

Enhancing Pediatric Patient Safety through Standardized Clinical Deterioration and Escalation Pathways in Saudi Hospitals

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Abstract- *Failure to recognize and respond to pediatric deterioration is a preventable patient-safety risk. Children may compensate physiologically before declining rapidly, while incomplete observations, age-inappropriate thresholds, hierarchical communication and unclear escalation responsibilities can delay intervention. This integrative review examines how Saudi hospitals can strengthen pediatric safety through standardized deterioration and escalation pathways. Evidence on Pediatric Early Warning Systems (PEWS), rapid response systems, structured communication, family activation and safety governance was synthesized and interpreted within Saudi Arabia's Health Sector Transformation Program. PEWS can improve situational awareness and communication, but a score alone does not guarantee better outcomes. Effective pathways combine reliable measurement, clinical concern, tiered escalation, time-bound response, treatment bundles, reassessment and organizational learning. The paper proposes a national adaptable framework with three escalation tiers, family concern as an independent trigger, electronic decision support and a balanced implementation dashboard. Standardization should preserve clinical judgement while reducing unwarranted variation. Saudi hospitals can use the framework to improve early rescue, reduce preventable cardiac arrest and unplanned intensive-care admission, and strengthen a culture in which escalation is expected, documented and supported.*

Indexed Terms- *pediatric patient safety; clinical deterioration; Pediatric Early Warning System; escalation of care; rapid response; Saudi Arabia; Vision 2030.*

I. INTRODUCTION

Hospitalized children may deteriorate because of sepsis, respiratory failure, neurological emergencies, cardiac disease, metabolic disturbance or postoperative complications. Unlike many adults, children can maintain apparently acceptable blood pressure until late shock. Recognition therefore depends on trends in respiratory effort, heart rate, perfusion, mental status, oxygen requirement and staff

or caregiver concern. When these signals are measured inconsistently or escalation depends on individual confidence, rescue becomes vulnerable to delay.

Clinical deterioration is a systems problem rather than a single missed observation. Harm can occur at several interfaces: observations may be incomplete; abnormal values may be normalized; a score may be calculated incorrectly; a junior clinician may hesitate to call; a senior reviewer may not arrive; treatment may start without reassessment; or transfer may stall because critical-care capacity is unclear. The WHO Global Patient Safety Action Plan 2021-2030 emphasizes eliminating avoidable harm through high-reliability systems, patient and family engagement, workforce capability, information and learning (WHO, 2021). These priorities align with Saudi Vision 2030 objectives to improve access, quality and value.

This review aims to develop an implementation framework for standardized pediatric deterioration and escalation pathways in Saudi hospitals. Its objectives are to summarize the evidence, identify design requirements, define a practical escalation model and propose measures for evaluating safety and equity.

II. METHODOLOGY

An integrative narrative review was undertaken using literature published mainly between 2020 and 2025. Search concepts included pediatric clinical deterioration, PEWS, rapid response teams, escalation of care, family-activated response, sepsis recognition, implementation science and patient safety. Peer-reviewed reviews, multicentre studies, quality-improvement reports and authoritative guidance were considered. Evidence was organized across five stages: detection, assessment, escalation, response and learning. Because PEWS tools and outcome definitions vary substantially, the review emphasizes

consistent mechanisms and implementation conditions rather than ranking a single score.

III. CLINICAL DETERIORATION AS A PEDIATRIC SAFETY PRIORITY

3.1 Why deterioration is difficult to recognize

Normal vital-sign ranges change with age, activity, fever and sleep. A single threshold may therefore create false reassurance or alarm fatigue. Respiratory decline may first appear as increasing work of breathing or oxygen need rather than a dramatic saturation change. Compensated shock may present through tachycardia, delayed capillary refill, reduced urine output or altered interaction. Reliable detection requires complete observations, age-adjusted interpretation and attention to trends. Clinical concern

must override a low score when the child's appearance or trajectory is worrying.

