Tertiary Trauma Survey: Nurses Performance and Polytrauma Patients' Outcomes

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ABSTRACT

Context: Tertiary Trauma Survey is an important tool for detecting missed injury, and some trauma units have created their protocol for tertiary trauma surveys to decrease the incidence of missed injuries in trauma patients.
Aim: This study aims to assess nurses' performance regarding tertiary Survey and Poly-trauma patients' outcomes.
Methods: Descriptive exploratory design was utilized to achieve the aim of the study. A convenient sample of all available nurses (50 nurses) working in the intensive care unit at the emergency hospital affiliated to Ain Shams University Hospitals. A purposeful sample composed of (50) adult patients diagnosed as polytrauma patients recruited from the same units. Data obtained through three main tools; Self-administered questionnaire for nurses, nurses practice observational checklist, and clinical outcome record for patients.
Results: Nurses had an unsatisfactory level of knowledge and practice regarding the tertiary trauma survey (44%&32%, respectively). There was a highly statistically significant positive correlation between the total level of knowledge and practice. There was a difference between injury severity score and laboratory, hemodynamic status, physical assessment, and radiological findings of polytrauma patients on admission and after 24 hours.
Conclusion: Less than half and less than one-third of the nurses under study had an unsatisfactory level of knowledge and practice, respectively, regarding the tertiary trauma survey. There was a highly statistically significant positive correlation between the total level of knowledge and total level practice. Polytrauma patients' outcomes revealed a statistically significant difference between injury severity score, hemodynamic status, physical assessment, and radiological findings in polytrauma patients on admission and after 24 hours. Recommendations: Further research is needed to follow the patients' outcomes and missed injury. Replication of the current study on a larger probability sample is recommended to achieve generalization of the result. Tailored Training courses are needed for nurses to improve unsatisfactory knowledge and practices regarding tertiary trauma survey– integrated studies with the emergency medical team to communicate patients' outcome research findings.

Keywords: Tertiary trauma survey, polytrauma, patients' outcome

1. Introduction

Trauma remains the leading cause of death and disability in young adults. Polytrauma is a significant cause of morbidity and mortality in both developed and developing countries. Polytrauma patients represent the ultimate challenge to the trauma care team, and the optimization of their care is a primary focus of clinical research. The most massive toll of traumatic deaths occurs within the first hour following trauma. Often defined as the "golden hour of trauma," following the principle of "time is essence" management during the first hour of injury is essential *(Kunreuther, 2012).*

Polytrauma is generally used to describe trauma patients whose injuries involve multiple body regions, compromise the patient's physiology, and potentially cause dysfunction of uninjured organs. The expected higher risk of mortality of polytrauma patients is based on the assumption that the underlying pathophysiological response of the injured person would aggravate the clinical outcome *(Paffrath, Lefering & Flohe, 2014).*

World Health Organization defines outcome measures as a "change in the health of an individual, group of people or population that is attributable to an intervention or series of interventions." Outcome measures (mortality, readmission, patient experience) are the quality and cost targets healthcare organizations are trying to improve *(Tinker, 2018).*

A standard quality indicator in trauma care is missed injury. Missed injuries result from the prioritization that takes place during the initial assessment and management in the emergency department (ED) and emergency intervention. Because the focus in the ED is on making time-critical decisions, complete injury identification during resuscitation (including primary and secondary surveys) is not always feasible *(Keijzers, Campbell, Hooper, Bost & Crilly, 2014).*

Missed injuries (MIs) adversely affect patient outcomes and damage physician/ institutional credibility. The primary and secondary surveys are designed to identify all of a patient's injuries and prioritize their management; however, MIs are prevalent in severely injured and multisystem trauma patients, especially when the patient's condition precludes completion of the secondary survey *(Pfeifer & Pape, 2014).*

In cases of emergency trauma, nursing care requires the health services and professionals to use a variety of

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practices to meet the high complexity and seriousness presented by violent or accident victims, who need specific health actions/interventions. Tertiary trauma surveys (TTS) are proposed to reduce the rate of missed injuries in hospitalized trauma patients. TTS is performed by the trauma nurse practitioners on critical care admissions within 24 hours and repeated before discharge. It includes physical assessment of the trauma patients from head to toes, detailed history, reviewing all radiographic imaging and laboratory value trends before interventions *(Aitken, Marshall & Chaoyer, 2015).*

2. Significance of the study

Trauma is a significant cause of death and disability and places huge social and economic requirements on health system resources. Studies have suggested that tertiary trauma survey protocol can identify life-threatening injuries and minimize the number and effect of missed injuries. There is little information on the current practice of tertiary survey performance in hospitals. Therefore, the present study was conducted to assess the nurses' level of knowledge and practice regarding the tertiary trauma survey and assess polytrauma patients' outcomes.

3. Aim of the study

This study aims to assess nurses' performance regarding tertiary surveys and polytrauma patient outcomes. This aim achieved through the following:

- Assess the nurses' level of knowledge regarding a tertiary survey for patients with polytrauma.
- Assess the nurses' level of practice regarding a tertiary survey for patients with polytrauma.
- Assess polytrauma patients' outcomes.

