Intervention Study to Upgrade Patient Safety Practices in Pediatric Intensive Care Units of Cairo University Children Hospital

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Abstract

BACKGROUND: The World Health Organization calls patient safety "an endemic concern." Keeping patients safe is viewed as a global public health problem and a human rights issue. An environment where safety culture prevails is considered the biggest obstacle to improve patient safety. Proactive efforts to identify, prevent, and eliminate errors have the potential to significantly improve safety. Pediatric intensive care unit (PICU) is high-hazard and -risk environments.

AIM: The aim of this study is to enhance compliance to patient safety practices within the general PICUs in Cairo University Children's Hospital.

METHODS: This is a pretest-posttest interventional study. A tailored intervention after the baseline assessment was designed and implemented followed by reassessment. All physicians and nurses present in the general PICUs who were available and consented participated in the study. A questionnaire for knowledge and attitude and a checklist for practice assessment of the participants were used.

RESULTS: The median age of the participants was 30 years and interquartile range (28–40). There was a statistically significant difference between those who received patient safety training and those who did not in patient safety knowledge. The median knowledge score increased significantly after the intervention. Regarding the attitude of the studied personnel toward their perception of patient safety culture's dimensions before and after the intervention, there was no statistically significant difference in some dimensions and a statistically significant improvement in some others.

CONCLUSION: The strategies based on patient safety awareness-raising among health-care providers together with commitment and enthusiasm among senior leadership in the hospital can potentially improve compliance with practice and consequently lead to better patient safety.

Background

To expect a flawless performance from humans working in complex and stressful environments is impossible, and will not improve safety [1]. Humans are protected from making errors when placed in an environment where the systems and processes they work in are well planned [2]. Accordingly, concentrating on the system that permits harm to occur by emphasizing the reporting, analysis, and prevention of medical error is the beginning of improvement. Recognizing that patient safety failures are among the 10 leading causes of death and disability in the world, the World Health Organization (WHO) calls patient safety "an endemic concern" [3]. Knowing that errors that were once perceived as unavoidable have now become preventable and open to mitigation, keeping patients safe is now viewed as a global public health problem and a human rights issue [4].

One of the biggest challenges facing health-care professionals is how to best match, prioritize, and implement effective and evidence-based safety interventions that are measurable, reliable, and relevant [5]. This can only occur in an open and transparent environment where a safety culture prevails, which is considered the biggest obstacle to improve patient safety [6]. This is a culture where a huge substance is placed on safety beliefs, values, and attitudes that are shared by people within the workplace [7]. Assessment of safety culture in a given institution helps to inform the perceptions and behaviors of administrators regarding safety as well as identify the most problematic areas for improvement [8].

While most attempts to improve safety in health care are reactive, proactive efforts to identify, prevent, and eliminate errors have the potential to significantly improve safety. To accomplish this, patient safety must be viewed as a strategic priority around which the entire efforts of the organization must be focused in a multidisciplinary approach involving everyone working as a team, supported by a safety culture [9].

Nowhere in the hospital is a greater challenge than the pediatric intensive care unit (PICU), as PICUs are high-hazard and -risk environments because of the heterogeneity of patients, their complexity and severity and the difficulty of the work and tools required to care for these patients. The fact that more opportunities to

prevent harm are not yet identified in PICUs may be explained by the limited detection methods [10].

Patient safety has been marked as a key priority of health care in recent decades not only because of the recognition of the extent and severity of the problem, but equally because of the demonstration that successful interventions can reduce, mitigate, or prevent known harm [4]. Thus, the aim of this study is to enhance compliance to patient safety practices and outcomes within the general PICUs in Cairo University Children's Hospital which is an around the clock institute providing pediatric patients with all kinds of care, it is also a research and teaching hospital, through applying a tailored patient safety program.

Methods

Study design and study setting

The current study is an intervention study, a pretest-posttest design, in which an initial assessment of health-care providers' patient safety knowledge, attitude, and practices was conducted within the four general PICUs of Cairo University tertiary teaching children hospitals which all have similar organizational and staffing structures. A tailored intervention according to the results of the baseline assessment was designed and implemented, and then, the patient safety situation was reassessed to detect the changes that occurred after the intervention. The intervention included patient safety education training, the training sessions were designed with the collaboration of the hospital quality team using PowerPoint presentations about patient safety definition, overview, goals, and safety culture, including the causes of errors, and incident reporting of "near misses," based on the WHO patient safety curriculum guide [11].

