Saudi Journal of Medicine and Public Health

https://saudijmph.com/index.php/pub

https://doi.org/10.64483/202522832

Integrated Surveillance-to-Rehabilitation Pathways for Musculoskeletal and Chronic Conditions: Roles of Epidemiological Surveillance, Radiology, General Nursing, Medical Secretaries, Health Services Administration, and Physical Therapy.

Muneer Munawir N Alamri[(1)] , Fawaz Ahmed Musa Alsharif[(2)] , Ghazi Shujan Ayed Alnefaie[(3)] , Hind Hassan Alhazmi[(4)] , ANA Nasser Ahmed Al-Aldawi[(5)] , Abdulaziz Mohammed Saleh Almutairi[(6)] , Saad Naem Alshehri[(7)] , Abdulmohsin Nawaf Alotibi[(8)] , Ali Abdulrahman Dhafer Alshehri[(9)] , Fadiyah Ahmed Ibraheem[(10)]

(1)Jeddah Health Cluster 2 – Eradah Complex for Mental Health – Jeddah, Ministry of Health, Saudi Arabia
(2)Urwah Health Center, Medina, Ministry of Health, Saudi Arabia
(3)Durma General Hospital, Ministry of Health, Saudi Arabia
(4)Women and Child Health Clinic, Al-Qasr Mall, Ministry of Health (Health Cluster 1), Saudi Arabia
(5)King Fahd Central Hospital, Jazan, Ministry of Health, Saudi Arabia
(6)Al-Muzahimiyah General Hospital, Al-Muzahimiyah City, Ministry of Health, Saudi Arabia
(7)King Salman Hospital (Riyadh), Ministry of Health (Health Cluster 1), Saudi Arabia
(8)Al-Hamra Health Center, Riyadh, Ministry of health, Saudi Arabia
(9)Ministry of Health, Riyadh, Saudi Arabia
(10)King Fahd Central Hospital, Jazan, Ministry of Health, Saudi Arabia

Abstract

Musculoskeletal and other chronic conditions are leading contributors to disability worldwide, yet care is often fragmented across surveillance systems, diagnostic services, primary care, administration and rehabilitation. This narrative review synthesises literature published between 2017 and 2025 to examine how epidemiological surveillance, radiology, general nursing, medical secretaries, health services administration and physical therapy can be organised into one integrated pathway. The evidence suggests that surveillance defines need and inequity, appropriate imaging limits low-value care, nurses sustain assessment and self-management, secretarial staff shape access and continuity, administrators provide governance and information systems, and physical therapists deliver exercise-based rehabilitation and outcome measurement. We propose a three-layer model with a feedback loop, summarise roles and barriers in two tables, and identify research priorities. Integration depends less on new technology than on shared indicators, defined roles and routine data return.

Keywords: musculoskeletal conditions; epidemiological surveillance; integrated care pathways; rehabilitation; health services administration.

Introduction

Musculoskeletal (MSK) conditions are the largest single contributor to the global need for rehabilitation. Global Burden of Disease estimates for 2019 indicated that roughly 2.41 billion people lived with a condition that could benefit from rehabilitation, and MSK disorders accounted for the largest share (Cieza et al., 2020). Low back pain has ranked first among causes of years lived with disability in successive assessments (Vos et al., 2017; GBD 2019 Diseases and Injuries Collaborators, 2020) and is projected to affect more than 800 million people by 2050 (GBD 2021 Low Back Pain Collaborators, 2023). Osteoarthritis (OA) follows a similar trajectory, with an estimated 595 million prevalent cases in 2020 and a projected rise towards one billion by 2050 (Steinmetz et al., 2023; see also Safiri et al., 2020). These conditions overlap with chronic pain, which affects about one in five adults in United States national surveys (Dahlhamer et al., 2018; Zelaya et al., 2020) and imposes wide-ranging personal and economic costs (Cohen et al., 2021; Mills et al., 2019).

Despite this burden, health systems rarely manage MSK and chronic conditions as a continuous process. A policy analysis of OECD countries found that musculoskeletal health was seldom integrated into noncommunicable disease strategies (Briggs et al., 2019), and Briggs et al. (2018) called for MSK conditions to receive the same policy attention as other major chronic diseases. Rehabilitation has meanwhile been repositioned as an essential health service. The World Health Organization's Rehabilitation 2030 initiative and subsequent guidance argue that rehabilitation should be embedded across the care continuum and supported by workforce, financing and information systems (Gimigliano & Negrini, 2017; World Health Organization [WHO], 2019). Stucki and Bickenbach (2017) proposed functioning as a third

*Corresponding author e-mail: muneer2020@gmail.com (Muneer Munawir N Alamri).
Receive Date: 07 December 2025, Revise Date: 29 December 2025, Accept Date: 31 December 2025

health indicator alongside mortality and morbidity, and Stucki et al. (2018) described rehabilitation as a health strategy for the 21st century. Unmet need nevertheless remains large and unevenly distributed (Kamenov et al., 2019).

The practical difficulty is that each step of care sits in a different professional and administrative domain. Epidemiologists produce population indicators that clinicians seldom see. Radiologists report images without always learning whether the findings changed management. Nurses and medical secretaries hold the relational and scheduling knowledge that determines whether a person is seen at all. Administrators control the resources and information systems on which every other role depends. Physical therapists deliver the exercise-based care that guidelines recommend as first-line treatment (Lin et al., 2020; Qaseem et al., 2017), but often at the end of a long and uncoordinated route.