3.1. Operational definitions

Nurses' performance: It assessed nurses' level knowledge and practice regarding tertiary trauma survey.

Patients' outcome: outcome measured in terms of the physical assessment, radiological findings, and lab investigations for polytrauma patients.

4. Subjects & Methods

4.1. Research design

The descriptive exploratory design was utilized to meet the aim of the study.

4.2. Setting

The study was conducted in the intensive care unit at Emergency Hospital affiliated to Ain Shams University hospitals.

4.3. Subjects

- A convenient sample of all available nurses (50 nurses) who are working in the above settings. The study included nurses of both genders.
- A purposeful sample composed of 50 adult patients of both sexes diagnosed as polytrauma patients recruited from the above settings.

Sample size: Study subjects include a purposive sample of total patients hospitalized during the period 2017. Their total number is 130 multiple injury patients in ICU. Based on the sample size equation, 50 patients will participate in the study. The sample size calculated by adjusting the power of the test to 80% and the confidence interval to 95% with a margin of error accepted adjusted to 5% and a known total population of 130 patients using the following equation:

$X = Z(c/100)2r(100-r)$

$N = Nx/((N-1)\ E2+x)$

$E = Sqrt\ [(N-n)\ x/n(N-1)]$

N is the population size, r is the fraction of studied responses, and Z(c/100) is the critical value for the confidence level *(Chow, Shao, & Wang, 2007).*

Patients selected according to the following criteria: Adults of both sexes and patients with polytrauma (any traumatic injury that included multiple body regions). Burned, pregnant women and geriatric patients were excluded from the selection.

4.4. Tools for data collection

4.4.1. Self-Administered Questionnaire For Nurses

It was developed by the investigator based on a review of relevant literature and translated into Arabic and retranslated to English *Urden, Stacy, and Lough, (2014).* It included two parts:

The first part was concerned with nurses' demographic characteristics (age, sex, years of experience, educational level, and training courses attended).

The second part concerned with the assessment of nurses' level of knowledge regarding the tertiary trauma survey. It consisted of 61 multiple choice questions with one question including 15 points. The assessment questions related to nurses' knowledge regarding polytrauma, definition, the purpose of a tertiary trauma survey, primary and secondary survey, trauma triage, injury severity score, diagnostic procedures, and laboratory investigations.

Scoring system

The tool scores as one grade given for each correct answer and zero for the incorrect answer. Sixty-two multiple-choice questions equal 62 grades, the total score of question number 49 equal 15 grades because it had 15 points, with a total grade of 76 grades, with a total (62) questions. The total level of nurses' knowledge score was categorized as more than or equal to 90% (55 marks) is considered the satisfactory level of knowledge, and less than 90% is considered an insufficient level of knowledge.

4.4.2. Nurses' Practice Observational Checklist

This tool was adopted from *Proehl and Allen (2009)* and modified by the investigator. It was used to assess nurses' level of practice regarding tertiary trauma surveys of patients with polytrauma. The checklist is composed of (141) steps. It is concerned with nurses' level of practice regarding primary assessment, secondary assessment, neurological assessment, pain assessment, pulse oximetry, patient monitoring, reporting laboratory findings, and radiological transfer.

Scoring system

The checklist scored as two grades for each step done correctly, one grade for that done incorrectly, and zero for the step that was not done, with a total grade =282 grades. The total level of nurses' practice score was categorized as

more than or equal to 90% (254 marks) is considered the satisfactory level of practice, and less than 90% is considered the poor level of practice.

4.4.3. Clinical Outcomes Tool

This tool was adopted from *Grossman and Born (2010).* It is used to assess polytrauma patients' outcomes on admission and after 24 hours. It involves two parts as follows:

The first part concerned with the patient's sociodemographic characteristics such as (age, gender, trauma activation type, history of present injury, past medical and surgical history).

The second part concerned with clinical outcomes of polytrauma patients that involved injury severity score, hemodynamic status, physical assessment of polytrauma patients, radiological findings review, and laboratory investigations findings.

Scoring system

The injury severity score adopted from *Chawda, Hildebrand, Pape, and Giannoudis (2014)* was used to assess trauma severity. It ranged from 1-75 and categorized as follows: Minor injury (1-8), moderate injury (9-15), serious injury (16-24), severe injury (25-49), critical injury (50-74), and un survival & maximum injury (75).

4.4.4. Glasgow Coma Scale

This scale adopted from *Healey, Rogers, Osler, Glance, and Meredith (2014)* used to describe the general level of consciousness in patients with polytrauma and define broad categories of head injuries. GCS has a total score of 15/15. Minor brain injury (13-15), moderate brain injury (9-12), and severe brain injury (3-8).

4.6. Procedures

The operational design includes a preparatory phase, tools validity, reliability, pilot study, and fieldwork. A preparatory phase included reviewing related literature to develop tools for data collection, testing validity by using face and content validity. The validity was done through a panel of seven experts from the Faculty of Nursing, Ain Shams University (four professors, two assistant professors, and one lecturer). Tools were tested for their reliability by test-retest measurement. It applied to 50 nurses with the alpha Cronbach test. The reliability scaled as follows: < 0-0.25 weak reliability, 0.25-0.75 moderate reliability, 0.75< 1 strong reliability and 1 is optimum. The reliability of the developed tool was 0.85.