Furthermore, posters were hung in the health-care providers' rooms, in addition to hand-outs, pocket leaflets, and badges as key tools to prompt and remind health care workers about the importance of patient safety and about the appropriate indications and procedures for performing it.

The training sessions were interactive and conducted for small groups inside the ICUs during their working day. A total of 12 sessions, three in each ICU, each about 30 min in addition to 15 min for open questions and discussion, were done over a period of 8 weeks.

Health-care personnel were tested for patient safety knowledge immediately after each training session and the test was collected in 15 min. After the assessment, each of the personnel was awarded a badge with the name and logo of "Patient Safety," written in English and Arabic.

Study population and sampling

All physicians and nursing staff present in the general PICUs of Cairo University Children Hospital who were available and consented to participate in the study at the time of the research.

Seventy-three out of 96 health-care providers; 20 physicians and 53 nurses were included in the baseline assessment, intervention, and end line assessment phases of the study, making the response rate around 76%, refusals were because of work overload.

Data collection tools

A designed self-administered questionnaire was formulated of seven questions to assess the health-care providers' knowledge about patient safety definition, concept, and patient safety goals basic knowledge.

This tool was translated into Arabic and back translated into English to ensure consistency with the original English version. The questionnaire was adapted to fit the Egyptian context to suit the culture in our hospitals and its items and questions were verified to be clear and comprehensive through pilot testing. Validation of the adapted and translated study tool was conducted before using it for data collection. The correct answer was scored as 1 and the wrong answer was scored as 0 with maximum possible total score of 7.

A Safety Attitudes Questionnaire (SAQ) was adopted to assess patient safety attitude of the study participants. These SAQ items were developed with the goal of obtaining a staff level perspective on patient safety in hospital setting and can be used to track changes in patient safety overtime and to evaluate the impact of patient safety interventions [8], [12]. The Arabic version of a previous study performed in Oman with Cronbach's alpha value of 0.97 was used [13].

It included the following safety culture dimensions; non-punitive response to error (one item), hospital Handoffs and transitions (one item), staffing and workload (6 items), feedback and communication about error (one item), management perception for patient safety (5 items), teamwork climate in hospital (2 items), overall perceptions of safety (2 items), interactions and communication in ICU (5 items), communication openness (3 items), incident reporting (3 items), organizational learning-continuous improvement (2 items), safety climate (6 items), teamwork climate in ICU (2 items), and job satisfaction (3 items). Five-point Likert response scale agreement (strongly disagree to strongly agree) was used. Grouping of the responses was done as follows: Positive responses for strongly agree and agree responses, neutral response for neither, and negative responses for strongly disagree and disagree responses. Reversal of the direction of the responses was done in negative wording questions.

A patient safety performance checklist was used to assess the PICUs health personnel's compliance based on the Joint Commission International (JCI) Accreditation Standards for Hospitals' patient safety standards after removing the items related to outpatient clinics and patient safety goal 4, which is related to surgical safety to fit the checklist to PICUs environment. The used checklist composed of five standards related to the international patient safety goals, and each goal had three measurable elements as follows: Goal 1: Identify patients correctly, Goal 2: Improve effective communication, Goal 3: Improve the safety of high-alert medications, Goal 5: Reduce the risk of health care-associated infections, and Goal 6: Reduce the risk of patient harm resulting from falls.

Twelve observations (three observations in each ICU) were undertaken by one of the researchers in the pre-assessment and then another 12 in the post-assessment. The observer did her best to position herself so that she does not cause an obstruction and can still see what is happening. The elements are scored as "met" = 2, "partially met" = 1, or "not met" = 0, making the maximum possible total score for each goal equal 6. The average of the 12 performed observations for each of the pre- and post-assessments was taken.

Data analysis

Data were summarized using number and percentages for qualitative variables, median and interquartile range (IQR) were used for quantitative variables.

Comparison of numerical variables between the study groups was done using Mann–Whitney U-test for independent samples when comparing two groups and Kruskal–Wallis test when comparing more than two groups. Comparison between pre- and post-program was done using McNemar test for qualitative variables and Kruskal–Wallis test for numerical variables. $p < 0.05$ was considered statistically significant.

