Improving Patient Safety Practices in Critical Care Departments, Ibb Hospitals (Yemen): An Intervention Study

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ABSTRACT

Background: Safety of health care is now a major global concern, it is likely that millions of people suffer harms related to medical care thus medical care related harms is now considered a global public health problem particularly in developing countries.

Aim: To improve patient safety knowledge and practices in two Intensive Care Units (ICUs) in Ibb governorate (Yemen).

Methods: The study was an intervention study conducted in two ICUs (one private and one governmental) in Ibb's hospitals. It passed through three stages; initial assessment of patient safety situation within studied ICUs, intervention stage including training, use of wrist band, verbal order documentation and critical values reporting, then re-evaluation to assess the changes happened after implementation of the intervention.

Results: A total of 53 healthcare providers were enrolled in to the study; 31 in the private ICU and 22 in the governmental ICU. Less than half of healthcare personnel had good knowledge (45.2% in the private ICU and 40.9% in the governmental ICU), after implementation of intervention the knowledge improved significantly to be 100% and 95.5% in the private and governmental ICUs respectively. Patient safety practices also improved significantly after intervention.

Conclusion: The overall patient safety situation in the studied ICUs was weak and it significantly improved after intervention conduction. Patient safety should be a top strategic priority for policy makers, managers and leaders. Institutional support, continuous monitoring, incidents' reporting as well as communication of the feedback to all staff members about patient safety performance are extremely crucial.

1. Introduction

No goals in health care are more critical than keeping patients safe from harm and improving the delivery and outcomes of their care [1]. Ensuring safety and optimizing care are at the heart of healthcare, and evidence-based medicine is the gold standard for achieving them [2]. Adverse Events (AEs) are still a major problem for patients and staff despite several medical improvements in diagnosis and treatment because these procedures are frequently extremely complex and can be impacted by a variety of problems including human error and hospital systems [3].

Globally, it is estimated that approximately 10% of patients have been affected by at least one AE, with mortality rate following such AEs was estimated at around 8% [3]. There is greater probability that AEs are more frequent in developing countries [4].

International interest in patient safety (PS) has been increasing over the last two decades, since the publication of the landmark Institute of Medicine (IOM) report, 'To Err is Human', in 1999 [5].

World Health Organization has defined patient safety as "The absence of preventable harm to a patient and the reduction of risk of unnecessary harm associated with healthcare to an acceptable minimum" [6]. Keeping patients safe isn't just a goal; it's the bedrock of high-quality health care [7].

Intensive Care Units (ICUs) stand out among the many healthcare settings in terms of patient safety. ICUs, emergency rooms, and operating rooms had the greatest error rates with significant implications, according to the IOM report [8]. Due to the complexity of the care offered, the severity of the patients treated in these units, and the work frequently carried out under stressful circumstances and with the involvement of a multidisciplinary team, ICUs are known to be more prone to adverse events (AEs). As a result, the ICU puts

patients' safety at risk [9].

Studies showed that critically ill patient typically experienced a mean of 1.7 errors per day and nearly all patients in an ICU were affected by a potentially life-threatening error at some point during their stay [10, 11].

Significance of the study; This research is timely because in Yemen PS is a relatively new focus where little is known about its current status in ICUs and health care organizations in general. As this study is the first in-depth study to explore patient safety in Yemeni ICUs; it will contribute to a better understanding of PS situation in Yemeni healthcare context and will enable health service providers to raise awareness about PS and to identify areas requiring improvement.

The current study aimed at enhancing PS knowledge and practices in ICUs in two hospitals in Ibb governorate (Yemen).

2. Methods

2.1 STUDY DESIGN AND SETTING

This study is an intervention study, a pretest-posttest design, in which an initial assessment of health-care providers' PS knowledge and practices was conducted in ICUs in two hospitals, one governmental and one private, in Ibb governorate (Yemen). An appropriate intervention was designed according to the results of baseline assessment then implemented. The PS knowledge, and practices were reassessed to evaluate the impact of the applied intervention.

2.2 STUDY POPULATION AND SAMPLING:

All physicians and nursing staff working in both governmental and private ICUs were consented to participate in the study. Thirty-one health care providers; 7 physicians and 24 nurses in the private ICU and twenty two health care providers; 6 physicians and 16 nurses in the governmental ICU were included in the pre- intervention assessment, intervention and post- intervention assessment phases of the study, with response rate= 100 %.

2.3 DATA COLLECTION TOOLS

❖ Patient safety Knowledge assessment: A pre-designed self-administered questionnaire formulated of 18 questions was developed by the researcher based on literature to assess the healthcare provider's knowledge about PS.