This review therefore asks how six components can be organised as an integrated surveillance-to-rehabilitation pathway: epidemiological surveillance, radiology, general nursing, medical secretaries, health services administration and physical therapy. It describes what each contributes, what evidence supports that contribution, where the evidence is thin, and how the components might be linked through shared data and defined hand-offs. Figure 1 gives an overview of the pathway that structures the remainder of the paper. Section 2 outlines the review approach, Sections 3 to 8 examine each component, Section 9 presents an integrated model, and Section 10 discusses barriers, implications and future research.

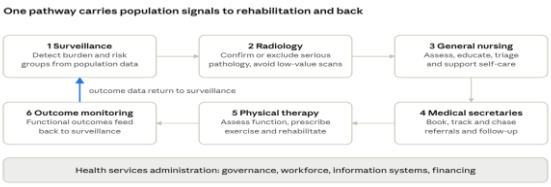


Figure 1 · conceptual pathway, author's synthesis

Figure 1. The pathway runs from surveillance through diagnosis, assessment and administrative coordination to rehabilitation. Outcome data return to surveillance, and health services administration enables every stage.

2. Review approach

This paper is a narrative review, a format suited to integrating evidence from epidemiology, diagnostics, nursing, administration and rehabilitation that cannot be pooled statistically. It was not conducted as a systematic review, and no formal protocol, exhaustive database search or risk-of-bias appraisal was applied. Sources were selected purposively to represent the best available evidence for each component, with priority given to systematic reviews and meta-analyses, clinical practice guidelines, Global Burden of Disease analyses, national surveillance reports, policy analyses and implementation studies published between 2017 and 2025.

Inclusion followed three pragmatic rules. First, sources had to address musculoskeletal conditions, chronic pain or closely related chronic conditions such as osteoporosis. Second, they had to bear on the role of at least one of the six components in detection, diagnosis, assessment, coordination, governance or rehabilitation. Third, they had to be published in English. Where recent evidence for a component was sparse, as it was for medical secretaries, the review draws on qualitative implementation studies and states plainly that the inferences are provisional.

Findings are organised by component rather than by study design. Each component section sets out its function, the supporting evidence, its contribution to data flow and the main limitations. The integrated model in Section 9 is this review's interpretive synthesis rather than an empirically validated framework, and the figures and tables are conceptual summaries of that synthesis. Readers should therefore treat the model as a basis for hypothesis generation and service design, not as proven practice. Because the review is not exhaustive, relevant studies may have been missed, and the weighting of evidence reflects judgments about relevance and quality that other reviewers might make differently.

3. Epidemiological surveillance: defining need, risk and access

Epidemiological surveillance is the continuous collection, analysis and interpretation of health data to guide planning and action. For MSK and chronic conditions its first contribution is to size the problem. Modelled estimates from the Global Burden of Disease programme have shown the scale of low back pain, osteoarthritis and other MSK disorders (Vos et al., 2020; GBD 2021 Low Back Pain Collaborators, 2023; Steinmetz et al., 2023) and have been translated into estimates of the need for rehabilitation by condition, age and region (Cieza et al., 2020). Such estimates allow ministries and health services to judge whether rehabilitation capacity matches need, an exercise that would be impossible from service-use data alone.

A second contribution is risk stratification. Population surveys describe prevalence by age, sex and socioeconomic position, and national chronic pain surveys have identified high-impact chronic pain, defined by its interference with work and daily activities, as a group warranting priority (Dahlhamer et al., 2018; Zelaya et al., 2020). Reviews of population-based studies show that chronic pain is more common in women and older adults and is associated with socioeconomic disadvantage, although estimates vary with definitions and methods (Mills et al., 2019). Economic surveillance adds a further dimension. In the United States, low back and neck pain were among the conditions with the highest

health care spending (Dieleman et al., 2020), which positions MSK care as a priority for efficiency as well as equity.

Burden estimates describe disease, but a pathway also needs indicators of function and access. Stucki and Bickenbach (2017) argued that functioning, measured with standardised classifications and instruments, should sit alongside mortality and morbidity in health information systems. The needs assessments synthesised by Kamenov et al. (2019) show that many people who could benefit from rehabilitation do not receive it, yet few systems monitor unmet need routinely. Lewis et al. (2019) emphasised prevention and health promotion across the life course, which implies surveillance of risk factors such as physical inactivity, obesity and falls as well as of established disease.

Clinical registries can link surveillance to care. The Good Life with osteoArthritis in Denmark (GLA:D) programme couples a standardised education and exercise intervention, delivered by trained physiotherapists, with a national registry recording participant characteristics, pain, function and treatment use. Early data from 9,825 registry participants were used to report symptomatic improvement and fewer participants taking analgesics or on sick leave (Skou & Roos, 2017). The model has since been adapted in Canada, where the registry also profiles who accesses the programme (Zywiel et al., 2021). Registries of this kind turn routine care into a source of surveillance data and allow services to compare their outcomes with national benchmarks.

Surveillance has limits. Global estimates are model-based and rest on sparse primary data in many low- and middle-income settings, where Buchbinder et al. (2018) warned that the burden of low back pain is rising while services remain weakest. Case definitions are also heterogeneous, and because most low back pain is non-specific (Hartvigsen et al., 2018), diagnostic coding in administrative records is imprecise, which weakens service-based surveillance. Finally, surveillance tends to stop at the population level. Indicators are published in reports that rarely reach the nurses, administrators and therapists who could act on them. A pathway must therefore specify which indicators are shared with which role, how often, and in what form. Section 9 returns to this problem.