3.2 Human and organizational barriers

Escalation is shaped by culture. Hierarchy, fear of criticism, workload, unclear responsibility and previous non-response can suppress speaking up. Fragmented records can hide trends across shifts. Families may notice subtle behavioral change before staff but feel unable to challenge the plan. Standardization should make escalation an expected safety behavior, protect staff who raise concern and require a documented response. Leaders must monitor not only whether calls occur but whether they are answered within the agreed time.

Table 1. Common deterioration-pathway failures and safety controls

Failure point	Patient-safety risk	Standardized control
Incomplete observations	Deterioration remains invisible	Minimum observation set, frequency rules and electronic completeness prompts
Incorrect age threshold	False reassurance or excessive alerts	Age-banded parameters with local validation and transparent override
Score without clinical context	Serious illness missed despite a low number	Staff and family concern as independent escalation triggers
Unclear escalation ownership	Calls are delayed or passed between teams	Named responder, backup tier and maximum response time
Treatment without reassessment	Failure to identify non-response	Time-stamped reassessment and automatic upward escalation
Weak organizational learning	Same defects recur	Case review, feedback, dashboard and accountable action closure

IV. EVIDENCE ON EARLY WARNING AND RAPID RESPONSE SYSTEMS

PEWS converts physiological observations and clinical features into a standardized risk signal. Its strongest contribution is often improved shared language: nurses, physicians and rapid response teams can communicate severity and trend quickly. Reviews suggest that early warning systems can support recognition and escalation, but evidence for mortality reduction is heterogeneous because tools, settings, adherence and response capacity differ (Chapman et al., 2019; Lambert et al., 2017; Trubey et al., 2019). A

technically accurate score cannot compensate for missing observations or an unavailable responder.

Rapid response systems provide the clinical capability behind the trigger. Mature systems include an afferent limb that detects deterioration, an efferent limb that responds, governance that reviews performance, and administrative support for staffing and improvement. Pediatric rapid response teams may reduce ward cardiac arrests and facilitate earlier intensive-care transfer, particularly when activation criteria include clinician worry and when teams can be called without seeking permission (Bonafide et al., 2014; Roland et al., 2014). The safety objective is not to avoid every

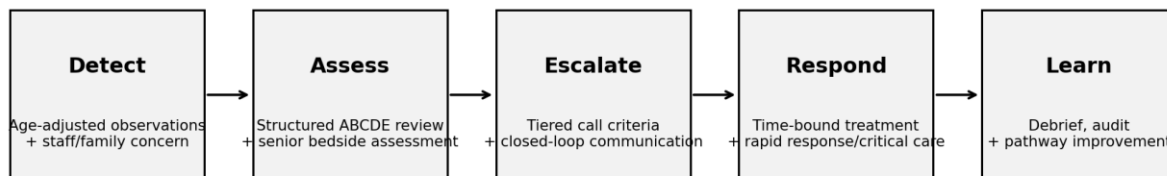
ICU transfer; it is to avoid late, unstable and preventable transfer.

Family activation is a complementary safeguard. Caregivers know the child's usual behavior and can recognize subtle change. Hospitals should provide a direct route for families to request urgent review after concerns have not been resolved. This does not replace routine communication; it creates an additional barrier against failure to rescue. Materials must be available in Arabic and other common languages and should explain that calling will not affect care relationships.

V. PROPOSED STANDARDIZED PATHWAY FOR SAUDI HOSPITALS

The proposed pathway begins with routine risk-based monitoring and continues until recovery or transfer. It uses a score as decision support, not as a substitute for clinical judgement. Figure 1 summarizes the cycle.

Standardized pediatric deterioration and escalation pathway



Reassessment continues after every intervention; family concern can trigger escalation at any stage.

Figure 1. Standardized pediatric deterioration and escalation pathway (author-developed).

5.1 Detection and documentation

Every inpatient area caring for children should use a defined minimum observation set: respiratory rate and effort, oxygen saturation and therapy, heart rate, blood pressure when indicated, temperature, consciousness or behavior, perfusion and pain. Frequency should reflect diagnosis, treatment and prior abnormalities. Electronic records should display trends, flag missing data and prevent silent normalization of values. High-risk children require individualized parameters documented by a senior clinician.

