Original Research Article

ADVERSE EVENTS DURING INTRA-HOSPITAL TRANSPORT : IMPACT OF TRAINED TEAM

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ABSTRACT: Caring for critically ill patients during intra-hospital transport is a high-risk task, and evidence regarding the effectiveness of specialized transport teams in this setting remains limited. We conducted a ambispective study in a multidisciplinary teaching hospital including all consecutive adult ICU patients transported for diagnostic or therapeutic purposes. A dedicated transport team comprising twenty nurses and six medical students were trained, and patients were accompanied by trained personnel. The patients were then divided into two groups for analysis, based on the pre and post training period to compare the incidence, type, and pattern of adverse events during transport. A total of 573 transports were analyzed, with 178 adverse events (31%) recorded, including physiological adverse events (39.8%), team failure (27.5%), equipment failure (21.5%), and delays (11.2%). There was a statistically significant difference in overall adverse events between the groups (p=0.003), particularly in events related to team failure (p=0.006) and equipment failure (p=0.001). These findings suggest that the use of a trained, specialized transport team, rather than a hybrid team drawn from sending units, can significantly reduce adverse events related to team and equipment failure during intra-hospital transport of critically ill patients, underscoring the importance of focused education and training to improve patient safety and team performance.

KEY WORDS : Intra Hospital Transfer, Adverse events, Equipment failure, Team failure

INTRODUCTION

The most secure place where the critically ill patient can be safely managed is the intensive care unit with multimodal monitoring facilities, organ support system and trained staff; all available at the bedside. However, there are situations when patients have to be shifted out of this secure environment to radiology or other departments for diagnostic or therapeutic interventions. This transport process involves shifting of the critically ill patients from advanced hemodynamic monitoring to portable devices, which may be associated with the high risk of adverse events. The incidence and pattern of adverse events depends on multiple factors such as severity of illness, duration of transfer and availability of experienced medical escort.[1-3] Studies have been conducted regarding the safety concerns of transferring of critically ill patients and the results show that timely transfer, hemodynamic stabilization before transfer, continuing monitoring and resuscitation during transfer are some factors that result in a smoother journey for critically ill patients.[4]

Despite the presence of guidelines for the transport of critically ill patients that emphasize the preparations before transfer, still the reported incidence of adverse events is up-to 70%.[5] This high incidence may be because of deviation from suggested standards. Even in our personal experience, there were of episodes of hypotension and desaturation of patients when transferred back to the intensive care unit following investigations. This inspired us to train our staff and residents for the transport of critically ill patients using a constructed model. Following model implementation, outcomes were compared before and after the structured training program.

METHODS

This ambispective study was conducted over a six-month period in the Intensive Care Unit (ICU) of a multidisciplinary, 1500-bed teaching hospital. The patients admitted to the ICU belonged to medical, surgical, and neurosurgical specialties. All ICU patients requiring intra-hospital transportation for either diagnostic or therapeutic purposes were included. The diagnostic category included transfer to radiology department for ultrasound, Computerized Imaging (CT) or Magnetic Resonance Imaging (MRI) or endoscopy room, whereas therapeutic category included transfer to operation theatre, intervention-radiology suite, or for invasive gastroenterological interventions. Patients younger than 18 years, whose stay in the ICU was less than 24 hours, or who did not consent were excluded from the study population. The study protocol was approved by the Institutional Ethics Committee (2018-277).

This prospective–retrospective study incorporated a structured model for intra-hospital transport of critically ill ICU patients. Initially, patient transfers were conducted by the primary care team trained in BLS and ACLS who have the privilege to do so as a part of their job responsibility. A dedicated transport team was later established, comprising 20 ICU nurses from various units and 6 junior residents (two each from medicine, anesthesia, and surgery). Team members underwent two weeks of structured training, delivered by certified Basic Life Support (BLS) and Advanced Cardiac Life Support (ACLS) instructors, using video modules and presentations based on ISCCM guidelines for inter- and intra-hospital transfer.