4. Radiology: confirming, excluding and reducing low-value imaging

Radiology occupies a gatekeeping position in the pathway. Imaging can confirm structural disease, exclude serious pathology such as fracture, infection or malignancy, and guide surgical or interventional decisions. For most people with non-specific low back pain, however, imaging adds little. Guidelines advise against routine imaging in the absence of red flags (Qaseem et al., 2017), and the Lancet low back pain series identified overuse of imaging, alongside opioids and surgery, as a feature of low-value care (Foster et al., 2018; Hartvigsen et al., 2018).

A systematic review and meta-analysis of imaging for low back pain found that clinical practice is frequently inconsistent with guideline recommendations (Jenkins et al., 2018). A review comparing imaging with no imaging found limited evidence of benefit for pain outcomes and signalled possible increases in health care use and costs (Lemmers et al., 2019). Chiarotto and Koes (2022) likewise reserve imaging for suspected serious pathology or for situations in which the result would change management. These findings make radiology a co-producer of appropriate care. Requests that bypass clinical assessment may generate age-related findings that do not explain the person's pain, which can heighten fear and encourage further low-value interventions.

In osteoarthritis, imaging plays a supporting role. Current international guidelines concentrate on non-surgical treatments, including exercise, education and weight management, that can begin without waiting for imaging (Bannuru et al., 2019; Kolasinski et al., 2020). The radiology service's contribution is to support diagnosis when the presentation is atypical and to inform surgical planning when conservative care has failed.

Radiology contributes most distinctively where imaging itself detects risk. Bone densitometry underpins fracture risk assessment in European guidance for postmenopausal osteoporosis, which integrates densitometry with clinical risk factors to decide who should be treated (Kanis et al., 2019). Radiographs and computed tomography obtained for other reasons can also reveal vertebral fractures that would otherwise go unrecognised. When reports of fragility fractures are routed to a fracture liaison service, meta-analytic evidence indicates better bone density testing, treatment initiation and clinical outcomes than usual care (Wu et al., 2018). In pathway terms, the radiology report becomes a trigger for case-finding rather than the end of an episode.

Radiology also generates data that other components can use. Request volumes by body region, appropriateness against local criteria, turnaround times and follow-up rates for incidental findings are quality indicators that administrators can monitor. Structured reports with standardised recommendations help nurses and secretaries to act on results, for example by arranging urgent review or onward referral. Feedback in the opposite direction, from clinicians to radiologists, is equally important, because without information on outcomes imaging services cannot learn which findings were clinically meaningful. Clinical decision support at the point of request and audit feedback to referrers are plausible strategies, although their effectiveness in MSK pathways needs further evaluation.

The main limitations are unequal access and the risk that guideline-driven restraint is experienced as denial of care. In low-resource settings, lack of imaging can

delay recognition of serious pathology, whereas in high-resource settings the problem is more often overuse. Patients may also expect imaging as a sign that they are being taken seriously, which makes communication by nurses and physical therapists (Sections 5 and 8) part of the radiology strategy.

5. General nursing: assessment, education and continuity

General nurses are often the first and most continuous clinical contact for people with MSK and chronic conditions, working in primary care, emergency departments, outpatient clinics, community services and hospital wards. Their contribution to the pathway has four parts: initial assessment and screening for red flags, education and support for self-management, coordination of care across providers, and capture of data on symptoms, function and risk. Best-practice recommendations for MSK pain emphasise person-centred care, education and encouragement of physical activity in preference to routine imaging or opioids (Lin et al., 2020), and these are tasks in which nursing time and communication skills are central.

Evidence on nurse-delivered MSK care is uneven. A systematic review and meta-analysis of allied health and nurse practitioner models of care for MSK conditions in emergency departments found limited research and very low certainty evidence. For example, a smaller proportion of patients were seen within 20 minutes by nurse practitioners (86%) and physiotherapists (77%) than by physicians (98%), and the review concluded that it remains unclear whether these models are more effective than physician care (Vella et al., 2024). Evidence is more encouraging for structured secondary prevention. Fracture liaison services, in which a coordinator, frequently a nurse, identifies patients, arranges bone health assessment and follows up treatment, have been associated with improved testing, treatment initiation and outcomes (Wu et al., 2018).

Education is the most consistent nursing contribution. Beliefs about pain, damage and activity shape engagement with exercise, and a Cochrane review examined how patient beliefs influence participation in exercise for hip and knee osteoarthritis and how programmes can address them (Hurley et al., 2018). Nurses are well placed to reassure patients, explain why imaging may not be needed, discuss analgesic safety and prepare people for rehabilitation. In chronic pain more broadly, effective management is typically multimodal and combines physical, psychological and educational components (Cohen et al., 2021), and nurses frequently coordinate these components in practice.

Many people with MSK conditions also live with diabetes, cardiovascular disease, depression or obesity. General nurses, who routinely manage these comorbidities, can integrate MSK care into chronic disease reviews, for instance by asking about pain interference and physical activity at each visit. This approach aligns with calls to integrate MSK health within noncommunicable disease programmes (Briggs et al., 2019). Because physical activity advice benefits several conditions (Warburton & Bredin, 2017), a single conversation can serve multiple health goals.

Nurses also contribute data. Structured use of patient-reported outcome measures at triage and follow-up creates the baseline and trend information on which physical therapists and surveillance systems depend. The limiting factors are usually time, training and recording systems rather than willingness. Where electronic records lack fields for pain, function or red-flag screening, the information remains in free text and is unavailable to other roles. Role clarity is equally important: standardised triage protocols, defined escalation thresholds and agreed criteria for referral to imaging or physical therapy allow nurses to work at the top of their scope without duplicating or delaying other services.

