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Incidents relating to the intra-hospital transfer of critically ill patients

An analysis of the reports submitted to the Australian Incident Monitoring Study in Intensive Care

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Abstract *Objective:* Transportation of critically ill patients within the hospital poses important risks. We sought to identify causes, outcomes and contributing factors associated with intra-hospital transport.
Design: Cross-sectional case review.
Setting: Incident reports submitted to the Australian Incident Monitoring Study in Intensive Care (AIMS-ICU).
Measurement and main results: Between 1993 and 1999, 176 reports were submitted describing 191 incidents. Seventy-five reports (39%) identified equipment problems, relating prominently to battery/power supply, transport ventilator and monitor function, access to patient elevators and intubation equipment. Hundred sixteen reports (61%) identified patient/staff management issues including poor communication, inadequate monitoring, incorrect set-up of equipment, artificial airway malpositioning and incorrect positioning of patients. Serious adverse outcomes occurred in 55 reports (31%) including major physiological derangement (15%), patient/relative dissatisfaction (7%), prolonged hospital stay (4%), physical/psychological injury (3%) and death (2%). Of 900 contributing factors identified, 46% were system-based and 54% human-based. Communication problems, inadequate protocols, in-servicing/training and equipment were prominent equipment-related incidents. Errors of problem recognition and judgement, failure to follow protocols, inadequate patient preparation, haste and inattention were common management-related incidents. Rechecking the patient and equipment, skilled assistance and prior experience were important factors limiting harm.
Conclusions: Intra-hospital transport poses an important risk to ICU patients. The adequate provision of highly qualified staff, specially designed and well maintained equipment, as well as continuous monitoring are essential to avoid/mitigate these incidents. Professional societies and local units should adopt guidelines/protocols for intra-hospital transportation. Monitoring of incidents should aid in the continuous improvement in patient safety.

Keywords Transportation of patients · Critical care · Incident monitoring · Adverse effects · Patient safety · Quality assurance

Introduction

Transporting critically ill patients between hospitals has been recognized as a potentially hazardous maneuver [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16]. Patient safety in that setting has been facilitated by the development of standard equipment and trained teams who often follow specific protocols [6, 8, 10, 12, 17, 18, 19, 20]. Intra-hospital transport of the critically ill patient is frequently required to either admit the patient to the intensive care unit (ICU) or to obtain diagnostic tests or procedures that cannot be undertaken in the ICU. Such transportation also exposes patients to risk [9, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41]. Several observational studies have documented adverse events relating to intra-hospital transport [22, 23, 24, 25, 26, 27, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41]. Few studies have attempted to identify important factors that may contribute to these adverse events, limiting the ability to devise strategies that can be used to reduce patient risk.

Methods

This study was a cross-sectional analysis of intra-hospital transfer incidents reported to the AIMS-ICU system. AIMS-ICU was established in 1993 to develop and evaluate an anonymous, voluntary incident reporting system for intensive care. The primary aim was to identify incidents and to determine their underlying causes and contributing factors. The initial development and methodology for the AIMS-ICU system have been previously described [42, 43]. We analyzed all incidents reported to the AIMS-ICU system between 1993 and 1999.

An incident is defined as any unintended event or outcome, which may have or did reduce the safety margin for the patient. The incident may or may not have been preventable and may or may not have involved an error on the part of the health team. ICU staff members from participating ICUs were invited to report any incident they were involved in, using standardized report forms. ICU staff members were asked to describe the incident in the narrative section, including reasons for its occurrence, outcomes and limiting factors. They were also asked to indicate their opinions with regard to contextual information by selecting appropriate choices from a list of potential responses. This contextual information related to patient and staff factors, the estimation of the effect of the incident on the patient and those factors contributing to or limiting it. Participating ICUs entered their reports into an AIMS-ICU local unit database, which were later added to the AIMS-ICU national database. National data managers reviewed the reports and allocated standardized keywords to the narratives. Many reports described multiple incidents. FoxPro (Fox Software, Perrysburg, Ohio, USA), a proprietary database program, was used for data entry, storage and retrieval.