Outcome Comparison: Pre- vs post-implementation

Outcome metrics were compared between the pre-intervention period (before training and protocol adoption) and the post-intervention period (after trained transport team deployment). Data collection was organized in a continuous and sequential way of all patients transferred from the ICU during the study period. The parameters collected consisted of demographic variables and clinical information which included diagnosis, prognostic scores, duration of hospital admission and presence of co-morbidities according to Charlson co-morbidity index.[6] Information regarding transport including indication for transport, procedure to be performed, vital in pre- and post-transport periods, presence of invasive devices (including vascular access, tubes, drains, infusion pumps),accompanying professionals, transportation time were recorded on the pre-structured proforma.

The incidence, type and severity of any adverse event (AE) during transport were also recorded. Adverse events were defined as any incident which influenced patient's stability and were divided according to the nature of the events into physiological alterations; team failures; equipment failures or delays. The severity was classified according to the International Classification of Patient Safety given by WHO[7] as: None-no symptoms detected and no treatment required; Mild-mild symptoms, loss of function or minimal or moderate damage with rapid duration, and only minimal interventions being required (extra observation, investigation, treatment review, and mild treatment); Moderate-symptomatic patient, requiring intervention as additional therapeutic procedure or treatment, increased hospitalization time, permanent or long-term damage or loss of function; Severe-symptomatic patient, need for intervention for life support, or major intervention, or long-term loss of function, or influence on life expectancy; and Death-within the probabilities, in the short term that the event caused or accelerated death.

Based on the model of transfer of patients, they were divided into two groups for comparison.

Group I: Patients who experienced an adverse event following completion of structured training and adoption of the transport model.

Group II: Patients who experienced an adverse event during transport pre-implementation of training model

The two groups were compared with respect to demographic and clinical characteristics, along with the incidence, type, and severity of transport-related adverse events.

Data Analysis- Descriptive statistics and frequencies were calculated for all data collected. Categorical data were compared using chi-square analysis. Statistical significance was adopted as 5% with 95% of the confidence intervals. The data were analyzed in the program Med Calc Statistical Software version 15.2.2 (MedCalcSoftware,Ostend, Belgium).

RESULTS

During the study period, 963 patients were admitted to the ICU out of which 141 patients were excluded as 67 patients remained in the ICU for less than 24 hours, 12 were under 18 years of age, and 62 patients had missing data. Also, 304 did not require any transportation during their stay in ICU. The study included 518patients with573 transportations, as some patients were transported more than once during their course of treatment in ICU (Figure1)

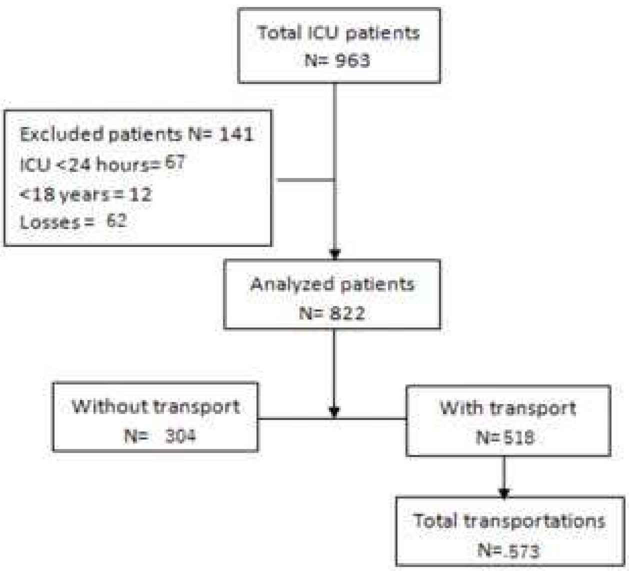

Figure-1 : Flow chart of study patients

Cohort characteristics- In this cohort, 390 (68%) patients were males. The mean age of the cohort was 53.5years, with range 24–78years. There were 240 (42%) patients that belonged to neurosurgical unit; 178(31%) and 155 (27%) patients belonged to medical and surgical specialty, respectively. All the patients during transportation had one or more invasive devices including endotracheal/tracheostomy tube, central venous/ arterial catheter, intercostals tubes or external ventricular/abdominal drains. Tracheal tube (endotracheal/tracheostomy-ETT/TT) was in-situ in 386(67.3%) patients, of which 256 were ventilated and remaining 130 had spontaneous breathing. The number of the devices for each patient was distributed as: 24% had one device, 51.2% had two devices (ETT/TT + CVC), 11.2% had three, 10.3% had four, and 3.3% had five devices in place during transfer. On 82 occasions (14.3%) patients were receiving one or more medications via continuous infusion pumps. The common medications used in decreasing order of frequency were vasopressors (7.8%), sedatives (4.4%)and others including amiodarone, insulin, adrenaline, 2.1% each. The duration of transport in our study ranged from 20-140minutes (mean-43 minutes).

