



Enterprise Risk Management and Patient Safety in War-Torn Healthcare Systems: A Cross-Sectional Study in Yemeni Referral Hospitals

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Abstract:

Background: Medical errors in public hospitals are increasingly viewed as reflections of administrative systemic fragility rather than isolated clinical lapses. This is particularly evident in healthcare environments operating under sustained operational pressure and resource scarcity.

Objective: This study aimed to explore the correlation between health risk management practices and the control of medical errors in three major public hospitals in Sana'a (Al-Thawra Modern General Hospital Authority, Al-Gomhouria Teaching Hospital, and Al-Kuwait University Hospital) during the year 2023.

Methodology: Utilizing a quantitative cross-sectional design (N=240), the study assessed risk management implementation across five dimensions.

Results: Findings revealed a moderate level of risk management implementation ($M = 3.42$), characterized by a critical dichotomy: while staff demonstrated high "Risk Awareness" ($M = 3.68$), practices regarding "Systematic Incident Investigation" were notably low ($M = 3.18$). Pearson correlation analysis confirmed a strong, statistically significant positive relationship between risk management maturity and medical error control ($r = 0.53$, $p < 0.001$). Multiple regression modeling explained 36% of the variance in patient safety outcomes ($R^2 = 0.36$), identifying "Leadership Support" and "Reporting Systems" as the strongest predictors of safety performance.

Conclusion: The study concludes that an urgent transition toward Enterprise Risk Management (ERM) and the adoption of High Reliability Organization (HRO) principles are essential. It advocates for institutionalizing risk management as a permanent administrative function and fostering a non-punitive culture to encourage the reporting of near-misses.

Keywords: Enterprise Risk Management (ERM); Medical Errors; Patient Safety; High Reliability Organizations (HRO); Public Hospitals; Yemen.

إدارة المخاطر المؤسسية وسلامة المرضى في الأنظمة الصحية المتأثرة بالحروب: دراسة مقطعية في المستشفيات المرجعية باليمن

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ملخص: هدفت هذه الدراسة إلى استقصاء العلاقة الارتباطية بين ممارسات إدارة المخاطر الصحية وآليات الحد من الأخطاء الطبية داخل ثلاث من كبرى المستشفيات الحكومية في العاصمة صنعاء، وهي: هيئة مستشفى الثورة العام النموذجي، ومستشفى الجمهوري التعليمي، ومستشفى الكويت الجامعي، وذلك خلال العام 2023. وسعت الدراسة بشكل محوري إلى فهم مدى مساهمة هذه الممارسات الإدارية في تعزيز كفاءة المنظومة الصحية في ظل التحديات التشغيلية الراهنة. اعتمد البحث على المنهج الوصفي

التحليلي عبر تصميم كمي مقطعي، حيث استُهدفت عينة مكونة من 240 فرداً من الكوادر الطبية والإدارية العاملة في المنشآت المذكورة، وقد تم تقييم فاعلية تطبيق إدارة المخاطر من خلال أداة قياس شملت خمسة أبعاد تنظيمية متكاملة لضمان شمولية التحليل ودقة النتائج.

كشفت النتائج عن مستوى تطبيق متوسط لإدارة المخاطر بمتوسط حسابي قدره (3.42)، مع رصد فجوة إحصائية بين الوعي المرتفع بالمخاطر وتدني ممارسات التحقيق الممنهج في الحوادث. وأثبتت تحليلات ارتباط "بيرسون" وجود علاقة طردية قوية وذات دلالة إحصائية ($r = 0.53$) بين نضج إدارة المخاطر والسيطرة على الأخطاء، حيث فسر نموذج الانحدار 36% من التباين في مخرجات سلامة المرضى، مبرزاً "دعم القيادة" و"أنظمة التبليغ" كأقوى العوامل المتنبئة بالأداء. أوصت الدراسة بضرورة التحول الاستراتيجي نحو تبني نموذج إدارة المخاطر المؤسسية (ERM) ومعايير المنظمات عالية الموثوقية (HRO) كركيزة أساسية لتطوير الأمان الصحي. وتشدد المخرجات على أهمية مأسسة إدارة المخاطر كوظيفة إدارية دائمة، مع ضرورة تطوير ثقافة تنظيمية "غير عقابية" تشجع على الشفافية والتبليغ عن الحوادث وشبكة الوقوع لضمان التحسين المستمر للجودة.