5.2 Tiered escalation

Tier 1 represents emerging concern and requires prompt bedside reassessment by the responsible nurse and clinician, correction of reversible problems and a documented monitoring plan. Tier 2 represents

significant or persistent abnormality and requires senior pediatric review within a defined time, structured ABCDE assessment and early treatment bundles. Tier 3 represents severe deterioration, any life-threatening concern or failure to respond and activates the rapid response or critical-care team immediately. Staff concern, family concern, repeated trigger or rapid trajectory can move a patient directly to a higher tier.

5.3 Closed-loop response and reassessment

Escalation is complete only when the call is acknowledged, the responder arrives, assessment occurs, actions are assigned and the child is reassessed. Communication should follow a standardized format such as SBAR, but the pathway must record time, urgency and ownership. Sepsis,

asthma, anaphylaxis, seizures and shock should link to condition-specific bundles. If the response target is missed or the child does not improve, escalation automatically advances to the next level.

5.4 Safe transfer

Children requiring critical care need early destination and transport planning. The referring team should stabilize airway, breathing, circulation, glucose and

temperature; estimate weight; secure appropriate access; and communicate physiological trends and treatment response. The receiving team should confirm acceptance and bed or service destination. Structured handover reduces information loss. Parents should receive clear updates, and safeguarding or language needs must accompany the transfer plan.

Table 2. Illustrative three-tier pediatric escalation model; exact thresholds require local validation

Escalation level	Typical triggers	Required response	Maximum target
Tier 1: concern	New mild abnormality, worsening trend, staff or family concern	Repeat observations; bedside review; initial intervention; monitoring plan	Within 30 minutes
Tier 2: urgent	Multiple abnormalities, persistent trigger, increasing oxygen or treatment need	Senior pediatric review; ABCDE assessment; treatment bundle; notify higher care	Within 15 minutes
Tier 3: emergency	Severe abnormality, airway/breathing compromise, shock, seizure, reduced consciousness or rapid decline	Immediate rapid response/critical care activation; resuscitation; prepare transfer	Immediate
Override	Any clinician or caregiver judges the child critically unwell	Activate the clinically appropriate tier regardless of calculated score	No delay

VI. IMPLEMENTATION IN THE SAUDI CONTEXT

A national core standard with local adaptation would reduce unwarranted variation while recognizing differences among tertiary, general and remote hospitals. Core elements should include one minimum observation set, approved age bands, three escalation tiers, independent concern triggers, response-time standards, family activation, structured transfer and mandatory case review after serious events. Hospitals may retain different electronic systems, but definitions and reporting should be interoperable.

Implementation should begin with baseline observation audits and staff interviews. Multidisciplinary design must include nurses, pediatricians, emergency and intensive-care clinicians, pharmacists, informatics teams, quality leaders and families. Training should combine brief instruction with ward-based simulation. Electronic alerts should be introduced carefully to avoid alarm fatigue; alerts need clear ownership, sensible

suppression rules and performance monitoring. Rollout should start in pilot wards, with rapid-cycle improvement before hospital-wide adoption.

Equity requires attention. Escalation performance should be compared by hospital type, region, language and time of day. Family materials should be multilingual and accessible. Smaller hospitals need remote senior advice and explicit transfer agreements so that a national standard does not become an unfunded requirement. The pathway should align with CBAHI expectations for patient assessment, communication, emergency response and quality improvement, while measurement supports Vision 2030's emphasis on safer, higher-value care.

VII. MEASUREMENT AND GOVERNANCE

A balanced dashboard should combine outcome, process and balancing measures. Outcomes include ward cardiac arrest, unplanned ICU admission, invasive ventilation soon after transfer, and preventable deterioration-related harm. Process

measures include complete observations, correct scoring, response within target, senior review, reassessment and family communication. Balancing measures include false alerts, staff workload, unnecessary transfers and alert overrides. Data should

be reviewed monthly by a pediatric deterioration committee with authority to assign and close corrective actions.