Ethical considerations

The used questionnaire was anonymous and voluntary. Verbal consent was obtained from all participants before recruitment in the study, after explaining the objectives of the work. Confidentiality was guaranteed on handling the data base and questionnaire forms. The researcher treated the health-care providers according to the Helsinki Declaration of biomedical ethics. The researcher obtained administrative approvals from the hospital and PICUs' managers. The study was approved by the public health and the pediatric departments of Faculty of Medicine, Cairo University.

Results

The total number of health-care personnel who participated in the study was 73, 69.9% of them were female. The median of their age was 30 and IQR 28–40. There was almost equal involvement of health-care personnel representing 24.7% from ICUs A, B, and C and 26.0% from ICU D. The majority of the included personnel were 45 nurses, representing 61.6% of the total personnel. More than half (43) of the included personnel have been working in the hospital from 1 to 15 years before the study, 64.4% of the personnel worked on a full-time basis. The vast majority (95.8%) said that they worked more than 8 h/day.

On comparing the patient safety knowledge among females and males, as shown in Table 1, no

Table 1: Relation between total knowledge score and sociodemographic and occupational characteristics among the studied health-care personnel

Item	Knowledge score median (IQR)	p-value
Sex		
Female	3.0 (3.00–4.00)	0.097
Male	3.0 (3.00–4.00)	
ICU		
A	3.0 (3.00–3.75)	0.530
B	3.5 (3.25–4.00)	
C	3.0 (3.00–3.75)	
D	3.0 (3.00–4.00)	
Duration of work in the hospital (years)		
<1	3.0 (3.00–4.00)	0.154
1–5	3.25 (3.00–4.00)	
6–10	3.0 (3.00–3.75)	
11–15	3.0 (3.00–4.00)	
>15	2.75 (2.50–3.75)	
Job title		
Staff physician	3.0 (2.75–4.00)	0.121
Head nurse	3.0 (3.00–4.00)	
Resident physician	3.0 (3.00–3.75)	
Nurse	3.0 (3.00–4.00)	
ICU job status		
Full time	3.0 (3.00–4.00)	0.727
Part time	3.0 (3.00–4.00)	
On contract	2.75 (3.00–3.75)	
Average weekly working hours (hours)		
20–39	3.0 (3.0–3.0)	0.345
40–79	3.0 (3.0–4.0)	
≥80	3.0 (3.0–4.0)	
Perceived patient safety grade		
Excellent	3.0 (3.00–4.00)	0.964
Very good	3.0 (3.00–4.00)	
Acceptable	3.0 (3.00–4.0)	
Poor	3.0 (3.00–3.75)	
Previous patient safety training		
Yes	6.0 (6.0–7.0)	<0.001
No	3.0 (3.0–4.0)	

IQR: Interquartile range; ICU: Intensive care unit.

statistically significant difference was found between them, so was among the studied ICUs, the duration of work in the hospital, job title, ICU job status, and their perceived patient safety grade. However, there was a statistically significant difference between those who received patient safety training and those who did not.

The box plot shown in Figure 1 expresses the change in total knowledge score before and after the intervention among the health-care personnel. The median total knowledge score was significantly increased from 3 and IQR (3.0–4.0) in the pre-assessment to 6 and IQR (5.0–7.0) post-assessment with $p = 0.01$.
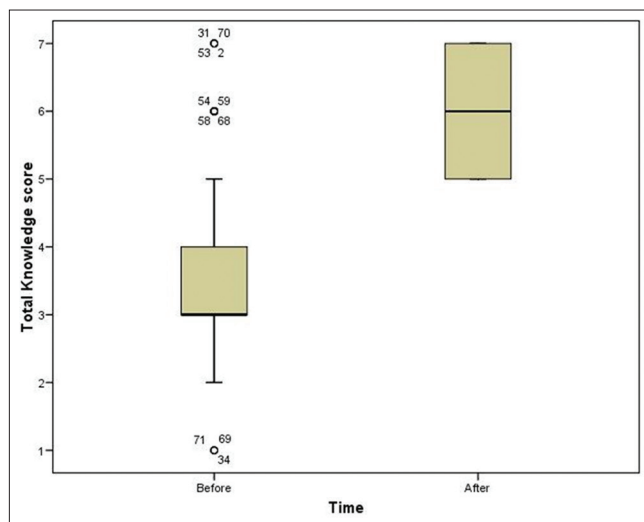
Figure 1: Effect of the intervention on the total patient safety knowledge

of "Overall perception of Patient Safety" showed a statistically significant decrease.