6. Medical secretaries: access, coordination and information integrity

Medical secretaries and administrative coordinators are rarely discussed in the clinical literature on MSK care, yet they control several determinants of whether a pathway functions: who is booked, how quickly, with which clinician, and whether results and referrals are tracked to completion. Their role extends from first contact by telephone or front desk, through scheduling of imaging and therapy, to correspondence, record keeping and the entry of coded data. The evidence base is correspondingly thin. What follows draws mainly on qualitative implementation research and on reasoning from pathway design, and it should be read as provisional.

The clearest evidence comes from physiotherapy-as-first-contact services. A qualitative evaluation of an in-practice physiotherapy self-referral scheme in United Kingdom general practices identified the work of administrative staff in redistributing patients as a key factor in implementation, alongside the management of patient expectations (Moffatt et al., 2018). Where reception teams understand which presentations suit physiotherapy and which need a doctor, patients can reach appropriate care sooner. Where they lack training, protocols or confidence, schemes can falter irrespective of the clinical skill available. A two-year service evaluation of physiotherapists acting as an alternative to general practitioners for MSK conditions found that physiotherapists could manage a large share of these presentations in primary care (Downie et al., 2019), a result that presupposes dependable signposting at the first point of contact.

Secretarial staff also sustain continuity. Booking, reminders, rescheduling, waiting-list validation and follow-up of missed appointments influence whether people complete a course of rehabilitation, and

exercise-based care depends on repeated attendance. Telerehabilitation, which has produced outcomes comparable to in-person care in MSK conditions (Cottrell et al., 2017; Seron et al., 2021), shifts rather than removes this administrative work, because patients must be introduced to platforms, appointments coordinated across modalities and technical problems resolved. In practice these tasks commonly fall to administrative staff, and they should be recognised and resourced.

A third contribution is the integrity of information. Referral letters, imaging requests, results and outcome measures are only useful to surveillance if they are recorded in consistent, coded fields. Secretaries often perform or verify this entry, so training in terminology, coding conventions and privacy requirements has direct consequences for the quality of downstream indicators such as waiting times, referral-to-treatment intervals and non-attendance rates. A pathway should treat them as data stewards, not merely as schedulers.

Practical measures include standard scripts and decision aids for front-desk signposting, escalation rules for red-flag symptoms, shared dashboards showing outstanding referrals, and inclusion of administrative staff in pathway design and audit meetings. Their omission from improvement work is an oversight that, as the evaluation by Moffatt et al. (2018) suggests, can limit implementation. Research should test whether training for administrative staff changes access, non-attendance and equity, an area in which robust trials are lacking.

7. Health services administration: governance, workforce and information systems

Health services administration provides the structure within which every other component operates. For MSK and chronic conditions, four administrative functions matter most: governance and policy, financing and purchasing, workforce planning, and information systems. The World Health Organization's guide to rehabilitation in health systems frames such elements as the building blocks that determine whether rehabilitation is available, affordable and integrated with other services (WHO, 2019). Gimigliano and Negrini (2017) similarly describe Rehabilitation 2030 as a call for leadership, workforce development, financing and data.

At policy level, the analysis by Briggs et al. (2019) suggests that integration cannot be assumed. MSK health is often absent from national noncommunicable disease plans, leaving no mandate or budget for prevention, early detection and rehabilitation. Administrators can create that mandate by adopting models of care that define the target population, entry points, roles and outcomes, and by linking them to funding. Briggs et al. (2018) set out priorities, including recognition of MSK conditions in health planning and investment in workforce and data, that offer a template.

Administration also shapes quality. A systematic review found that physical therapists' adherence to guidelines for MSK conditions was variable and often incomplete (Zadro et al., 2019), which points to the need for audit, feedback and supportive organisational structures rather than reliance on individual motivation. Consensus care recommendations for MSK pain (Lin et al., 2020) can be converted into measurable indicators, such as the proportion of people with low back pain who receive imaging or opioids without red flags and the proportion who are offered education and exercise. Administrators control the reporting systems that make such measures visible.

Financing matters because MSK conditions are costly and prolonged. The spending analysis by Dieleman et al. (2020) shows that substantial resources are consumed by low back and neck pain in the United States, and Foster et al. (2018) noted that system-level incentives can reinforce overuse of low-value interventions. Administrators can realign incentives through bundled payments, funding of first-contact physiotherapy, and support for group-based programmes such as GLA:D, whose national training and registry infrastructure was designed to implement guideline-concordant care at scale (Skou & Roos, 2017; Zywiel et al., 2021).

Workforce planning must reflect the integrated pathway: enough physical therapists and nurses with appropriate extended skills, adequately trained administrative staff, and radiology capacity matched to appropriate demand. The need estimates of Cieza et al. (2020) provide a denominator for such planning, while Kamenov et al. (2019) show that unmet need must be measured rather than presumed.

Finally, information systems connect the components. Interoperable records, common minimal datasets, patient identifiers that persist across services and secure data sharing enable the surveillance-to-rehabilitation loop. Embedding a functioning indicator in the minimal dataset (Stucki & Bickenbach, 2017) gives all roles a common outcome language. Without such infrastructure, the registry and indicator concepts described above remain aspirational. Administrators must also protect privacy and ensure that data collection burdens are proportionate, since excessive reporting demands erode clinicians' goodwill.

8. Physical therapy: first contact, exercise-based rehabilitation and outcome measurement

Physical therapy is the component through which most guideline recommendations are delivered. Exercise, education and activity promotion are first-line treatments for chronic low back pain and osteoarthritis (Bannuru et al., 2019; Kolasinski et al., 2020; Qaseem et al., 2017). An overview of Cochrane reviews concluded that physical activity and exercise can improve pain severity, physical function and quality of life in adults with chronic pain, with little evidence of serious harm, although the certainty of evidence was generally low (Geneen et al., 2017). A Cochrane

review of exercise therapy for chronic low back pain found that exercise probably reduces pain compared with no treatment or usual care (Hayden et al., 2021). Benefits extend beyond the musculoskeletal system, since regular physical activity is associated with lower risk of many chronic diseases (Warburton & Bredin, 2017), which makes rehabilitation a natural point of contact with multimorbidity prevention.