A pilot study was carried out on 10 % of nurses (5 nurses) from the study subjects to test the tools' clarity, applicability, feasibility, relevance and determine the needed time to complete the study tools. The nurses who were included in the pilot study were included in the sample because no modification was done after conducting the pilot study. The research approval obtained from the scientific research ethics committee of the Faculty of Nursing, Ain Shams University, before initiating the study work. The researcher clarified the objectives and aim of the study in addition to verbal informed consent obtained from each participant. The researcher assured maintaining anonymity and confidentiality of subjects' data. Nurses informed that they are allowed to withdraw from the study at any time without any pressure.

Fieldwork: The purpose of the study was simply explained to the nurses who agreed to participate in the study before data collection. The actual work of this study started and was completed within four months from March 2017 to June 2017. Data were collected by the researcher four days per week at morning and afternoon shifts in the previously mentioned settings. The researcher started assessing nurses' practice using an observational checklist to assess nurses' practice regarding tertiary trauma survey. Also, the researcher delivers the self-administered questionnaire for nurses to assess nurses' knowledge. The nurses filled in the questionnaire in about 20 minutes for each nurse. The clinical outcome tool to assess polytrauma patient' outcomes, filled in by the researcher by using patients' files and observation; it took about 2 hours to fill it for every patient on admission and 2 hours after 24 hours from admission.

5. Results

Table 1 shows that 50% of the nurses under study were less than 30 years with a mean age (30.52 ± 3.82). As regards gender, 72% of the studied nurses were females. Regarding the educational level, 52% of the studied nurses had a technical institute diploma. About 62% of the nurses had experienced less than ten years with a mean of 9.28±2.32. Regarding attending training courses, 58% of the nurses did not attend any training courses.

Table 2 shows that the nurses had an unsatisfactory level of knowledge regarding the definition of tertiary trauma survey, purpose of tertiary trauma survey, trauma triage, and injury severity score (60%, 56%, 70%, 80%). Respectively. The table also clarifies that the nurses under study had a satisfactory level of knowledge regarding polytrauma, secondary survey, diagnostic procedures, and laboratory investigations (84%, 76%, 86%, respectively). Additionally, table 2 shows that 22 44%) of the studied nurses had a total unsatisfactory level of knowledge.

Table 3 shows that 68% of studied nurses had a satisfactory level of practice regarding the primary assessment, as, regarding secondary assessment, the table shows that the nurses had an unsatisfactory level of practice regarding history taking, head, and maxillofacial assessment, cervical spine, and neck assessment, and identifying and reporting laboratory findings (40%, 44%, 46%, 70%) respectively. Concerning nursing practice regarding checking of radiological transfer, table 3 reveals that 80% of nurses had a satisfactory level of practice. Finally, the table shows that 32% of the nurses under study had a total unsatisfactory level of practice.

Table 4 shows a highly statistically significant positive correlation between nurses' total level knowledge and their total level of practice regarding the tertiary trauma survey ($r = 0.537$ at p-value <0.001).

Table 5 shows that 44% of the studied patients were within the age group 30-45 years with a mean of age 30.5±2.82. As regards gender, 72% of the studied patients were males. Regarding trauma activation type, it was observed that 54% of the studied patients were classified as type 1. concerning the type of present injury, table 5 clarifies that 70% of the studied patients had blunt trauma. As regards past history, it found that the studied patients did not have a medical and surgical history (58%, 80%), respectively.

Table 6 shows a statistically significant difference between patients' injury severity scores on admission and after 24 hours. Regarding moderate injury, the results reveal an increase from 4(8%) of the studied patients on admission to 6(12%) after 24 hours. Whereas serious injury, there was an increase from 8(16%) of the studied patients on admission to 10(20%) after 24 hours, and critical injury decreased from 16(32%) of the studied patients on admission to 12(24%) after 24 hours from admission.

Table 7 shows a difference between polytrauma patients' hemodynamic status on admission and after 24 hours. Regarding blood pressure, the table shows there was an increase in the number of hypotensive patients 30(60%) on admission to 34(68%) after 24 hours. Regarding the respiratory rate, the table also shows an increase in the number of bradypnea patients from 7(14%) on admission to 18(36%) after 24 hours with a statistically significant difference ($p < 0.05$). Concerning body temperature, 15(30%) of the studied patients had hypothermia after 24 hours.

Table 8 shows a statistically significant difference between patients' physical assessment on admission and 24 hours regarding head injuries, chest injuries, abdominal injuries, and extremities injuries (88%, 90%, 72%,92% respectively at $p < 0.05$).

Table 9 shows a statistically significant difference between patients' radiological findings of polytrauma patients on admission and after 24 hours. In contrast, there was an increase in the percentage of injuries after 24 hours, regarding flail chest, fracture acetabulum pelvis, fractured C1, fracture L1, L2, fractured femur, frontal hematoma, and retroperitoneal hematoma (62%, 48%, 32%, 38%, 56%, 68%, 78% respectively).

