Society of Medical Education & Research

2026, Volume 6, Issue 2, Page No: 49-60
ISSN: 3108-4850

Annals of Pharmacy Education, Safety, and Public Health Advocacy

# Medication Safety Improvements Must Be Reproduced Through Everyday Work: Explaining Maintenance Effort, Staff Turnover, and the Persistence or Erosion of Organizational Change

**Sarah Mitchell[1], Kwame Asante[2]*, Lisa Chen[3], Mohamed Al-Hassan[4]**

[1]Department of Pharmaceutics and 3D-Printed Medicines, University of Toronto, Toronto, Canada.
[2]Department of Pharmacy Practice and Personalized Dosing, University of Ghana, Accra, Ghana.
[3]Department of Pharmaceutical Technology and Additive Manufacturing, National Taiwan University, Taipei, Taiwan.
[4]Department of Clinical Pharmacy and Dispensing Systems, Qatar University, Doha, Qatar.

***E-mail** ✉ asante@ug.edu.gh

## Abstract

Medication-safety interventions are often judged by whether they are implemented and remain present, yet continued existence is an incomplete account of sustainability. Safer practice has to be reproduced through recurrent work: routines enacted, exceptions managed, knowledge transferred, conditions monitored, and adaptations kept compatible with the safety functions they are meant to protect. This article develops a Practice-Theory Persistence–Erosion Model explaining how medication-safety improvements can persist, adapt, stabilize, or gradually erode after implementation. The model distinguishes recurrent enactment from maintenance effort, separates staff turnover from the knowledge loss that may follow it, and differentiates adaptive maintenance, drift, and workaround formation. Persistence is sustained reproduction of safety-relevant functions under changing conditions; erosion is cumulative weakening or displacement of those functions when losses and modifications outpace replenishment, learning, and repair. Sustainability is therefore treated as a dynamic organizational accomplishment with multiple trajectories, generating testable implications for longitudinal monitoring, workforce continuity, adaptation assessment, and organizational learning.

**Keywords:** Medication safety, Sustainability, Implementation, Practice theory, Staff turnover, Workarounds

## Introduction

Sustainability research increasingly recognizes that the continued presence of an intervention does not establish that its intended functions remain active. A comprehensive definition incorporates continued delivery or behavior, adaptation, and continued benefits over time [1]. Healthcare research nevertheless uses heterogeneous sustainability approaches [2], while reviews emphasize interacting intervention, organizational, workforce, and contextual conditions [3]. Sustainment has also been studied less often than several other implementation outcomes [4].

Medication safety makes this distinction consequential because safety improvements are enacted through recurring work. Checks, handoffs, escalation routines, documentation practices, technology-supported procedures, and learning processes may remain formally present while their performance changes. The research question is therefore temporal and mechanistic: what conditions allow medication-safety improvements to be reproduced over time, and through which mechanisms do

**Access this article online** https://smerpub.com/

**Received:** 19 March 2026; **Accepted:** 08 July 2026



**How to cite this article:** Mitchell S, Asante K, Chen L, Al-Hassan M. Medication Safety Improvements Must Be Reproduced Through Everyday Work: Explaining Maintenance Effort, Staff Turnover, and the Persistence or Erosion of Organizational Change. Ann Pharm Educ Saf Public Health Advocacy. 2026;6(2):49-60. https://doi.org/10.51847/skGtWLzkcc

maintenance effort, turnover, knowledge loss, adaptation, drift, and workarounds produce persistence or erosion?

*Sustainability as more than initial implementation*

Across healthcare programs, recurrent sustainability facilitators include leadership, continuing support, workforce capacity, resources, and contextual fit [5]. A recent review of theories, models, and frameworks similarly found adaptability, scalability, and sustainability distributed across several interacting domains [6]. Sustainability is thus better treated as a configuration problem than as a single post-implementation indicator.

Longitudinal evidence shows why. Veterans Health Administration practices followed over time displayed divergent pathways from implementation to sustainment; initially strong implementation did not uniquely determine later persistence [7]. Long-horizon replication in another clinical domain likewise found substantial post-support decline in evidence-based practice [8]. These findings establish the possibility of erosion without making it inevitable. Structured sustainability action planning can improve sustainability capacity [9], indicating that organizations may actively preserve conditions under which practice remains reproducible. The important question becomes what must keep happening for safety-relevant functions to remain available.

*Practice-theory foundations*

Practice theory directs attention to recurrent enactment. Normalization Process Theory describes implementation as collective work involving sense-making, participation, coordinated action, and appraisal [10]. A safer medication practice therefore becomes durable through repeated recognition of what it requires, allocation of effort, coordination, and assessment of whether it still works locally.

System complexity strengthens this argument. The NASSS framework locates sustainability within interactions among technologies, users, organizations, wider institutions, and change over time [11]. Multilevel implementation scholarship similarly requires explicit specification of levels, cross-level relationships, and temporal ordering [12]. Medication-safety sustainability may consequently depend on individual skill, team coordination, managerial resourcing, technological reliability, and institutional demands simultaneously.

Implementation theory also benefits from specifying mechanisms rather than listing determinants [13]. Here, the central mechanism is reproduction: a safety improvement persists when the work carrying its protective functions is repeatedly accomplished under changing conditions. Exact behavioral replication is unnecessary; sufficient continuity in routines, knowledge, actors, resources, and feedback is what matters.