The reporter was asked "where the incident occurred", with response choices including "transportation within hospital" and "transportation outside hospital". Reports in which "transportation within hospital" was selected were included as "cases" for our study. Dependent variables included the type of incident described, whether there was harm and contextual information including factors that may have contributed to the incident or limited the harm (Tables 1 and 2).

Table 1 Prominent incidents identified during intra-hospital transportation, (n=191 incidents in 176 reports)

Type of incident	Number of incidents
Equipment-related incidents	75 (39%)
Monitors	
Battery supply problem	8
Not available	2
Faulty monitors	2
Airway equipment	
Problem with intubation/airway equipment	7
Transport ventilator malfunction	4
Problems with oxygen supply	3
Drugs	
Delayed administration/failure to deliver drug	14
Infusion interruption	4
Emergency drugs unavailable	2
Infusion pumps	
Battery supply problem	6
Not available	1
Other	
Emergency elevator access	18
Bed-related problems	4
Patient/staff management issues	116 (61%)
Staff management	
Communication/liaison problems	18
Inappropriate staff escort	4
Lack of staff	6
Inadequate notification of arrival	5
Airway/ventilation management	
Malposition of artificial airway	10
Inadequate securing of airway	6
Unplanned reintubation	4
Accidental extubation	3
Portable ventilator incorrectly set-up	2
Failure to check oxygen supply	2
Vascular line management	
Accidental dislodgment	9
Disconnection/loose connection	3
Inadequate securing	7
Monitor use	
Inadequate monitoring	11
Alarm parameters not used/inadequate	3
Incorrect set-up	2
Other	
Incorrect moving of patient	10
Incorrect stabilization of injured site	4
Staff back-lifting injury	4
Other	3

We also noted the "level of ICU" for units that had submitted intra-hospital transport incidents. Australian ICUs are classified from levels 1 to 3 according to the increasing level of care provided. A level 3 ICU is a tertiary referral unit for intensive care patients, capable of providing the highest level of care including multi-system life support. Patients are referred for management to the attending intensive care specialist. A minimum of 1:1 nursing is provided for ventilated patients [44].

We conducted a descriptive analysis of the intra-hospital transport incidents.

Results

Between 1993 and 1999, 93 ICUs enrolled in AIMS-ICU—submitting 7525 reports comprising over 11,000 incidents. Of these, 176 reports described events occur-

Table 2 Factors contributing to incidents during intra-hospital transportation, (n=900 selections in 176 reports). Reporter could select multiple factors for each report

Contributing factor	Number of selections
System-based factors	412
Work practices	
Communication problem	47
Inadequate protocol	47
Inadequate training	31
Lack of supervision	14
Insufficient staff	13
Equipment	
Equipment failure	34
Inadequate equipment	22
Poor design of equipment	20
Poor maintenance	19
Equipment not available	17
Inadequate in-service	16
Physical environment infrastructure	
Lack of space	29
High unit activity	20
Lack of support staff	22
Human-based factors	488
Knowledge-based error	
Error of problem recognition	58
Error of judgement	50
Lack of knowledge	22
Rule-based error	
Failure to follow protocol	42
Patient preparation inadequate	32
Patient assessment inadequate	26
Failure to check equipment	24
Misuse of equipment	13
Unfamiliar equipment	12
Skilled-based error	
Haste	42
Distraction/inattention	20
Stress	8
Technical error	
Fault of technique	20
Inexperience	23

ring during intra-hospital transportation. Thirty-seven ICUs reported intra-hospital incidents. These included 20 (54%) level 3 units, 12 (32%) level 2 units and 5 (14%) level 1 units. These submitted 138 (78%), 24 (14%) and 14 (8%) reports, respectively.

The 191 incidents identified from 176 reports fell into two main problem areas: equipment problems in 75 cases (39%) and patient/staff management issues in 116 (61%) (Tables 1). Common equipment-related problems involved access to patient elevators, battery/power supply, drug delivery systems, intubation equipment, transport ventilators, oxygen supply and monitors. Common patient/staff management problems involved communication/liaison, airway management (securing, accidental extubation, unplanned reintubation), vascular line use (dislodgment, disconnection, inadequate securing), patient monitoring and positioning and set-up of equipment.

