



Evaluation of the Ghanaian Healthcare Environment and Patient Safety context using the SEIPS model of Work System

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Abstract

Objective:

This paper aimed to evaluate hazards contributing to patient safety incidents within Ghana's healthcare system using a human factors engineering model to trace risks across interacting domains.

Methods:

The Systems Engineering Initiative for Patient Safety (SEIPS) model framed analysis of challenges within the dimensions of healthcare Personnel, Tasks, Tools/Technology, Environment, Organization and Processes. Over 25 studies provided multi-dimensional empirical evidence, with insights synthesized across domains to depict risk pathways enabling patient harm events.

Conclusions:

The analysis reveals a severely overburdened and constrained healthcare ecosystem unable to reliably deliver safe care processes – with risks stemming from financing limitations, infrastructure deficits, equipment failures, health worker shortages and skills gaps, supply variability, leadership prioritization, and information systems. Solutions require coordinated commitment across these interdependent aspects.

Recommendations:

Six priority actions are proposed spanning governance, culture, staffing, health IT, quality programs and financing – grounded in concrete evidence-based initiatives but connected through systems thinking.

Significance:

This systems analysis substantially advances understanding of patient safety threats in Ghana to motivate action. The model approach further demonstrates application of human factors engineering methods to diagnose healthcare quality challenges in limited-resource settings.

Keywords: Ghanaian healthcare, patient safety, SEIPS model of Work System

Cite this paper as: Tenkorang-Twum, D., Atibila, F. & Gyapong, F. (2024). Evaluation of the Ghanaian Healthcare Environment and Patient Safety context using the SEIPS model of Work System. Ghana Journal of Nursing and Midwifery (GJNMID), 2024 (2), 10-19.

<https://doi.org/10.69600/GJNMID.v01.i02.10-20>



Introduction and Contextual statement

Ghana has made impressive strides expanding healthcare access, yet preventable harm events persist at alarming rates that underscore quality gaps. An estimated 1,560 mothers die annually from largely avoidable causes during childbirth across hospitals (Kyei-Nimakoh et al., 2017). Meanwhile over 113,000 babies perish within their first month, often due to lack of bag-valve ventilation support and other basic life-saving interventions (UNICEF, 2022). Medication errors also remain highly prevalent, with wrong drug or dose incidents occurring among nearly 1 in 4 inpatients at a leading teaching hospital (Truter et al., 2017).

The harms stemming from these and other adverse events take an incredible human toll, worsen outcomes, and heighten utilization costs estimated at 6-29% of hospital spending (World Bank, 2021). Yet patient safety has only recently begun to gain overdue attention within national healthcare priorities and academic literature given the focus on nursing shortages, doctor strikes, limited infrastructure and medical equipment - daily crises that disrupt care delivery across Ghana.

Still with aggressive "fifty-fifty" targets to halve facility maternal and under-five child deaths alongside goals to upgrade healthcare access and quality under the Sustainable Development Goals, addressing preventable harm within clinical environments is now imperative (GHS, 2022). This systems analysis intends to catalyze commitment by illuminating interconnected risks across Ghana's healthcare ecosystem that predicates adverse safety events. The Systems Engineering Initiative for Patient Safety (SEIPS) model will evaluate domains from capital financing through governance, materials, staffing, culture and information systems to depict how health systems deficiencies ultimately compromise reliable care processes and harm patients. Establishing this empirical baseline can help shift discussion from frustration to solutions - motivating coordinated quality investments between health and finance leaders that reliably uplift clinical environments and unlock universal health coverage gains.

Scientific Contributions

This systematic analysis makes several key scientific contributions to the understudied domain of patient safety in Ghana's healthcare sector:

Firstly, it assembles one of the more comprehensive assessments to date analyzing the range of socio-technical factors compromising patient safety outcomes using a human factors engineering model tailored to health systems. Prior discussion of healthcare challenges in Ghana has centered more on access, spending, and care quality indicators without as robust focus connecting systems-level patterns explicitly to patient safety incidents.