*Reproduction through everyday work*

Sustainability strategies commonly involve continuing alignment, adaptation, support, and resources [14]. In everyday work these appear as maintaining shared expectations, ensuring required tasks remain performable, repairing breakdowns, updating knowledge, and preserving compatibility with surrounding workflows.

Difficult conditions do not determine failure. A multicentre emergency-nursing implementation evaluation found sustained use across sites despite turnover and other challenges when supporting structures remained active [15]. Sustainability can also be made an explicit design concern, as shown by user-centred development of a dissemination-and-sustainability planning platform [16]. Organizational learning contributes to this work: qualitative evidence links evidence-based practice transformation to group learning and organizational alignment [17], while another sustainability study identifies updating, compatibility, communication, leadership, and culture as relevant to continued implementation [18].

These findings suggest five analytically distinct reproduction units. They are proposed synthesis rather than universal requirements, but they identify where continued enactment can become fragile.

**Table 1.** Everyday reproduction units through which safer medication practice remains performable

| Reproduction unit | What must recur | Maintenance dependency | Weakening signal | Function-preserving response |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| **Routine verification** | Expected checking or confirmation | Time, role clarity, usable tools | Checks become compressed or omitted | Adjust workflow while retaining verification |
| **Information continuity** | Safety-relevant information crosses transitions | Shared conventions and current information | Context repeatedly reconstructed | Strengthen transfer points and clarification |
| **Exception escalation** | Atypical situations reach appropriate expertise | Clear routes and access to expertise | Improvisation replaces escalation | Redesign escalation without normalizing unresolved exceptions |
| **Local learning and updating** | Recurring problems generate shared learning | Feedback, review time, accountable ownership | Problems handled repeatedly as isolated events | Convert recurring exceptions into reviewed adjustments |
| **Entry and re-entry** | New or returning staff acquire local practice logic | Onboarding, coaching, supervised participation | Orientation does not produce reliable local performance | Pair codified guidance with situated feedback |

Note: Proposed article-specific analytical synthesis; units need not appear identically in every medication-safety intervention.

*Maintenance effort*

Reproduction consumes organizational capacity. Staffing is one component because workforce conditions influence turnover and continuity of clinical work. A systematic review found consistent relationships between nurse staffing and turnover, with less uniform evidence for some schedule variables [19]. A large meta-analysis shows that turnover is common enough across health systems to pose a continuing organizational problem, although rates vary substantially by setting [20].

Pharmacy provides a direct example. Research with pharmacy technicians in England associated turnover intention with organizational and occupational conditions, including commitment and advancement opportunities, with differences across sectors [21]. Broader retention evidence suggests that continuity is supported through combinations of onboarding, leadership, work-environment, development, and related supports [22].

Maintenance effort therefore extends beyond retaining headcount. It includes preserving time to learn, experienced support, functional tools, clear decision rights, and opportunities to repair recurring problems. Workforce instability may matter for safety, but causal language requires restraint. Unit-level hospital research has associated turnover with patient falls [23], yet cross-sectional evidence cannot establish turnover as the cause or transfer directly to medication errors. In this model, turnover increases maintenance demand; whether it becomes erosion depends on what knowledge and coordination are lost and how effectively they are replenished.

*Staff turnover and knowledge loss*

Turnover is not a direct proxy for sustainability failure. An umbrella review shows organizational conditions as one major class of turnover determinants alongside individual and cultural influences [24]. The same organization that experiences turnover therefore also shapes how disruptive it becomes.

The key distinction is between personnel loss and knowledge loss. Personnel turnover is observable; knowledge loss is a functional consequence requiring demonstration. Some safety knowledge is codified in protocols, digital systems, and formal training, while other knowledge is situated in local workflows, exception patterns, informal coordination, and the practical meaning of escalation rules. Departure may remove little unique capability when knowledge is redundant and transferable. Modest turnover can be disruptive when a departing actor carries disproportionate local knowledge or connective capacity.

Pharmacy-technician evidence reinforces this conditional account because turnover intention varies with organizational and sector conditions [21]. The model consequently treats knowledge continuity as a mediating property. Turnover raises vulnerability when knowledge carriers leave faster than relevant capability can be redistributed, taught, codified, or regenerated. It can also prompt beneficial renewal when onboarding is strong and previously tacit routines become explicit.

*Adaptation, drift and workaround formation*

Adaptation must be described by what changes, when, by whom, and for what reason. The FRAME formalizes

these distinctions and their relationship to fidelity [25], preventing all modification from being classified as either improvement or failure. Longitudinal implementation research shows that modifications can accumulate and that personnel or contextual changes may prompt them [26]. Under service pressure, organizations also employ multiple anticipatory and real-time adaptive strategies [27], while intensive-care research shows staffing and skill shortages producing varied improvised responses [28].

Adaptive maintenance is defined here as modification that changes the form of work while deliberately preserving, restoring, or improving the safety-relevant function. Drift denotes cumulative displacement of that function through repeated local changes whose combined effect is insufficiently recognized or reviewed. Drift is a proposed construct in this article, not an outcome attributed to every adaptation. Workarounds form a third category: local departures from prescribed or expected processes used to accomplish work under constraints. A recent scoping review found mixed consequences of workarounds around safety standards and substantial representation of medication-related standards [29].