Table 4 shows the change in the achievement scores of patient safety goals in the studied PICUs between the baseline and end line assessment, where there was a statistically significant difference in all goals except for goal 6 which showed no change.

Discussion

Research indicates, however, that health-care systems face a big challenge to ensure safe care for patients and prevent harm. Thus, it is important to identify the weakest areas in the knowledge of health-care professionals. By doing so, we may create the best strategy to increase the level of knowledge, to achieve safer clinical practice [14].

On looking more in depth in the total knowledge scores of the studied participants, no statistically significant relation was found between their patient safety knowledge and their demographic and background characteristics, including sex, job title, years of experience, specific ICU, ICU job status, or weekly working hours, which comes in accordance with de Oliveira *et al*. and showing the homogeneity of the four PICUs, which have the same organizational and staffing structure [15].

However, there was a statistically significant difference between those who received previous patient safety training prior to the study and those who did not

Tables 2 and 3 display the change in the attitude of the studied personnel regarding their perception to patient safety culture's dimensions before and after the intervention, where there was no statistically significant difference in the dimensions of "Job Satisfaction, Teamwork Climate in ICU, Teamwork climate in hospital, Staffing and workload, Hospital handoffs and transitions, Organizational learning continuous improvement, Feedback and communication about errors, and Non-punitive response to errors" and a statistically significant improvement in some items under the dimensions of "Safety Climate, Management Perception toward patient safety, Interactions and Communication in the ICU, Communication openness, and Incident reporting." However, the dimension

Table 2: Frequency of patient safety attitude's positive responses in the pre- and post- assessments regarding job satisfaction, teamwork climate, staffing, and safety among the studied health-care personnel

Patient safety culture dimensions	Item	Pre-assessment n	Pre-assessment %	Post-assessment n	Post-assessment %	p-value
Job satisfaction	I like my job	59	80.8	62	84.9	0.125
	I am proud to work in this hospital	65	89	67	91.8	0.157
	Morale in this ICU is high	58	79.5	60	82.2	0.346
Teamwork climate in ICU	I get the support I need from other personnel to care for patients	54	74.0	55	75.3	1
	The physicians and nurses here work together as a well-coordinated team	43	58.9	46	63.0	0.125
Teamwork climate in hospital	When this unit gets really busy, other units help out	38	52.1	35	47.9	0.346
	There is good cooperation among hospital units that need to work together	26	35.6	23	31.5	0.176
Staffing and workload	The level of staffing in this PICU is enough to handle the number of patients	20	27.4	19	26.0	1
	New personnel are trained well and are adequately supervised in this ICU	23	31.5	23	31.5	
	High levels of workload are common in this PICU	20	27.4	17	23.3	0.176
	Fatigue impairs my performance during routine care (e.g., ventilator checks, medication reviews, transfer orders)	22	30.1	24	32.9	0.346
	Fatigue impairs my performance in emergency situations	40	54.8	39	53.4	1
	During emergency situations (e.g., emergency resuscitation), my performance is not affected if I work with inexperienced or less capable personnel	39	53.4	39	53.4	
Safety climate	I would feel safe being treated here as a patient	31	42.5	35	47.9	0.376
	Physicians/intensivist in this ICU are doing a good job	62	84.9	65	89	0.514
	Personnel know the rules or guidelines (e.g., handwashing, sterile fields, treatment protocols) established in this ICU	45	61.6	52	71.2	0.003
	There is widespread adherence to clinical guidelines and evidence-based rules (e.g., handwashing, sterile fields, treatment protocols) established in this ICU	43	58.9	41	56.2	0.125
	All the personnel in this unit take responsibility for patient safety	40	54.8	52	71.2	<0.001
	The medical equipment in this ICU is adequate	60	82.2	60	82.2	
Management perception toward patient safety	Patient safety is constantly reinforced as a priority in this ICU	35	47.9	64	87.7	<0.001
	Hospital management provides a work climate that promotes patient safety	40	54.8	46	63.0	0.030
	Hospital management does not knowingly compromises the safety of patients	31	42.5	38	52.1	0.046
	This hospital deals constructively with problem personnel	19	26.0	18	24.7	1
	Hospital management supports my daily efforts	25	34.2	27	37.0	0.514
Overall perception of patient safety	I have made errors that had the potential to harm patients	38	52.1	31	42.5	0.030
	I have seen others make errors that had the potential to harm patients	11	15.0	9	12.3	0.317

ICU: Intensive care unit.