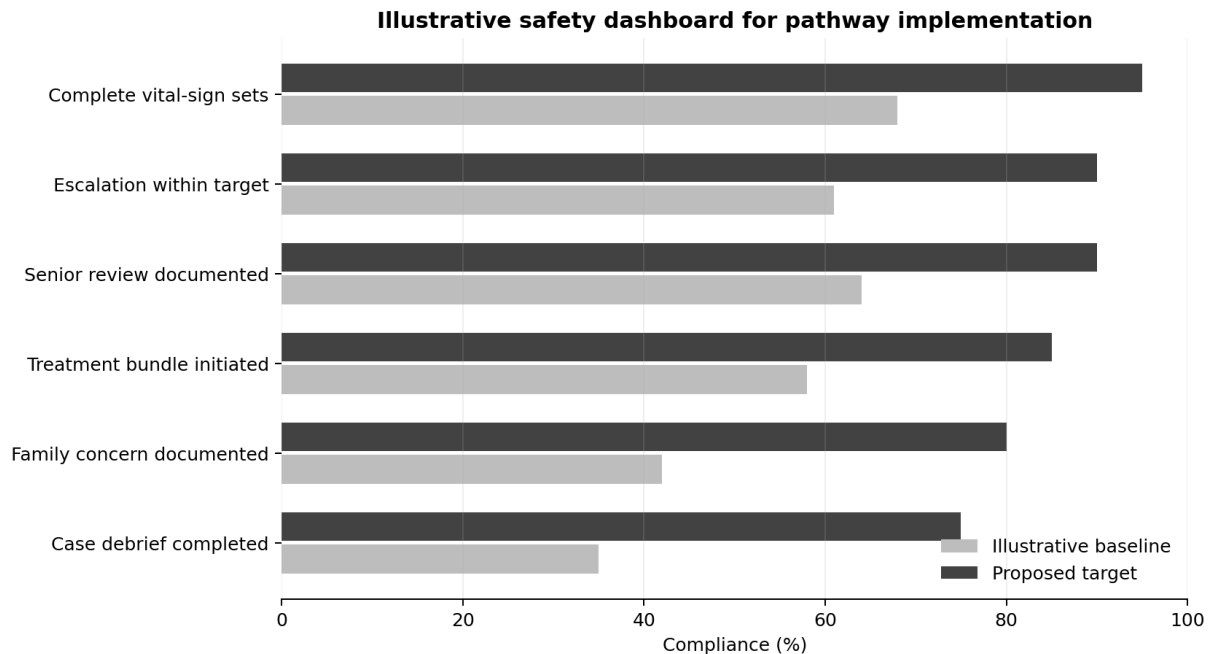


Figure 2. Illustrative safety dashboard; values are examples and not patient data.

Serious cases require structured review that reconstructs the timeline from first abnormal observation to definitive response. Reviews should identify latent system conditions rather than attribute harm solely to individual error. Feedback must reach frontline teams quickly, and repeated defects should trigger pathway redesign, staffing action or technology change. Annual external benchmarking can support consistency across hospital networks.

7.1 Designing Age-Adjusted Observation Standards

A national pathway should define the minimum observation dataset while allowing clinical services to add condition-specific measures. Respiratory rate must be counted accurately rather than estimated, and oxygen saturation should always be interpreted with oxygen delivery and work of breathing. Heart rate should be assessed with temperature, pain, medication and hydration status. Blood pressure is valuable but can remain preserved until late shock; it must not be used as the sole circulation trigger. Conscious level, behavior, capillary refill, urine output and caregiver

description provide complementary information. Age bands should be transparent, embedded in electronic records and visible at the bedside. When a child has congenital heart disease, chronic lung disease or another condition with unusual baseline values, a senior clinician should document individualized parameters, escalation conditions and review frequency. This prevents inappropriate alarms while ensuring that deviation from the child's own baseline remains visible.

