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Allocating Clinical Pharmacy by Pharmacotherapy Instability Rather Than Ward Geography Could Move Specialist Expertise Toward Preventable Harm

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ABSTRACT

Hospital clinical-pharmacy services are commonly organised around wards, specialties, or fixed service lines because these structures support continuity, accountability, and integration with multidisciplinary teams. Yet medication-related demand is not spatially fixed. It can rise abruptly when organ function changes, high-risk treatment is initiated or intensified, interacting therapy is added, monitoring becomes inadequate, care transitions occur, or unresolved medication problems accumulate. Existing prioritisation tools show that patient and regimen characteristics can be used to rank pharmacy need, but their construction, validation, transportability, and implementation vary substantially. The evidence does not establish that a hospital-wide dynamic allocation strategy improves patient outcomes or pharmacist efficiency compared with geography-based coverage. A more defensible question is whether dynamic pharmacotherapy instability can identify episodes in which specialist reassessment is more likely to be needed, and whether acting on those signals improves targeting without damaging continuity or creating excessive false-positive workload. Pharmacotherapy instability is defined here as a time-varying state in which the likelihood that a medication regimen requires near-term pharmacist reassessment rises because medication exposure, patient physiology, treatment transitions, monitoring adequacy, interacting therapies, or unresolved medication problems are changing or unresolved. This construct should not be treated as a validated composite score. It is better regarded as a service-design proposition that requires measurable signals, explicit update rules, human interpretation, and comparative testing. The central implication is conditional: geography remains an important organisational scaffold, but fixed coverage may be insufficient when medication-management demand changes faster than ward boundaries can respond.

Keywords: Clinical pharmacy, Medication risk stratification, Pharmacotherapy instability, High-risk medicines, Medication-related harm, Service allocation

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Introduction

Clinical pharmacy is delivered under a hard resource constraint: specialist time cannot be simultaneously concentrated on medication review, discharge work, medicines information, multidisciplinary discussion, reconciliation, monitoring, and urgent problem solving. Multisite time-motion evidence shows that hospital pharmacists spend most of their observed time in clinical work, with medication review and discharge activity constituting substantial shares, while interruptions are frequent [1]. A staffing model based on wards or specialties

can make this workload governable. It provides a defined clinical home, embeds pharmacists in local teams, and can preserve specialty knowledge. The difficulty is that the location of the patient is only an indirect marker of the immediacy and complexity of medication-management need.

Hospitals have already tried to solve part of this problem through patient-prioritisation tools. A systematic review identified substantial heterogeneity in hospital pharmaceutical-care assessment tools, with incomplete validation and little evidence that tool use itself improved medication outcomes [2, 3]. This matters because "risk" is not a single operational quantity. A tool may predict an adverse drug event, detect a potentially preventable medication-related problem, rank complexity, identify medicines requiring specialist oversight, or simply help pharmacists decide which charts to review first. These purposes overlap, but they are not interchangeable.

Prediction research reinforces that distinction. Models for adverse drug events in hospitalised patients have shown variable validation and, historically, little direct evidence that prediction improves clinical outcomes [4]. The Medicines Optimisation Assessment Tool demonstrated that routinely available patient and treatment characteristics can produce clinically usable but only moderate discrimination for preventable medication-related problems [5]. More importantly, fully independent validation of a clinical-pharmacy prioritisation score in another setting showed that the original model transported poorly and required updating; time-varying clinical and medication variables also mattered during admission [6]. A prioritisation system can thus be technically coherent and still lose performance when the population, workflow, or temporal context changes.

Transitions provide a clear example of why temporal context matters. In older adults, medication-related harm after hospital discharge is common and a substantial proportion is potentially preventable [7]. That does not mean that adding pharmacist contact to every apparently high-risk transition will necessarily improve outcomes. In a randomised trial involving patients prescribed selected high-risk medicines, a multifaceted clinical-pharmacist intervention did not significantly reduce the prespecified medication-safety outcomes compared with usual care [8]. The implication is not that pharmacist involvement lacks value. It is that selecting patients who look "high risk" and delivering an intervention are separate steps from demonstrating that the allocation strategy is efficient, timely, and clinically beneficial.

The practical question is consequently narrower than whether high-risk patients deserve pharmaceutical care. It is whether specialist clinical-pharmacy capacity could be deployed more responsively when medication-management conditions are changing, while retaining the advantages of geography-based continuity. Answering that question requires three separations. First, patient risk must be distinguished from pharmacy demand. Second, observable instability signals must be distinguished from a validated score. Third, any proposed allocation strategy must be evaluated against both patient outcomes and the opportunity costs created when scarce specialist time is moved.