Physical therapists increasingly act at the start of the pathway. In first-contact models, patients see a physiotherapist without prior physician consultation, receive assessment, advice and self-management support, and are referred for imaging or specialist review when indicated. The service evaluation reported by Downie et al. (2019) and the implementation research by Moffatt et al. (2018) suggest that such models are feasible in primary care, although they depend on training in red-flag recognition and on administrative support. Systematic evidence for emergency department models is still limited (Vella et al., 2024), so claims about benefits in acute settings should be made cautiously.

Structured programmes show how physical therapy can be standardised and measured. In GLA:D, certified physiotherapists deliver patient education and supervised neuromuscular exercise, and every participant is entered into a registry that records pain, function and use of analgesics (Skou & Roos, 2017). The Canadian adaptation extends the model and reports characteristics of the people it reaches (Zywiel et al., 2021). Programmes of this type address a known weakness, namely inconsistent adherence to guidelines by clinicians (Zadro et al., 2019), by pairing training, a defined protocol and routine outcome feedback.

The quality of exercise rehabilitation also depends on patient engagement. Hurley et al. (2018) showed that beliefs about OA and exercise influence participation, so physical therapists must address fear of movement, expectations of imaging and understanding of pain. This work overlaps with nursing education (Section 5), and a pathway that provides consistent messages across professions is likely to be more effective than one in which each professional gives different advice. Chiarotto and Koes (2022) emphasise reassurance, advice to remain active and graded return to normal activity as foundations of care for non-specific low back pain, messages that radiologists, nurses and secretaries can all reinforce.

Telerehabilitation extends reach. A meta-analysis found that real-time telerehabilitation for MSK conditions produced outcomes comparable to standard in-person practice (Cottrell et al., 2017), and a rapid overview found telerehabilitation to be effective across a range of conditions, including MSK disorders (Seron et al., 2021). It is not a substitute for in-person care for everyone, and digital exclusion, privacy and reimbursement need attention, but it offers a way of reducing travel and waiting for people in rural or low-access areas.

Finally, physical therapists are the principal producers of functional outcome data. Standardised measures of pain, function and participation, recorded at baseline and discharge, provide the evidence needed to evaluate services and to feed surveillance. Stucki et al. (2018) argued that rehabilitation should be understood as a health strategy defined by functioning, which implies that physical therapists' measurements are not only clinical tools but health system indicators. Their value depends on the recording infrastructure maintained by nurses, secretaries and administrators, which is why integration, not isolated excellence, is the goal.

9. An integrated surveillance-to-rehabilitation model

The preceding sections show that each component contributes a distinct function, a distinct data stream and a distinct risk of fragmentation. Table 1 summarises these contributions and the principal evidence base for each. The evidence is strongest for surveillance, imaging appropriateness and exercise-based rehabilitation, moderate for nurse-coordinated secondary prevention, and weakest for the administrative components that nevertheless determine whether the other pieces connect.

Table 1. Components of the surveillance-to-rehabilitation pathway: functions, illustrative evidence and data contributed

Component	Core function in the pathway	Illustrative evidence	Data contributed
Epidemiological surveillance	Quantify burden, risk groups and unmet need; monitor trends	Cieza et al. (2020); Steinmetz et al. (2023); Dahlhamer et al. (2018)	Incidence, prevalence, disability, access gaps
Radiology	Confirm or exclude serious pathology; detect fracture risk; limit low-value imaging	Jenkins et al. (2018); Lemmers et al. (2019); Kanis et al. (2019)	Appropriateness, turnaround, incidental findings
General nursing	Assess, screen red flags, educate, coordinate follow-up	Wu et al. (2018); Hurley et al. (2018); Vella et al. (2024)	Symptoms, risk screening, patient-reported outcomes
Medical secretaries	Manage access, scheduling, referral tracking and record accuracy	Moffatt et al. (2018); Downie et al. (2019)	Waiting times, non-attendance, referral completion

Component	Core function in the pathway	Illustrative evidence	Data contributed
Health services administration	Set governance, financing, workforce and information systems	Briggs et al. (2019); WHO (2019); Zadro et al. (2019)	Quality indicators, costs, workforce capacity
Physical therapy	Deliver first-contact assessment, exercise rehabilitation and outcome measurement	Geneen et al. (2017); Hayden et al. (2021); Skou & Roos (2017)	Function, pain, adherence, discharge outcomes

The proposed model organises these components into three layers, shown in Figure 2. A population layer, led by surveillance, defines need, risk and access. A service layer, comprising radiology, nursing, medical secretaries and physical therapy, delivers detection, assessment, coordination and rehabilitation to individuals. An enabling layer, led by health services administration, supplies governance, workforce, financing and information systems. Information moves between layers in both directions: need and risk signals flow down to services, outcomes and quality data flow up to surveillance and administration, and resources and policy flow from administration to services.

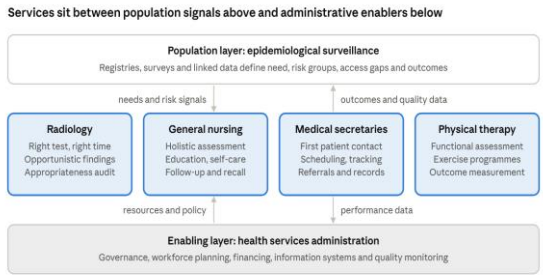


Figure 2 · three-layer model, author's synthesis

Figure 2. A three-layer model. The service layer is the clinical pathway; the population and enabling layers supply need signals and resources, and receive outcome and performance data in return.