Medication administration supplies direct evidence. Prospective observation of barcode-assisted medication administration found frequent workarounds associated with contextual factors including workload [30]. A Safety-II analysis identified multiple workaround types and contributing factors with both desired and undesired potential consequences [31]. Workaround formation therefore cannot be equated with erosion. A workaround may preserve an important function when formal procedure fits poorly; it may also bypass a safeguard, conceal recurrent weakness, or become normalized in ways that displace the original safety logic.

The distinction is functional and temporal. Repeated workaround dependence may signal divergence between formal and actual work. Whether that divergence represents adaptive maintenance or emerging erosion depends on the safety function retained, new risk introduced, visibility of the change, and whether feedback produces learning or normalization without review.

*Development of the persistence–erosion model*

Methodological work on adaptation recommends linking modifications explicitly to timing and to proximal and distal outcomes [32]. Building on that logic, the Persistence–Erosion Model treats sustainability as an evolving balance among recurrent enactment, maintenance effort, knowledge continuity, adaptation, and organizational feedback.

Persistence occurs when safety-relevant functions continue to be reproduced despite variation in personnel, workload, technology, and context. Faithful repetition may characterize some components while others adapt substantially. Maintenance effort supplies resources and coordination; knowledge continuity keeps practice interpretable and teachable; adaptation preserves viability as conditions change; feedback identifies mismatches requiring repair.

Erosion begins when losses and modifications accumulate faster than replenishment and review. Staff loss may increase workload, reduce access to experienced colleagues, and increase local improvisation without necessarily causing failure. Redistribution of expertise, supported onboarding, review of emerging workarounds, and updating of formal practice may stabilize an adapted but still safety-producing configuration. Persistent pressure without adequate replenishment can instead allow tacit knowledge to thin and local deviations to become routine before terminal outcomes deteriorate. Erosion is therefore cumulative functional displacement, not a single event.

Because maintenance, learning, and adaptation remain possible, recovery is also possible. **Figure 1** shows the feedback structure and distinguishes evidence-supported relationships from the article's integrative propositions.

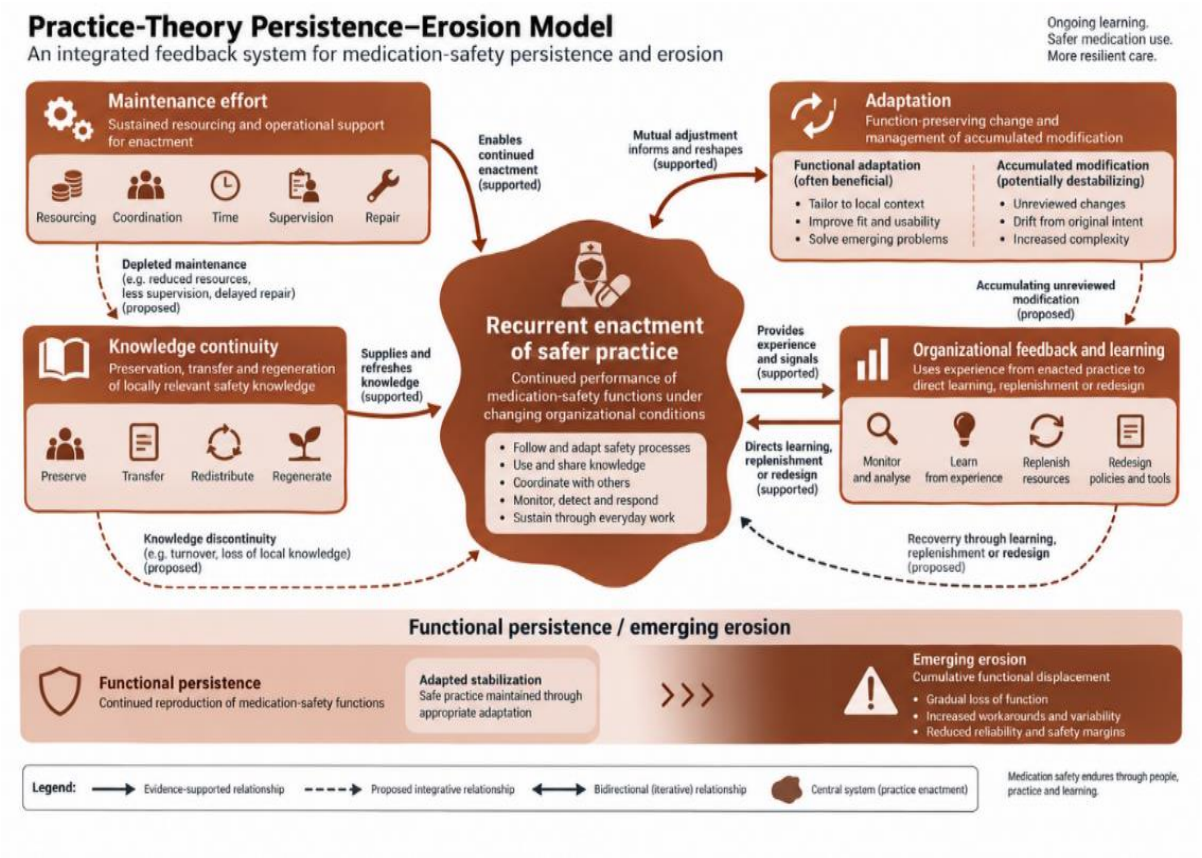


**Figure 1.** Reproduction balance in medication-safety work: feedbacks linking enactment, maintenance, knowledge continuity, and adaptation