Current prioritisation identifies patient risk but imperfectly identifies pharmacy demand

Clinical-pharmacy work-prioritisation systems already range from simple patient lists to informatics-supported ranking tools. Early evaluation of such tools showed wide variation in whether they were patient oriented, task oriented, or integrated with electronic systems, and only a minority had empirical validation [9]. That diversity is understandable because "priority" can refer to very different operational problems. A pharmacist deciding which patient to review first is solving a different problem from a service manager deciding where specialist capacity should be deployed for the next shift.

When pharmacists themselves identify high-priority cases, clinically plausible criteria recur. Renal impairment, high-risk medicines, therapeutic drug monitoring, and other indicators of medication-related vulnerability are commonly treated as reasons for earlier or more intensive review [10]. Delphi work has likewise generated broad sets of hospital prioritisation criteria spanning health problems, medicine characteristics, laboratory abnormalities, and other clinically relevant features [11]. These studies are important because they show that prioritisation is not arbitrary. They do not, however, demonstrate that all criteria have equal predictive value or that a single combination should govern staffing.

Implementation exposes a second limitation. A locally developed hospital prioritisation tool altered the distribution of patients classified at different clinical-priority levels, but performance varied with pharmacist experience [12]. In a separate study, pharmacists using the same clinical-pharmacy risk stratification tool frequently assigned different risk codes to identical patient cases, with very low agreement; qualitative analysis suggested that non-patient factors and individual interpretation influenced the assigned priority [13]. A tool can

standardise attention without eliminating professional judgement or workflow effects. In practice, the measured "risk" may partly reflect how the system is used.

Contemporary tool development has become more structured. The PrioFarClinH work formalised a wide set of adult-patient criteria across health conditions, medicine classes, and laboratory information, showing that multidomain prioritisation can be standardised [14]. Yet setting specificity remains substantial. In UK mental-health inpatient services, formal prioritisation approaches were used inconsistently across organisations, many were locally developed, and evaluation was limited [15]. Retrospective hospital data also suggest that features such as impaired renal function and medication-related characteristics are associated with whether pharmacists review patients and intervene [16]. Such associations are useful for identifying candidate demand signals, but they remain partly shaped by existing service practice.

The central service-design problem is that patient risk and pharmacy demand are related but not identical. A patient may be intrinsically vulnerable yet pharmacologically stable, with a well-monitored regimen and no unresolved medication problem. Another patient may have a lower baseline burden but experience a sudden fall in renal function, a new interacting medicine, an unmonitored high-risk treatment, or a complex transfer of care. The second patient may temporarily require more specialist pharmacy attention. A useful allocation construct must capture that time dependence without pretending that it replaces established risk assessment or professional judgement.

Pharmacotherapy instability as a time-varying service-demand construct

Medication-related harm is not evenly distributed across medicines or adverse-event types. Systematic synthesis of drug-related hospital admissions shows recurring contributions from particular medicine classes and adverse events, supporting the view that pharmacological hazard is heterogeneous [17]. Hazard alone, however, is too static for service allocation. A chronically prescribed high-risk medicine that is stable, monitored, and understood by the care team may generate less immediate pharmacy demand than a lower-risk regimen undergoing rapid change.

Medication complexity illustrates the same problem. In a large population-based study of older adults after hospital discharge, distinct medication clusters were associated with different 30-day adverse drug event risks; importantly, apparently more complex configurations did not uniformly translate into greater adjusted risk [18]. Drug-drug interactions are similarly non-equivalent. In older acutely admitted patients, the presence of any relevant interaction was not significantly associated with adverse-drug-reaction-related admission overall, whereas specific bleeding-related combinations showed a stronger association [19]. These findings argue against treating medicine count, polypharmacy, or an undifferentiated interaction alert as direct proxies for pharmacy demand.

Physiological change is more compelling when it can plausibly alter exposure, dosing, monitoring, or the safety margin of ongoing treatment. In hospitalised patients with chronic kidney disease, drug-related problems were frequent and many pharmacist recommendations were accepted and followed by documented problem resolution [20]. This supports renal dysfunction as an important source of pharmacist-manageable medication problems, but it does not justify prioritising every patient with kidney disease equally. High-risk prescription lists provide another useful layer. Consensus work in older emergency-department patients has identified medicine classes that warrant particular scrutiny [21], yet list membership should be interpreted as a hazard signal, not a complete statement of current need.

