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**ORIGINAL PAPER**

# Adverse events during intra-hospital transport of critically ill patients: an observational study

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## Abstract

*Aim:* This study aimed to describe adverse events occurring during intra-hospital transportation of adult patients from the emergency room to the intensive care unit and to analyze the associated risk factors. *Design:* This study uses a quantitative analytical observational design. *Methods:* In total, 151 critically ill patients out of 159 with indicated intra-hospital transportation participated in the study. Patients were transported from the emergency room to the intensive care unit in a class A general hospital in Central Java, Indonesia. The statistical analysis included descriptions of demographic, medication, monitoring, equipment, and clinical characteristics of the cohort, and identified risk factors for adverse events during transportation by univariate and multivariate logistic regression analyses. *Results:* The overall incidence of adverse events was 78.8%. Risk factors were: transport team, hemodynamic monitoring, equipment preparation, and patient's condition, and were associated with adverse events ($p < 0.05$). Multivariate analysis showed that equipment preparation was the factor most contributing to adverse events with Exp(B) = 22.6. *Conclusion:* This study showed that the incidence of adverse events during transportation of critically ill patients was high. We recommend that transports be performed by fully equipped teams of medical professionals. Monitoring of intra-hospital transportation-related events is also recommended to reduce frequency of adverse events.

**Keywords:** adult patients, adverse events, critical care, emergency room, intensive care unit, intra-hospital transport, observational study, risk factors.

## Introduction

Transfer of patients in hospitals is the physical relocation of patients that occurs between rooms and buildings within the same hospital for diagnostic purposes, therapeutic procedures, or transfer to a specialist unit (Shields et al., 2015). Transfer of critically ill patients is an unavoidable procedure in the emergency room (Salt et al., 2020). Intra-hospital patient transfers aim to ensure the continuity of patient care but have an associated risk of adverse events (AEs) (Bergman et al., 2020; Kulshrestha & Singh, 2016). Management of patient care in the emergency department can affect the safety of critical patients before being transferred to the intensive care unit (ICU) (Swickard et al., 2018).

The prevalence of AEs during intra-hospital transport of critically ill patients is high in a number of countries (Brunsveld-Reinders et al., 2015; Parmentier-Decrucq et al., 2013). AEs related to the clinical condition of the patient are 40% for the circulatory system, 30% for the respiratory system, and 25% for the nervous system (Tolentino et al., 2018). AEs are related to patient anxiety, agitation, and pain or discomfort (Geldenhuys et al., 2020; Jones et al., 2016). The incidence of cardiac arrest during transfer of critically ill patients in the hospital was in the range 1.1%–1.5% (Min et al., 2019; Salt et al., 2020). Non-physiological incidents included loose or non-functioning intravenous ducts (18.3%), change in position of endotracheal tube (1.6%), drainage (2.5%), and nasogastric tube (0.8%) (Harish et al., 2016). AEs related to team communication failures and delays on duty (Bourn et al, 2018). Critically ill patients undergoing intra-hospital transfer were at risk of various adverse events including hypotension, desaturation, and peripheral line dislocation. It is important to recognize the risks as early as possible and maintain the level of care so that side effects during transfer are minimal. Critical care patients are

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at high risk of side effects when transferred during the night shift and when receiving inotropes or vasopressors (Min et al., 2019).

The risk factors that arise during intra-hospital transportation can be influenced by the severity of the patient's illness, inappropriate equipment, insufficient number of competent staff, lack of monitoring, staff communication, and ineffective actions during transportation. Nurses play an active role during intra-hospital transportation procedures in their role as staff from the sending and receiving department or as members of the intra-hospital transportation team. Nurses follow or issue guidelines, conduct training, and are actively involved in assessing and stabilizing the patient's health condition before the procedure, thereby improving the quality of care levels for transported patients (Swickard et al., 2018).

The incidence of side effects and causes was lower in the observation group and was significantly influenced by disease, staff, equipment, and environment (Gu et al., 2021). Side effects that occur during transfer which require treatment can be clinical – such as hypotension (55%), and technical (45%) – due to monitor failure (32%), ventilator failure (9%), and infusion pump failure (4%) (Seilbea & de Vasconcellos, 2020). Research shows that non-technical skills, such as situational awareness and teamwork, are needed to prevent and manage critical incidents during intra-hospital transport. For this reason, it is important to have a reliable team that has the technical skills and knowledge to carry out patient transfers. Finally, the institution should provide a supportive transport environment and ensure there are minimal transport-related hazards (Bergman et al., 2020).