الكلمات المفتاحية: إدارة المخاطر المؤسسية (ERM)؛ الأخطاء الطبية؛ سلامة المرضى؛ المنظمات عالية الموثوقية (HRO)؛ المستشفيات العامة؛ اليمن.

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1. Introduction

1.1 General Background

Patient safety has evolved from a purely clinical objective into a holistic administrative strategy aimed at identifying "latent errors" before they escalate into catastrophic incidents. In conflict-affected health systems, such as that of the Republic of Yemen, health risk management serves as a vital defensive mechanism against operational complexities arising from severe resource shortages. It is well-established that medical errors do not occur in a vacuum; rather, they typically emerge following prolonged periods of operational stress, overcrowding, and adherence to administrative routines that fail to adapt to daily workflow exigencies (Braithwaite et al., 2015).

In the context of Yemeni public hospitals, the adaptation of workflows and the utilization of alternative pathways have become normalized practices. Consequently, risks accumulate silently within the institutional system. When harm eventually occurs, it is frequently treated as an isolated individual failure, whereas recent literature suggests that root causes lie deep within the organization's "latent conditions"

(Neuhaus et al., 2018). In this regard, Qabban and Al-Wesabi (2025) emphasized the necessity of prioritizing career development programs for nursing staff in Yemeni hospitals. They argued that a supportive organizational culture and active administrative leadership are prerequisites for enhancing performance and fostering a culture of safety.

Health risk management aims to break this cycle by identifying risks early, analyzing their causes, and preventing recurrence. However, its effectiveness is contingent upon its integration into daily administrative decision-making rather than being reduced to inactive committees (Vincent, 2010). This study is particularly significant given the context in Sana'a, where referral hospitals like Al-Thawra, Al-Gomhouri, and Al-Kuwait operate under acute shortages of personnel and supplies, making preventive functions a major administrative challenge (World Health Organization, 2022).

1.2 Problem Statement

The core problem addressed by this study is that risk management practices in resource-limited environments are often reduced to bureaucratic procedures or dormant committees, leading to a loss of "learning

opportunities" from near-misses. While medical staff possess self-awareness regarding risks, the institutional system remains unable to translate this awareness into proactive responses due to the absence of a "non-punitive culture" and weak digital reporting mechanisms (Alsabri et al., 2021).

This study seeks to transcend traditional descriptive monitoring by adopting the High Reliability Organizations (HRO) framework to evaluate the administration's capacity to create a work environment that is "preoccupied with failure" and sensitive to operations. Understanding the relationship between risk management practices and patient safety outcomes in Sana'a's public hospitals is an administrative imperative for transitioning from narrow clinical management to Enterprise Risk Management (ERM), which ensures institutional sustainability and protects lives under difficult regional conditions (Qazi & Simsekler, 2021).

The urgency of this issue is underscored by regional reports indicating that 83% of adverse events in the Eastern Mediterranean Region are preventable, with 30% leading to mortality (Abdi et al., 2024). In Yemen, immense operational pressures have marginalized preventive functions in favor of urgent therapeutic responses, leading to the "normalization of risk" where near-misses are accepted as routine without investigation (Kwiecień-Jaguś et al., 2025; Qabban & Al-Wesabi, 2025). Furthermore, despite global research volume, there is a "geographical bias," with low-income countries like Yemen contributing less than 0.5% to global patient safety research (Angarita-Pacheco et al., 2025).

1.3 Research Questions

1. What is the level of health risk management practice implementation in public hospitals in Sana'a?
2. Are there statistically significant differences in risk management

application attributable to the hospital type (Al-Thawra, Al-Gomhourri, Al-Kuwait)?

3. What is the nature and strength of the relationship between health risk management practices and medical error control?
4. To what extent can risk management dimensions (Leadership, Reporting, Prevention, Awareness) predict patient safety outcomes?

1.4 Objectives

- **Diagnose** the reality of health risk management practices in Sana'a public hospitals for the year 2023.
- **Identify** institutional disparities in risk management efficiency.
- **Measure** the statistical impact of risk management on reducing medical error recurrence.
- **Develop** a strategic roadmap for enhancing patient safety based on empirical field data.

1.5 Significance

- **Scientific Significance:** Contributes fresh data from a conflict-affected, resource-limited environment, addressing the gap in global literature regarding safety in complex contexts.
- **Practical Significance:** Provides decision-makers at the Ministry of Health with diagnostic tools to identify administrative dysfunctions, supporting policy reforms to reduce preventable mortality.

