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Implementing and Sustaining Quality Improvement Behaviors in a Resource-Limited ICU System: A 12-Month Prospective Study

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Abstract

Background/Objectives: Intensive care units (ICUs) in resource-limited settings face barriers including staffing shortages, limited infrastructure, and cultural challenges to adverse event reporting, which undermine patient safety and quality improvement (QI) efforts. This study aimed to evaluate the impact of a context-sensitive educational intervention on ICU providers' confidence, engagement, and sustained QI behaviors.

Methods: We conducted a prospective educational intervention consisting of a two-day QI workshop delivered to 50 ICU healthcare professionals in a Jordanian public healthcare network. Outcomes were assessed using anonymous surveys administered pre-intervention, immediately post-intervention, and at 12-month follow-up. Analyses were descriptive due to unlinked responses.

Results: Confidence in applying QI principles increased from 73.5% pre-intervention to 93.2% post-intervention and remained elevated at 73.7% at 12 months. At follow-up, 82% of participants reported ongoing use of adverse event reporting tools, and 86.7% expressed willingness to engage in future QI initiatives. Persistent barriers included staffing shortages, workload burden, and system-level limitations.

Conclusions: A structured, context-sensitive educational intervention improved ICU providers' confidence and engagement in QI practices, with sustained effects at 12 months. Ongoing institutional support is required to maintain long-term impact in resource-limited settings.

1. Introduction

Patient safety and quality improvement (QI) have become central priorities in modern healthcare systems, catalyzed in large part by the Institute of Medicine's landmark report documenting the burden of preventable medical error [1]. As healthcare delivery has grown more complex, robust QI frameworks have emerged as indispensable tools for reducing preventable harm, improving care processes, and building accountable, learning health systems [2, 3].

In Jordan, implementing QI initiatives presents unique challenges due to systemic, cultural, and resource-related barriers. The Ministry of Health launched Jordan Health Accreditation Project (JHAP) in 2007 to enhance healthcare quality through accreditation [4]. While this effort represented an important milestone, progress has been limited by persistent resource constraints, variability in staff training, and cultural barriers to reporting adverse events [4, 5]. Over-reliance on accreditation as the primary quality improvement strategy, coupled with the absence of standardized quality indicators, has further impeded the establishment of a sustainable culture of continuous improvement and transparency [4, 6].

In addition to structural constraints, cultural factors play a critical role in shaping quality improvement adoption. Fear of blame, hierarchical communication patterns, and limited psychological safety have been identified as key barriers to adverse event reporting and open discussion of clinical errors,

particularly in high acuity settings such as the ICUs [7, 8]. Psychological safety, defined as a shared belief that team members can speak up without fear of punishment or embarrassment, is increasingly recognized as a foundational component of safety culture and effective quality improvement implementation [2]. Structured forums such as morbidity and mortality conferences provide an opportunity to foster this environment by promoting reflective learning, transparency, and non-punitive discussion of adverse events. Strengthening these cultural norms is therefore an important target for educational interventions aimed at improving reporting behaviors and patient safety outcomes.

Beyond these structural and cultural challenges, Jordan's healthcare system also faces significant geopolitical and socioeconomic pressures. Hosting large populations of refugees has strained resources and infrastructure, while rising rates of smoking, obesity, and road traffic injuries contribute to increasing healthcare costs and reduced productivity [9, 10] These challenges are compounded by shortages in hospital beds (1.45 per 1,000 population) and imbalances in the healthcare workforce, with a relative oversupply of physicians and pharmacists but low numbers of nurses per capita [5]. Collectively, these constraints exacerbate inefficiencies in service delivery and limit the system's ability to achieve comprehensive and sustainable improvements in care.