Table (1): Frequency and percentage distribution of sociodemographic characteristics of studied nurses (n=50).

Demographic characteristics	No.	%
Age (years)		
<30 year	25	50.0
30-45 year	23	46.0
>45 years and more	2	4.0
Mean±SD	30.52±3.82	
Gender		
Male	14	28.0
Female	36	72.0
Educational level		
Nursing secondary school diploma	12	24.0
Nursing technical institute diploma	26	52.0
Nursing B.Sc.	10	20.0
Postgraduate study	2	4.0
Experience in years		
<10 years	31	62.0
≥10 years	19	38.0
Mean±SD	9.28±2.32	
Training courses attended		
Yes	21	42.0
No	29	58.0

Table (2): Frequency and percentage distribution of nurses' level of knowledge regarding polytrauma and tertiary trauma survey (n=50).

Knowledge domain	Satisfactory		Unsatisfactory	
	No.	%	No	%
Poly-trauma	42	84	8	16
Tertiary trauma survey				
Definition of tertiary trauma survey	20	40.0	30	60.0
Purpose of tertiary trauma survey	22	44	28	56
Trauma triage	15	30	35	70
Primary survey	30	60	20	40
Injury severity score	10	20	40	80
Secondary survey	38	76	12	24
Diagnostic procedures and laboratory investigations	43	86	7	14
Total knowledge	28	56	22	44

Table (3): Frequency and percentage distribution of nurses' level of practice regarding tertiary trauma survey (n=50).

Nursing practices	Satisfactory		Unsatisfactory	
	No.	%	No.	%
Primary Assessment (ABCDE)				
Alertness / Airway	35	70.0	15	30.0
Breathing	45	90.0	5	10.0
Circulation	26	52.0	24	48.0
Disability	23	46.0	27	54.0
Exposure / environmental control	40	80.0	10	20.0
Total	34	68.0	16	32.0
Secondary Assessment				
History taking	30	60.0	20	40.0
Head and maxillofacial	28	56.0	22	44.0
Cervical spine and neck assessment	27	54.0	23	46.0
Chest	41	82.0	9	18.0
Abdomen / flanks	45	90.0	5	10.0
Back and Extremities	40	80.0	10	20.0
External genitalia	35	70.0	15	30.0
Total	35	70.0	15	30.0
Neurological assessment	38	64.0	12	24.0
Pain assessment	41	82.0	9	18.0
Pulse oximetry	35	70.0	15	30.0
Connect Patient to monitor	39	78.0	11	22.0
Report laboratory findings	15	30.0	35	70.0
Check for radiological transfer	40	80.0	10	20.0
Total practice	34	68.0	16	32.0

Table (4): Correlation between nurses' total level of knowledge and nurses' total level of practice regarding tertiary trauma survey (n=50).

Variables	Total Practice	
	Correlation Coefficient	p-value
Total Knowledge	0.537	<0.001

Table (5): Frequency and percentage distribution of patients' sociodemographic characteristics (n=50).

Sociodemographic characteristic	No.	%
Age (years)		
<30 year	11	22.0
30-45 year	22	44.0
>45 years and more	17	34.0
Mean± SD	30.5±2.82	
Gender		
Male	36	72.0
Female	14	28.0
Trauma activation type		
Type 1(unstable patient)	27	54.0
Type 2 (stable patient)	23	46.0
Type of present injury		
Penetrating trauma	15	30.0
Blunt trauma	35	70.0
Past medical history		
Hypertension	10	20.0
Diabetes mellitus	6	12.0
Asthma	5	10.0
None	29	58.0
Past surgical history		
Appendectomy	7	14.0
Cholecystectomy	3	6.0
None	40	80.0

Table (6): Injury severity score of polytrauma patients on admission and after 24 hours (n=50).

Injury severity score	On admission		After 24hrs		x^2	p-value
	No.	%	No.	%		
Minor injury	10	20.0	10	20.0	0.000	1.000
Moderate injury	4	8.0	6	12.0	0.100	0.752
Serious injury	8	16.0	10	20.0	0.250	0.617
Severe injury	10	20.0	10	20.0	0.000	1.000
Critical injury	16	32.0	12	24.0	0.632	0.427
Un survival injury	2	4.0	2	4.0	0.000	1.000

Table (7): Hemodynamic status of polytrauma patients on admission and after 24 hours (n=50).

Hemodynamic status	On admission		After 24hrs		x^2	p-value
	No.	%	No.	%		
Vital signs						
Blood pressure						
Normal (90/60-120/80) mm Hg	15	30.0	13	26.0	0.036	0.850
Hypertension (above normal range)	5	10.0	3	6.0	0.125	0.724
Hypotension (below normal range)	30	60.0	34	68.0	0.141	0.708
Pulse rate						
Normal (60-100) beat/minute	20	40.0	22	44.0	0.024	0.877
Tachycardia (above normal range)	15	30.0	16	32.0	0.031	0.859
Bradycardia (below normal range)	15	30.0	12	24.0	0.148	0.700
Respiratory rate						
Normal (12-18) breath/minute	18	36.0	12	24.0	0.833	0.361
Tachypnea (above normal range)	25	50.0	20	40.0	0.356	0.551
Bradypnea (below normal range)	7	14.0	18	36.0	4.000	0.046
Body temperature						
Normal (36.5-37.3) ċ	25	50.0	21	42.0	0.356	0.551
Hypothermia (below a normal range	11	22.0	15	30.0	0.346	0.556
Hyperthermia (above normal range)	14	28.0	14	28.0	0.000	1.000

Table (8): Physical assessment of polytrauma patients on admission and after 24 hours (n=50).