2. Theoretical Framework and Literature Review

This study integrates Reason's Swiss Cheese Model and High Reliability Organization (HRO) theory, within the broader context of Enterprise Risk Management (ERM).

2.1 Systems Theory and the "Swiss Cheese" Model

James Reason's model conceptualizes organizational defenses as layers of cheese with holes (weaknesses). When these holes align due to active failures and latent conditions, errors penetrate the system (Reason, 2000; Swensen et al., 2005; Karami et al., 2024). Studies confirm that shifting from "blaming individuals" to "repairing systems" is the only path to sustainable safety (Braithwaite et al., 2015; Neuhaus et al., 2018). Locally, Al-Wesabi and Murad (2017) found a high correlation between human resource development and the efficacy of applying accreditation standards in Yemeni hospitals.

2.2 High Reliability Organizations (HRO) and ERM

HROs operate on the principle of "preoccupation with failure," viewing near-misses as free learning opportunities (Hales & Chakravorty, 2016; Syaifullah, 2024). The concept has evolved to include Enterprise Risk Management (ERM), which integrates clinical risks with strategic and financial risks (Qazi & Simsekler, 2021; Saleem et al., 2025). Recent bibliometric research indicates this comprehensive approach is becoming the global standard for hospital sustainability (Sae-Lim & Singhara Na Ayudhaya, 2024). Locally, Qabban et al. (2025) revealed that applying patient-centered Joint Commission International (JCI) standards can enhance care quality in Yemen, provided there is a focus on safety training. This supports Alwesabi (2022), who highlighted that deficits in infection control standards in Yemeni hospitals directly impact patient safety and epidemic outbreaks.

2.3 Safety Culture in the Region

Studies in Palestine, Jordan, and Saudi Arabia reveal gaps in "non-punitive response to error," with some hospitals scoring as low as 21.3% in this dimension (Alsabri et al., 2021; Zabin et al., 2022). In Yemen, interventional studies have shown that leadership training can raise patient safety knowledge from 40.9% to over 95% (Al-Maqtari et al., 2024; Simo et al., 2025). Furthermore, Al-Saleet et al. (2025) found that Total Quality Management (TQM) implementation significantly improves healthcare service quality in Yemeni hospitals, emphasizing that systematic processes and strategic policies are key drivers of quality even in unstable conditions.

3. Methodology

3.1 Study Design and Sample

The study employed a quantitative **cross-sectional design**. Data was collected in 2023 from a sample of **240 participants** (physicians, nurses, administrative staff) across three hospitals in Sana'a: Al-Thawra Modern General Hospital Authority, Al-Gomhouri Teaching Hospital, and Al-Kuwait University Hospital (n=80 per hospital).

3.2 Instruments and Analysis

A structured questionnaire was used, validated for content and reliability (Cronbach's Alpha > 0.70). Data analysis was performed using SPSS v.26, utilizing descriptive statistics, One-Way ANOVA, Pearson correlation, and multiple linear regression to determine the impact of risk management on error control.

4. Results

4.1 Level of Health Risk Management Practices

The overall level of risk management application was moderate (M = 3.42). A significant gap was observed between "Risk Awareness" and "Incident Investigation."

Table 1: Level of Health Risk Management Practices

Dimension	Mean	SD	Level
Risk Identification & Awareness	3.68	0.64	Relatively High
Preventive Control Measures	3.55	0.66	Moderate
Leadership Support & Safety Culture	3.39	0.69	Moderate
Incident Reporting Systems	3.21	0.72	Moderate/Low
Incident Investigation & Analysis	3.18	0.70	Low

4.2 Comparative Analysis

One-Way ANOVA results indicated statistically significant differences between the three hospitals.

Table 2: ANOVA Results for Hospital Comparison

Hospital	Mean	F-Value	Sig (p)
Al-Thawra Modern General Hospital	3.58	6.84	< 0.05
Al-Gomhouri Teaching Hospital	3.41		
Al-Kuwait University Hospital	3.26		

Al-Thawra Hospital demonstrated the highest performance, likely reflecting its organizational structure as an Authority and accumulated expertise.

4.3 Correlation Analysis

Pearson correlation revealed a strong positive relationship between risk management and error control.