Intensive care units (ICUs) represent a particularly high priority area for quality improvement given the acuity and complexity of patient care in these settings. Barriers to effective implementation are magnified in ICUs, where hierarchical professional cultures, inconsistent leadership commitment, and limited outcome measurement hinder progress [2, 7] These challenges are not unique to Jordan, but are well documented across resource constrained settings, emphasizing the importance of tailored context-sensitive approaches [8].

Therefore, this study aimed to (1) characterize the existing QI environment and identify implementation barriers within Jordanian ICUs, and (2) develop and evaluate a context-sensitive educational intervention designed to improve QI knowledge, engagement, and sustained practice.

2. Materials and Methods

2.1 Study Design

We conducted a prospective educational intervention at The Ministry of Health - Intensive Care Units in Jordan between January 2024 and March 2024. The study protocol was approved by the institutional review board (STUDY00028046) from Oregon Health and Science University on November 25, 2024, and written informed consent was obtained from all participants via survey responses. The intervention followed a mixed-methods evaluation framework, modeled after program evaluation standards in academic medical education research, with a focus on clear objectives, multi-stakeholder engagement, and systematic assessment of both immediate and longer-term outcomes [11, 12]. Reporting follows the SQUIRE 2.0 guideline.

2.2 Curriculum Development

A multinational faculty team with experience in ICU quality improvement, led by the primary investigator, developed a comprehensive two-day workshop curriculum using a systematic, evidence-based approach. The curriculum was informed by a preliminary needs assessment, and stakeholder consultation designed to characterize existing quality improvement practices, reporting barriers, and infrastructure gaps within participating ICUs [13]. Culturally appropriate case studies and hands-on exercises were incorporated to reinforce learning. The development process followed best practices as outlined in the AMEE Guide No. 87, including literature review, expert validation, and iterative refinement of materials [14].

2.3 Workshop Structure

The workshop combined lectures and interactive sessions covering core domains of ICU quality improvement, Quality Improvement Foundations, Adverse Events Reporting Systems, Quality Metrics, Practical Applications, M&M Conference Structure, Data Analysis and Interpretation, Implementation Strategies, Action Planning. (Appendix 1: detailed curriculum). The sequence and instructional strategies were informed by faculty development and program evaluation literature to maximize active learning and engagement [5]. A detailed session-by-session curriculum is provided in Appendix 1.

2.4 Participants and Setting

The study was conducted at Jordanian Ministry of Health Intensive Care Units network with 330 beds and an average annual admission rate of 13,621 patients [15]. The Jordanian Ministry of Health (MoH) uses a national electronic health record (EHR) system called Hakeem, which is based on the open-source WorldVistA platform. WorldVistA is an open-source version of the U.S. Department of Veterans Affairs' VistA EHR system [16]. They utilize a locally developed system to report adverse events, that is reviewed by the Quality and Patient safety committee within each unit and then reported to the Ministry central Quality and Patient Safety office. A purposive, stratified sampling strategy ensures representation from physicians, nurses, pharmacists, quality officers, and administrators.

2.5 Data Collection

Surveys were administered electronically using Qualtrics (Provo, UT) at three time points: immediately before the workshop, immediately after, and 12 months post-intervention. Items were adapted from validated instruments like SAQ and TeamsSTEPPS [17, 18] and refined to reflect the workshop content and Jordanian ICU context, following AMEE guidelines for survey design [14]. No incentives were offered for participation. Anonymity was maintained throughout to encourage honest reporting; participants were additionally given the option to voluntarily provide contact information for future collaboration and training opportunities. .Surveys assessed participants' knowledge, attitudes, and confidence in applying QI and patient safety principles. Response rates and potential nonresponse bias were monitored and reported in line with recommendations for survey-based research [11].