Care transitions add a temporal dimension that static medicine lists cannot capture. Consensus guidance for medication discharge planning in older adults emphasises reconciliation, communication, monitoring, and the transfer of accurate medication information across settings [22]. Transition-associated vulnerability can arise even when the medicine itself is familiar: the instability may lie in the hand-off, the monitoring plan, uncertainty about what changed, or whether the intended regimen will actually be implemented.

For the present service-design question, pharmacotherapy instability can be operationally defined as a time-varying state in which the likelihood that a medication regimen requires near-term pharmacist reassessment rises because medication exposure, patient physiology, treatment transitions, monitoring adequacy, interacting therapies, or unresolved medication problems are changing or unresolved. This definition deliberately avoids a single latent "risk" construct. Medication complexity, therapeutic index or high-risk medicine status, organ-function change, transitions, monitoring deficits, interacting treatment, and unresolved medication problems

remain separate domains because they can create different types of pharmacist work and different false-positive risks.

The construct is intended to describe potential demand for reassessment, not the probability of patient harm. That difference is essential. Harm prediction asks whether an adverse outcome is likely. Pharmacy-demand assessment asks whether additional specialist medication work is likely to be useful now. The two may correlate, but the service decision also depends on whether the problem is detectable, modifiable, time sensitive, and within the pharmacist's scope and available capacity.

Signals that can be measured without pretending they are a validated score

Any instability-responsive allocation system would need observable signals, yet observability alone is not enough. Predictive modelling of adverse drug events illustrates the challenge: even models with moderate discrimination can have low positive predictive value when the event is uncommon [23]. In service terms, a low-precision signal can consume specialist capacity through repeated reviews that do not identify an actionable problem. A dynamic allocation model must consequently care about false-positive workload as much as statistical association.

Interpretability and workflow fit are equally important. Hospital pharmacists evaluating a medication-harm prediction tool recognised its potential to support prioritisation but also identified practical barriers to implementation [24]. Combined with observed disagreement when pharmacists apply existing risk tools [13], this suggests that a useful instability signal should be intelligible enough to invite rapid clinical verification instead of functioning as an opaque assignment command. Human review is not a defect in the design; it is a safeguard against context-free escalation.

Candidate signals can be grouped by what has changed and what action that change might trigger. Organ-function change may prompt dose, exposure, or monitoring reassessment. Initiation or intensification of a medicine with a narrow safety margin may increase the value of early specialist review. A newly interacting treatment may matter when the interaction has a plausible mechanism and consequence, but generic interaction flags can be noisy. Transition into or out of hospital can increase uncertainty around reconciliation, implementation, monitoring, and responsibility. Monitoring deficits become more important when the medicine or physiological state makes delay consequential. An unresolved medication problem is especially relevant because it indicates that risk has already become an actionable management issue.

These signals should not be added into an unvalidated points system. Existing prioritisation studies support the relevance of several domains, while external validation and implementation studies show that weights, thresholds, and interpretations are setting dependent [5, 6, 14, 16]. The more defensible first step is to specify candidate variables in terms of measurability, time sensitivity, pharmacist-manageability, and likely false-positive pathways. That preserves the difference between an evidence-informed service hypothesis and a clinical prediction model.

The candidate domains can be compared according to the kind of change they detect, how quickly they may become stale, and what specialist action they plausibly trigger.

Table 1. Candidate pharmacotherapy-instability signals for dynamic clinical-pharmacy allocation

Candidate instability signal	Observable change or state	Why it may indicate near-term pharmacy demand	Time sensitivity	Pharmacist-manageable question	Principal false-positive or interpretation risk	Likely data source / refresh logic
Organ-function change	New or worsening renal or hepatic dysfunction; clinically important laboratory trend	Drug exposure, dose suitability, accumulation risk, or monitoring requirements may have changed	High when function is changing rapidly	Does the current regimen remain appropriate for the patient's present physiology?	Chronic stable impairment may trigger repeated review without a new management issue	Laboratory/EHR trend; refresh with a new relevant result