The model's central mechanism is a continuous feedback loop, shown in Figure 3. Indicators are measured, interpreted using diagnostic and clinical audit data, used by managers to set priorities, translated into service delivery by clinical and administrative teams, and evaluated for outcomes and equity before the next measurement cycle. The GLA:D registry approach (Skou & Roos, 2017; Zywiel et al., 2021) is a concrete example of a loop that already operates for one condition. The loop works only if indicators are defined once and shared across disciplines. A minimal common set could include time from referral to first assessment, proportion of imaging requests that meet appropriateness criteria, proportion of patients receiving education and exercise as first-line care, non-attendance, and change in a standardised functional measure.

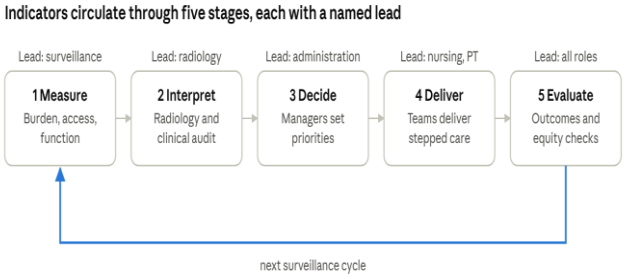


Figure 3. The feedback loop. Each stage has a named owner, but the indicators that move between stages are common to all disciplines.

10. Barriers, implications and future directions

Four groups of barriers recur. Data barriers arise when systems are incompatible, indicators are defined differently across professions, or free-text records hide key information. Role barriers arise when responsibilities overlap or are unclear, as in the shared education task of nurses and physical therapists, or when administrative staff are excluded from design (Moffatt et al., 2018). Resource barriers include workforce shortages and funding that rewards procedures over rehabilitation (Dieleman et al., 2020; Foster et al., 2018). Equity barriers arise because need is greatest where services and data are weakest (Buchbinder et al., 2018; Kamenov et al., 2019). Table 2 pairs each barrier with its consequence, an enabling strategy and the role best placed to lead it.

Table 2. Barriers to integration, consequences and enabling strategies

Barrier	Consequence for the pathway	Enabling strategy	Lead role
Incompatible data systems and undefined indicators	Surveillance cannot see service performance, so the feedback loop breaks	Minimal shared dataset including a functioning measure (Stucki & Bickenbach, 2017); interoperable records	Health services administration
Low-value imaging and routine opioid use	Avoidable cost and harm; delayed rehabilitation	Appropriateness criteria, audit feedback and consistent patient messages (Jenkins et al., 2018; Lin et al., 2020)	Radiology with nursing

Unclear front-door access	Delayed or misdirected referrals; unequal access	Front-desk training and scripts; first-contact physiotherapy (Downie et al., 2019; Moffatt et al., 2018)	Medical secretaries
Variable guideline adherence in rehabilitation	Inconsistent care and outcomes	Structured programmes with training and registries (Skou & Roos, 2017; Zadro et al., 2019)	Physical therapy
Unmet need and inequity	Highest-burden groups receive least rehabilitation	Needs-based planning, telerehabilitation, targeted outreach (Kamenov et al., 2019; Seron et al., 2021)	Surveillance with administration

For practice, the model implies that integration begins with modest operational changes: agreeing a common minimal dataset, defining hand-offs between roles, giving administrative staff a named place in pathway design, and returning outcome data to the teams that generate them. For policy, it implies that MSK and chronic conditions should be planned as one pathway with an accountable owner and shared indicators, rather than as separate services. For education, interprofessional training that includes administrative staff would build a shared understanding of the pathway and of each role's contribution to it.

Several research priorities follow. First, the effects of administrative interventions, such as front-desk training and reminder systems, on access, non-attendance and equity are poorly studied. Second, trials or quasi-experimental evaluations should test whether returning service-level outcome data to teams changes practice. Third, implementation studies should assess nursing roles in MSK care beyond emergency departments and fracture liaison services, because current evidence is limited and of low certainty (Vella et al., 2024). Fourth, minimal indicator sets need consensus development and testing across settings, particularly in low- and middle-income countries. Fifth, digital tools, including telerehabilitation and decision support, require evaluation of equity and workload as well as clinical outcomes (Cottrell et al., 2017; Seron et al., 2021).

The review has limitations. It is narrative and purposive rather than systematic, so relevant studies may be missing. Evidence for the administrative components is sparse and partly extrapolated from qualitative implementation research. Most of the evidence originates from high-income settings, and the three-layer model and feedback loop are conceptual syntheses that have not been empirically validated.

11. Conclusion

Musculoskeletal and chronic conditions place a large and growing demand on health systems, and the care that guidelines recommend, namely education, exercise and appropriate use of diagnostics, depends on coordination among professions that rarely share data or goals. Surveillance defines need, radiology and nursing shape the quality of assessment, medical secretaries determine access and information accuracy, administrators supply the structure, and physical therapists deliver and measure rehabilitation. Treating these as one pathway, linked by common indicators and a deliberate feedback loop, offers a practical route towards more equitable and efficient care. The priority now is to test this integration in real services and to measure whether it improves access, function and cost.