*Conditions supporting reproduction of safer practice*

A medication-safety improvement is more likely to persist when organizations maintain the conditions that allow its protective functions to be repeatedly enacted. Learning-health-system guidance emphasizes workforce capacity, governance, access to usable evidence, data infrastructure, and feedback cycles that connect observation with adjustment [33]. These conditions matter because reproduction is rarely self-sustaining. Even well-designed routines encounter new staff, changing technologies, workload shifts, competing priorities, and altered local constraints.

The model therefore treats organizational buffering as a replenishing process. Buffering does not mean insulating practice from change. It means maintaining enough capacity to absorb disruption without losing the intervention's safety-relevant function. This can include protected learning time, experienced supervision, accessible escalation, monitoring of recurring exceptions, reliable technical support, and mechanisms for converting local adaptations into shared practice rather than leaving them tacit. Buffering is consequently functional rather than merely structural: resources matter insofar as they help practitioners continue, repair, or appropriately modify safety work.

Knowledge distribution is especially important. A practice dependent on one experienced pharmacist, technician, nurse, or manager may appear stable while that individual remains present yet be structurally fragile. More resilient reproduction distributes understanding across people, artifacts, routines, and feedback processes. Codification alone is insufficient when safe performance depends on situated judgment; conversely, tacit expertise alone creates vulnerability when staff change. The relevant condition is therefore complementary redundancy between formal guidance and situated capability.

Buffering also changes how turnover and adaptation operate. Where onboarding, cross-coverage, feedback, and knowledge transfer are strong, turnover may increase maintenance work without producing erosion. Where these supports are weak, the same staffing change can

create knowledge gaps, fragmented routines, and greater reliance on improvisation. Similarly, adaptation is more likely to remain function-preserving when its purpose is visible, consequences are reviewed, and useful local learning can travel beyond the individual or shift where it originated. Sustainability therefore depends on configurations of support rather than on the presence of a single facilitator.

*Pathways to gradual erosion*

Erosion is unlikely to appear first as complete abandonment. More plausibly, it develops through accumulating changes in how safety work is accomplished. Longitudinal sustainment research shows that practices can weaken after apparently successful implementation [8]. In the present model, this weakening begins when maintenance demands repeatedly exceed the organization's capacity to replenish people, knowledge, coordination, or feedback.

One route begins with workforce discontinuity. Staff departure can increase workload for remaining personnel, redistribute responsibilities, weaken access to experienced colleagues, and create pressure for accelerated onboarding. None of these changes necessarily damages safety. The erosion risk arises when the organization compensates by simplifying, postponing, or informally reallocating safety work in ways that become routine before their functional consequences are understood. What begins as temporary compensation can then become the locally normal version of the intervention.

A second route begins with mismatch between formal process and actual operating conditions. Local adaptations can initially preserve throughput or even protect safety, yet repeated workarounds may gradually shift actual practice away from an intended safeguard. Because workarounds can be either protective or harmful [29], their significance depends on what they preserve, what they bypass, and whether they remain visible to organizational learning. A workaround reviewed and incorporated into redesign can become adaptive maintenance; the same workaround reproduced silently across shifts can conceal a recurring system problem.

A third route involves cumulative modification without obvious crisis. Each individual change may be defensible, but interactions among changes can reduce redundancy, transfer responsibility, or alter where verification occurs. This is the core meaning of drift in the model: functional displacement emerging from the accumulation and interaction of modifications, not deliberate rule breaking. Drift may therefore remain invisible if monitoring examines only whether the intervention label or formal policy is still present.

Erosion is consequently nonuniform. One trajectory may involve turnover followed by incomplete knowledge transfer, recurrent improvisation, and declining consistency. Another may begin with rising workload, workaround dependence, and normalization of deviations. A third may involve repeated adaptation that remains functional for a time but gradually displaces a safeguard as local conditions change. None is irreversible. Replenishment, redesign, restoration of expertise, or review of recurring exceptions can stabilize practice before functional loss becomes entrenched.