Secondly, in integrating over 25 studies ranging from frontline worker surveys to maternal mortality reviews, it triangulates multiple data sources to paint a multi-dimensional picture of safety hazards embedded within different aspects of care delivery. This fusion of empirical findings establishes an evidentiary baseline for the complex interplay of gaps posing risks.



Thirdly, it structures analysis using the SEIPS framework to methodically trace risks arising from the care environment through to impacts on clinical workflows and ultimate patient harm events. This causality mapping provides a foundation to trace solutions back to originating systems failures at organizational, tools/technology, infrastructure and other levels in need of intervention.

In summary, this paper works to advance patient safety science in Ghana through systematic analysis of health systems threats using human factors principles with detailed empirical grounding – establishing baseline visibility, dimensional understanding, and priority areas to catalyze targeted improvement efforts.

Practical Significance

This systems analysis of patient safety hazards in Ghana delivers several practical benefits to inspire action:

First, it generates visibility of the patient safety challenge in Ghana for policymakers and healthcare leaders who may not fully recognize the scale of adverse events occurring nor depth of systems constraints enabling risks. The aggregation of empirical evidence across multiple studies substantiates the urgency and gravity of threats that may otherwise seem isolated.

Secondly, the causal depictions of how broader healthcare ecosystem gaps manifest in clinical workflows to directly harm patients provides an accountability roadmap. Rather than nebulous claims of needing to generally invest more in healthcare, specific organizational, infrastructure, workforce and other redesign priorities are outlined that require leadership commitment to strengthen system reliability.

Thirdly, the model outlines measurable domains facility and program leaders can evaluate within their own context to self-assess safety culture, technology availability, staffing burdens, adherence to safety protocols and incidence of near misses or harm events. This enables benchmarking against the consolidated evidence-base to develop contextual solutions.

Lastly, it elevates patient safety as a distinct science warranting research and quality improvement resourcing in Ghana. The analysis approach demonstrates how human factors engineering principles can be applied to diagnose healthcare systems threats. Investing further in such methods is warranted to match solutions to country needs.

In summary, this paper provides an action-oriented platform for healthcare leaders at multiple levels to recognize threats, pinpoint areas of control, access tools, and ultimately mobilize around a shared patient safety agenda.

Analytical Framework

The SEIPS (Systems Engineering Initiative for Patient Safety) model provides a socio-technical framework for evaluating the complex interactions across the components of a healthcare work system to identify hazards and opportunities to improve patient safety outcomes.

Specifically, it considers:



- Person(s): the healthcare staff involved in care processes
- Tasks: the clinical workflow steps staff must execute
- Tools/Technology: the medical equipment, information systems etc. used by staff
- Environment: the physical infrastructure and conditions where care occurs
- Organization: the safety culture, policies, financing, leadership etc.
- Processes: the care delivery activities from initial assessment through treatment

This model was highly relevant for assessing patient safety domains within Ghana's healthcare ecosystem. By systematically analyzing each component and interdependencies, key risk factors emerged – from health worker fatigue and skills gaps to missing or failing technologies and clinical infrastructure overload. The composite picture highlights why safety protocols are challenging to implement fully and reliably in such a strained system.

The analysis was conducted by initially researching literature reviews and published studies describing Ghana's healthcare challenges and patient safety outcomes. Quantitative and qualitative findings on issues like hospital overcrowding, technology availability, healthcare spending, safety culture maturity and measurements of care quality were compiled across each SEIPS component. Reports providing root cause assessments of adverse safety events were analyzed for examples of how systems limitations directly contribute to patient harm.

The discussion integrated 25 references across peer-reviewed articles, government data sources, NGO evaluations and case reports. The model structure facilitated synthesizing the complexity of real-world interactions that compromise safety in Ghana to produce risk insights. This methodical socio-technical approach could be replicated to evaluate patient safety domains in other low-resource healthcare systems or adapted to assess quality/safety issues for specific clinical areas, care settings, or patient cohorts. The SEIPS framework helps shift discussions from individual blame toward collaborative systems solutions for strengthening patient safety.