High-risk or narrow-safety-margin therapy	Initiation, re-initiation, dose escalation, route change, or major regimen change	Small changes in exposure or monitoring can have disproportionate clinical consequence	High around initiation or change; lower once stable	Is the treatment, dose, monitoring, and mitigation plan appropriate now?	Static list membership can over-prioritise stable long-term therapy	Medication orders plus recent-change detection
Regimen-complexity change	Rapid increase in medicines, formulation changes, administration constraints, or multiple concurrent adjustments	Complexity can create reconciliation, administration, adherence, and interaction problems	Moderate to high during active regimen change	Has complexity created a specific unresolved medication-management problem?	Medication count alone is nonspecific and may penalise clinically appropriate polypharmacy	Medication-order history; compare current with recent regimen
Clinically consequential interacting treatment	Addition or removal of a drug pair with plausible pharmacokinetic or pharmacodynamic consequence	Interaction may alter exposure, toxicity, efficacy, or monitoring requirements	High after the interacting change	Does the interaction require modification, monitoring, timing separation, or documented acceptance?	Generic interaction alerts produce substantial noise; not all interactions are clinically important	Interaction engine plus pharmacist clinical verification
Care transition	Admission, internal transfer with major medication change, discharge, or transfer to another care setting	Reconciliation, information transfer, implementation, and responsibility can become uncertain	Highest near the transition	Are medication changes reconciled, communicated, implementable, and adequately monitored?	Transition status alone may generate unnecessary review when medication management is already complete	Admission/discharge/transfer event plus reconciliation status
Monitoring deficit	Missing, delayed, discordant, or unacted monitoring relevant to current treatment	Safety or effectiveness cannot be adequately assessed without required information or response	Depends on medicine and consequence of delay	Is required monitoring present, timely, interpreted, and linked to action?	“Missing” data may be clinically unnecessary, scheduled elsewhere, or not yet due	Laboratory/observation schedule with medicine-specific context
Unresolved medication problem	Open discrepancy, unexplained therapy, untreated indication, suspected adverse effect, dose concern, adherence/administration problem, or unimplemented recommendation	The need for medication-management work is already evident instead of merely predicted	Usually high until resolved or intentionally accepted	What decision or action remains outstanding, and who owns it?	Duplicate alerts, already accepted deviations, or problems outside pharmacist influence	Pharmacy documentation, reconciliation record, clinical notes, task status

Therapeutic drug monitoring need	New level due, unexpected concentration, changing physiology, or dose-concentration discordance	Exposure cannot be inferred reliably from dose alone in selected therapies	High when concentration guides near-term dosing	Does measured exposure require dose change, repeat sampling, or interpretation in context?	Mistimed samples or levels obtained without a decision consequence can create avoidable work	Drug level plus sampling time, dosing history, and relevant physiology

Note: The table is an evidence-informed service-design synthesis. The listed domains are not a validated composite score, and no weighting, threshold, or automatic escalation rule is implied.

When ward location and medication-management demand diverge

Ward geography remains useful because clinical-pharmacy work benefits from continuity, specialty familiarity, established team relationships, and predictable responsibility. The allocation problem arises when the intensity of medication-management need changes independently of location. A patient can remain in the same bed while renal function deteriorates, therapeutic monitoring becomes overdue, a clinically important interaction appears, or a treatment decision leaves an unresolved medication problem. Evidence that prioritisation models can require updating as clinical variables change during admission supports the importance of this temporal dimension [6]. Retrospective service data similarly show that renal and medication-related characteristics are associated with the likelihood of pharmacist review and intervention [16].

Operational demand also fluctuates independently of the patient's underlying medication risk. Clinical pharmacists work within interruption-prone environments [1], and prioritisation decisions are influenced by both clinical criteria and immediate organisational pressures [10]. Variation between pharmacists applying the same risk-stratification tool further indicates that priority is partly constructed through local interpretation and workflow [13]. Fixed ward allocation therefore provides organisational stability, but it cannot guarantee that specialist time is concentrated where medication-management conditions are changing most rapidly.

The relevant divergence is not “high-risk ward versus low-risk ward.” Medication patterns associated with subsequent adverse events can occur across conventional specialties [18], and interaction risk depends more on the particular combination and clinical context than on an undifferentiated interaction flag [19]. High-risk medicines [21], impaired organ function [20], transitions [22], or electronically detectable risk patterns [23] may transiently concentrate pharmacy demand within several wards at once. Conversely, some patients carrying static risk labels may be pharmacologically stable and already well managed. An instability-responsive service would therefore treat ward location as one organisational coordinate while allowing specialist capacity to respond to changing clusters of medication-management need.

Figure 1 illustrates how potential demand for specialist reassessment can shift across wards. The depicted concentrations are qualitative and do not represent validated risk scores, prevalence estimates or predicted benefit.