Physical assessment	On admission		After 24hrs		x^2	p-value
	No.	%	No.	%		
Bodyweight						
From 50- 70 kgs.	5	10.0	10	20.0	1.067	0.302
>70-90 kgs.	32	64.0	32	64.0	0.000	1.000
>90-120 kgs.	13	26.0	8	16.0	0.762	0.383
Glasgow Coma Scale						
Minor brain injury	18	36.0	20	40.0	0.026	0.871
Moderate brain injury	22	44.0	22	44.0	0.000	1.000
Severe brain injury	10	20.0	8	16.0	0.056	0.814
Head injuries	33	66.0	44	88.0	5.647	0.018
Eye injuries	17	34.0	17	34.0	0.000	1.000
Ear injuries	10	20.0	11	22.0	0.065	0.799
Nose injuries	15	30.0	15	30.0	0.000	1.000
Throat injuries	11	22.0	11	22.0	0.060	0.806
Neck injuries	15	30.0	17	34.0	0.047	0.829
Heart injuries	6	12.0	6	12.0	0.000	1.000
Chest injuries	32	64.0	45	90.0	8.131	0.004
Lungs injuries	37	74.0	40	80.0	0.052	0.817
Abdominal injuries	25	50.0	36	72.0	4.203	0.040
Back injuries	26	52.0	29	58.0	0.161	0.688
Rectal injuries	14	28.0	16	32.0	0.190	0.663
Extremities injuries	33	66.0	46	92.0	8.680	0.003

Table (9): Radiological findings review of polytrauma patients on admission and after 24 hours (n=50).

Radiological finding review	On admission		After 24hrs		x^2	p-value
	No.	%	No.	%		
X-ray findings						
Chest x-ray						
Lung contusion	30	60	30	60	0.000	1.000
Pneumothorax	25	50	30	60	0.646	0.421
Hemothorax	29	58	29	58	0.000	1.000
Flail chest	18	36	31	62	6.760	0.009
Fracture second, the third rib	10	20	12	24	0.058	0.809
Fracture fourth, fifth, sixth rib	8	16	8	16	0.000	1.000
Fracture sternum	5	10	7	14	0.095	0.758
Fracture seventh, eighth ribs	8	16	9	18	0.017	0.895
Pelvis						
Fracture acetabulum pelvis	6	12.0	24	48.0	9.633	0.002
Open fracture	10	20	11	22	0.024	0.877
Closed fracture	6	12	6	12	0.000	1.000
C- spine						
Fracture C 1	7	14.0	16	32.0	3.614	0.057
Fracture C2	8	16	10	20	0.068	0.795
Thorax/Lumbar/Sacral spine						
Fracture L1, L2	9	18.0	19	38.0	4.018	0.045
Scapular fracture	0	0	2	4	0.510	0.475
Extremities						
Upper limbs						
Fracture humerus	1	2	1	2	0.000	1.000
Lower limbs						
Fracture open wound leg	1	2	1	2	0.000	1.000
Fracture Tibia	0	0	2	4	0.510	0.475
Fracture Femur	20	40.0	28	56.0	5.252	0.022
Fracture Fibula	0	0	2	4	0.510	0.475
Fracture HIP	5	10	6	12	0.045	0.831
Head CT						
Frontal hematoma	22	44.0	34	68.0	4.051	0.044
Fracture base of the skull	7	14	7	14	0.000	1.000
Cerebral contusion	8	16	9	18	0.017	0.895
Fracture depressed	2	4	2	4	0.000	1.000
Subarachnoid hemorrhage	10	20	10	20	0.000	1.000
Subdural hematoma	6	12	6	12	0.000	1.000
Neck CT						
Tracheal deviation	0	0	1	2	0.169	0.681
Fracture mandible	2	4	7	14	1.954	0.162
Chest CT						
Diaphragm injury	2	4	5	10	0.614	0.433
Fracture clavicle	1	2	3	6	0.260	0.609
Abdomen/ Pelvis CT						
Liver tear	2	4	5	10	0.614	0.433
Spleen injury	0	0	2	4	0.510	0.475
Duodenal injury	0	0	2	4	0.510	0.475
Pancreatic injury	0	0	3	6	1.375	0.241
Retroperitoneal hematoma	27	54.0	39	78.0	5.392	0.020
Vaginal tear	2	4	3	6	0.048	0.826

6. Discussion

The current study was carried out to assess nurses' performance regarding tertiary trauma surveys and polytrauma patients' outcomes. The nurses' demographic characteristics revealed that half of the studied nurses' ages were below 30 years with a mean age (30.52±3.82). This result may be because nurses more than 30 years old had a workload that makes them leave the ICU work and transfer to another unit. This finding was inconsistent with a study done by *Mohamed (2015)* entitled "Impact of a designed head trauma nursing management protocol on critical care nurses' knowledge and practices at emergency hospital Mansoura university," who reported that two-thirds of the studied nurses had 30 years old and more with the mean age of nurses 32.22±5.29.