7.2 Nursing Surveillance and Interprofessional Communication

Nurses are central to deterioration recognition because they observe changes across time, treatments and family interactions. The pathway should protect nursing authority to escalate directly and should not require sequential permission when emergency criteria are present. Structured safety huddles can identify children with rising oxygen need, repeated triggers, recent transfer from critical care or staff concern. During handover, the team should communicate

trajectory rather than isolated values: what has changed, how quickly, what treatment was given and whether the child responded. SBAR can organize the call, but it must include a clear request and urgency. The receiver should repeat critical information and state an arrival time. If that target is missed, the caller must have a named backup route. Interprofessional simulation is useful because it reveals hierarchy, role ambiguity and communication delay that written policy cannot detect.

7.3 Integrating Sepsis and Respiratory Failure Pathways

Early warning systems are most effective when connected to treatment. For suspected sepsis, escalation should trigger focused assessment of perfusion, mental status, lactate or other indicated tests, antimicrobial timing, source evaluation and repeated review after fluids. Fluid treatment requires caution and reassessment because not every child benefits from repeated boluses. For respiratory deterioration, the pathway should record work of breathing, oxygen requirement, air entry, fatigue and response to bronchodilator or respiratory support. Increasing oxygen or repeated rescue treatment should raise the escalation level even when saturation temporarily improves. High-flow oxygen, non-invasive ventilation or invasive support requires clear location and competency rules. Linking general deterioration triggers with diagnosis-specific bundles reduces the gap between calling for help and delivering effective care. Audit should examine both response time and completion of the appropriate clinical bundle.

7.4 Medication Safety during Escalation

Deteriorating children are vulnerable to medication error because doses depend on weight, urgency compresses checking time and multiple teams may work simultaneously. The pathway should require a current measured weight when feasible, with an approved estimation method for emergencies. Standard concentrations, smart-pump libraries and clearly separated high-alert medicines reduce variation. Verbal orders should use closed-loop confirmation, including drug, dose, route and units. Decimal notation needs particular care, and trailing zeros should be prohibited. A designated clinician or nurse should maintain an intervention timeline during

resuscitation to prevent duplicate dosing and missed reassessment. Pharmacy involvement in rapid response governance can identify recurring calculation, storage or availability problems. Medication incidents and near misses should be reviewed as pathway data rather than as isolated pharmacy events.

7.5 Family Activation and Safeguarding

A family escalation process should be simple, visible and independent of the ordinary complaint route. Parents need to know whom to contact when they believe the child is becoming worse or when repeated concerns have not produced review. Staff should first encourage families to speak with the bedside team, but an unresolved concern must permit direct activation of a senior clinical response. The process should be explained at admission and displayed in Arabic, English and other locally relevant languages. Activation data can reveal communication gaps, delayed review and differences in access. Safeguarding remains essential: caregiver concern should be heard without automatically accepting unsafe requests, and unaccompanied or vulnerable children require appropriate protection. The response should document the concern, assessment, explanation and agreed plan so families are partners in safety rather than informal observers.

7.6 Electronic Decision Support and Alarm Governance

Electronic PEWS can calculate scores, display trends and notify responders, reducing arithmetic error and supporting audit. However, poorly designed alerts can create fatigue, interruption and workarounds. Governance should specify which values generate an alert, who receives it, expected acknowledgment time, escalation after non-response and rules for temporary suppression. The interface should show the clinical components behind the score so users can understand why risk increased. Overrides should require a reason but remain possible when senior judgement supports an individualized plan. Hospitals should monitor alert volume, positive predictive value, acknowledgment, response time and missed deterioration. Technology teams need a clinical safety process for software updates, device integration and downtime. Before deployment, usability testing should involve nurses

and physicians from high- and low-acuity wards, night shifts and smaller facilities.

7.7 Education, Simulation and Competency Assessment

Education should teach the complete rescue process rather than score calculation alone. Staff need to recognize age-specific abnormality, communicate concern, initiate ABCDE assessment, deliver immediate treatment, activate the correct tier and reassess. Simulation scenarios should include ambiguous early deterioration, competing workload, family concern, delayed responder arrival and transfer barriers. Debriefing should examine technical care and system behavior, including whether junior staff felt able to escalate. Competency can be assessed through chart review, direct observation and simulation performance. New staff require pathway orientation before independent duty, while established teams need short recurring refreshers. Training data should be linked with incident patterns; for example, repeated delay in recognizing respiratory fatigue should lead to targeted practice. Simulation findings require the same action tracking as real incidents, because an uncorrected drill failure predicts vulnerability.