Total items (18) were divided into eight parts: Patient Safety definition& responsibility, correct patient identification, effective communication, medications safety, safety of clinical alarm system, infection control measures, bed sore prevention and incidents. The tool was translated into Arabic and back translation to English was done to ensure that the Arabic version is consistent with the original English version. pilot testing phase was carried out on (10%) five of studied participants in the two ICUs to adapt the questionnaires to fit the Yemeni context, to suit the culture in the hospitals and verify that and questions are clear and comprehensible. The Arabic version was given to nurses and English version to physicians

❖ Scoring system: Each question was scored as "0" for incorrect and "1"for correct answer. The total score of the questionnaire was 18 marks.

▪ Good knowledge. When healthcare providers respond the mean or above the mean score on knowledge questions concerning PS [12, 13].

▪ Poor knowledge. When healthcare providers respond below the mean score on knowledge questions concerning PS [12, 13].

❖ PATIENT SAFETY PRACTICES CHECKLIST [14, 15].

A modified form of Hospital National Patient Safety Goals (NPSG) Effective January 2020, Hospital Accreditation Program was used. The goals are structured in the form of a standard (goal statement) and measurable elements (Elements of Practices). Measurable elements were modified to fit the ICU environment, items that were not applicable in ICU e.g.: prevention of mistakes in surgery were removed, the used checklist had 6 goals, and each goal had measurable elements.

❖ SCORING SYSTEM:

Elements are scored as “met”=2, “partially met”=1, or “not met”=0. Making the maximum possible total score (MPTS) for all goals= 54.

1- NPSG (1): Improve the accuracy of patient identification (6 items)

(MPTS score= 12)

2- NPSG (2): Improve effectiveness of Communication among health care givers (4 items)

(MPTS = 8)

3- NPSG (3): Improve Safety of using medications (9 items)

(MPTS = 18)

4- NPSG (6): Reduce the harm associated with clinical alarm systems (3 items)

(MPTS = 6)

5- NPSG (7): Reduce the Risk of Health Care-Associated Infections (4 items)

(MPTS = 8)

6- NPSG (15): Reduce risk of suicide

(One item)

(MPTS = 2)

7- Prevent mistakes in surgery (Universal Protocol) was not included, as operating rooms were not included in the study.

Eleven visits for observation (6 visits in private ICU and 5 visits in governmental ICU) were done by the investigator in pre assessment phase. The observations on activities of staff were carried out over 24 hours, in different times and schedules, including morning, afternoon and night shifts. Each visit was 1-2 hours. If not all checklist activities took place during the 1-2 hours period, the observation period was extended.

❖ INTERVENTION:

The investigator, in addition to two of the quality department staff, joined with ICU's head nurse created the "Patient Safety team", in both private and governmental ICUs.

A. PATIENT SAFETY TRAINING:

Lectures and on job hand washing training sessions were designed with collaboration of the quality team using PowerPoint presentations about PS definition, overview, all PS goals, hand washing, bed sores, guidelines for management of central lines and urinary catheter and safety culture, including medical errors, incidents, and incident reporting.

Education sessions for small groups inside the ICUs during working day were done. Eight lectures and one hand washing training session were conducted .A total of 24 sessions (in each ICU) each about 40 minutes and 5 minutes for open questions and discussion were done over a period of eight weeks (each lecture was repeated more than once to ensure the attendance of the entire nurse staff).

Hand-outs were given to healthcare providers and Posters were hung in the ICUs.

B. USE OF IDENTIFICATION WRIST-BANDS:

To ensure positive patient identification; the wristband was applied to all patients who were admitted to the studied ICUs. It was established that wristband must contain, at the minimum, two identifiers; complete name of the patient and file number. Patient’s room or bed number are not considered acceptable identifiers.

The PS team (mainly the investigator and the head nurse) worked to ensure the correct use of wristbands and that:

- All patients at ICUs were identified by a wristband.
- Wristband contains complete and accurate information for identification.
- Identification elements used in wristband being in accordance with the identification data found in the patient's hospital records.
- Furthermore, the specimen containers should be labeled in the presence of the patient using the same two identifiers of the wrist band.

C. DOCUMENTATION OF VERBAL ORDRES (VOS):

A verbal order is an order that is communicated orally either in place (face to face) or by telephone by a licensed healthcare provider, regarding a medication, diagnostic test, or other treatment [16]. In this study, verbal orders that are communicated by telephone were considered as the use of face-to-face verbal orders which is clearly necessary when the prescriber is in the middle of a procedure or medical emergency, and it is impractical to stop patient care to write a patient care order.

Verbal Order Policies and Procedures: The PS team with cooperation of both hospitals' managements and quality departments created a new policy that provides guidance on how ICU staff should handle verbal orders.

The procedures:

1. Verbal orders regarding prescriptions, medications, and tests are not to be used as common practice; it should be limited to an emergent situation when written communication is not feasible by the healthcare provider and the delay of writing an order can affect patient safety.