About gender, the present study shows that less than three-quarters of the nurses under study were females. This finding may be because a more significant fraction of the nurses' task force in Egypt was females and may also relate to the study of nursing in Egyptian universities exclusive for females until a few years ago. This finding agreed with a study done by *Taha (2015)* entitled "Assessment of critical care nurses' knowledge and practices regarding oxygen therapy at El Minia University hospi-

tal," who reported that more than half of nurses were females.

Regarding the educational level of nurses, results reveal that more than half of the nurses under study were holding nursing technical institute diplomas. From the investigator's point of view, this may be because many bedside nurses in governmental hospitals graduated from the nursing technical institute diploma. After all, bachelor nurses in governmental hospitals are usually working as head nurses or nursing supervisors. These findings are in the same line with a study done by *Loutfi (2016)* entitled "Nurses' performance regarding nasogastric tube feeding among critically ill patients," who reported that near half of the nurses under study were having technical institute diploma. In contrast to the current study, a study was done by *Mansour, Farhan, Othman, and Yacoub (2010)* entitled "Knowledge and nursing practice of critical care nurses caring for patients with delirium in intensive care units in Jordan" who reported that most studied nurses had a bachelor's degree of nursing science.

Regarding years of experience, the result shows that less than two-thirds of studied nurses had less than ten years of experience. This result may be because half of the studied nurses were young, less than 30 years old. This result agrees with *Ghoneim's (2012)* study entitled "Impact of implementing nursing care protocol on moderate head-injured patients' outcome," which reported that most of the studied nurses had years of experience ranged from 1-5 years.

The present result shows that more than half of the studied nurses did not attend any training course regarding training courses attended. This finding may be because most nurses were females with family commitments, lack of time, and workload in the intensive care unit may also be the reason behind. This finding is consistent with a study done by *Shahin (2012)* entitled "Nurses' knowledge and practices regarding enteral nutrition at the critical care department," who reported that most of the nurses under study had no previous training courses.

Concerning the nurses' level of knowledge, the present result shows that most of the nurses under study had a satisfactory level of knowledge regarding polytrauma, diagnostic procedures, and laboratory investigations. This result may be because more than half of the nurses under study were less than 30 years old, and they still retain some of the necessary knowledge and receive many polytrauma patients in the intensive care unit. This result is consistent with a study done by *Maarouf (2012)* entitled "Nurses performance for patients with a traumatic head injury during golden hour," who reported that more than half of nurses had adequate knowledge regarding laboratory and diagnostic procedures.

The present result also shows that more than half of the studied nurses had an unsatisfactory level of knowledge regarding the definition and purpose of a tertiary trauma survey. Besides, more than two-thirds of them had an unsatisfactory level of knowledge regarding trauma triage. This result may be because they did not attend any training courses specific to a tertiary trauma survey.

This result is inconsistent with a study done by *Fathoni, Sangchan, and Songwathana (2013)* entitled "Relationships between triage knowledge, training, working experiences, and triage skills among emergency Nurses in East Java, Indonesia," who reported that nurses had satisfactory level regarding trauma patients' triage.

Concerning nurses' level of knowledge regarding injury severity score, the results reveal that most nurses had an unsatisfactory level of knowledge regarding injury severity score. This result may be because nurses did not use the trauma severity scores, so they are not acquainted with them.

The present study reveals that more than half of studied nurses and more than three-quarters of them had a satisfactory level of knowledge regarding the primary and secondary survey, respectively. This finding may be because the ICU admission form includes a database of the primary survey, history taking, and head-to-toe assessment. This result is consistent with a study done by *Considine and Currey (2014)* entitled "Ensuring a proactive, evidence-based, patient safety approach to patient assessment," which reported that nurses had adequate knowledge regarding the primary and secondary survey.

Regarding nurses' total level of knowledge, the result shows that less than half of the nurses under study had an unsatisfactory level of knowledge. This finding may be due to lack of nurses' time to update their knowledge, time constraints, lack of co-worker's support, and work commitments, especially those who are working in intensive care units for several years who are also overloaded by an increasing number of patients assigned for each nurse. Concerning nurses' level of practice regarding the primary trauma survey, it was clear that more than two-thirds of the studied nurses have a satisfactory level of practice regarding primary assessment. This result may be because some of the nurses attended training courses, and the routine work of ICU admission allows the nurses to have hands-on all the time. This finding is consistent with the results of a study done by *Morad (2010)* entitled "Developing a clinical pathway map for patients with traumatic spinal cord based on needs," who reported that the majority of nurses had a satisfactory level of practice regarding the primary assessment of the traumatized patient.