Table 3: Frequency of patient safety attitude's positive responses in the pre- and post- assessments regarding communication, organizational learning continuous improvement, and errors' culture among the studied health-care personnel

Patient safety culture dimensions	Item	Positive responses				p-value
		Pre-assessment		Post-assessment		
		n	%	n	%	
Interactions and communication in the ICU	Interactions in this ICU are collegial more than hierarchical	34	46.6	36	49.3	0.476
	I receive appropriate feedback about my performance	31	42.5	36	49.3	0.125
	Decision-making in this ICU utilize input from relevant person	36	49.3	36	49.3	
	All the necessary diagnostic and therapeutic information are available to me	39	53.4	37	50.7	0.514
	I know the appropriate channels to direct questions regarding patient safety in this unit	21	28.8	51	69.9	<0.001
Hospital handoffs and transitions	Disruptions in patient care (e.g., patient transfer) can be detrimental to patient safety	14	19.2	18	24.7	0.157
Organizational learning continuous improvement	The culture of this ICU makes it easy to learn from the errors of others	25	34.2	30	41.1	0.176
	In this unit, it is difficult to discuss errors	58	79.5	66	90.4	<0.001
Communication openness	It is easy for personnel in this ICU to ask questions when there is something they do not understand	54	74.0	60	82.2	0.073
	I am encouraged by my colleagues to report any patient safety concerns I may have	51	69.9	60	82.2	0.046
	Staff will freely speak up if they see something that may negatively affect patient care	34	46.6	51	69.9	<0.001
Feedback and communication about errors	I am provided with adequate, timely information about events in the hospital that might affect my work	28	38.4	30	41.1	0.514
Non-punitive response to errors	When an error is made in this PICU, it is handled appropriately (i.e., not who is right, but what is right for the patient)	15	20.6	19	26.0	0.25
Incident reporting	If necessary, I know how to report errors that happen in this ICU	27	37.0	59	80.8	<0.001
	A confidential reporting system that documents medical incidents is necessary for improving patient safety	44	60.3	70	95.9	<0.001
	I would hesitate to use the reporting system for fear of being identified	47	64.4	70	95.9	<0.001

ICU: Intensive care unit.

Table 4: Total achievement scores of patient safety goals in the pediatric intensive care units according to the joint commission international patient safety standards in the pre- and post-assessments

Goals	Median (IQR)	p-value
Goal 1 (patient identification)		
Pre	3.00 (2.00–3.00)	0.046
Post	4.00 (4.00–4.00)	
Goal 2 (communication)		
Pre	2.00 (1.00–2.00)	0.035
Post	2.50 (2.00–3.00)	
Goal 3 (medication safety)		
Pre	2.50 (2.00–3.00)	0.020
Post	3.00 (3.00–3.75)	
Goal 5 (health-care acquired infections)		
Pre	4.00 (4.00–4.75)	0.011
Post	5.00 (4.00–5.00)	
Goal 6 (falls prevention)		
Pre	2.00 (1.00–2.00)	
Post	2.00 (1.00–2.00)	

IQR: Interquartile range; ICU: Intensive care unit.

with p < 0.001, similar to the findings by the Ethiopian study by Wami *et al.* to study health care workers' view on patient safety culture and its related factors [16].

Introducing the concept of patient safety to the health-care personnel was crucial being relatively new for most of them, as shown in the results of the baseline assessment, with the median score was 3.0 and IQR (3.0–4.0).

The studies on health-care professionals' knowledge levels yielded contradictory results. Some studies reported a good knowledge level [17], yet others identified knowledge deficits [18], [19].

In the study intervention, patient safety goals and standards were clear and focused on and were communicated clearly in the training sessions, which is vital to any patient safety training program. In addition to relying on local clinical leadership, using multiple strategies to gain support of staff and sharing learning and solutions with health-care personnel that helped create more momentum [20], [21]. This helped the health-care personnel's knowledge to significantly improve in all of the questioned items and in the overall patient safety knowledge score, where the median total knowledge score before

the training was 3 and IQR 3.0–4.0, while after the training, it was 6 and IQR 5.0–7.0, where there was a statistically significant difference between the results in the pre-assessment and post-assessment, with p = 0.01.