2. Verbal orders may be refused if the person receiving the order believes this may compromise either his/her individual practice or the patient's care and treatment.

3. Define Healthcare provider who is authorized to give a verbal order (specialist and resident physicians).

4. Receiver of the order should follow these steps:

- Immediately write the verbal order down on the approved verbal order template that was prepared by the investigator
- Abbreviations must not be utilized.
- Read the order back to the physician and receive confirmation, to ensure that he/she has properly heard and understood the order and that the order is correct.

5. Healthcare provider who gave the verbal or telephone order must authenticate the verbal order template by validating the correct patient, correct order within 1- 2 days.

D. Laboratory critical values reporting:

The PS team in cooperation with both hospitals' managements, quality departments and laboratory managers created a new policy and procedures to provide guidelines for identification, reporting and notification of critical values of laboratory tests.

Procedures & steps

1- Defined Laboratory critical values as "a test result that is significantly outside normal range and may represent life threatening values" [17].

2- A list of laboratory tests with critical values was prepared after referring to relevant literature and discussion with the ICU specialist who use laboratory services, the list comprise biochemistry, hematology and microbiology tests, both for adult and pediatric patients [18]. A copy of the list was delivered to the laboratory workers and a poster with this list was hung on the laboratory wall.

3- The critical value should be verified before reporting it to clinicians, including rechecking the specimen, repeating test or contacting with clinicians for confirmation. Then it should be reported by laboratory personnel to the attending physician or nurse either within 30 minutes from the time that the value were announced, or within 60 minutes from the time of order, from the testing area.

4- Laboratory personnel must document the critical value in the critical values documentation form that was prepared by the investigator, then call the attending physician, if the physician is unavailable laboratory technician must call the responsible nurse, the staff member reporting the critical value shall:

- Identify him- or herself
- Give the patient's name and file number
- Report the critical value(s)
- Request a read back of the patient information and critical value(s) by the physician or nurse receiving the information for verification

5- The attending physician or nurse receiving the information should record the information in critical value record that was hung on the wall beside the telephone to make data recording easier for the staff [18].

6- A quality indicator, reporting rate (number of critical values reported by technician/total number of critical values required to be reported× 100) is used to monitor whether the critical value is reported or not.

7- Monitoring of the work, on monthly basis, done by the PS team through: collecting data on the frequency of critical value reporting by the laboratory and comparing data in the lab records and that in the critical value documentation forms with those in the ICU's critical value record to ensure that that every critical value was reported by the lab and documented in the ICU's critical value record.

E. OTHER IMPLEMENTED INTERVENTIONS:

✓ Supplying all departments' rooms with alcohol dispensers.

✓ Providing free support from pharmaceutical companies to supply the governmental ICU with alcohol.

✓ Labeling of high alert medications with red label.

✓ High alert medications lists posters were hanged in the ICUs

❖ POST INTERVENTION ASSESSMENT:

➢ By using the same initial assessment tools PS knowledge and practices, were assessed over a period of two months.

➢ Assessment of Critical values reporting and Verbal orders documentation compliance over a period of six months.

2.4 DATA MANAGEMENT AND STATISTICAL ANALYSIS

Data was checked, coded, and entered into the software program of Statistical Package for Social Science (SPSS) Version 24 where all statistical analyses were performed. All data normality was tested by Kolmogorov's test, and almost all were not-normally distributed. Descriptive statistics were applied to summarized data using numbers and percentages for qualitative variables, mean and standard deviation for quantitative normally distributed variables while median and inter quartile range (IQR) was used for not normally distributed quantitative variables.

Analytic statistics were applied to compare pre- and post- intervention items of assessment, using McNemar test for qualitative and Wilcoxon test for quantitative data. For comparison between groups, Chi-square test was used for analysis of qualitative variables (Fishers exact test was used as alternatives for Chi-square test if there were many small expected values) and Mann-Whitney U-test for quantitative variables. P values ≤ 0.05 were considered statistically significant.

2.5 ETHICAL CONSIDERATIONS

Approval of the Medical Ethics committee, Faculty of Medicine, Cairo University was obtained (Code: MD-329-2021) and administrative approvals were obtained from the managements of both hospitals. Confidentiality was assured all patients' data was anonymously presented.

3. Results

A total number of health-care personnel who participated in the study was 53; thirty one in the private ICU and

twenty two in the governmental ICU. In the private ICU; 54.8% of healthcare personnel were males, their median age was 26 and IQR (6.0). The majority of the included personnel were nurses (24), representing 77.4%. In the governmental ICU the majority (91%) of healthcare personnel were males and the median of their age was 31 and IQR (20.0). The nurses (15) representing 68.2% of the total personnel. All health care personnel (100%) of private ICU worked on a full-time basis while (54.5%) of governmental ICU's health care personnel worked on contract as shown in Table (1).