2.6 Data Analysis

Because survey responses were anonymous and unlinked across timepoints, all analyses were descriptive. Individual level longitudinal comparisons were not possible; therefore, aggregate proportions and summary statistics were used to evaluate changes across the pre-, post-, and 12-month surveys. Denominators varied across survey items due to item-level nonresponse. Frequencies and percentages were calculated for categorical variables, and trends were examined to assess shifts in participants' confidence, engagement in QI activities, and use of adverse event reporting tools. This approach aligned with recommended practices for analyzing unpaired survey data in quality improvements and medical education research [19]. Likert-scale responses collapsed into three categories (Agree, Neutral, Disagree) to improve interpretability and statistical stability, consistent with recommended reporting practices in quality improvement and medical education research [14].

3. Results

3.1. Participant Characteristics and Survey Completion

A total of 50 participants were recruited using purposive, stratified sampling to ensure representation across ICU professional groups. The cohort included physicians (n = 15), nurses (n = 25), quality officers (n = 5), and hospital administrators (n = 5), with varying levels of clinical experience and training backgrounds

Survey completion occurred at three time points: pre-intervention (n = 34/50, 68%), immediately post-intervention (n = 44/50, 88%), and at 12-month follow-up (n = 19/50, 38%). Because responses were anonymous and unlinked, analyses were conducted using unpaired descriptive statistics.

3.2. Confidence in Quality Improvement and Patient Safety

3.2.1 Quality Improvement Confidence

Confidence in applying quality improvement (QI) principles increased substantially following the intervention (Table 1; Fig. 1). Agreement rose from 73.5% pre-workshop to 93.2% immediately post-workshop and remained 73.7% at 12 months, remaining above baseline. Neutral responses decreased from 14.7% at baseline to 4.5% post-intervention and 5.3% at follow-up, while disagreement decreased from 11.8% to 2.3% immediately post-workshop but increased to 21.1% at 12 months.

3.2.2 Patient Safety Confidence

A similar pattern was observed for confidence in applying patient safety principles (Table 1; Fig. 2). Agreement increased from 75.8% at baseline to 93.2% post-intervention and was sustained at 68.4% at 12 months. Neutral responses decreased from 15.2% to 4.5% post-intervention and 5.3% at follow-up, while disagreement decreased from 9.1% at baseline to 2.3% post-intervention before increasing to 26.3% at 12 months.

3.3. Additional Domains of Confidence

3.3.1 Process and Outcome Measures

Confidence in using process and outcome measures (Table 2) was reported by 90.9% of participants immediately post-intervention and remained high at 77.8% at 12 months.

3.3.2 Morbidity and Mortality Conference Participation

Confidence in participating in morbidity and mortality (M&M) conferences (Table 2) was reported by 93.2% of participants post-intervention and remained elevated at 72.2% at 12 months, with a minority of participants reporting disagreement (16.6%) at follow-up

3.3.3 Sustained Engagement and Application of QI Practices

At 12-month follow-up, participants reported continued application of workshop content (Table 3), with 50% strongly agreeing and 33.3% somewhat agreeing that they continued to apply best practices introduced during the workshop. Engagement with adverse event reporting systems remained high, with 82% of participants reporting ongoing use and 61.5% rating the system as somewhat or very easy to use. Willingness to participate in future QI initiatives was reported by 86.7% of respondents.

3.4 Reported Barriers to Implementation

Qualitative responses identified several persistent barriers to implementation, including staffing shortages, high clinical workload and burnout, equipment limitations, usability challenges related to adverse event reporting systems, and limited institutional infrastructure to support sustained QI efforts.

3.5 Figures and Tables

Table 1
Confidence Applying QI and Patient Safety Principles

Domain	Timepoint	Agree n (%)	Neutral n (%)	Disagree n (%)
QI Principles	Pre (n = 34)	25 (73.5)	5 (14.7)	4 (11.8)
	Post (n = 44)	41 (93.2)	2 (4.5)	1 (2.3)
	12-mo (n = 19)	14 (73.7)	1 (5.3)	4 (21.1)
Patient Safety	Pre (n = 33)	25 (75.8)	5 (15.2)	3 (9.1)
	Post (n = 44)	41 (93.2)	2 (4.5)	1 (2.3)
	12-mo (n = 19)	13 (68.4)	1 (5.3)	5 (26.3)