Regarding secondary assessment, the result reveals that more than two-thirds of the nurses had a satisfactory level of practice. This finding is the opposite of the study done by *Ahmed (2011)* entitled "Developed of nursing standards for the management of organophosphorus poisoned patients," who reported that most nurses in the emergency unit had an unsatisfactory level of practice regarding the secondary assessment of trauma patients.

Concerning nurses' level of practice regarding tertiary trauma survey, the present study shows that less than half of nurses understudy had an unsatisfactory level of practice regarding history taking, head and maxillofacial assessment, and cervical spine and neck assessment. This result may be due to a lack of specific training sessions, lack of qualification as more than half of nurses were technical institute diploma. Also, the absence of continuous education and evaluation and workload could be attributed to the lack of knowledge reflecting on their performance. The present study also shows that more than two-thirds of nurses had unsatisfactory practice regarding reporting laboratory findings. This result may be because nurses usually send lab requests and forgot to follow the

results, as well as a lack of supervision and workload may play a role.

Interestingly enough, the present study shows that most nurses had a satisfactory level of practice regarding checking for radiological transfer. This result was supported by *Mansour (2014)* in a study entitled "The effect of implementing triage training competencies on newly graduated nurses working in the emergency department at the emergency hospital" and by *Morad (2010)* in a study entitled "Developing a clinical pathway map for patients with traumatic spinal cord based on needs" both results showed that nurses had a satisfactory level of practice regarding checking of radiological transfer. From the researcher's point of view, this may be because physicians usually follow the results of the radiological study, and it is critical in decision-making for the trauma patient, so nurses are obliged to make sure it was done in a timely manner.

By studying the correlation between participants' total level of knowledge and the total level of practice, the current study reveals a highly statistically significant correlation between nurses' total level of knowledge and their total level of practice regarding tertiary trauma surveys. This finding may be due to that nurses' knowledge increase with more practice and vice versa. This result is consistent with a study done by *Mohammed (2014)* entitled "Critical care nurses' knowledge and practice regarding administration of total parenteral nutrition at critical care areas in Egypt," who stated a highly statistically significant correlation between participants' knowledge and practice.

Regarding the patients' characteristics, the present study reveals that less than half of the patients under study their age were at range 30-45 years with a mean of age (30.5±2.82). This result may be because this age is the most productive age, and people at that age have an active life. This result is following a study done by *Payal, Sonu, Anil, and Prachi (2013)* entitled "Management of polytrauma patients in the emergency department: an experience of a tertiary care health institution of northern India" who reported that most of the trauma patients were in the age group between 15 -30 years.

Regarding trauma activation type, the result clarifies that more than half of the patients under study were type 1 (unstable patient). This finding may be because road traffic accidents are severe and fatal; lack of using the safety belt usually results in serious injuries. The delayed arrival of an ambulance due to street overcrowding in Egypt may be a significant factor in deteriorating trauma patients at the scene. This result is consistent with a study done by *Davis et al. (2010)* entitled "Prospective evaluation of a two-tiered trauma activation protocol in an Australian major trauma referral hospital," who reported that the full trauma activation group had a significantly higher proportion of the major trauma outcome.

The current study reveals that more than two-thirds of the patient under study had blunt trauma. This finding may be because road traffic accidents are common in Egypt because of bad roads, sports injuries, and fall from height. This result follows a study done by *Thomson and Greaves (2010)* entitled "Missed injury and the tertiary trauma survey," which reported that most trauma patients were blunt trauma.

The present study showed that more than half of the patients under study did not have any medical or surgical history. This result may be due to their young age. This result is following a study done by *Yuan, Chien, Chang, Chen, Ying Chien, and Huang (2018)* entitled "Impact of comorbidities on the prognoses of trauma patients: Analysis of a hospital-based trauma registry database" who reported that most of the trauma patients were medically free, and the severity of comorbidity associated with higher hospital mortality among traumatized patients.

About severity scores, as regards many patients have moderate and severe injury severity scores, it is observed that there is an increasing number of patients who had a severe injury after 24 hours of admission. These results may be due to either deterioration in patients' conditions or detection of missed injury. This result following a study did by *Mohamed, Ismail, Aziz, and El-Laban (2013)* entitled "Relation between Injury Severity Score and outcome of polytrauma patients" who reported that polytrauma patients who had injury severity score of more than 15 admitted to an intensive care unit increased related to the mechanism of injury. In contrast to this finding, the present study showed that the number of patients who had a critical injury decreased after 24 hours of admission. This finding may be due to improving patients' conditions after surgical interventions.

Regarding the hemodynamic status of studied patients on admission and after 24 hours, blood pressure and respiratory rate results reveal an increase in the number of patients who suffer from hypotension and bradypnea. Regarding blood pressure, the results reveal that more than half of patients had hypotension after 24 hours of their admission. This finding may be due to detecting missed injuries or hidden bleeding. This result agreed with a study done by *Holcomb, Salinas, McManus, Miller, and Cooke (2010)* entitled "The manual vital signs reliably predict the need for life-saving interventions in trauma patients all vital signs decreased during the measurement time frame" who reported that heart rate and the respiratory rate dropped at the same time, the systolic and diastolic blood pressure decreased by 5 percent.