Table (2) shows, Comparison between private and governmental ICUs regarding PS knowledge among studied healthcare personnel: There was no statistically significant difference between both ICUs regarding the percent of healthcare personnel who have good PS knowledge except in the knowledge of safety of clinical alarm system and bed sore prevention where private ICU's healthcare personnel had a statistically significant better knowledge score.

Table (3) shows relation between PS knowledge and socio-demographic and occupational characteristics among studied healthcare personnel in the studied ICUs; On comparing PS knowledge among females and males, no statistically significant difference was found between them, so was among experience in hospital/ unit, average weekly working hours and their perceived patient safety grade, only the job title showed statistically significant difference in the private ICU with percent of physician with good knowledge is higher than nurses percent (100%, 29.2%respect) p-value = .001

Table (4) shows change in the knowledge about PS of the studied healthcare personnel in private ICU before and after the intervention, there was a statistically significant improvement in the percentage of healthcare personnel with good knowledge of PS. The percentage significantly increased from 45.2%, 40.9% in the baseline assessment to 100%, 95.5% in the end line assessment in the private and public ICUs respectively.

Table (5) shows change in the achievement scores of PS goals in studied ICUs between the baseline and end line assessment, where there was a statistically significant difference in all goals except for goals 6 and 15 which showed no change while in

Table (6) it shows a Comparison between private ICU and governmental ICU regarding the achievement scores of the patient safety goals according to the JC Hospital NPSG, where there was a statistically significant difference in the End line assessment for both goals 3 and 6 and for the total score.

Figure (1) shows proportion of critical values reported in newly implemented critical value reporting system in private ICU over the period of 6 months.

While in governmental ICU: most of laboratory tests with critical values were not done in the laboratory, it was found that reported critical values were only for CBC and blood sugar tests and they were only one reported critical value in the 1st, 2nd, 3rd, 5th and 6th months and no reported critical value in the 4th month.

Figure (2) shows number of verbal orders documented in newly implemented verbal order documentation system in both ICUs.

Table (1): Socio-demographic and occupational background of the healthcare personnel in the studied ICUs

Item		Private ICU		Governmental ICU	
		N=31	%	N=22	%
Sex	Male	17	54.8	20	91
	Female	14	45.2	2	9
Age	Median (IQR)	26 (6.0)		31 (20.0)	
Job Title	Specialist physician	1	3.2	2	9.1
	Resident physician	6	19.4	4	18.2
	Head nurse	1	3.2	1	4.5
	Nurse	23	74.2	15	68.2
Working experience in hospital/unit (years)	less than 1 year	16	51.6	8	36.4
	1-5 years	15	48.4	7	31.8
	More than 5 years	0	0	7	31.8
ICU job status	Full time	31	100	10	45.5
	On contract	0	0	12	54.5
Average weekly working hours	less than 20 hours	4	12.9	5	22.7
	20-39 hours	7	22.6	7	31.8
	40-59 hours	20	64.5	5	22.7
	≥ 60 hours	0	0	5	22.7

Table (2): Comparison between private ICU and governmental ICUs regarding Patient safety knowledge among studied healthcare personnel

Patient Safety Knowledge items	Baseline assessment		
	Private ICU	Governmental ICU	P-value*
	Good knowledge No (%)	Good knowledge No (%)	
Patient safety definition	22 (71)	11 (50)	0.121
Correct patient identification	15 (48.4)	9 (40.9)	0.590
Effective communication	13 (41.9)	8 (36.4)	0.683
Medications safety	26 (83.9)	17 (77.3)	0.545
Safety of clinical alarm system	28 (90.3)	13 (59.1)	0.007
Infection control measure	5 (16.1)	4 (18.2)	1.00
Bed sore prevention	24 (77.4)	11 (50)	0.038
Incidents	9 (29.0)	3 (13.6)	0.183
Total PS knowledge	14 (45.2)	9 (40.9)	0.758

*Chi- Square test

Table (3): Relation between Patient safety knowledge and socio-demographic and occupational characteristics among studied healthcare personnel

Item		Private ICU		Governmental ICU	
		Good Knowledge	P-value*	Good Knowledge	P-value*
Sex	Female	5 (35.7)	0.337	0 (0.0)	0.494
	Male	9(52.9)		9 (45)	
Experience in hospital/ unit (years)	< 1 year	7 (43.8)	0.870	3 (37.5)	0.09
	1-5 years	7 (46.7)		5 (71.4)	
Job title	physician	7 (100)	0.001	1 (14.3)	0.178
	Nurse	7 (29.2)		4 (66.7)	
Average weeklyworking hours	less than 20 hours	0 (0.0)	0.143	5 (31.3)	0.173
	20-39 hours	4 (57.1)		6 (60)	
	40-59 hours	10 (50)		5 (41.7)	
Perceived patient safetygrade	Excellent & Very Good	5 (41.7)	0.950	3 (60)	0.720
	Acceptable	8 (47.1)		4 (57.1)	
	Poor& Failing	1 (50)		0 (0.0)	