Transport characteristics- On analyzing the pattern of transport, 300(52.3%) patients were transported for diagnostic purpose and 273 (47.7%) for therapeutic reasons. Transport for imaging studies was done in 181 (31.6%) patients while 152 (26.4%) were transported for surgical or neurosurgical procedures, 133 (23.1%) for endoscopic procedures, 67 (11.7%) to intervention radiology suite and 40(7.1%) to other units within the hospital.

Adverse events (AE)-During 573 transportations, there were 178 (31%) adverse events and more than one adverse event occurred in 34 (5.9%) patients (Table1).

Out of all the transports adverse events, most common were physiological variations. They occurred in 71 (39.8%) transports with alterations in heart rate being the most frequent event. Equipment failure occurred in 38(21.5%) occasions with kinking of the breathing circuit being the most common. Failure of the team coordination occurred in 49(27.5%) transports followed by delays in

Table 1 : Frequency distribution of adverse events observed during intra-hospital transport of critically ill patients.

Adverse events	N=178 (31%)
Physiological alterations	*71 (39.8)*
Variation in HR ≥20BPM	22
Arrhythmias	9
Hypotension	15
Variation in RR≥10 breaths	10
Saturation drop <90%	5
Agitation	5
Hypertension	4
Vomiting	1
Equipment failures	*38 (21.5)*
Exhaustion of infusion pump battery	*13*
Kinking of breathing circuit	*12*
ETT dislodgement	*9*
Accidental extubation	*2*
Exhaustion of 02 cylinder	*2*

Team failures	*49 (27.5)*
Secretions in tracheal tube	*9*
Lack of communication to target location	*7*
Interrupted ventilation < 1 minute	*7*
02 mask misplaced	*6*
Infusion medication need to be refilled	*5*
Loss of venous access	*3*
Returned without procedure done	*4*
Failure to carry required medications	*4*
Failure to carry required documents	*4*
Delays	*20 (11.2)*
Wait time >20mins at target location	*9*
Lift delay >5mins	*5*
Obstacle on the transport path	*4*
Bed not compatible with the lift	*2*

20(11.2%) occasions (Figure2). With regard to severity, 58(32.6%) AEs caused no damage, 67(37.7%) events resulted in mild damage, and 53(29.7%) resulted in moderate damage. There were no record of serious injury or death in this study (Figure3).

Out of 573 transportations, 339(59%) transports were performed post training and remaining 234(41%) transports were performed prior to the training model implementation. We compared the occurrence of AEs of the two groups. AEs occurred in 80 patients (23%) in group I and in 98(43%) patients in group II. This difference in adverse events between the two groups was statistically significant (p=0.003). The demographic and clinical characteristics of both the groups were

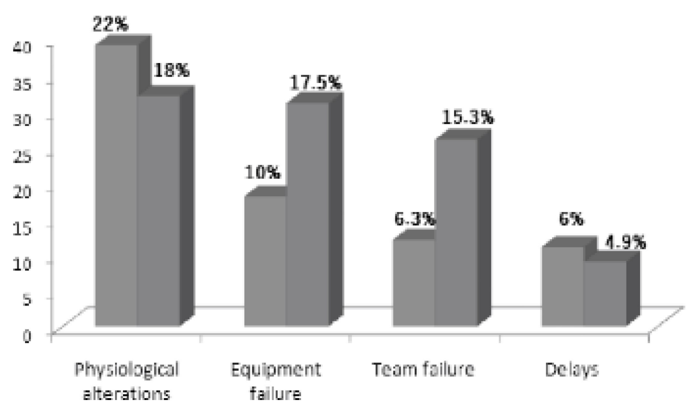

Figure2. Frequency of adverse events observed during intra-hospital transport of critically ill patients broadly divided into categories as - physiological alterations, team failure, equipment failure and delay

comparable and are shown in Table2. However, the mean SOFA score of group I was much higher (8.5) than in group II (3.2). as was the number of in situ devices (as central