Table 2
Confidence Using Process and Outcome Measures and Participation in Morbidity and Mortality Discussions

Domain	Timepoint	Agree (%)	Neutral (%)	Disagree (%)
Process and Outcome Measures	Post (n = 44)	90.9	4.5	4.5
	12-mo (n = 18)	77.8	5.5	16.6
Morbidity and Mortality Participation	Post (n = 44)	93.2	4.6	2.3
	12-mo (n = 18)	72.2	11.2	16.6

Table 3
Sustained Application and Adverse Events Reporting Engagement at 12 months

Domain	12-mo %
Actively applying best practices	83.3
Using adverse events reporting system	82.0
Rates adverse event reporting as somewhat/very easy	61.5
Willing to participate in future QI projects	86.7

4. Discussion

This study demonstrates the feasibility and impact of a targeted, context-sensitive educational intervention designed to enhance ICU quality improvement capabilities within a resource-constrained healthcare system. Consistent with previous research, the workshop produced immediate gains in participants' confidence applying quality improvement and patient safety principles, with substantial increases from pre- to post-intervention and with improvements sustained above baseline at 12 months despite some attenuation over time These findings suggest both meaningful short-term learning and a degree of retained competence over time, though the self-reported nature of the data limits causal inference regarding competence change.

Beyond knowledge and confidence, several indicators of behavioral engagement were evident. At 12 months, most participants reported ongoing use of their local adverse event reporting system, continued application of best practices introduced during the workshop, and high willingness to engage in future QI initiatives. These patterns indicate that structured, participatory training, when aligned with local needs, can promote lasting engagement with safety systems, even in the presence of significant structural barriers. However, these findings also suggest that educational interventions alone are insufficient to drive sustained change without parallel investments in infrastructure, workforce capacity, and leadership support. Long-term improvement requires integration of quality improvement training into routine clinical practice and institutional policy.

The workshop curriculum was intentionally designed to address barriers identified during the pre-intervention needs assessment. Stakeholder consultations with ICU clinicians, quality officers, and administrators, along with review of prior local QI initiatives, revealed gaps in adverse events reporting familiarity, limited exposure to ICU-specific quality metrics, uncertainty surrounding morbidity and mortality conference structure, and a lack of practical tools for applying improvement concepts. Accordingly, the curriculum emphasized hands-on adverse event reporting, case-based exploration of ICU-specific indicators, and structured approaches to morbidity and mortality discussions. This alignment between identified needs and curricular design likely contributed to improvements in confidence and engagement, consistent with implementation science principles supporting context-sensitive, stakeholder-informed interventions [8, 11].

Despite these positive trends, a modest decline in confidence and a rise in disagreement responses was observed across several domains at the 12-month time point. Workforce turnover and the inclusion of newly hired staff who did not participate in the original workshop likely influenced follow-up responses. The decline in confidence observed at 12 months may also reflect the well-recognized challenges of sustaining newly acquired competencies without ongoing reinforcement, a phenomenon highlighted in implementation science literature emphasizing the importance of continued training and system support for behavior change [8]. Persistent system pressures, including workload and staffing shortages, may have further limited sustained practice change. These findings delineate the importance of periodic reinforcement strategies and integration of quality improvement education into routine professional development to sustain implementation gains over time, consistent with implementation research highlighting the need for ongoing support mechanisms [8].

Situating these findings within the broader national context highlights structural challenges shaping QI adoption in Jordan. The Jordanian healthcare system has long relied on accreditation as the central mechanism for improving quality, particularly through initiatives such as the Jordan Health Accreditation Project (JHAP). Although accreditation frameworks establish important standards, clinicians frequently describe these processes as bureaucratic, burdensome, and inadequately tied to actual patient outcomes [4]. This dynamic may help explain why participants gravitated toward practical, frontline-focused tools such as structured adverse event reporting processes, ICU-specific metrics, and unit-level improvement strategies. Prior studies have similarly concluded that accreditation alone is insufficient to generate sustainable improvement without parallel investments in outcomes monitoring, staff training, and capacity building [3, 4].