*Chi- Square test

Table (4): Patient safety knowledge of healthcare personnel in the baseline and end line assessments in the studied ICUs

Patient Safety Knowledge	Private ICU		P value*	Public ICU		P value*
	Base line - Assessment	End line - Assessment		Base line Assessment	End line Assessment	
Patient safety definition	22 (71)	31 (100)	0.004	11 (50)	19(86.4)	0.008
Correct patient identification	15 (48.4)	31 (100)	<0.001	9 (40.9)	221 (100)	<0.001
Effective communication	13 (41.9)	31 (100)	<0.001	8 (36.4)	22(100)	<0.001
Medications safety	26 (83.9)	31 (100)	0.06	17 (77.3)	20 (90.9)	0.453
Safety of clinical alarm system	28 (90.3)	30(96.8)	0.625	13 (59.1)	18(81.8)	0.125
Infection control measure	5 (16.1)	25 (80.6)	<0.001	4 (18.2)	17 (77.3)	<0.001
Bed sore prevention	24 (77.4)	28 (90.3)	0.123	11 (50)	18 (81.8)	0.016
Incidents	9 (29.0)	28 (90.3)	<0.001	3 (13.6)	18 (81.8)	<0.001
Total PS knowledge	14 (45.2)	31(100)	<0.001	9 (40.9)	21 (95.5)	<0.001

*McNemar test

Table (5): Achievement scores of patient safety goals according to the JC Hospital NPSG in baseline and end line assessment in the studied ICUs

Item		Private ICU		Governmental ICU	
		Median (IQR)*	P value**	Median (IQR)*	P value**
Goal (1)	Baseline	5.0 (1.0)	0.026	5.0 (1.5)	0.038
	End line	10.0 (1.0)		10.0 (1.0)	
Goal (2)	Baseline	1.0 (1.0)	0.024	2.0 (1.0)	0.038
	End line	6.0 (1.0)		6.0 (0.50)	
Goal (3)	Baseline	9.0 (2.0)	0.024	5.0 (1.5)	0.041
	End line	13.0 (1.25)		9.0 (1.5)	
Goal (6)	Baseline	4.0 (0.0)		2.0 (0.0)	
	End line	4.0 (0.0)		2.0 (0.0)	
Goal (7)	Baseline	2.0 (0.0)	0.027	0.0 (0.0)	0.041
	End line	6.0 (2.25)		5.0 (2.0)	

Goal (15)	Baseline	0.0 (0.0)		0.0 (0.0)	
	End line	0.0 (0.0)		0.0 (0.0)	
Total score	Baseline	20.0 (2.25)	0.027	14.0 (3.5)	0.038
	End line	38.0 (3.0)		31.0 (2.5)	

*Interquartile Range; **Wilcoxon- sign test

Table (6): Comparison between private ICU and governmental ICU regarding the achievement scores of the patient safety goals according to the JC Hospital NPSG

Item	Baseline assessment Median (IQR)		P-value*	End line assessment Median (IQR)*		P-value*
	Private ICU	Governmental ICU		Private ICU	Governmental ICU	
Goal (1) Total score=12	5.0 (1.0)	5.0 (1.5)	0.838	10 (1.0)	10 (1.0)	0.827
Goal (2) Total score=8	1.0 (1.0)	2.0 (1.0)	0.004	6 (1.0)	6 (0.5)	0.637
Goal (3) Total score=18	9.0 (2.0)	5.0 (1.5)	0.006	13 (1.25)	9 (1.5)	0.005
Goal (6) Total score=6	4.0 (0.0)	2.0 (0.0)	0.002	4 (0.0)	2.0 (0.0)	0.002
Goal (7) Total score=8	2.0 (0.0)	0.0 (0.0)	0.002	6 (2.25)	5.0 (2.0)	0.218
Goal ((15) Total score=2	0.0 (0.0)	0.0 (0.0)	1.00	0.0 (0.0)	0.0 (0.0)	1.00
Total score (54)	20.0 (2.25)	14.0 (3.5)	0.006	38 (3.0)	31.0 (2.5)	0.005