Analysis and Results

Person:

A major factor influencing patient safety within Ghana's healthcare work system is healthcare personnel shortages, especially of highly skilled workers. Ghana has approximately 1.2 healthcare workers per 1,000 patients, far below the WHO's minimum threshold of 4.5 per 1,000 (Adisah-Atta, 2011). Such shortages lead to excessive caseloads and overtime among nurses and physicians. A cross-sectional survey across Ghana revealed that nurses regularly work 12-13 hour shifts up to 6 days per week, facing a 71% likelihood of fatigue-related clinical errors (Bakker et al., 2011). Fatigued frontline staff are at higher risk for improperly adhering to safety protocols.

Additionally, while task-shifting to less specialized cadres has been adopted to mitigate healthcare personnel deficits in Ghana, a study of 500 healthcare workers across three regions identified critical patient safety-related knowledge gaps regarding medications, patient monitoring, infection control, and



identifying adverse events (Okyere, Mwanri & Ward, 2017). Just 34% correctly identified risk factors for adverse drug events for example, reflecting need for improved competency-based training even for substitute healthcare roles.

Finally, the hierarchical nature of roles, with physicians and administrators wielding greater authority than frontline nurses for example, inhibits interdisciplinary teamwork and speaking up for safety. A survey of Ghanaian operating theatre staff found only 53% felt psychological safety to voice concerns about patient treatment to superiors (Ackah & Kwashie, 2023). Such deficiencies in team dynamics hamper detection and prevention of errors suggesting more egalitarian safety culture interventions are warranted.

In summary, while Ghana has made strides expanding its healthcare workforce, ongoing shortages coupled with issues around fatigue, occupational burnout, skills gaps related to safety practices, and impediments to open communication for some roles underscore key leverage points for improvement within the Person aspect of the nation's healthcare work system to further strengthen patient safety.

Tasks:

With healthcare worker deficits, those remaining are saddled with immense workloads, facing more complex, high-acuity cases with heightened risk profiles but limited time for complete assessments, planning, and execution of care. A time-motion study across multiple Ghanaian emergency departments revealed physicians spend just 9 minutes on average with each patient – though 73% of cases warranted more time based on complexity (Gerein, Green & Pearson, 2006). Rushed workflows contribute to missed steps in care processes, failed procedures, and suboptimal outcomes. Nurses similarly describe struggling to properly monitor assigned patients given inadequate staff numbers, using faulty cognitive shortcuts that introduce clinical errors (Vaismoradi et al., 2020).

While health worker task-shifting has been touted to mitigate personnel shortfalls in Ghana, additional patient safety risks arise when less qualified cadres take on roles with less training. A series of focus groups with community health volunteers recently assigned to administer medications, wound care, and maternal health duties revealed most felt unprepared for such clinical responsibilities without supervisory support (Okyere et al., 2017). As frontline workers operate beyond their competencies, the odds of mistakes heighten considerably.

Finally, fragmented health information systems that rely heavily upon paper-based records lead to impaired communication, delays finding needed data, and missed steps coordinating care across settings. Investigations into maternal mortality clusters in Ghana pointed to poor handoffs and misplaced laboratory results or blood products during referrals (Dzakpasu, 2012). Digitizing processes for ordering tests, transmitting records, clinical decision support, and data reporting could thus strengthen reliable task completion.

In summary, healthcare personnel shortfalls significantly reshape workflows, forcing staff to operate under strained conditions raising risks of adverse events. Targeted changes to task allocation, training for complex cases, and health IT adoption could help buffer some related patient safety gaps.



Tools/Technology:

With limited infrastructure investments, Ghanaian healthcare facilities often lack necessary physical space and layouts to safely execute clinical care tasks. A study of district hospitals revealed most operating theatres, emergency units, and maternity wards exceeded recommended occupancy rates by 3-4 fold, with beds crammed closely together (Bosu et al., 2007). Such overcrowding fuels rising infections, delays in responses to deteriorating patients, and risks of falls or other incidents. Nurses describe struggling to even access patients for routine checks given cramped quarters (Vaismoradi et al., 2020).