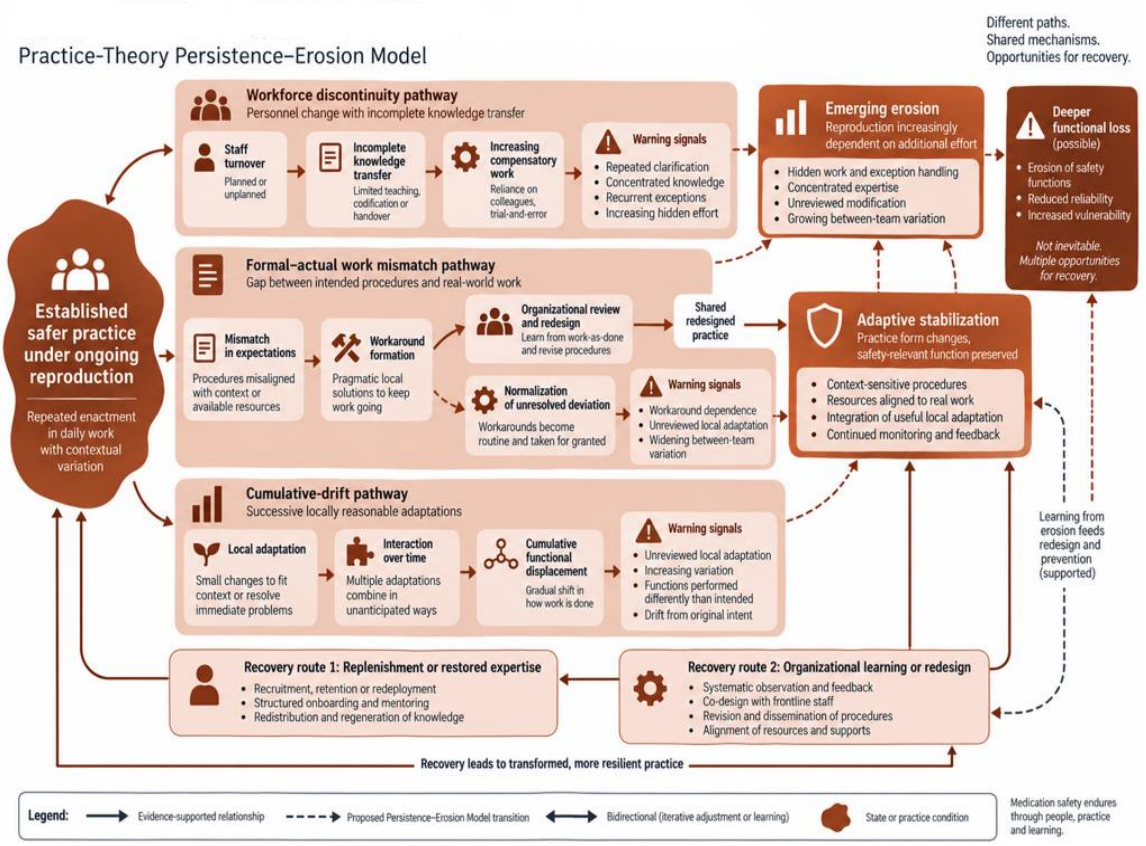


**Figure 2.** Nonuniform erosion trajectories in medication-safety work

*Detecting sustainability failure*

If erosion is gradual, detection cannot rely only on whether an intervention remains formally present. Monitoring systems for implementation require linked processes for data collection, appraisal, stakeholder engagement, and revision [34]. For medication safety, this means observing changes in the work that carries the intervention before relying solely on distal adverse outcomes.

A useful detection strategy asks three questions. First, is the safety-relevant function still being achieved? Second, has the amount or distribution of work required to achieve it changed? Third, are repeated adaptations, exceptions, or staffing transitions generating information that reaches organizational review? These questions separate surface fidelity from functional continuity. A practice may look different yet remain protective, while an apparently unchanged procedure may require increasing hidden effort or depend on a shrinking group of experienced personnel.

Useful warning signals include recurrent exception handling, growing workaround dependence, widening variation across teams, repeated clarification needs, delayed escalation, concentrated reliance on a small number of experienced staff, and adaptations that remain local rather than becoming reviewed organizational learning. None is a validated standalone threshold. Their value lies in showing where reproduction is becoming more effortful, less redundant, or more dependent on informal compensation.

Detection should also examine combinations and trajectories rather than isolated occurrences. A single workaround may be benign; a recurring workaround combined with staff loss, repeated clarification, and delayed review may indicate a different organizational state. Adaptation-sensitive monitoring should therefore connect what changed, when it changed, who carried the compensating work, and what followed. This avoids treating every deviation as failure while making cumulative drift empirically observable.

**Table 2.** Detecting emerging erosion before formal abandonment

| Observable pattern | What it may indicate | What must be checked before inferring erosion | Appropriate organizational response |
|---|---|---|---|
| **Recurrent exception handling** | Routine–practice mismatch | Whether exceptions preserve or bypass safety functions | Review recurring cases and redesign the mismatch |
| **Rising workaround dependence** | Formal process no longer fits actual work | Function preserved, new risk introduced, visibility of workaround | Examine causes and decide whether to redesign or constrain |
| **Knowledge concentrated in few staff** | Fragile continuity | Whether critical knowledge is codified, transferable, and redundant | Strengthen cross-training and situated onboarding |
| **Increasing between-team variation** | Uneven reproduction | Whether variation reflects legitimate adaptation or loss of core function | Compare functions, not surface conformity alone |
| **Repeated clarification or escalation delays** | Eroding coordination | Whether workload, access, role ambiguity, or knowledge gaps dominate | Repair access, role clarity, and feedback routes |
| **Adaptations remain local and unreviewed** | Weak organizational learning | Whether local change is beneficial, neutral, or harmful | Create review and diffusion mechanisms |

Note: Proposed diagnostic structure. The patterns are signals for investigation, not validated thresholds or causal indicators.