*Mann- Whitney test

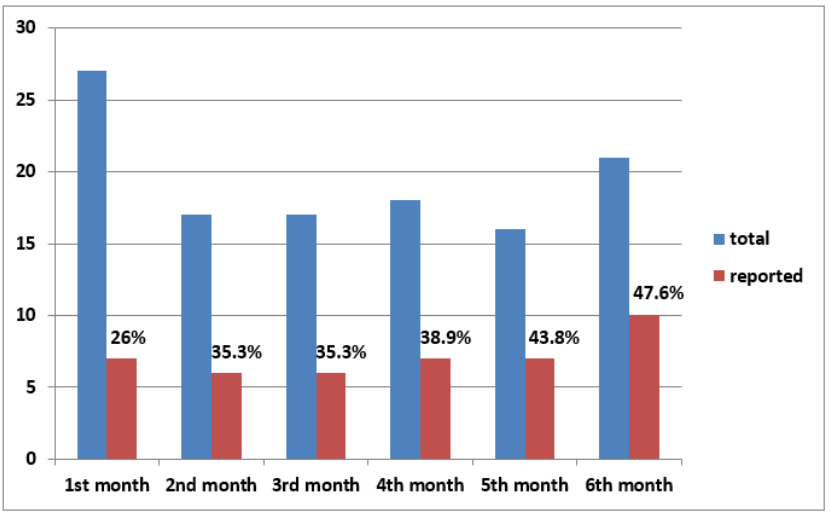

Figure (1): Proportion of critical values reported compared to the total number of critical values in private ICU

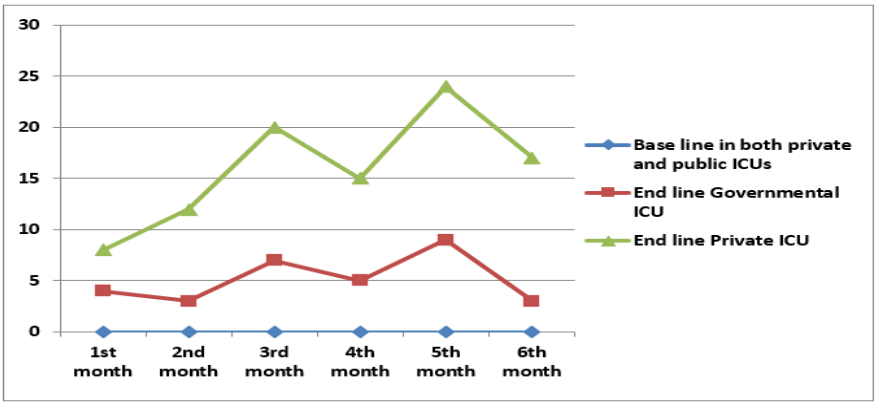

Figure (2): Number of documented verbal orders in baseline and end line assessment in both Private and governmental ICUs

4. Discussion

Recently, patient safety in ICUs has been given increasing attention because ICUs are high-risk environments for the occurrence of adverse events with serious consequences [20].

Introducing patient safety concepts to the healthcare personnel was crucial, as the baseline assessment revealed it was relatively new for a majority of them; with less than half of them have good knowledge (45.2% in private ICU and 40.9% in governmental ICU), which could be explained by the lack of educational programs on patient safety. Working load and busy schedules the staff face during their work in the ICUs could be another explanation. As demonstrated by Brasaite et al., nurses who received information about patient safety during educational program were 4.39 times more likely to have good knowledge as compared to those who had not [21].

The current study results are consistent with results reported by an Ethiopian study in which less than half (48.4%) of the respondents had good knowledge [22]. On the other hand, this finding was lower when compared with a study conducted to assess knowledge, attitude, practice, and associated factors towards patient safety among nurses which reported that more than half of the nurses 58.7% had good knowledge [13]. Also when compared with results reported by two more; Brazilian and Indian studies, it was found that 89.8% and 93% of nurses respectively had good knowledge [23, 24]. These differences might be due to targeting of health professionals by different educational and training programs and developmental status of the country like the presence of separate patient safety units in their institutions.

Furthermore, the present results is better than results of an additional Egyptian study which stated that only 38% of the nurses had satisfactory knowledge [25]. This difference may be due to inclusion of nurses only in the assessment.

Scientific research indicates that healthcare systems face a big challenge to ensure safe care for patients and prevent harm. Thus, it is important to identify the weakest areas in knowledge of healthcare professionals. Accordingly, best strategy could be created to increase the level of knowledge, in order to achieve safer clinical practice [26].

Mamdouh et al., found that the worst rated knowledge items were knowledge about incidents, effective communication and infection control measures [26], which is similar to the result obtained in the present study; as knowledge about incidents, effective communication and infection control measures achieved lowest percent of good knowledge. Also, the current results are consistent with patient safety authority, which recommended that majority of incidents reported were related to pressure sores, infection control, patient miss identification, patient falling and medication error due to the defect in nurses knowledge[27].

On studying relation between PS Knowledge and socio-demographic and occupational factors of studied participants, including; sex, job title, years of experience ICU job status or weekly working hours, it was found that job title had statistically significant relation with PS knowledge in private ICU, where all physicians had good PS knowledge. While in governmental ICU no statistically significant association was found between PS knowledge and socio-demographic and occupational factors of health care personnel.