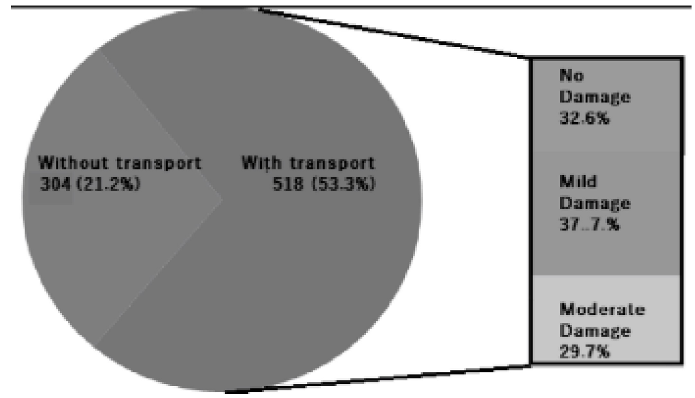

Figure3. Distribution of adverse events according to the International Classification of Patient Safety given by WHO

lines, arterial lines, drains) which was higher in group I compared to group II. Also, in groupI,65 (81.8%) patients were on ventilator as compared to 23(23.5%) patients in group II. Mean duration of transport in group I was

Table2: Comparison of demographic data and clinical characteristics of patients with adverse events requiring intra-hospital transport

Characteristic	***Group I n=80***	***Group II n=98***	***p value***
Age, mean (years)	*52.5*	*56.7*	
Sex, No. (n,%)			
Male	*21 (48.8)*	*28 (45.9)*	
Female	*22 (51.1)*	*33 (54)*	
Initial vital signs (mean ± SD)			
Glasgow Coma Scale	*9.8 +3.4*	*12.8 + 2.8*	
Systolic blood pressure, mm Hg	*120.8 + 22.8*	*134.7 +12.3*	
Diastolic blood pressure, mm Hg	*64.4 +15.9*	*73.4 + 10.6*	
Pulse, beats per minute	*103.5 + 23.7*	*96.1 + 16.8*	
Respiratory rate, breaths per minute	*23.5 + 9.9*	*13.8 + 4.7*	
Oxygen saturation	*94.2 +7.1*	*96.7 + 2.3*	
Devices			
Central venous line	*63*	*51*	*0.0002*
Intra-arterial catheter	*25*	*10*	*0.0004*
Vasopressor/inotropic drugs	*37*	*24*	*0.002*
Three or more invasive devices	*46*	*32*	*0.001*
SOFA Score	*8.5*	*3.2*	*0.001*
Mechanically ventilated (n,%)	*65 (81.3)*	*23 (23.5)*	*0.001*
Oxygen by Mask/ T-piece (n,%)	*22 (27.5)*	*30 (30.6)*	*0.64*

94.2+7.6 minutes as compared to 110+5.4 minutes in group II. Table 2 shows that there was statistically significant difference between the two groups when compared for adverse events based on invasive devices, vasopressor use, mechanical ventilation and SOFA score.

On comparison of type of AEs, there was statistically significant difference between the groups in relation to team failure (p=0.006) and equipment failure (p=0.001). The incidence of physiological adverse events were more in group I but the difference was not statistically significant(p=0.79). On the other hand, delays were more common in group II but difference was not statistically significant(p=0.19) (Table3).

DISCUSSION

Intensive care patients who are transported within the hospital for imaging or upgraded treatment are at risk of adverse events. This is because they have deranged physiology and require intensive monitoring devices. Guidelines suggest that transport of such patients should be supervised by experienced medical staff, with appropriate equipment and careful preparation so as to establish the safety of the patient during transit.[8]We adopted a model for training for intra-hospital transfer of critically ill patients at a tertiary care hospital and studied the impact of the presence of trained medical personnel during transit.