The physical state of disrepair also causes direct incidents. For example, a regional hospital assessment linked ceiling leaks to contamination of sterile instrument trays used in orthopedic procedures (Asuman, Ackah & Enemark, 2018). Infrastructure breakdowns divert clinical activities to preventive maintenance. And where climate control systems are lacking, extremes of heat in particular have been tied to impaired provider cognitive performance (Tawiah et al., 2017).

Finally, the care environment extends beyond the facility walls to encompass supply chain integrity. Medication shortages necessitate sometimes inadequate substitutions or rationing in doses. Clinicians report supply uncertainty leads to burnout, feeling they cannot properly care for patients (Odonkor & Frimpong, 2020). Where consumables like gloves, syringes, or disinfectants are depleted, compliance with safety protocols wavers. These factors again interact – without reliable tools to prevent infections, overburdened nurses in crowded spaces heighten transmission risks.

In summary, while Ghana has expanded facility infrastructure, persisting gaps in capacity, design, and reliability coupled with supply chain challenges coalesce to undermine safe execution of clinical workflows. Renewed policy commitments to capital investments, preventative maintenance, storage/transport considerations, and climate resiliency planning could help transform hazardous care environments.

Organizational:

Ghana's healthcare sector struggles with systemic organizational deficiencies that introduce risks and hinder mitigation across clinical environments:

Foremost, extreme constraints in health financing curtail facilities' abilities to maintain safe infrastructure, purchase medical equipment, offer competitive salaries to retain staff, and invest in continuous safety improvements. Current expenditures remain around \$67 per capita – sharply below the \$100 benchmark deemed necessary to provide essential care in low to middle income countries (Adisah-Atta, 2017). The resultant gaps manifest in substandard care conditions, technology failures, overextended workforces, and variable safety protocol adoption as explored in prior sections. Targeted policies to increase public health funding levels could begin addressing these interrelated hazards.

Secondly, incident surveillance and reporting systems to monitor safety gaps remain marginal within most care settings. A survey of 64 Ghanaian hospitals found just 14% had functioning occurrence screening mechanisms (Agyepong et al., 2017), and among facilities with basic reporting channels, the lack of robust



closed-loop processes to analyze incidents for root contributing factors and implements system-level solutions results in safety hazards persisting indefinitely. For example, case reviews of facility-based maternal mortalities repeatedly documented delayed responses to postpartum hemorrhages due to such long-standing health systems issues as nursing personnel shortages on labor wards and delays receiving blood products from overloaded laboratories (Sacks et al., 2022).

Lastly, there is little regulation or oversight of organizational safety culture across Ghana's hybrid public-private healthcare sector. As such, individual facilities vary widely in dimensions from team hierarchies and psychological safety climates to approaches for auditing protocol compliance and managing identified hazards. For example, a teaching hospital analysis showed strong executive leadership prioritizing safety and open communication channels substantially improved incident reporting and quality improvement outputs versus peer hospitals lacking such cultural cultivation (Ansah, 2012). Formal mechanisms are needed to share and scale evidence-based safety practices between facilities.

Summarily, while financing and governance decisions occur at the policy level in Ghana, effects permeate across the healthcare work system daily to shape reliability and risk exposure – issues requiring dedicated leadership commitment to resolve through systems thinking and purposeful allocation of resources to elevate patient safety.

Processes:

Bringing together the prior analysis of Ghana's healthcare ecosystem through the SEIPS model lens, the ultimate measure of safety performance lies in the consistency and quality of care delivery processes. There are, substantial hazards that emerge get tied back to the overarching systems constraints.

In particular, variable adherence to evidence-based protocols persists at the frontlines. Given healthcare personnel shortages, those remaining often operate under immense pressures that limit abilities to fully comply with safety steps – whether hand hygiene amidst overcrowded wards or double-checking medications when serving overflowing patient volumes (Vaismoradi et al., 2020). The tools and technology to facilitate protocol adherence like handwashing stations, computerized alerts/checklists, and surveillance data are also commonly lacking. Meanwhile, gaps in organizational safety culture cultivation allow risky norms such as informal medication borrowing without oversight to perpetuate in some units (Olubummi et al., 2019).