These findings come in accordance with Wake et al., De Oliviera et al., and Lillykutty et al. [13, 23, 24]. On the contrary, Biresaw et al. reported that age, level of education, length of work experience, training about patient safety were significantly associated with nurses' PS knowledge [12].

In the study intervention, patient safety goals and standards were clear and focused upon and were communicated clearly in the training sessions, which is vital to any patient safety training program. In addition, relying on local leadership, using multiple strategies to gain support of staff and sharing learning and solutions with healthcare personnel helped create more momentum. This helped the healthcare personnel's knowledge to significantly improve in all of the knowledge items and in the total PS knowledge, where the good knowledge percentage before the training was 45.2% and 40.9%, while after the training it was 100% and 95.5% in the private and governmental ICUs respectively, the difference between the results in the pre-assessment and post-assessment was statistically significant.

Similar findings were reported by Soliman et al. and Shaw et al. where statistically significant knowledge improvement was found; post-intervention knowledge score was significantly higher than the pre- intervention score [28, 29]. Furthermore Kirkman et al. systematically reviewed studies including evaluation of patient safety

training interventions delivered to trainees/residents and medical students, they reported that the majority of such courses improves PS knowledge, skills and attitudes [30].

The observation of patient safety practices and hospital measures according to JC Hospital National Patient Safety Goals checklist revealed that regarding patient identification process; both ICUs achieved similar scores, all patients were not identified by two patient identifiers as recommended by the JCI in (2016) [31]; identification primarily relied on their names only. This poor practice might be explained by poor health care providers' knowledge about correct patient identification and lack of proper patient identification guidelines. All patients' identities were confirmed before doing diagnostic procedures, providing treatments, and performing other procedures. ICUs lack a formal procedure for reliably identifying patients in special cases, like comatose individuals or unnamed newborns.

This result is similar to that obtained by Soliman et al. and Kulju et al. who found that patient misidentification is prevalent in both inpatient and outpatient settings and the most common root cause was not using two patient's identifiers [28, 32].

Containers used for blood and other specimens were not labeled in the units, they were sent to the laboratory wrapped by the test request causing an increased risk of specimen labeling errors. This is not in line with recommendations of Joint Commission on Accreditation of Healthcare Organizations' (JCAHO) National Patient Safety Goal (NPSG) for 2006 to use two patient-specific identifiers whenever taking blood or other samples from a patient, and to label the sample collection container in the presence of the patient. Specimen labeling errors accounted for 55.5% of identification errors in a previous study conducted by the College of American Pathologists [33].

Regarding communication in ICUs, both ICUs achieved low score with governmental ICU achieved a higher score than private ICU due to presence of critical values reporting policy in the governmental ICU, even though it is not functional. Verbal and telephone orders or test results were usually neither documented nor read back by the receiver and not confirmed by the individual giving the order. Regarding critical values reporting; the private ICU does not have critical values' reporting policy while the governmental ICU has critical values' reporting policy, yet it is not functional.

It was observed in the current study that the shift change (handover) between nursing team in both ICUs was a verbal type only. While between physicians it was written and verbal handover in the private ICU and verbal only in governmental ICU. These results are in line with the result obtained by Wung et al. study conducted in Taiwan in which the goal of communication had achieved the lowest score [34].

As for goal 3, due to lacking of quality departments' role which were deemed inactivated in both governmental and public hospitals, the private ICU has not yet identified a list of high-alert medications nor developed or implemented a process for their management, while the governmental ICU although it has a list of high-alert medications, it has not implemented a process for their management. Furthermore neither a list of look-alike/sound-alike medications nor an implemented process for their management was present in both ICUs. The results reported by Soliman et al. are consistent with the current study results regarding high-alert medications, while they contradict those regarding look-alike/sound-alike medications [28].

In accordance with recommendations of (NPSG3) to reduce the likelihood of patients harm associated with the use of anticoagulant therapy, the private ICU uses evidence-based practice guidelines for initiation and maintenance of anticoagulant therapy and for reversal of anticoagulation. Also programmable pumps for heparin administration are used in private ICU, while governmental ICU has applied one element only "uses evidence-based practice guidelines for the initiation and maintenance of anticoagulant therapy".

With regard to goal 7, though there is a committee for infection control in the private hospital, yet the system required to reduce the risk of health care acquired infections is still deficient, hence it achieved low score. It has partially adopted current evidence-based hand- hygiene guidelines and evidence-based practices to prevent central line–associated bloodstream infections and indwelling catheter-associated urinary tract infections (CAUTI), hand-washing and hand-disinfection procedures were not always used in accordance with hand-hygiene guidelines throughout the hospital. Although the governmental hospital has an infection control committee, it is not functional, hence it achieved zero score. The findings in the private ICU are in accordance with findings by Soliman et al. [28].