Table 3: Comparison of observed adverse events during intra-hospital transport of critically ill patients between two groups

Type of adverse event	Post implementation	Pre implementation	p value
Physiological alterations	39	32	0.79
Team failure	18	31	0.006
Equipment failure	12	26	0.001
Delays	11	9	0.19
Total	80	98	0.003

The results of this study show that about 59.5% patients needed transport during ICU stay, with approximately 2-3 transports occurring daily, and all patients had at least one invasive device in situ. We observed AEs in 31% patients, with 5.9% having more than one event when transferred for diagnostic (52.3%)or therapeutic (47.7%) procedure. This is much lower than data found in the literature where global incidence of AEs has known to reach about 68%.[9,10]

In this study, among all AEs the incidence of physiological alterations was the maximum (39.8%) but much lower than previously reported in literature.[11] As there was no significant difference of physiological alterations between the study groups (p=0.79), it highlights the fact that physiological changes are not solely due to transport but are related to the critical condition of the patient. However, The presence of a trained personnel can anticipate problems in advance and reduce the incidence of AEs in-spite of having higher SOFAs score and multiple invasive devices in situ. There is evidence in the literature that dedicated transfer teams improve the outcome of critical patients transferred between hospitals. Patients transferred by specialized teams demonstrated significantly better arterial blood gas despite having higher APACHE-II scores than standard transfer groups.[12] Hence, severity of illness is an important determinant of the occurrence of AEs during transfer but can be reduced by the presence of specialized teams that continuously monitor the compromised cardio-respiratory and neurological status of the patient during transfer. Knight et al. report that when patients were not monitored due to the limitation of human and technological resources in low-income countries, AEs were detected at destination.[13] Though it is recommend to have minimum mandatory monitoring of electro-cardiogram and pulse-oximetry continuously, and periodic measurement of blood pressure, pulse rate, and respiratory rate during intra-hospital transfer,[14]but it may not be sufficient for critically ill patients who require more intense monitoring even during intra-hospital transfer.

In this study, AEs second in frequency were related to equipment failures, most commonly being the exhaustion of equipment batteries (34.2%) and were significantly higher in group II as compared to group I. Shirley et al. reported that more than half of AEs during transfer are related to ventilation and airway problems while one-fourth are associated with tubes, drains or monitoring line malfunction.[15] A prospective observational study in the Netherlands evaluated AEs during Mobile Intensive Care Unit (MICU) transfers, comparing specialized retrieval team to standard ambulance transfer. The incidence of AEs decline from 34% to 12.5%, with all being related to equipment failure.[16] Reports from literature also suggest that the incidence of adverse events is not only related to severity of patient's condition, but also number of various supportive care measures.[17] Hence, the number of invasive lines in any patient is directly proportional to equipment-related risk factor. This is of major concern because such incidents are avoidable and use of checklists of hardware before transfer by trained personnel can decrease the AEs related to equipment malfunction significantly.

Similarly, statistically significant difference in the team-related AEs in our study suggests inter-team communication failures. Up to 61% of AEs related to team failures have been reported.[18] Kwack et al. reported that trained personnel and dedicated team reduced unexpected problems related to team and equipment.[19] Such unexpected situations affect not only the patient but also staff and can easily be avoided by training professionals involved in transfer with emphasis on bilateral communication with the destination site and effective planning. Reduction in the frequency of such events will shorten transfer time and ensure safety to the patient.

Another advantage of adopting specialized transport teams is that physicians and staff in the ICU continue to focus on other patients and their responsibilities within the ICU. Lastly, use of specialized trained teams makes it possible to obtain diagnostic investigations and procedures for critically ill patients, safely and quickly, as they bridge the gap of ongoing care and monitoring. Hence, the successful model for the transport of critically ill patients by specialized and trained teams within the hospital should be based on models as for out-of-hospital transport environment focusing on i) careful planning and efficient execution, ii) qualified personnel iii) appropriate equipment iv) minimum mandatory monitoring v) bilateral communication.

Limitations of the study are that we did not analyze data of patients in the ICU who were not transported and hence, it is difficult to state if transport was beneficial for patient survival. Secondly, the small number of the study cohort may have underpowered the analysis of the adverse events. Another limitation is training to team was non-formal without any certification. Strength of the study is that we prospectively tried to rate the clinically significant adverse events specific to our institutional setting and formulate corrective measures accordingly.

Lessons learnt

1. *Transfer of critically ill patient by trained team rather hybrid team that includes different providers makes a difference in the frequency and pattern of adverse events.*
2. *Education and training should be a major focus as it enhances patient care during intra-hospital transfer.*
3. *In spite of best efforts commonest adverse events are respiratory or cardiovascular in nature.*
4. *Skills and training should focus on issues of transport of critically ill patients including airway and vascular access, understanding deranged patho-physiology and pharmacology.*

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