Similar findings were discovered in another study by El-Sayed *et al.*, where statistically significant knowledge improvement was found in the general aspects of patient safety [19].

The results of the present study revealed that the overall patient safety grade was rated acceptable by 53.4% of the interviewed subjects. A similar result was found by Aboul-Fotouh *et al.* in a study in Ain Shams University to assess patient safety culture, where 57.3% of the participants found it acceptable [22].

However, it came in contrast to the overall patient safety grade in a similar study done in Saudi Arabia by Alahmadi, where 33% of the respondents found it to be acceptable. Still, the Saudi study had a few limitations, where the data used were from 13 hospitals and merged in the analysis despite the fact that these institutions were variable in terms of size, complexity, and focus on patient safety [23].

In the current study, the highest dimension of patient safety in this current study was job satisfaction among the participants of this study with 83.1%, which is similar to the Palestinian study, where job satisfaction area received the highest safety attitude area with 71.2% of positive responses.

While, the lowest dimension in the patient safety culture among the study participants was "Hospital Handoffs and transitions" (19.2%) revealing a problem in safe continuity of care, with a high possibility of losing important patient information that may affect the progress of medical condition, alter the desired outcome, and contribute to adverse events and near miss [24], thus, the efficient and effective transfer of patient care information from one hospital staff member to another is an essential element of positive safety

culture [25]. Similar result of low positive responses of 24.6% was found by Aboul-Fotouh *et al.* [22].

Furthermore, the "non-punitive response to error" received an average low positive response of 20.6% of the study participants; however, events' reporting in a non-punitive environment is crucial for improving patient safety. This result was agreed on by Aboul-Fotouh *et al.* at 19.8%, revealing that the health-care personnel are not at ease when it comes to reporting errors [22]. On the other hand, higher positive responses were found in other studies, the US hospitals (44%) [26], Abdelhai and associates, 2012, with 33.3% [27] and the score in Lebanese Hospitals was 24.3% [28].

In the present study, the effect of the intervention on patient safety culture was investigated. The findings suggest that the intervention significantly improved some of the aspects of patient safety culture. This was synonymous to the study by Verbakel *et al.* [29]. As well as a case–control study performed in India by Amiri *et al.* to study the effect of an educational program on the attitudes of nurses toward patient safety, significant improvements were observed in 5 out of 12 dimensions in the experimental group [30].

In the current study, significant improvement occurred in two items of "safety climate," in the attitude toward personnel guidelines' knowledge and responsibility for patient safety, coinciding with Amiri *et al.*'s overall safety climate score, which could be explained by the significant increase in their knowledge of patient safety and their involvement in the program and raising their sense of responsibility toward incident reporting [30].

In addition to, three of the five items of management perception to patient safety were significantly improved. This can be explained by the fact that the ICU management team as well as the quality department team were involved in the program with reassurance and enhancing the trust of the health-care personnel, a finding that is similar to Amiri's *et al.* study results in 2018 [30].

Improved management perception to patient safety together with teaching the health-care personnel to speak up, through incident reporting specially about near misses that were included in the study intervention might explain the significant improvement in "communication openness" dimension after the intervention and the differences between the current findings and those from previous studies. This finding was in line with the findings of a study by Andreoli *et al.* [31]. However, it was in contradiction with the results of two other studies, in which patient safety education and teamwork training of nurses and hospital staff did not improve their attitudes on communication openness [32], [33].

The item of "I have made errors that had the potential to harm patients" in the "overall perception of patient safety" dimension was significantly deteriorated,

which might be explained by the increase in their knowledge and awareness of the quality of care that should be performed in their PICUs.

The use of the pertinent JCI IPSGs as a framework offers specific tools to improve patient safety to validate that these standards are being met, it addresses the day-to-day patient care issues [34].

Moving on in the pursuit to understand the baseline assessment of the patient safety situation in the PICUs' observation of patient safety practices and hospital measures according to JCI accreditation checklist was done.