Factors that influence security and safety during the process of transfer of critical ill patients intra-hospital are very diverse. They include the patient's condition (clinical instability), equipment (equipment factors), team transfer factors (human factors), and organizational factors (organizational transport) (Fanara et al., 2010). Medications given before transfer also affect AEs during the transfer of critically ill patients in the hospital. The use of sedatives and vasoactive medications is associated with AEs during the transfer of critically ill patients in the hospital (Min et al., 2019).

## Aim

The main objectives of this observational study were to determine the frequency and risk factors for AEs during intra-hospital transportation (IHT) of critically ill patients.

## Methods

### *Design*

An observational study with cohort prospective data collection was conducted over a one-month period (5–31 January 2020) on all emergency department patient transfers to the ICU in a class A government hospital in Central Java, Indonesia.

### *Sample*

In total, 151 patients from the 159 who met the criteria for transfer to the ICU were analyzed in this study. The sampling technique applied was convenience sampling. The inclusion criteria included critical patients aged older than 16 years and eligible to be transferred to ICU levels 2 and 3 (level 2 refers to patients with one organ failure and level 3 refers to patients with two or more organ failures requiring observation and intervention) (Hunt, 2018). The exclusion criteria were deceased patients and those referred to other hospitals before being transferred.

### *Data collection*

The data were collected by a qualified researcher assisted by two nurses as evaluators, working in three shifts per day. The research instrument was an observation sheet. Critical patients were observed before, during, and after transfer from the Emergency room to the ICU. Prior to being used in this study, the observation sheet was evaluated for content validity through expert judgement by three health professionals, namely an acute care nurse, an emergency specialist, and an anesthesiologist. The Individual-Content Validity Index (I-CVI) value was 1, meaning it was feasible for use. This observation sheet was tested on two evaluators who were assessed for three observations with a good Kappa value, (almost perfect agreement). The observation sheet was, therefore, determined to be reliable for use.

The observation sheet contained seven items: two items to measure patient factors (patient condition and medication while in the emergency department), two items to measure transfer attendant factors (monitoring and equipment preparation) and three items to measure organizational factors (transfer time, waiting time in the emergency room, and service schedule). An additional item was used to quantify incidents during the transfer process.

The patients' condition was measured with the National Early Warning Score (NEWS). NEWS measurements are taken when a decision is made to move the patient to the ICU. The results of NEWS

were grouped into three categories: low (NEWS score 0–4), moderate (NEWS score 5–6) and high (NEWS score ≥ 7) (Royal College of Physicians, 2017). Medications are categorized into four groups: no-medication, vasoactive, sedative, and both vasoactive and sedative. Hemodynamic monitoring was categorized as uncompleted, partial, and completed. Completed monitoring is defined as when both frequency and monitoring elements, (consciousness level, blood pressure, heart rate, respiratory rate, body temperature, oxygen saturation, etc.) are normal (Kulshrestha & Singh, 2016). The equipment preparations were categorized as either uncompleted and completed. Completed equipment is considered to be equipment that is suitable for the patients' clinical needs and transfer levels. Adverse events during patient transfers were grouped into categories, "yes" or "no". "Yes" was selected if at least one adverse event parameter (physiological and / or non-physiological) was present in the patient. The hemodynamics measurement was carried out before and after the patient transfers to determine the data gaps. Observations for adverse events commenced after the patient left the Emergency Department and continued until the patient was handed over to the ICU. The parameters of adverse events during the transfers were based on the model developed by Jones et al. (2016). Table 1 was validated by three clinicians or experts in the field of emergency medicine.

**Table 1** Adverse events during intra-hospital transport of critically ill patients

| Classification | Notes |
|---|---|
| **Physiological** | early-systolic-blood decrease or increase > 20%, systolic < 90 mmHg, $O_2$ saturation < 90%, bleeding, RR < 8 or > 30 breaths per minute, HR < 40 or > 130 beats per minute, new onset arrhythmias, agitation, seizures, decreased awareness (GCS), nausea / vomiting, increased pain score (CPOT), falling, cardiopulmonary arrest (PEA, asystole), patient died |
| **Non-physiological** | oxygen supply depleted, ventilator unprepared, equipment failing, low battery used, alarm, loose vein access device, non-current, change in ETT location, change in drain position, change in NGT / OGT position, dislocation of urine catheter, delay in destination > 5 minutes, the patient required travel restraint, discontinuation of therapy, medication errors, incomplete documentation |

*mmHg – millimetre high; $O_2$ – Oxygen; RR – respiratory rate; HR – heart rate; GCS – glasgow coma scale; CPOT – critical care pain observation tool; PEA – pulseless electrical activity; ETT – endotracheal tube; NGT – nasogastric tube; OGT – orogastric tube*

### *Data analysis*

The data were processed using SPSS version 16. The descriptive data are presented in frequency and percentage. The bivariate test used Chi-square, while the Multivariate test used logistic regression with a level of significance less than 0.05.