7.8 Equity across Hospital Types and Regions

A standardized pathway must not assume that every hospital has on-site pediatric intensive care. Secondary and remote hospitals need defined access to senior pediatric advice, transport coordination and receiving centres. Response standards may use different team configurations while preserving the same safety functions. Teleconsultation can support assessment, but local teams must retain competence in immediate stabilization. Measurement should compare performance by region, hospital level, time of day, language and insurance or residency status where ethically and legally appropriate. Large differences may indicate workforce, transport or communication barriers rather than patient complexity. National benchmarking should avoid punishing hospitals that report openly; its purpose should be improvement and targeted support. Investment can then prioritize sites with delayed senior response, incomplete monitoring or recurrent transfer instability.

7.9 Research and Evaluation Design

Saudi evaluation should move beyond before-and-after counts from a single ward. A stepped-wedge implementation across hospitals could introduce the pathway sequentially while examining trends in unplanned intensive-care admission, ward cardiac arrest, urgent interventions and response time. Interrupted time-series analysis can separate intervention effects from existing improvement. Qualitative interviews with staff and families can explain why triggers were ignored, escalations delayed or alerts overridden. Economic analysis should measure training, staffing and digital cost alongside intensive-care use, length of stay and avoidable harm. Predictive studies can test combinations of physiology, treatment intensity and clinician concern, but models require external validation and bias assessment before deployment. A core outcome set would allow Saudi hospitals to compare results consistently and contribute internationally relevant evidence on pediatric rescue systems.

Future evaluation should also examine sustainability after implementation. Hospitals need evidence on whether observation quality, response times and staff confidence remain stable when project support ends, leadership changes or alert volumes rise. Longitudinal audits can identify declining compliance before harm occurs. Comparative research should test which governance models maintain improvement, how frequently simulation is required, and whether feedback delivered to wards changes behavior. These findings would help Saudi health networks invest in pathway components that produce safety gains.

VIII. DISCUSSION

Standardization is valuable because deterioration is predictable as a workflow even when diagnoses differ. The same safety functions recur: observe, interpret, communicate, respond and reassess. A common pathway reduces cognitive burden and clarifies accountability. Nevertheless, excessive dependence on a numerical score can create new risk. Saudi implementation should retain concern-based activation and direct access to senior help.

Leadership behavior will determine whether the pathway works. Staff must see escalation as good practice, not failure. Responders should thank callers, explain decisions and provide feedback. Hospitals must also resource the pathway; monitoring without adequate senior or critical-care response simply identifies risk without controlling it. Digital transformation can improve trend visibility and auditability, but technology must be designed around clinical work.

The proposed framework offers a defensible national direction while leaving room for validation. A multicentre Saudi program could compare baseline and post-implementation performance using interrupted time-series or stepped-wedge designs. Research should examine which trigger combinations predict deterioration, how family activation functions across cultures and languages, and whether remote expert support improves rescue in smaller hospitals.

IX. LIMITATIONS

The evidence base includes heterogeneous tools and mostly observational implementation studies. Definitions of deterioration and rapid response vary, limiting direct comparison. Saudi-specific published evidence is limited, so the pathway requires local clinical validation, governance review and testing before use. The response-time targets in this paper are illustrative and should not replace approved hospital policy.

X. CONCLUSION

Saudi hospitals can strengthen pediatric patient safety by standardizing the pathway from early warning to definitive response. The safest model combines reliable age-adjusted observations, clinical and family concern, tiered escalation, time-bound senior response, condition-specific treatment, reassessment, safe transfer and organizational learning. PEWS should support rather than replace judgement. With national core standards, local validation, digital integration and accountable governance, the pathway can reduce preventable deterioration and advance Vision 2030 goals for quality, value and trusted healthcare.

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