References

1. Bannuru, R. R., Osani, M. C., Vaysbrot, E. E., Arden, N. K., Bennell, K., Bierma-Zeinstra, S. M. A., ... & McAlindon, T. E. (2019). OARSI guidelines for the non-surgical management of knee, hip, and polyarticular osteoarthritis. *Osteoarthritis and cartilage*, *27*(11), 1578-1589. https://doi.org/10.1016/j.joca.2019.06.011
2. Briggs, A. M., Persaud, J. G., Deverell, M. L., Bunzli, S., Tampin, B., Sumi, Y., ... & Slater, H. (2019). Integrated prevention and management of non-communicable diseases, including musculoskeletal health: a systematic policy analysis among OECD countries. *BMJ Global Health*, *4*(5), e001806.
3. Briggs, A. M., Woolf, A. D., Dreinhöfer, K., Homb, N., Hoy, D. G., Kopansky-Giles, D., ... & March, L. (2018). Reducing the global burden of musculoskeletal conditions. *Bulletin of the World Health Organization*, *96*(5), 366.
4. Buchbinder, R., van Tulder, M., Öberg, B., Costa, L. M., Woolf, A., Schoene, M., ... & Turner, J. A. (2018). Low back pain: a call for action. *The Lancet*, *391*(10137), 2384-2388.
5. Chiarotto, A., & Koes, B. W. (2022). Nonspecific low back pain. *New England Journal of Medicine*, *386*(18), 1732-1740.
6. Cieza, A., Causey, K., Kamenov, K., Hanson, S. W., Chatterji, S., & Vos, T. (2020). 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. *The Lancet*, *396*(10267), 2006-2017.

7. Cohen, S. P., Vase, L., & Hooten, W. M. (2021). Chronic pain: an update on burden, best practices, and new advances. *The lancet*, *397*(10289), 2082-2097.
8. Cottrell, M. A., Galea, O. A., O'Leary, S. P., Hill, A. J., & Russell, T. G. (2017). Real-time telerehabilitation for the treatment of musculoskeletal conditions is effective and comparable to standard practice: a systematic review and meta-analysis. *Clinical rehabilitation*, *31*(5), 625-638.
9. Dahlhamer, J. (2018). Prevalence of chronic pain and high-impact chronic pain among adults—United States, 2016. *MMWR. Morbidity and mortality weekly report*, *67*.
10. Dieleman, J. L., Cao, J., Chapin, A., Chen, C., Li, Z., Liu, A., ... & Murray, C. J. (2020). US health care spending by payer and health condition, 1996-2016. *Jama*, *323*(9), 863-884.
11. Downie, F., McRitchie, C., Monteith, W., & Turner, H. (2019). Physiotherapist as an alternative to a GP for musculoskeletal conditions: a 2-year service evaluation of UK primary care data. *British Journal of General Practice*.
12. Foster, N. E., Anema, J. R., Cherkin, D., Chou, R., Cohen, S. P., Gross, D. P., ... & Woolf, A. (2018). Prevention and treatment of low back pain: evidence, challenges, and promising directions. *The Lancet*, *391*(10137), 2368-2383.
13. 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), e316-e329.
14. Geneen, L. J., Moore, R. A., Clarke, C., Martin, D., Colvin, L. A., & Smith, B. H. (2017). Physical activity and exercise for chronic pain in adults: an overview of Cochrane Reviews. *Cochrane database of systematic reviews*, (1).
15. Gimigliano, F., & Negrini, S. (2017). The World Health Organization" rehabilitation 2030: a call for action". *European journal of physical and rehabilitation medicine*, *53*(2), 155-168.
16. Hartvigsen, J., Hancock, M. J., Kongsted, A., Louw, Q., Ferreira, M. L., Genevay, S., ... & Woolf, A. (2018). What low back pain is and why we need to pay attention. *The Lancet*, *391*(10137), 2356-2367.
17. Hayden, J. A., Ellis, J., Ogilvie, R., Malmivaara, A., & van Tulder, M. W. (2021). Exercise therapy for chronic low back pain. *Cochrane Database of Systematic Reviews*, (9).
18. Hurley, M., Dickson, K., Hallett, R., Grant, R., Hauari, H., Walsh, N., ... & Oliver, S. (2018). Exercise interventions and patient beliefs for people with hip, knee or hip and knee osteoarthritis: a mixed methods review. *Cochrane Database of Systematic Reviews*, (4).
19. Jenkins, H. J., Downie, A. S., Maher, C. G., Moloney, N. A., Magnussen, J. S., & Hancock, M. J. (2018). Imaging for low back pain: is clinical use consistent with guidelines? A systematic review and meta-analysis. *The Spine Journal*, *18*(12), 2266-2277.
20. Kamenov, K., Mills, J. A., Chatterji, S., & Cieza, A. (2019). Needs and unmet needs for rehabilitation services: a scoping review. *Disability and rehabilitation*, *41*(10), 1227-1237.
21. Kanis, J. A., Cooper, C., Rizzoli, R., Reginster, J. Y., & Scientific Advisory Board of the European Society for Clinical and Economic Aspects of Osteoporosis (ESCEO) and the Committees of Scientific Advisors and National Societies of the International Osteoporosis Foundation (IOF). (2019). European guidance for the diagnosis and management of osteoporosis in postmenopausal women. *Osteoporosis international*, *30*(1), 3-44.
22. Kolasinski, S. L., Neogi, T., Hochberg, M. C., Oatis, C., Guyatt, G., Block, J., ... & Reston, J. (2020). 2019 American College of Rheumatology/Arthritis Foundation guideline for the management of osteoarthritis of the hand, hip, and knee. *Arthritis & rheumatology*, *72*(2), 220-233.
23. Lemmers, G. P. G., Van Lankveld, W., Westert, G. P., Van der Wees, P. J., & Staal, J. B. (2019). Imaging versus no imaging for low back pain: a systematic review, measuring costs, healthcare utilization and absence from work. *European Spine Journal*, *28*(5), 937-950.
24. Lewis, R., Gómez Álvarez, C. B., Rayman, M., Lanham-New, S., Woolf, A., & Mobasheri, A. (2019). Strategies for optimising musculoskeletal health in the 21st century. *BMC musculoskeletal disorders*, *20*(1), 164.
25. Lin, I., Wiles, L., Waller, R., Goucke, R., Nagree, Y., Gibberd, M., ... & O'Sullivan, P. P. (2020). What does best practice care for musculoskeletal pain look like? Eleven consistent recommendations from high-quality clinical practice guidelines: systematic review. *British journal of sports medicine*, *54*(2), 79-86.
26. Mills, S. E., Nicolson, K. P., & Smith, B. H. (2019). Chronic pain: a review of its