*Organizational and research implications*

Organizations should treat sustainability as an operating responsibility rather than a post-implementation status check. A learning-health-system orientation supports repeated observation, feedback, and revision [33]. Governance approaches that integrate knowledge mobilization and measurement across implementation phases likewise illustrate how sustainment can be embedded in organizational infrastructure [35]. For medication safety, the practical implication is to assign ownership for maintenance work, knowledge transfer, adaptation review, and response to emerging signals of erosion.

Ownership should not be interpreted as assigning sustainability to one manager or committee. The work is distributed. Front-line practitioners recognize recurring mismatches; experienced staff transmit situated knowledge; managers allocate time and staffing; quality teams aggregate signals; technology teams alter system constraints; and governance structures decide whether local adaptations should be formalized, modified, or stopped. The organizational problem is connecting these contributions so that information about changing practice can travel to actors capable of responding.

This also changes how workforce investment is evaluated. Retention remains valuable, but the model predicts that continuity of safety functions depends partly on how knowledge is distributed and regenerated. An organization with moderate turnover but strong cross-training, onboarding, documentation, and feedback may preserve practice more effectively than an organization with lower turnover but high dependence on a few knowledge holders. Workforce metrics should therefore be interpreted alongside measures of knowledge concentration, supervisory access, and repeated local compensation.

Operationally, organizations can also review maintenance burden after major staffing, technology, or workflow changes instead of waiting for annual sustainability assessments. A short post-change review can ask whether responsibilities shifted, expertise became concentrated, exceptions increased, or newly adopted workarounds have been examined. This does not create a new performance score; it makes reproductive work and its changing burden visible enough for timely organizational response.

The model also changes what should be studied. Longitudinal designs should distinguish staff turnover from actual knowledge discontinuity, document adaptations prospectively, and assess whether safety-relevant functions are preserved even when surface routines change. Multilevel studies should examine how team-level reproduction interacts with organizational staffing, technology, governance, and resource conditions. Mechanism-focused analyses should test whether maintenance capacity and knowledge continuity mediate or moderate the relationship between disruption and later sustainment.

Several discriminating tests follow. Turnover should be more strongly associated with erosion where local knowledge is poorly distributed or difficult to regenerate. Repeated adaptations should predict different trajectories depending on whether they preserve the original safety function. Clusters of recurrent workarounds may precede visible deterioration when they indicate unresolved system–practice mismatch, but they may also predict stabilization when they are reviewed and converted into safer redesign. A further test is whether leading indicators of reproductive strain—such as increasing exception work or knowledge concentration—change before conventional outcome measures. These propositions require temporal evidence and should not be interpreted as established causal effects.

## Results and Discussion

The Persistence–Erosion Model reframes medication-safety sustainability as the continuing reproduction of safety-relevant functions. Its central distinction is between an intervention remaining present and the organization continuing to accomplish the work that makes it protective. This makes maintenance effort, knowledge continuity, adaptation, and feedback theoretically central rather than peripheral post-implementation concerns.

The model adds a temporal explanation to familiar sustainability determinants. Leadership, resources, staffing, fit, and monitoring matter because they influence whether recurrent enactment can be replenished, interpreted, and repaired. Turnover becomes analytically important when it changes access to knowledge or coordination; adaptation matters according to the function it preserves or displaces; and workarounds matter according to whether they solve, signal, or conceal mismatch. These distinctions explain why the same visible event can have different implications across organizations.

The strongest rival explanation is that apparent persistence or erosion reflects external change rather than internal reproductive capacity. Funding shifts, technology redesign, demand, regulation, leadership change, or intervention complexity may alter practice independently of turnover or maintenance effort. The model therefore does not assign erosion to a single cause. It proposes that these pressures matter through their interaction with an organization's capacity to replenish knowledge, coordinate work, review adaptations, and restore disrupted functions. Empirical tests should compare this account against explanations based primarily on intervention characteristics or external shocks.

The evidence base also imposes boundaries. Much sustainment research comes from healthcare domains outside pharmacy, and turnover evidence is dominated by nursing. Direct medication-safety evidence is stronger for workarounds and medication-administration processes than for long-term persistence trajectories. Workarounds themselves have mixed consequences, making them inappropriate as automatic markers of failure. The model should therefore be tested prospectively in medication-safety interventions with repeated measurement of implementation, workforce transitions, adaptation, work practices, and safety-relevant functions.

A further boundary concerns automation. Where a safety function is strongly encoded in reliable technology and minimally dependent on discretionary local work, personnel turnover may have less influence than the model predicts. Conversely, settings dependent on tacit coordination may be highly sensitive to the departure of experienced staff even when formal procedures remain unchanged. These contrasts make the model falsifiable: similar interventions should display different trajectories when their dependence on situated knowledge and maintenance work differs.

The model also resists equating persistence with fidelity. Exact procedural stability may be undesirable when technologies, populations, or workflows change. Conversely, extensive local adaptation can be compatible with persistence when the safety function remains intact and consequences are reviewed. The appropriate unit of sustainability analysis is therefore neither the intervention label nor surface conformity alone, but the continued organizational capacity to reproduce the relevant protective function under changing conditions.