The current study reveals a statistically significant difference between the physical assessment of studied patients on admission and after 24 hours. In contrast, there was an increase in the number of patients who had injuries of the chest, abdomen, and extremities after 24 hours of admission. The result also reveals a minor increase in patients with ear, neck, lung, back, and rectal injuries after 24 hours of admission. This finding may be because missed injuries usually appeared after 24 hours with repeated examinations and repeated radiology surveys.

In the same line, the results reveal that the majority of the patients had chest injuries after 24 hours from their admission, which may be due to suspected surgical emphysema and auscultations of wheezy sounds. This result is similar to the results of a study done by *Enderson, Lawson, Daley, and Ormsby (2011)* entitled "Missed injuries in the era of the trauma scan," who reported that there were five thoracic injuries (23.33%) patients with chest trauma.

Regarding abdominal injuries, the results reveal that less than three-quarters of the patient had abdominal inju-

ries after 24 hours from their admission, this may be due to that palpation of the hard abdomen, absent bowel sound, and large abdomen usually appear on the second day. This result is similar to a study done by *Enderson et al. (2011)* entitled "Missed injuries in the era of the trauma scan," which reported that half of the patients had intraabdominal injuries.

The results reveal that the majority of the patient had extremities injuries after 24 hours of their admission. From the investigator point of view, this may be due to the that significant attention usually are given to vital organs like the brain, heart, and lung, and any source of bleeding, penetrating trauma, or major trauma with many casualties, with negligence to further assessment of all extremities and edema in lower limbs, this result is consistent with a study done by *Roche, McDonald, and Liu (2015)* entitled "Missed orthopedic injuries in adult trauma patients at a major trauma center" who reported that half of the patients had fractures or dislocations.

Regarding radiological findings review for studied patients, the results reveal a statistically significant difference between patients finding on admission and after 24 hours. In contrast, after 24 hours of admission, there was an increase in the number of patients who had flail chest, fracture acetabulum, fracture C-1, fracture L- L-2, fractured femur, frontal hematoma, and retroperitoneal hematoma. This finding may be because missed injuries usually appeared after 24 hours with repeated examinations and repeated radiology surveys.

Likewise, the result shows that less than half of patients had fracture acetabulum pelvis. This result may be due to lack of orthopedic assessment on admission, instability of patients' hemodynamic status, the attention is given to vital organs and vital signs, and repeated trauma surveys. This result is consistent with a study done by *Giannakopoulos et al. (2012)* entitled "Injuries Missed during Initial Assessment of Blunt Trauma Patient," who reported that half of the patients had fractured pelvis.

Most importantly, the results show that less than one-third of the studied patients and more than one-third of them had fractures in Cervical 1, Lumbar 1, Lumbar 2, respectively. This result may be because upon admission, the patient is usually admitted with a disturbed level of consciousness, and more attention is given to computed tomography (CT) brain finding; patient complaints of pain may be misleading. This result is consistent with a study was done by *Janjua, Sugrue, and Deane (2008)* entitled "Prospective evaluation of early missed injuries and the role of tertiary trauma survey" who reported that half of the patients had missed cervical fracture spine, and tibia.

The result reveals an increase in the number of patients who had liver and spleen injuries. This result is consistent with a study done by *Sung and Kim (2009)* entitled "Missed injuries in abdominal trauma," who reported that more than half of patients had missed injuries in the spleen and liver.

In the same way, the present study reveals that more than three-quarters of patients had a retroperitoneal hematoma, this may be due to concerning on admission (CT) scan brain, chest, sometimes CT machine not working, delaying in writing reports of films and sending results of reports to the unit. Lack of coordination amongst various specialists, lack of documentation, a workload with polytrauma patients resulting from clinical misinterpretation of the X-ray images by the trauma team in the resuscitation room. Radiological review as part of the tertiary survey would have led to the earlier diagnosis in these cases. This result is consistent with a study done by *Tammelin, Handolin, and Söderlund (2016)* entitled "Missed injuries in polytrauma patients after tertiary trauma survey in trauma intensive care unit" who reported that half of the patients had an abdominal hematoma.

7. Conclusion

Based on the findings of the current study, it can be concluded that: Less than half and less than one-third of the nurses under study had an unsatisfactory level of knowledge and practice respectively, and this is contrary to the level at which a nurse should be base on to care critically ill patients in life-threatening condition. There was a highly statistically significant positive correlation between the total level of knowledge and total level practice. After 24 hours of admission, a minor increased number of patients were suffering from hypotension and bradypnea. There was a statistically significant difference regarding physical assessment and radiological findings review of studied patients on admission and after 24 hours that indicate the presence of missed injury.

8. Recommendation

The results of the present study projected the following recommendations:

- Further research is needed to follow the patients' outcomes and missed injury.
- Replication of the current study on a larger probability sample is recommended to achieve generalization of the result.
- Tailored training courses are needed for nurses to improve unsatisfactory knowledge and practice regarding tertiary trauma survey.
- Integrated studies with the emergency medical team to communicate patients' outcome research findings.

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