## Results

During the one-month study period, a total of 119 patients were identified as experiencing an adverse event during transport. There was no difference in adverse events between men (77.8%) and women (80.3%) during the transfer. Age group (< 45 years = 81.8%; 46–65 years = 72%; > 65 years = 88%) and the patient's main comorbidity (surgery = 88%; internal disease = 83.7%; cardiovascular disease = 68%; neurological disease = 87%, lung disease = 100%), (p > 0.05) were not found to be significant. The majority of patients with three comorbid adverse events (95.5%), (p = 0.030) was found to be significant (Table 2).

**Table 2** Demographic characteristics of respondents (n = 151)

| Variable | | | Adverse events | | | | |
|---|---|---|---|---|---|---|---|
| | | | Yes | | No | | |
| | | n | n | % | n | % | p-value |
| **Sex** | male | 90 | 70 | 77.8 | 20 | 22.2 | 0.707 |
| | female | 61 | 49 | 80.3 | 12 | 19.7 | |
| **Age group (years)** | > 65 | 43 | 38 | 88.0 | 5 | 12.0 | |
| | 46–65 | 75 | 54 | 72.0 | 21 | 28.0 | 0.099 |
| | ≤ 45 | 33 | 27 | 81.8 | 6 | 18.2 | |
| **Primary Case** | surgery | 17 | 15 | 88.0 | 2 | 12.0 | |
| | internal disease | 37 | 31 | 83.7 | 6 | 16.3 | |
| | cardiovascular diseases | 66 | 45 | 68.0 | 21 | 32.0 | 0.062 |
| | neurological diseases | 23 | 20 | 87.0 | 3 | 13.0 | |
| | lung diseases | 8 | 8 | 100.0 | 0 | 0.0 | |
| **Comorbidities** | > 1 | 70 | 57 | 81.4 | 13 | 18.6 | |
| | one disease | 59 | 41 | 69.5 | 18 | 30.5 | 0.030 |
| | none | 22 | 21 | 95.5 | 1 | 4.5 | |

 

Incomplete health professional teams during the transfer of critically ill patients to the ICU was associated with adverse events (83.6%) – with significant differences found in the transfer personnel (p = 0.027). NEWS assessment results with a high category of adverse events occurred during IHT – with significant differences found in the NEWS category on adverse events (p-value = 0.000). There was no difference in adverse events during IHT according to the medication used [vasoactive (90.3%), sedative (78%), vasoactive and sedative (100%), without use of vasoactive or sedative medication (74.7%)]. Complete hemodynamic monitoring is less likely (68%) to trigger AEs than partial (87%) and incomplete hemodynamic monitoring (93.5%) – differences were found to be significant (p = 0.000). The majority of adverse events occurred when the preparation of equipment was incomplete (94%) – differences in the equipment preparation category on AEs during the IHT were identified as significant (p = 0.000) (Table 3).

Table 4 shows that the patient's condition variables increase by 1.916 adverse events after controlling for hemodynamic monitoring variables and tool readiness. Variable hemodynamic monitoring increases by 1.027 adverse events after controlling for the patient's condition and tool readiness. Variable tool readiness increases by 3.122 adverse events after controlling for patient condition variables and hemodynamic monitoring. The variable with the largest influence on adverse events is the completeness of the equipment (p = 0.000) with the strength of influence Exp(B) = 22.682. Table 4 provides evidence that the fulfillment of the two multiple logistic regression assumptions test requirements were met. The Hosmer and Lemeshow test (p = 0.56) indicates better results with independent variables than without. $R^2$ = 0.54 means that the ability of independent variables to explain the dependent variable is 54%; the remaining 46% is explained by other variables not included in this modeling.