Starting with the identification process of patients in the four PICUs, sometimes patients were not identified using two patient identifiers, and sometimes they were identified using their file number, as recommended by the JCI in 2016. All patients' identities were confirmed before performing diagnostic procedures, providing treatments, and performing other procedures. The PICUs do not have a documented process that ensures the correct identification of patients in special circumstances, such as the comatose patient or newborn who is not immediately named. In a study by Gray *et al.*, 50% of the patients in the neonatal ICU were at risk of misidentification [35].

Regarding communication in the PICUs, verbal and telephone orders or test results were not documented and read back by the receiver and confirmed by the individual giving the order. The PICUs have defined critical values for each type of diagnostic test and to whom they are reported. Data from adverse events resulting from handover communications were not tracked and used to identify ways, in which handovers can be improved, and improvements are implemented. This came in accordance to the results obtained by Craig *et al.* in a study designed to strengthen handover communication in PICUs [24].

As for the high-alert medications safety, two of the PICUs have not yet identified in writing their list of high-alert medications or developed and implemented a process for their management. Three of the PICUs have a list of look-alike/sound-alike medications and developed and implemented a process for their management. However, all the four PICUs have yet to develop a process that prevents inadvertent administration of concentrated electrolytes to follow the guidelines of the JCI in 2016.

Although there is a committee for infection control in the hospital, yet the system required to reduce the risk of health-care acquired infections is still deficient. The hospital has adopted current evidence-based hand hygiene guidelines, the hospital implements a hand hygiene program throughout the hospital, handwashing, and hand disinfection procedures were not always used in accordance with hand hygiene guidelines throughout the hospital which was similar to the findings by Owens

and Stoessel, where hand hygiene practices were not followed at all times by the health-care personnel [36].

Finally, regarding falls prevention, the PICUs are in the process of implementing a process for assessing all inpatients for fall risk and using assessment tools/ methods that are appropriate for the patients being served, however, it was not yet implemented till the end of this study. However, measures to reduce fall risk are implemented for all inpatients, situations, and locations within the PICUs, particularly those expected to be at risk by the physicians, for example, convulsing patients, including raising bedrails and adjusting the beds for the patients, and preventing slippery floors. In the study by Heafner *et al.*, the lack of falls risk assessment was the reason to develop a tool to assess risk for falls in women in hospital obstetric units [37].

On examining the results of the end line assessment of the patient safety practices after this study intervention, four of the five studied goals improved significantly after the intervention. While only the falls prevention did not show improvement, as the rest of the standards of this goal should be met by implementing a fall risk assessment checklist in the PICUs, which was planned but not yet implemented up until the end of the current study.

A similar study to ours by Verbakel *et al*. found that patient safety practices improved significantly after administering of a patient safety culture questionnaire followed by a workshop [29]. Ragsdale also found similar results on implementing the JCI standards in an endoscopy unit in 2011 [38].

A recent study conducted in Portugal with the purpose of determining the impact of educational initiatives on the indicator for adherence to verification of patients' identification detected major improvements in the proposed intervention, with increased adherence overtime for up to 94.37% of the sample [39].

The success of the intervention to improve the practices in the PICUs can also be explained using employees' awareness-raising strategy and the fact that patient safety interventions with evidence of sincerity, commitment, and enthusiasm among senior leadership in the hospital about improving patient safety enjoyed a very high level of commitment, as they could link the program very clearly and explicitly to local need and that they saw it as helpful in providing a response to incidents [40].

Conclusion and Recommendations

The results of the current study led to the conclusion that patient safety knowledge, culture, and practice had much room for improvement in the hospital and that the strategies based on patient safety awareness-raising among health-care providers together with commitment and enthusiasm among senior leadership in the hospital can potentially improve compliance with practice and consequently lead to better patient safety, thus patient safety should be a top strategic priority for policy-makers, managers, leaders, and frontline staff of Cairo University Hospitals. Implementation of multifaceted interventional patient safety program is important for improving the compliance to patient safety standards including interval patient safety training programs for health-care personnel with continuous monitoring and performance indicators calculation as well as communication of the feedback to all staff members about patient safety performance being beneficial. Furthermore, incorporation of patient safety as a concept and approach in the educational curricula is recommended as well as training for medical students during their internship.

Limitations of the study

The sample in this study was limited to health-care providers working in one pediatric teaching hospital in Egypt which limits the generalization of results to other teaching hospitals.

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