking may be one hope, but not the only one. A fuller set of questions would be: Will she have expert rehabilitation early enough? Will her pain be controlled? Will she be listened to? Will she have access to equipment, housing adaptations and psychological support? Will the system help her return to roles that give life meaning?

PRM changes the meaning of recovery. Recovery is not always cure or return. Sometimes it is compensation, adaptation, participation, acceptance, or reinvention. It can be saying one word after a brain injury, standing for five seconds with assistance, sanding wood in a workshop, or enjoying the thrill of speeding on a wheelchair.

The question "Is a life worth living if ruled by disability?" now feels like an uncomfortable inheritance from a curriculum that overvalues normality. A better question is: "What would allow this person to live a life they

value?” Rehabilitation medicine exists in that question. It reminds the rest of medicine that saving life is not the endpoint of care; the work after survival is where dignity, identity and agency are rebuilt.

As a medical student, I encountered PRM only in glimpses centred around brain and spine injuries: a critically injured casualty, a day at a neurorehabilitation centre, and vivid memories of a gym and parasports at a spinal injuries centre. But those glimpses altered the way I understand medicine and life. They taught me that the body we stabilise acutely is attached to a future. PRM is the specialty that insists we take responsibility for that future. It is time medical education did the same.

References

1. World Health Organization. *Rehabilitation in health systems*. Geneva: WHO; 2017.
2. World Health Organization. *International Classification of Functioning, Disability and Health*. Geneva: WHO; 2001.
3. Cieza A, Causey K, Kamenov K, Hanson SW, Chatterji S, Vos T. Global estimates of the need for rehabilitation based on the Global Burden of Disease study 2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet*. 2020;396(10267):2006–2017. doi:10.1016/S0140-6736(20)32340-0.
4. National Institute for Health and Care Excellence. *Rehabilitation after traumatic injury*. NICE guideline NG211. London: NICE; 2022.
5. British Society of Rehabilitation Medicine. *Specialist Rehabilitation in the Trauma pathway: BSRM core standards*. London: BSRM; 2018.
6. Turner-Stokes L, et al. *Specialist Rehabilitation following Major Injury: National Clinical Audit of Specialist Rehabilitation for Patients with Complex Needs following Major Injury (NCASRI), Final Report*. London: UK Rehabilitation Outcomes Collaborative; 2019.
7. Maas AIR, Menon DK, Adelson PD, et al. Traumatic brain injury: integrated approaches to improve prevention, clinical care, and research. *Lancet Neurol*. 2017;16(12):987–1048. doi:10.1016/S1474-4422(17)30371-X.
8. Maas AIR, Menon DK, Manley GT, et al. Traumatic brain injury: progress and challenges in prevention, clinical care, and research. *Lancet Neurol*. 2022;21(11):1004–1060. doi:10.1016/S1474-4422(22)00309-X.
9. Turner-Stokes L, Pick A, Nair A, Disler PB, Wade DT. Multi-disciplinary rehabilitation for acquired brain injury in adults of working age. *Cochrane Database Syst Rev*. 2015;(12). doi:10.1002/14651858.CD004170.pub3.
10. Wade DT. Goal setting in rehabilitation: an overview of what, why and how. *Clin Rehabil*. 2009;23(4):291–305. doi:10.1177/0269215509103551.
11. Joint Royal Colleges of Physicians Training Board. *Rehabilitation Medicine Training Curriculum*. London: JRCPTB; 2021.
12. World Health Organization and International Spinal Cord Society. *International Perspectives on Spinal Cord Injury*. Geneva: WHO; 2013.
13. Gómara-Toldrà N, Sliwinski M, Dijkers MP. Physical therapy after spinal cord injury: a systematic review of treatments focused on participation. *J Spinal Cord Med*. 2014;37(4):371–379. doi:10.1179/2045772314Y.0000000194.
14. Albrecht GL, Devlieger PJ. The disability paradox: high quality of life against all odds. *Soc Sci Med*. 1999;48(8):977–988. doi:10.1016/S0277-9536(98)00411-0.
15. Craig A, Tran Y, Middleton J. Psychological morbidity and spinal cord injury: a systematic review. *Spinal Cord*. 2009;47(2):108–114. doi:10.1038/sc.2008.115.
16. Post MWM, van Leeuwen CMC. Psychosocial issues in spinal cord injury: a review. *Spinal Cord*. 2012;50(5):382–389. doi:10.1038/sc.2011.182.
17. Jorge RE, Arciniegas DB. Mood disorders after TBI. *Psychiatr Clin North Am*. 2014;37(1):13–29. doi:10.1016/j.psc.2013.11.005.
18. Shakespeare T, Watson N. The social model of disability: an outdated ideology? *Res Soc Sci Disabil*. 2002;2:9–28. doi:10.1016/S1479-3547(01)80018-X.
19. Sivan M, Cirasanambati M, Okirie E, Jeddi F, Smith M, Basu B, et al. A proposal for expansion of the medical specialty of rehabilitation medicine. *Rehabil Process Outcome*. 2022;11:11795727221137213. doi:10.1177/11795727221137213.
20. Gutenbrunner C, Schiller J, Schwarze M, Fischer V, Paulmann V, Haller H, Küther G. Hannover model for the implementation of physical and rehabilitation medicine teaching in undergraduate medical training. *J Rehabil Med*. 2010;42(3):206–213. doi:10.2340/16501977-0513.