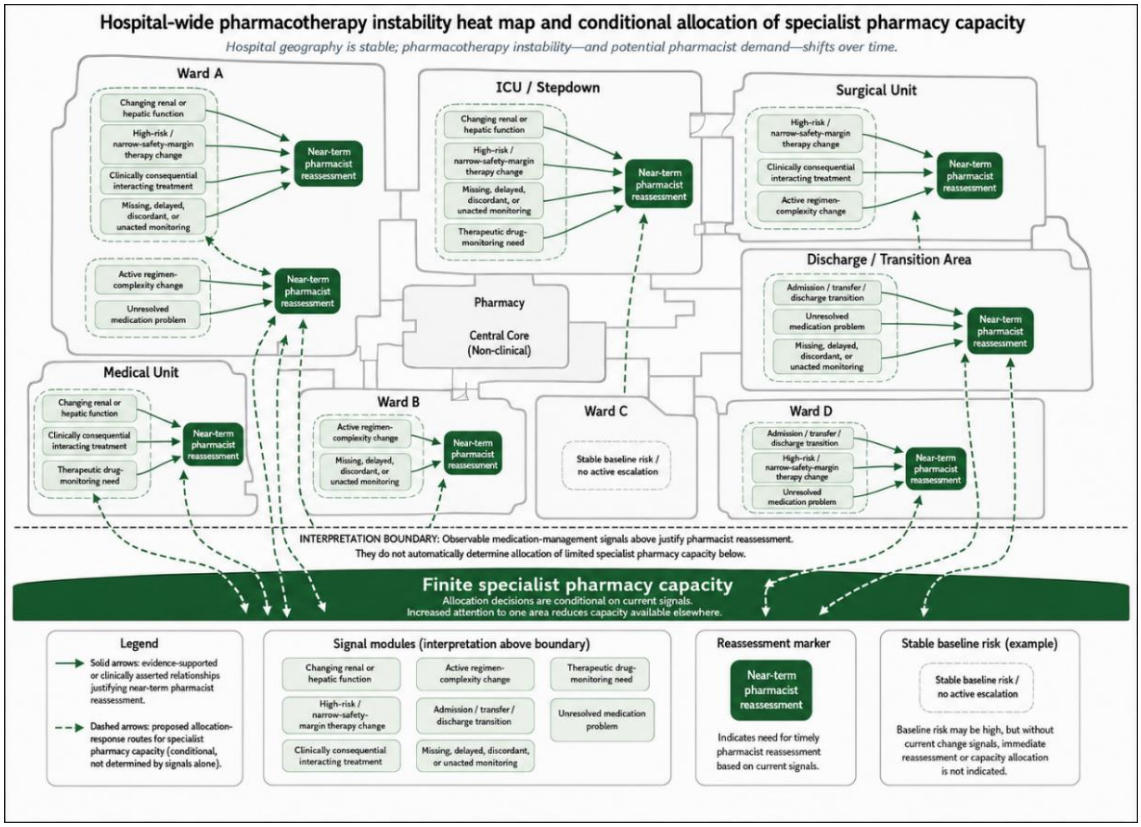

Figure 1. Pharmacotherapy instability can create shifting concentrations of specialist pharmacy demand across otherwise stable hospital geography

Designing instability-responsive specialist coverage without assuming benefit

A practical service model need not abolish ward-based pharmacy. It could preserve a geographically anchored baseline while making a defined portion of specialist capacity responsive to emerging medication-management demand. The value of such a model would depend on how quickly signals are detected, whether reassessment identifies an actionable problem, and whether redeployment causes important work elsewhere to be delayed. Local prioritisation experience shows that structured tools can alter which patients receive attention [12], while disagreement between users warns against treating algorithmic ranking as self-executing [13].

Allocation must also be separated from intervention effectiveness. Pharmacist-led medication reconciliation combined with interprofessional ward activity has been associated with fewer drug-related problems at discharge in some settings, whereas medication reconciliation alone has shown less certain benefit [25]. Across post-discharge medication-review studies and hospital medication-review trials, interventions, intensity, settings, and outcomes remain heterogeneous [26–27]. A more accurate service evaluation therefore asks two questions: did the allocation strategy identify patients whose medication management required specialist input, and did the intervention subsequently delivered improve an outcome that matters?

Several service configurations could test that distinction without presuming a preferred result.