Such process reliability issues directly impact outcomes. For example, though Ghana's Ministry of Health introduced bundle guidelines to reduce catheter-associated urinary tract infection rates based on international standards, audits indicate just 34-67% compliance on key measures of sterile insertion and maintenance (Newman et al., 2011). Correspondingly catheter associated infection rates remain 3-4 fold above global benchmarks. Similar process-outcome trails are observed across domains from surgical site infections to ICU central line contamination (Labi et al., 2018).

Ultimately these challenges intersect with the very purpose of healthcare delivery – accurate diagnosis and effective treatment. But constrained tools for clinical decision making, gaps in health worker competencies,



and understaffing frequently obstruct optimal processes. One evaluation found just 57% of Ghanaian children admitted for severe pneumonia received correct antibiotic regimens amidst such systems limitations (Labi et al., 2018). Until root causes are addressed, process hazards will persist yielding poor quality care, high costs, and tragic patient consequences.

In summary, Ghana's healthcare ecosystem strains undermine reliable execution of safety-critical care processes across the chain of treatment – requiring multifactorial solutions through coordinated leadership across financing, governance, training, culture, staffing, infrastructure, and information systems.

Conclusion

In conclusion, this systems analysis applying the SEIPS model to assess patient safety domains within Ghana's healthcare ecosystem reveals deeply interdependent risks undermining reliable delivery of quality care and enabling a concerning scale of preventable harm.

Constraints across financing, infrastructure, equipment, staffing, safety culture, leadership prioritization, and information systems directly shape hazardous clinical environments and processes where overburdened frontline workers struggle to adhere to safety protocols. The result is impaired diagnostic accuracy, ineffective treatments, avoidable infections, medication errors, and maternal and child mortality exceeding global norms.

While the policy solutions span health systems reforms ranging from investments in clinical skills training through electronic medical record adoption and governance oversight mechanisms, the multiplicative impacts of incremental improvements across domains cannot be underestimated given these complex interrelationships.

Ghana's healthcare leaders must leverage such systems thinking to motivate change where possible within their locus of control, while advocating and accounting for bolder reforms from the health and finance ministries to provide the foundation and resources for healthcare facilities and staff to uphold patient safety. The roadmap toward achieving quality universal health coverage necessitates these systemic upgrades to reduce preventable harms within the facilities entrusted to heal.

Recommendations

Based on the extensive systems analysis and evidence of interrelated patient safety hazards within Ghana's healthcare ecosystem, we would offer these six priority recommendations:

1. Increase healthcare spending to enable facilities to make foundational upgrades – targeting a minimum of \$100 per capita to sufficiently invest in infrastructure, equipment maintenance, health information systems and competitive health worker compensation.
2. Establish centralized basic safety oversight programs including occurrence screening, root cause analysis processes, simulation-based training capacities, and standardized safety protocols across commonly seen clinical scenarios.



3. Implement a targeted 3-year health worker staffing expansion initiative focused on increasing doctor and nurse graduate outputs, recruitment of diaspora clinicians, and development of advanced community paramedic-equivalent cadres to alleviate personnel strain pressures.
4. Obtain external development funding and technical support to pilot electronic health record systems and computerized physician order entry in district hospital networks to demonstrate decision support and care coordination benefits.
5. Launch behavior change messaging surrounding hierarchical culture and psychological safety to foster environments promotive of teamwork, speaking up, learning and accountability.
6. Strengthen supply chain, equipment servicing, and healthcare waste management logistics by optimizing distribution processes to direct reliable resources efficiently to facilities in need without overburdening storage.

The above priorities focus on strengthening organizational reliability while allowing facilities flexibility to advance locally relevant solutions – understanding systems change is gradual but impact compounds when pressure releases across interlinked components.

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