Finally Regarding goal that concerned with measures to reduce the risk for suicide; both ICUs do not have

implemented measures for identification of individuals at risk for suicide while under care of or following discharge from a health care Organization. The JC identifies inpatient suicide as a sentinel event. Little is known about the epidemiology of hospital suicides other than that they are rare and occur mostly in psychiatry wards [35].

Williams et al. reported that the average number of hospital inpatient suicides ranges from 48.5 to 64.9 per year [36].

On examining the results of the end line assessment of the patient safety practices after conduction of intervention in both private and governmental ICUs, four of the six studied goals improved significantly after the intervention, while goal 4& 6 didn't show improvement, because they were not involved in the intervention during this study.

Soliman et al. found similar results in Pediatric Intensive Care Units. Also, Verbakel et al. reported that patient safety practices significantly improved after administering patient safety culture questionnaire followed by a workshop [28, 37].

CRITICAL VALUES REPORTING

Establishing an effective policy of critical value reporting, besides being fundamental for patient's treatment and safety, must be considered an opportunity for closer cooperation between laboratory staff and the medical staff [38]. Lack of reporting of critical values may have had a direct impact on morbidity and mortality [39, 40].

The reporting rate for the critical values in the private ICU's newly implemented critical value reporting system was higher compared to findings of study conducted by in Kenya where the rate of critical value reporting was 21% [41].

Regular sensitization of laboratory staff, throughout this study, regarding critical value reporting policy and procedures led to increased awareness among laboratory staff and so increase reporting rate. However it is important to further improve the reporting process and this can be achieved by:

(1) Continuous (sustained) training and sensitization of staff.

(2) Addressing staff workload issues.

(3) Implementing technology solutions

Also, periodical revision and updating of the established list of critical values in consultation with the clinicians will add to the improvement.

VERBAL ORDERS DOCUMENTATION

Verbal orders have become a target for medical institutions in efforts to improve patient safety practices and prevent medication errors [41].

The observed increase in the rates of verbal orders in the 3rd and 5th month coincided with the Eid holiday when specialists were on leave from work. The result of implemented policy is in consistence JCAHO standards that requires verbal orders be "write down" by the receiver who should read back the order and the sender must confirm that what has been written down and read back is accurate [35].

Wakefield et al. in their review of Verbal Order Policies in 40 Acute Care Hospitals across the United States found that all of the study hospitals' VO policies required the use of read-backs by the person receiving the VO to the person giving the VO and most of these hospitals required documentation of who gave the VO, who received the VO, the date and time that the order was received and the implemented order [43].

5. Conclusion

Patient safety knowledge and practice related to NPSG were low in both private and governmental ICUs. Education sessions and training has significantly improved patient safety knowledge among healthcare personnel. Also implemented intervention has significantly improved the patient safety practices related to NPSG in the studied ICUs and led to some beneficial actions enhancing the ICUs' patient safety situation.

- AVAILABILITY OF DATA AND MATERIAL

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

- Abbreviations

AEs: Adverse events

ICU: Intensive Care Unit

IOM: Institute of medicine

JC: Joint Commission

JCAHO: Joint Commission on Accreditation of Healthcare Organization

JCI: Joint Commission International

NPSGs: National Patient Safety Goals

PS: Patient safety

VO: Verbal Order

- Declarations

- ETHICAL APPROVAL AND CONSENT TO PARTICIPATE:

All participants had received information about the study aim and procedures and they had been informed that participation is strictly voluntary and can be discontinued at any time at their convenience. All information gathered from the included healthcare providers were treated according to the Helsinki Declaration of biomedical ethics [19].and confidentiality was guaranteed on handling the data. Verbal consent was obtained from the healthcare providers before they were involved in the study.

Approval of the Medical Ethics committee, Faculty of Medicine, Cairo University was obtained (Code: MD-329-2021) and administrative approvals were obtained from the managements of both hospitals.

- CONSENT FOR PUBLICATION

Not applicable. All data was anonymously presented.

COMPETING INTERESTS

The authors declare that they have no competing interests.

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AUTHORS' CONTRIBUTION

This research was conducted in collaboration between all authors. MAA contributed to the study design, acquisition, analysis, and interpretation of the data, original draft preparation and writing the manuscript. HAE contributed to study conception, supervision, and review. AME contributed to the development of study tools, interpretation of the results, and review. FHO contributed to supervision, and review. EME contributed to interpretation of the data, supervision, review and writing and editing the manuscript. All authors read and approved the final manuscript.

- All authors have approved the submitted version and have agreed both to be personally accountable for the author's own contributions and to ensure that questions related to the accuracy or integrity of any part of the work, even ones in which the author was not personally involved, are appropriately investigated, resolved, and the resolution documented in the literature.

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