Table 2. Service-allocation scenarios for testing geography-based and instability-responsive clinical-pharmacy coverage

Service-allocation scenario	Baseline geographic coverage	Dynamic response to instability signals	What is being tested	Potential operational advantage	Principal failure mode	Outcome interpretation

Fixed ward coverage	Specialist pharmacists remain assigned to defined wards or specialties	No formal cross-ward redeployment	Performance of current geography-led organisation	Continuity, team integration, specialty familiarity, clear accountability	High-demand cases outside well-resourced wards may wait; workload may not match changing need	Serves as the practical comparator rather than an assumed inferior model
Geographic base with specialist surge capacity	Routine ward service retained	A limited mobile specialist resource responds to verified instability	Whether selective mobility improves targeting without disrupting continuity	Preserves ward relationships while allowing response to transient demand clusters	Surge team may become overloaded or duplicate local review	Benefit requires evidence of better targeting or outcomes without excessive displacement
Instability-prioritised cross-ward review queue	Ward teams continue routine work	Selected cases from multiple wards enter a shared pharmacist-review queue	Whether signal-based prioritisation identifies actionable medication problems more efficiently	Makes cross-hospital demand visible	False-positive signals may consume capacity; queue ownership may become unclear	Higher review volume alone is not evidence of improvement
Specialty-expertise matching	General pharmacy coverage remains geographic	Complex instability cases are routed to pharmacists with relevant expertise	Whether matching expertise to medication problem adds value beyond location	May improve management of unusual or high-complexity problems	Fragmentation and additional hand-offs	Requires outcome or decision-quality improvement, not merely consultation counts
Time-limited instability response followed by return to ward care	Ward pharmacist retains longitudinal responsibility	Mobile specialist input is activated only while instability remains unresolved	Whether temporary escalation captures high-demand periods while preserving continuity	Limits permanent fragmentation	Poor hand-back may recreate transition risk inside the pharmacy service	Success depends on both resolution and reliable return of responsibility

These scenarios are deliberately non-quantified. Their relative performance cannot be inferred from existing evidence. Excessive false-positive signalling could consume specialist time, and frequent cross-ward movement could weaken continuity or specialty integration. Conversely, a purely geographic arrangement may leave periods of intense medication-management demand under-recognised. The empirical question is which configuration performs better under comparable staffing constraints.

Comparative tests that could support or falsify the proposition

Evaluation should move beyond counting pharmacist activity. A systematic review of inpatient clinical-pharmacy key performance indicators found that the large majority measured processes, with relatively few outcome or structure indicators and variable validation [28]. Intervention counts, review counts, or signal-response times may be useful implementation measures, but they cannot alone establish preventable-harm reduction or superior resource use.

A credible comparison would examine geography-based and instability-responsive allocation under approximately equivalent pharmacist capacity. Candidate measures include the proportion of reviewed patients with a verified pharmacist-manageable problem, time from clinically important change to pharmacist

reassessment, unresolved high-priority medication problems at transition points, clinically meaningful medication-related harm, workload displacement, continuity failures, and the number of low-value escalations generated by false-positive signals. These outcomes should be specified before implementation rather than selected retrospectively around favourable performance.

The proposition is falsifiable. It would be weakened if instability-responsive allocation did not improve the timely identification or resolution of important medication problems after accounting for staffing and case mix; if gains were explained entirely by providing more pharmacist time; if signal burden diverted resources toward patients without actionable needs; or if loss of ward continuity produced offsetting medication-management failures. It would also be weakened if ward geography already captured most meaningful variation in specialist demand within a given hospital.

Conversely, evidence for the proposition would require more than showing that instability signals correlate with pharmacist intervention. The stronger demonstration would be that dynamic allocation changes who receives timely specialist attention and improves an agreed outcome or targeting metric under comparable resource constraints. Until such comparisons exist, pharmacotherapy instability should remain an evaluable service-design hypothesis rather than a staffing algorithm.

Conclusion

Medication-management need can change faster than hospital geography. Existing prioritisation research supports the use of clinical, medication, laboratory, transition, and unresolved-problem information to identify patients who may require greater pharmacy attention, but it also exposes weaknesses in transportability, reliability, precision, and implementation. These limitations argue against replacing ward structures with an unvalidated composite risk score.

A more defensible direction is to retain geography as an organisational foundation while testing whether dynamically detected pharmacotherapy instability can identify periods when specialist reassessment is particularly valuable. The proposition succeeds only if it improves meaningful targeting or patient outcomes without creating excessive false-positive workload, fragmentation, or displacement of other necessary pharmacy work. The appropriate next step is therefore comparative service evaluation, not premature algorithmic adoption.

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