**Table 3** Risk factors and outcomes of patients with and without adverse events during transport (n = 151)

| Variable | | | Adverse events | | | | |
|---|---|---|---|---|---|---|---|
| | | | Yes | | No | | |
| | | n | n | % | n | % | p-value |
| **Personnel transfer** | completed | 47 | 32 | 68.0 | 15 | 32.0 | 0.027 |
| | non-completed | 104 | 87 | 83.6 | 17 | 16.4 | |
| **Patients condition (NEWS)** | high | 36 | 36 | 100.0 | 0 | 0.0 | |
| | moderate | 40 | 34 | 85.0 | 6 | 15.0 | 0.000 |
| | low | 75 | 49 | 65.3 | 26 | 34.7 | |
| **Medication** | sedative | 9 | 7 | 78.0 | 2 | 22.0 | |
| | vasoactive | 31 | 28 | 90.3 | 3 | 9.7 | 0.204 |
| | both (sedative & vasoactive) | 4 | 4 | 100.0 | 0 | 0.0 | |
| | none | 107 | 80 | 74.7 | 27 | 25.3 | |
| **Hemodynamic monitoring** | uncompleted | 31 | 29 | 93.5 | 2 | 6.5 | |
| | partial | 62 | 54 | 87.0 | 8 | 13.0 | 0.000 |
| | completed | 58 | 36 | 62.0 | 22 | 38.0 | |
| **Equipment preparation** | uncompleted | 84 | 79 | 94.0 | 5 | 6.0 | 0.000 |
| | completed | 67 | 40 | 60.0 | 27 | 40.0 | |

*NEWS – National Early Warning Score*

**Table 4** The logistic regression analysis

| Variables | B | S.E. | Wald | Sig. | Exp(B) | $R^2$ |
|---|---|---|---|---|---|---|
| **Step 7[a]** | | | | | | |
| **Constant** | -13.675 | 2.379 | 32.904 | 0.000 | 0.000 | 0.54 |
| **Patient condition (NEWS)** | 1.916 | 0.523 | 13.394 | 0.000 | 6.792 | |
| **Hemodynamic monitoring** | 1.027 | 0.447 | 5.290 | 0.021 | 2.793 | |
| **Equipment preparation** | 3.122 | 0.624 | 25.027 | 0.000 | 22.682 | |

*Hosmer and Lemeshow test p = 0.56; [a]Variable(s) entered on step 7 – patient condition, hemodynamic monitoring, equipment preparation; NEWS – National Early Warning Score; B – co-efficient fro the constant; S.E – standard error around the co-efficient for the constant; Wald – chi square statistics; Sig. – significance level; Exp(B) – exponentiation of B co-efficient which is an odds ratio (OR); $R^2$ – R-Squared or the coefficient of determination*

## Discussion

The level of condition of patients in the Emergency Room had a significant relationship with AEs during intra-hospital transfer in this study. These results are consistent with previous studies, which showed that the more severe the patient's condition and the more complex the patient's case, the more susceptible they are to hemodynamic status deterioration and physiological function (Nonami et al., 2022). Critical patients are at very high risk of changes in airway patency due to movement or similar changes during intra-hospital transfer, as a result of which pneumothorax and atelectasis can occur. Other studies have shown that patients in poor condition before transfer have a high risk of AEs during transfer, and thus need to be thoroughly prepared (Gimenez et al., 2017). There was a significant relationship between the condition of patients attached to a ventilator and hemodynamic instability with AEs during transfer (Kwack et al., 2018). Changes in the patient's condition are influenced by external factors when the transfer occurs. These include changes in the position of the patient, causing interruption of fluid flow or medication (intravenous catheter); and extubation and ventilator connections, causing respiratory problems and pain due to movement or removal of drain (Eiding et al., 2022; Temsah et al., 2021). Critically ill patients experience changes so quickly that a complete prior risk identification of the patient's condition is needed. Healthcare professionals are responsible for the safe transfer of critically ill patients.

During the transfer of critical patients in the intensive care unit, an incomplete team of health professionals can cause side effects. Hemodynamic monitoring conducted by healthcare professionals in this study showed there was a significant correlation with adverse effects during the transfer of critical patients from the emergency department to the intensive care unit. The occurrence of adverse events was observed, as were changes in blood pressure in patients (Parveez et al, 2020). Evaluation of the patient's condition before transfer is very important to minimize the risk of AEs during IHT. Observations must be recorded in the patient's medical record (Murata et al., 2022). Critically ill patients should be monitored at least hourly, and every 15 minutes if they are undergoing vasoactive and sedative therapy (Jones et al., 2016). Monitoring of vital signs should be done before giving medication through the intravenous route (Kulshrestha & Singh, 2016). Vital signs must be accurately assessed before physiological changes occur (Jarvis et al., 2015). A key component of risk mitigation is the importance of adequate equipment and patient monitoring during transport by health workers. Considerations for speed of transport and a reliable transport team are associated with better outcomes, while disease severity presents unintended complications. The type of monitoring that can be carried out during transportation can vary according to the environment, the skills of the staff, and the severity of the patients' illness (Branson & Rodriquez, 2020).