System-level fragmentation also emerged as a key contextual factor influencing workshop impact. Persistent disconnects between frontline clinicians, administrators, and policymakers, well documented in regional literature, were reflected in participants' reports of staffing shortages, high workload, limited institutional infrastructure, and inconsistent leadership support for QI activities [4, 6]. These pressures likely constrained participants' ability to consistently apply workshop concepts. Nevertheless, participants' continued engagement in reporting systems and sustained willingness to participate in QI projects suggest that a well-designed educational intervention can serve as a bridge across

organizational silos by strengthening frontline capability and shared understanding of improvement tools.

Finally, the notable increase in confidence participating in morbidity and mortality (M&M) conferences, remaining high at 12 months, suggests that the workshop influenced not only technical knowledge but also psychological safety and may reflect early signals of cultural change. Given the recognized role of psychological safety in facilitating reporting behaviors and reflective learning, these findings may represent an early signal of cultural change within participating units. Strengthening M&M participation is a key component of high-reliability ICU practice and highlights the potential for targeted educational intervention to influence both individual competencies and team-based safety culture.

5. Limitations

This study is subject to several limitations. First, the survey data are self-reported and unlinked across timepoints, limiting the ability to draw causal inferences or perform match pair statistical analyses. While anonymity likely encouraged honest responses, it also precluded tracking individual trajectories of change. Second, the sample size at the 12-month follow-up was smaller, potentially introducing response bias and limiting generalizability. Third, because the study was conducted in a single country, findings may not be transferable to other health system contexts without adaptation.

Another important limitation is the absence of process indicators and patient-related clinical outcomes. Because the study team did not have access to ICU performance data such as infection rates, ventilator-associated event rates, or mortality and length of stay metrics, we were unable to assess whether changes in participant attitudes translated into measurable improvements in patient care. Including such outcomes in future studies would strengthen the evidence base for the impact of QI educational interventions

Finally, while thematic analysis of open text responses added valuable depth, the lack of formal qualitative interview data limited the richness of contextual understanding. Future studies should consider mixed-methods approaches including focus groups or interviews to further explore systemic barriers and facilitators to QI implementation.

6. Conclusions

Structured, context-sensitive QI training improved provider confidence and engagement, with improvements sustained above baseline at 12 months despite attenuation over time. However, long-term success depends on continued institutional support, system-level investment, and integration of QI practices into routine care.

Abbreviations

The following abbreviations are used in this manuscript:

QI	Quality Improvement
ICU	Intensive Care Unit
M&M	Morbidity and Mortality
JHAP	Jordan Health Accreditation Project
EHR	Electronic Health Record

Declarations

- **Ethics approval and consent to participate**
  - **Institutional Review Board Statement:** The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board from Oregon Health and Science University (STUDY00028046 and November 25, 2024).
  - **Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study.
- **Consent for publication**
  - Not Applicable. (the manuscript doesn't contain any individual person's data in any form)
- **Availability of data and materials**
  - Data available upon request.
- **Competing interests**
  - The authors declare no conflicts of interest.
- **Funding**
  - This study received no external funding. All phases of the project—including design, data collection, analysis, interpretation, and manuscript preparation—were conducted independently by the research team.
- **Authors' contributions**
  - Conceptualization, S.O., M.W., B.A. and K.K.; methodology, S.O., M.W, R.Z. and M.J.; survey creation and distribution S.O., A.A. and M.J.; formal analysis, T.E and H.A.; data curation, S.O., R.Z. and T.E.; writing—original draft preparation, S.O., M.W., H.A. and T.E..; writing—review and editing, S.O., T.E., H.A., R.Z., M.W., K.K., B.A, M.J., and A.A.; supervision, S.O., B.A., K.K. and M.W.; All authors have read and agreed to the published version of the manuscript.