## Conclusion

Medication-safety improvement does not sustain itself merely because an intervention remains in place. Persistence depends on the repeated organizational accomplishment of its safety-relevant functions through enactment, maintenance, knowledge continuity, adaptation, and learning. Turnover, workarounds, and modification become threats when they weaken those functions faster than the organization can replenish or

repair them, but each can also be absorbed or redirected under supportive conditions. Sustainability is therefore best understood as a dynamic balance between reproduction and erosion, with persistence, adaptation, stabilization, decline, and recovery all remaining possible over time. The central implication is conditional: medication-safety improvements persist when organizations continue to reproduce, replenish, and appropriately adapt the work that carries their protective functions.

**Acknowledgments:** None

**Conflict of Interest:** None

**Financial Support:** None

**Ethics Statement:** None

**References**

1. Moore JE, Mascarenhas A, Bain J, Straus SE. Developing a comprehensive definition of sustainability. Implement Sci. 2017;12(1):110. doi:10.1186/s13012-017-0637-1
2. Lennox L, Maher L, Reed J. Navigating the sustainability landscape: A systematic review of sustainability approaches in healthcare. Implement Sci. 2018;13(1):27. doi:10.1186/s13012-017-0707-4
3. Shelton RC, Cooper BR, Stirman SW. The sustainability of evidence-based interventions and practices in public health and health care. Annu Rev Public Health. 2018;39:55-76. doi:10.1146/annurev-publhealth-040617-014731
4. Proctor EK, Bunger AC, Lengnick-Hall R, Gerke DR, Martin JK, Phillips RJ, et al. Ten years of implementation outcomes research: A scoping review. Implement Sci. 2023;18(1):31. doi:10.1186/s13012-023-01286-z
5. Zurynski Y, Ludlow K, Testa L, Augustsson H, Herkes-Deane J, Hutchinson K, et al. Built to last? Barriers and facilitators of healthcare program sustainability: A systematic integrative review. Implement Sci. 2023;18(1):62. doi:10.1186/s13012-023-01315-x
6. Sun L, Booth A, Sworn K. Adaptability, scalability and sustainability (ASaS) of complex health interventions: A systematic review of theories, models and frameworks. Implement Sci. 2024;19(1):52. doi:10.1186/s13012-024-01375-7
7. Nevedal AL, Opra Widerquist MA, Reardon CM, Arasim M, Jackson GL, White B, et al. Understanding pathways from implementation to sustainment: A longitudinal, mixed methods analysis of promising practices implemented in the Veterans Health Administration. Implement Sci. 2024;19(1):34. doi:10.1186/s13012-024-01361-z
8. Dopp AR, Bongard M, Han B, Hindmarch GM, Shiferaw M, Mendon-Plasek SJ, et al. Minimal progress toward sustainment: 10-year replication of substance use EBP sustainment trajectories and associations with implementation characteristics. Implement Sci. 2025;21(1):3. doi:10.1186/s13012-025-01471-2
9. Moreland-Russell S, Combs T, Gannon J, Jost E, Farah Saliba L, Prewitt K, et al. Action planning for building public health program sustainability: Results from a group-randomized trial. Implement Sci. 2024;19(1):9. doi:10.1186/s13012-024-01340-4
10. May CR, Cummings A, Girling M, Bracher M, Mair FS, May CM, et al. Using Normalization Process Theory in feasibility studies and process evaluations of complex healthcare interventions: A systematic review. Implement Sci. 2018;13(1):80. doi:10.1186/s13012-018-0758-1
11. Greenhalgh T, Wherton J, Papoutsi C, Lynch J, Hughes G, A'Court C, et al. Beyond adoption: A new framework for theorizing and evaluating nonadoption, abandonment, and challenges to the scale-up, spread, and sustainability of health and care technologies. J Med Internet Res. 2017;19(11). doi:10.2196/jmir.8775
12. Lengnick-Hall R, Williams NJ, Ehrhart MG, Willging CE, Bunger AC, Beidas RS, et al. Eight characteristics of rigorous multilevel implementation research: A step-by-step guide. Implement Sci. 2023;18(1):52. doi:10.1186/s13012-023-01302-2
13. Geng EH, Powell BJ, Goss CW, Lewis CC, Sales AE, Kim B. When the parts are greater than the whole: How understanding mechanisms can advance implementation research. Implement Sci. 2025;20(1):22. doi:10.1186/s13012-025-01427-6
14. Hailemariam M, Bustos T, Montgomery B, Barajas R, Evans LB, Drahota A. Evidence-based intervention sustainability strategies: A systematic