The results of this study indicated that device preparation was the dominant factor for AEs during the transfer of critically ill patients from the emergency room to the intensive care unit. These results are in line with other studies, which state that adverse events that occur during intrahospital transportation are caused by the unavailability of equipment (Chaichotjinda et al., 2020). Adequate equipment preparation increases patient safety and security during intra-hospital transfers (Swickard et al., 2018). Of the 84 patients whose device preparation was incomplete, 79 (94%) had AEs. Common mistakes which occur include health workers not checking the availability of oxygen, not fixing equipment properly, and not acquiring essential equipment. Often the health worker accompanying the patient puts a urinary catheter on the bed. Placement of a urinary catheter that does not adhere to the standard clinical protocol, (parallel to or higher than the bladder) will cause reflux and risk of infection (Sampathkumar, 2017). Equipment is an essential factor and must be well prepared before transferring the patient. Tool preparation includes sufficient battery life, sufficient oxygen, a machine that is easy to operate, and a functioning alarm (Hunt, 2018). Preparations must be made correctly, and be safe and stable in order to continue functioning properly (Droogh et al., 2015). Although the transfer of critical patients is carried out in a short time and over relatively short distances, all equipment must be checked properly to ensure that no equipment is left behind, in case the patient's condition worsens at any time during IHT. Safe venous access during transfer of critically ill patients is mandatory and there should be at least two intravena cannulas and an arterial cannula if necessary, which are excellent for monitoring blood pressure (Bourn et al, 2018).

The majority of respondents in this study had comorbidities (> 70 people), and of these, 57 (81.4%) had AEs. Comorbidities are considered on admission to the intensive care unit based on supportive clinical and laboratory factors. Comorbid factors such as chronic arterial disease, diabetes mellitus, and chronic heart failure are comorbidities that contribute to increased complications during IHT in critically ill

patients (Nonami et al., 2022). The results of the observation showed that the majority of respondents (106) were transferred by an unsuitable team. Of these, 87 (83.6%) experienced AEs during transfer. The results of this study are consistent with previous studies, in which there was a significant relationship between transfers accompanied by a doctor or not accompanied by a doctor (Yang et al., 2017). A transfer team is recommended to include a doctor with experience in airway management, a trained critical nurse, and a technician trained in mechanical ventilation equipment (Parmentier-Decrucq et al., 2013; Quenot et al., 2012). The multidisciplinary transfer team should be effectively able to address potential problems that occur during the transfer of critical patients (Kue et al., 2011; Kulshrestha & Singh, 2016). There should be at least two critical patient transfer assistants. If the patient's is intubated, an anesthesiologist should be included.

The implication for practice from this study is an improvement in the quality of in-hospital patient transfer services for emergency and critical care nurses by increasing monitoring and communication skills when transferring critical patients. The results of this study are expected to be implicated in nursing education so that students pay attention to factors that can affect outcomes when transferring patients, especially critical patients.

The results of this study can be used as a reference for hospitals in making policy decisions. They will also guide nurse managers when planning strategic steps to reduce incidents that occur so as to create a culture of security and patient safety during the transfer of critical patients in the hospital. Policies that can be applied according to the results of this study include equipment and monitoring practices, such as procedures which ensure the completeness and safety of equipment used by the patient during the transfer and which ensure that therapy continues during patient transfers. The monitoring policy is the procedure for monitoring critical patients in the emergency setting (with or without the use of sedative and vasoactive agents) and recording observations in the patient's medical records. Risk management to minimize incidents that occur during critical patient transfer can also be developed based on the results of this study.

## Conclusion

This study provides data on the prevalence of adverse events and the factors influencing these during the transfer of critically ill patients from the emergency department to the intensive care unit. Incidents may be physiological and / or non-physiological. The factors related to incidents during the transfer of critical patients are related to patient factors, patient escort, and transfer organization. The high number of adverse effects in critically ill patients undergoing intra-hospital transfer requires the attention of hospital management and health personnel. There needs to be a policy and guidelines regarding the completeness of the equipment, the team of professional staff involved, and monitoring to be applied during intra-hospital transport to minimize adverse effects.

## Ethical aspects and conflict of interest

This study received ethical clearance from the Health Research Ethics Committee, Dr. Moewardi General Hospital, Number. 1.418/XII/HREC/2019. Approval was granted by the study site. Every respondent was given information about the objectives, benefits, and research procedure. Information was given to the patient (if the patient was mentally competent) or family (if the patient was not competent). Respondents provided their informed consent to participation in the study. Participation in the study was not compulsory or monetized.

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## Author contributions

Concept and design (KRP, IW, TS, AH), data collection (IW), data analysis and interpretation (KRP, IW), drafting of the manuscript (KRP, IW, TS, AH), critical revision of the manuscript (KRP, IW, TS, AH), final approval and accountability (KRP, IW, TS, AH), supervision (KRP).

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