epidemiology and associated factors in population-based studies. *British journal of anaesthesia*, *123*(2), e273-e283.

27. Moffatt, F., Goodwin, R., & Hendrick, P. (2018). Physiotherapy-as-first-point-of-contact-service for patients with musculoskeletal complaints: understanding the challenges of implementation. *Primary Health Care Research & Development*, *19*(2), 121-130. https://doi.org/10.1017/S1463423617000615
28. Qaseem, A., Wilt, T. J., McLean, R. M., Forciea, M. A., & Clinical Guidelines Committee of the American College of Physicians*. (2017). Noninvasive treatments for acute, subacute, and chronic low back pain: a clinical practice guideline from the American College of Physicians. *Annals of internal medicine*, *166*(7), 514-530.
29. Safiri, S., Kolahi, A. A., Smith, E., Hill, C., Bettampadi, D., Mansournia, M. A., ... & Cross, M. (2020). Global, regional and national burden of osteoarthritis 1990-2017: a systematic analysis of the Global Burden of Disease Study 2017. *Annals of the rheumatic diseases*, *79*(6), 819-828.
30. Seron, P., Oliveros, M. J., Gutierrez-Arias, R., Fuentes-Aspe, R., Torres-Castro, R. C., Merino-Osorio, C., ... & Sanchez, P. (2021). Effectiveness of telerehabilitation in physical therapy: a rapid overview. *Physical therapy*, *101*(6), pzab053.
31. Skou, S. T., & Roos, E. M. (2017). Good Life with osteoArthritis in Denmark (GLA: D™): evidence-based education and supervised neuromuscular exercise delivered by certified physiotherapists nationwide. *BMC musculoskeletal disorders*, *18*(1), 72.
32. Steinmetz, J. D., Culbreth, G. T., Haile, L. M., Rafferty, Q., Lo, J., Fukutaki, K. G., ... & Singh, S. (2023). Global, regional, and national burden of osteoarthritis, 1990–2020 and projections to 2050: a systematic analysis for the Global Burden of Disease Study 2021. *The Lancet Rheumatology*, *5*(9), e508-e522.
33. Stucki, G., & Bickenbach, J. (2017). Functioning: the third health indicator in the health system and the key indicator for rehabilitation. *European journal of physical and rehabilitation medicine*, *53*(1), 134-138.
34. Stucki, G., Bickenbach, J., Gutenbrunner, C., & Melvin, J. L. (2018). Rehabilitation: The health strategy of the 21st century.
35. Vella, S. P., Melman, A., Coombs, D., Maher, C. G., Swain, M. S., Monk, E., & Machado, G. C. (2024). The effectiveness of allied health and nurse practitioner models-of-care in managing musculoskeletal conditions in the emergency department: a systematic review and meta-analysis. *BMC Emergency Medicine*, *24*(1), 13. https://doi.org/10.1186/s12873-023-00925-4
36. Vos, T., Abajobir, A. A., Abate, K. H., Abbafati, C., Abbas, K. M., Abd-Allah, F., ... & Criqui, M. H. (2017). Global, regional, and national incidence, prevalence, and years lived with disability for 328 diseases and injuries for 195 countries, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. *The Lancet*, *390*(10100), 1211-1259.
37. Vos, T., Lim, S. S., Abbafati, C., Abbas, K. M., Abbasi, M., Abbasifard, M., ... & Bhutta, Z. A. (2020). Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. *The lancet*, *396*(10258), 1204-1222.
38. Warburton, D. E., & Bredin, S. S. (2017). Health benefits of physical activity: a systematic review of current systematic reviews. *Current opinion in cardiology*, *32*(5), 541-556.
39. World Health Organization. (2018). *Rehabilitation in health systems: guide for action*. World Health Organization.
40. Wu, C. H., Tu, S. T., Chang, Y. F., Chan, D. C., Chien, J. T., Lin, C. H., ... & Tsai, K. S. (2018). Fracture liaison services improve outcomes of patients with osteoporosis-related fractures: a systematic literature review and meta-analysis. *Bone*, *111*, 92-100.
41. Zadro, J., O'Keeffe, M., & Maher, C. (2019). Do physical therapists follow evidence-based guidelines when managing musculoskeletal conditions? Systematic review. *BMJ open*, *9*(10), e032329.
42. Zelaya, C. E., Dahlhamer, J. M., Lucas, J. W., & Connor, E. M. (2020). Chronic pain and high-impact chronic pain among US adults, 2019.

Zywiel, M., Ellis, K., Veillette, C. J., Skou, S. T., & McGlasson, R. (2021). Implementation of the Good Life with osteoArthritis in Denmark (GLA: D) Program across Canada for the Management of Hip and Knee Osteoarthritis. *Healthcare Quarterly (Toronto, Ont.)*, *24*(1), 54-59. https://doi.org/10.12927/hcq.2021.26464.