review. Implement Sci. 2019;14(1):57. doi:10.1186/s13012-019-0910-6
15. Curtis K, Kennedy B, Considine J, Murphy M, Lam MK, Aggar C, et al. Successful and sustained implementation of a behaviour-change informed strategy for emergency nurses: A multicentre implementation evaluation. Implement Sci. 2024;19(1):54. doi:10.1186/s13012-024-01383-7
16. Kepper MM, L'Hotta AJ, Shato T, Kwan BM, Glasgow RE, Luke D, et al. Supporting teams with designing for dissemination and sustainability: The design, development, and usability of a digital interactive platform. Implement Sci. 2024;19(1):82. doi:10.1186/s13012-024-01410-7
17. Ishii K, Takemura Y, Kitamura A. Organizational transformation elements for evidence-based practice by hospital nursing staff: A qualitative study using 7-S framework. BMC Nurs. 2025;24(1):625. doi:10.1186/s12912-025-03271-x
18. Zhang N, Zhang Q, Li C, Huang Y, Hu J, Wang J, et al. Barriers and facilitators of implementation sustainability of evidence-based practice for peristomal irritant contact dermatitis: A descriptive qualitative study. Int J Nurs Sci. 2025;12(3):285-92. doi:10.1016/j.ijnss.2025.04.002
19. Bae SH. Assessing the impacts of nurse staffing and work schedules on nurse turnover: A systematic review. Int Nurs Rev. 2024;71(1):168-79. doi:10.1111/inr.12849
20. Ren H, Li P, Xue Y, Xin W, Yin X, Li H. Global prevalence of nurse turnover rates: A meta-analysis of 21 studies from 14 countries. J Nurs Manag. 2024;2024:5063998. doi:10.1155/2024/5063998
21. McDermott I, Willis S, Hindi A, Schafheutle E. Why are pharmacy technicians leaving? Factors contributing to turnover intention and strategies for retention. Res Social Adm Pharm. 2025;21(2):94-103. doi:10.1016/j.sapharm.2024.10.010
22. Kiptulon EK, Elmadani M, Szőllősi A, Zrínyi M, Ujváriné Siket A. The race to retain nursing workforce in healthcare: An umbrella review of effectiveness of retention interventions and strategies. BMC Health Serv Res. 2025;25(1):1344. doi:10.1186/s12913-025-13365-6
23. Mauricio K, Bulger AL, Jurgens CY, Ruscitti B, Gregory KE, Bowser D. Nurse practice environment, job satisfaction, and turnover and patient falls. JAMA Netw Open. 2025;8(12). doi:10.1001/jamanetworkopen.2025.51223
24. Chang SY, Sunaryo EYAB, Kristamuliana K, Lee HF, Chen CM. Factors influencing nurses' turnover: An umbrella review. Nurs Outlook. 2025;73(5):102464. doi:10.1016/j.outlook.2025.102464
25. Stirman SW, Baumann AA, Miller CJ. The FRAME: An expanded framework for reporting adaptations and modifications to evidence-based interventions. Implement Sci. 2019;14(1):58. doi:10.1186/s13012-019-0898-y
26. McCarthy MS, Ujano-De Motta LL, Nunnery MA, Gilmartin H, Kelley L, Wills A, et al. Understanding adaptations in the Veteran Health Administration's Transitions Nurse Program: Refining methodology and pragmatic implications for scale-up. Implement Sci. 2021;16(1):71. doi:10.1186/s13012-021-01126-y
27. Page B, Irving D, Amalberti R, Vincent C. Health services under pressure: A scoping review and development of a taxonomy of adaptive strategies. BMJ Qual Saf. 2024;33(11):738-47. doi:10.1136/bmjqs-2023-016686
28. Page B, Irving D, Carthey J, Welch J, Higham H, Vincent C. Strategies for adapting under pressure: An interview study in intensive care units. BMJ Qual Saf. 2025;34(2):81-91. doi:10.1136/bmjqs-2024-017385
29. Clark D, Lawton R, Baxter R, Sheard L, O'Hara JK. Do healthcare professionals work around safety standards, and should we be worried? A scoping review. BMJ Qual Saf. 2025;34(5):317-29. doi:10.1136/bmjqs-2024-017546
30. van der Veen W, Taxis K, Wouters H, Vermeulen H, Bates DW, van den Bemt PMLA; BCMA Study Group. Factors associated with workarounds in barcode-assisted medication administration in hospitals. J Clin Nurs. 2020;29(13-14):2239-50. doi:10.1111/jocn.15217
31. Cossul D, Saurin TA, Fraga RS, Pasin SS, Kuchenbecker RS. Learning from workarounds in barcode medication administration: A Safety-II perspective. Appl Ergon. 2025;129:104605. doi:10.1016/j.apergo.2025.104605
32. Aschbrenner KA, Rabin BA, Bartels SJ, Glasgow RE. Methodological recommendations for assessing the impact of adaptations on outcomes in implementation research. Implement Sci. 2025;20(1):30. doi:10.1186/s13012-025-01441-8

33. Lane C, McCrabb S, Turon H, Bialek C, Couper L, Wilczynska M, et al. Learning health system for implementation, scale-up, and sustainment: A systematic review to consolidate guidance for improvement. Implement Sci. 2026;21(1):13. doi:10.1186/s13012-025-01482-z
34. Zucca A, Lane C, Pascoe W, Peden B, Gardner C, Shoesmith A, et al. Monitoring systems for public health program and policy implementation in community settings: Features and suggested actions from a scoping review. Implement Sci. 2026;21(1):49. doi:10.1186/s13012-026-01491-6
35. Grinspun D, Chee J, Pavez Hurtado T, Bonilla Marciales AP, Tian R, Moreno-Casbas MT. The Best Practice Spotlight Organization® Model: An integrated guideline implementation methodology. Int J Nurs Sci. 2026;13(3):230-9. doi:10.1016/j.ijnss.2026.04.007