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Figures

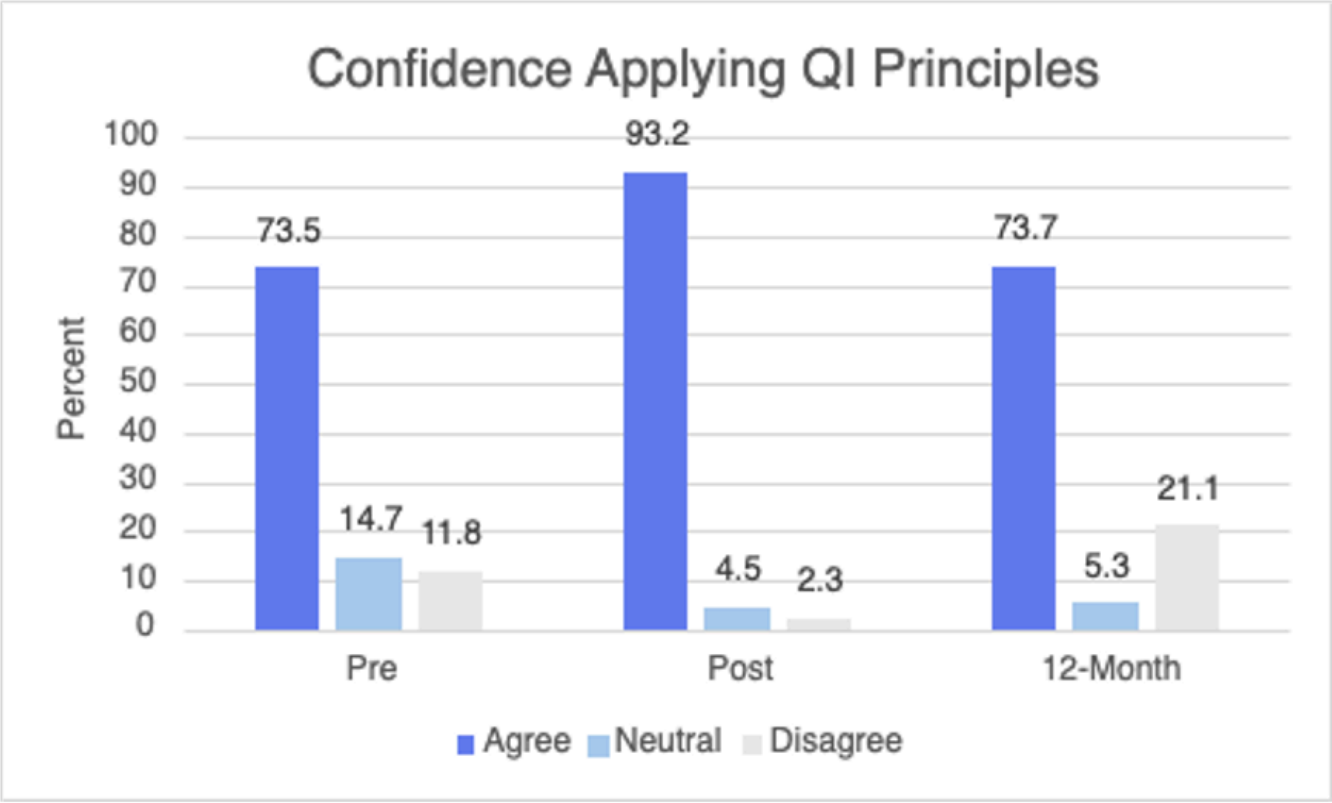


Figure 1

Confidence applying quality improvement principles across pre-, post-, and 12-month surveys