Table 3: Pearson Correlation Matrix

Variable	Correlation (r) with Error Control	Sig (p)
Total Risk Management	0.53	< 0.001
Leadership Support	0.51	< 0.001
Reporting Systems	0.49	< 0.001
Risk Awareness	0.38	< 0.01

4.4 Regression Analysis

Simple linear regression showed that risk management practices explain 28% of the

variance in medical error control ($R^2 = 0.28$, $\beta = 0.53$, $p < 0.001$).

Multiple regression identified the specific drivers of safety.

Table 4: Multiple Linear Regression Results

Independent Variables	Standardized Beta (β)	t-value	Sig (p)
Leadership Support	0.31	4.12	< 0.001
Reporting Systems	0.29	3.85	< 0.01
Preventive Measures	0.18	2.14	< 0.05
Risk Awareness	0.12	1.65	> 0.05 (NS)
<i>Model Summary</i>	$R^2 = 0.36$	$F = 18.42$	< 0.001

Notably, "Risk Awareness" was not a significant independent predictor ($p > 0.05$), aligning with findings by Huang et al. (2024).

5. Discussion

The study revealed statistically significant differences between hospitals ($F = 6.84$), consistent with global trends linking performance quality to organizational structure rather than resources alone (Kim et al., 2013). The high correlation of leadership support ($r = 0.51$) and its decisive impact in regression analysis ($\beta = 0.31$) aligns with recent EMRO studies confirming that top management commitment is the sole guarantor of shifting from a punitive to a learning culture (Alsabri et al., 2021).

The results corroborate global assertions that risk awareness alone is insufficient without effective reporting systems (Qabban et al., 2025). The low score for "Incident Investigation" (3.18) is consistent with regional findings in Palestine, identifying "punitive culture" as the primary barrier to organizational learning (Zabin et al., 2022).

The regression model's explanatory power increased from 28% to 36% in the multiple analysis, highlighting the importance of integrating administrative dimensions. This supports the view that management commitment serves as the critical mediator in translating risk practices into outcomes (Mondal & Sameer, 2024). Furthermore, the limited independent impact of "Awareness" underscores the need to transition from theoretical training to automated systems that support clinical decision-making (Chow et al., 2025). In the absence of advanced technology in Yemen (Lappalainen et al., 2020), transformational leadership acts as a critical compensatory mechanism (Alharbi et al., 2024). Additionally, Al-Yahawy and Alwesabi (2022) emphasized the need to activate clinical risk management through improved

microbiological techniques and antibiotic stewardship.

6. Conclusions

- **Systemic Deficit:** Staff possess high risk awareness ($M = 3.68$), but this does not translate into effective investigation ($M = 3.18$), indicating a system failure rather than individual incompetence.
- **Leadership Centrality:** Leadership commitment is the most influential variable ($\beta = 0.31$), confirming that patient safety in Sana'a is primarily a leadership function.
- **Reactive Culture:** The low reporting of near-misses ($M = 3.12$) indicates a reactive system that ignores "free lessons," predisposing the system to preventable disasters.
- **Organizational Design:** Hospitals with clearer administrative structures (e.g., Al-Thawra) achieve better safety outcomes, suggesting that organizational design and role clarity are determinants of safety.
- **HRO Gap:** Current practices lack the HRO principles of "preoccupation with failure" and "sensitivity to operations."

7. Recommendations

Administrative & Leadership:

- **Institutionalize ERM:** Transform risk committees into executive departments with direct reporting lines to the Director General and "stop-work" authority.
- **Adopt "Just Culture":** Formally separate human error from negligence to eliminate the fear of reporting.

- **Leadership Rounds:** Mandate weekly safety walk-rounds by senior management to build trust and gather intelligence on latent risks.

Operational & Technical:

- **Smart Reporting:** Implement anonymous, digital reporting systems (e.g., WhatsApp bots) focusing on near-misses.
- **Digital Transformation:** Invest in Computerized Physician Order Entry (CPOE) systems, which can reduce mortality by up to 47% (Alwesabi, 2020).
- **Feedback Loops:** Mandate feedback mechanisms to inform staff of corrective actions taken post-reporting.

Training & Policy:

- **Root Cause Analysis (RCA):** Shift training focus from general awareness to technical RCA skills for department heads.
- **Budgeting for Safety:** Link hospital funding to safety process indicators (reporting rates) rather than just error rates.

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