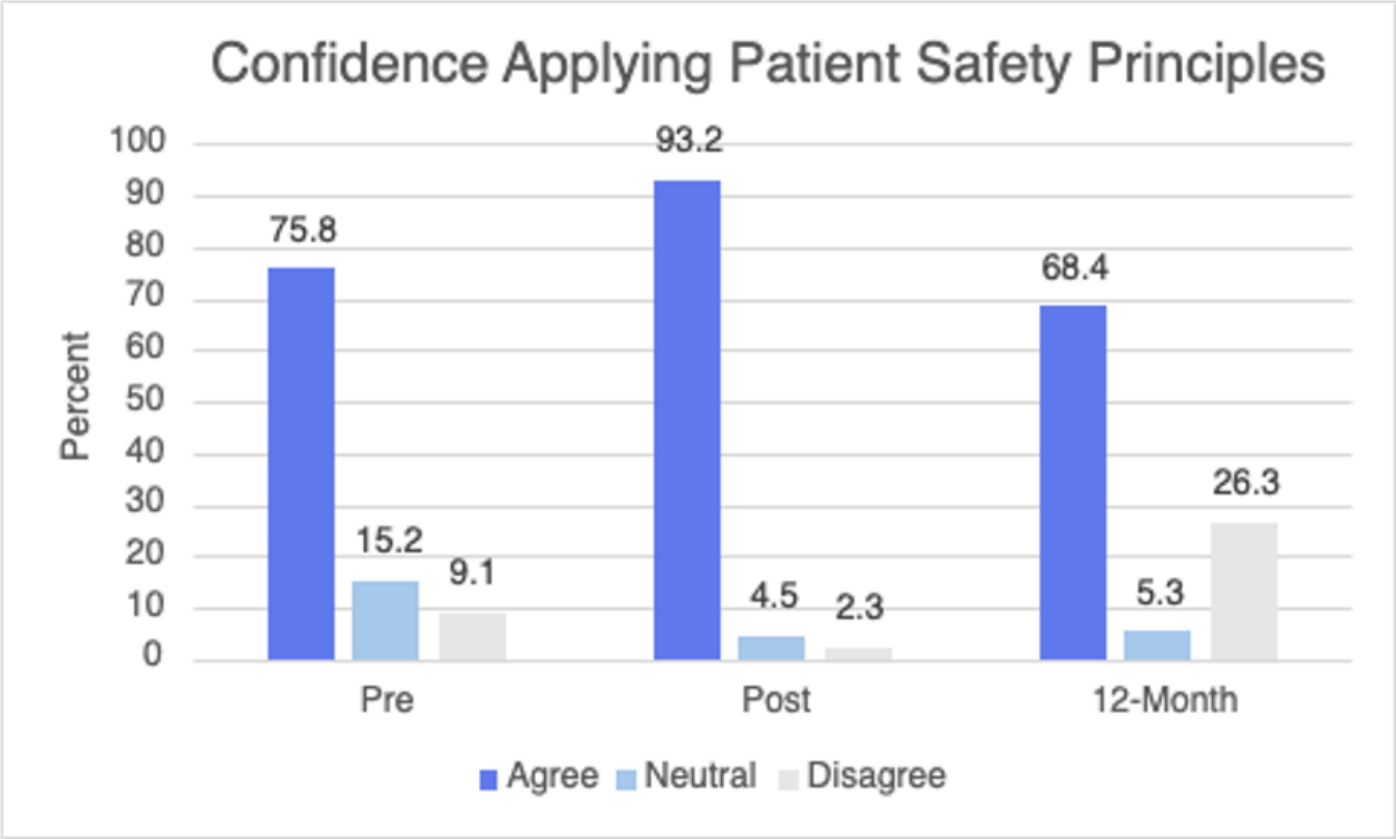


Figure 2

Confidence applying patient safety principles across pre-, post-, and 12-month surveys.

Supplementary Files

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- AppendixA.docx