Thirty-one percent of the incidents had significant adverse outcomes, including major physiological derangement in 26 reports (15%), patient/relative dissatisfaction in 12 reports (7%), prolonged hospital stay in 7 reports (4%), physical/psychological injury in 6 reports (3%) and death in 4 reports (2%). The major physiological derangement described in 26 reports included hypoxia/hypoventilation in 21 (11%), hypotension in 5 (3%) and cardiac arrest in 6 (3%).

In 61 (35%) reports the transport occurred as part of the ICU admission, 78 (44%) during on-going ICU care and 14 (8%) during an emergency intervention. In the remaining 23 (13%) reports this information was not provided. The operating theatre was the patient destination or origin in 36% of the reports, the radiology department in 35%, a hospital ward in 12%, the emergency department in 9% and another site in 3%. This information was not known in 5% of the reports. Hundred eighteen incidents (67%) occurred during the weekday day shift (0700–1900 h), 41 incidents (23%) during a weeknight shift and 17 incidents (10%) occurred on weekends or during a public holiday.

Precipitation of the incident was fairly evenly distributed between medical, nursing and other health professionals (26%, 22% and 22%, respectively). The detection of incidents was primarily by nursing staff (82%). In 68(39%) reports a provider other than the ICU team precipitated the incident (24% operating room or recovery room, 7% Emergency Department, 6% Radiology and 2% spinal injury assistants). Incidents were detected through routine checking in 112 (64%) reports and was an incidental finding in 61 (35%) reports. "Method of detection" included "checking the patient" in 80 reports (45.5%), "checking the equipment" in 75 (42.5%) reports and "checking the monitor" in 37 (21%) of the reports. "Other/unknown method of detection" was selected in 28 (16%) of the reports. In 61% of the reports, the incident was detected within 5 min of occurrence. Detection was delayed up to 1 h in 19%, up to 1 day in 9% and delayed by more than 1 day in 1% of the reports. The timing of detection was unknown in 11% of reports.

Factors contributing to the incident were classified as system-based factors (412 selections, 46%) or human-based factors (488 selections, 54%) (Table 2). Multiple selections for each report were possible, with 900 factors selected in 176 reports. The system-based group included the areas of work practice issues in 21%, equipment problems in 14% and environmental infrastructure issues in 11%. Common system-based contributing factors included communication problems, inadequate protocols, in-servicing/training and equipment/facilities. Human-based contributing factors involved knowledge-based errors in 22%, rule-based errors 18%, skill-based errors 8% and technical errors 6%. Significant human-based contributing factors included errors of judgement and problem recognition, haste and inattention, failure to follow protocol and inadequate preparation of equipment and patient.

A number of factors were identified as having prevented or limited harm. Selections included "rechecking equipment" in 62 reports (35%), "rechecking the patient" in 60 (34%), "prior experience" in 51 (29%), "use of correct protocol" in 40 (23%) and "skilled assistance" selected in 39 reports (16%).

Discussion

Transportation of the critically ill patient between hospitals is associated with increased complications [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16]. Intra-hospital transportation poses many of the same risks that are associated with inter-hospital transport [9, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41]. In this study we examined incidents incurred during intra-hospital transport of ICU patients. These findings are important because they highlight specific opportunities to improve patient safety during transportation.

In more than a third of the reports regarding intra-hospital transportation, the patient suffered serious adverse outcomes. In comparison, inter-hospital transport incidents reported to AIMS-ICU identified a 42% incidence, and reports related to neither of these transport groups identified a 23% incidence of adverse outcomes. The incidence of physiological changes associated with intra-hospital transport has varied in the literature, ranging from 6–68% of transports [22, 23, 25, 26, 29, 30, 31, 32, 34, 35, 37, 38, 39, 40, 41]. Discrepancies between the results of these studies may be attributed to differences in patient population and/or to the definitions used for physiological change. In most of these studies, for example, the physiological changes reported were less severe than those reported in our study.

When considering moving a patient out of the ICU, the benefits to be gained need to be weighed against possible risks. Benefits may include obtaining diagnostic information or procedures that cannot be undertaken in the ICU. Caruana et al. [25] describes two studies of patient management after transport. They observed care plan changes within 48 h for 39% of transports in one study and 24% in the other. Abdominal CT scans and angiography resulted in the most frequent changes in the trauma patients studied. Although our study cannot assess the benefit of the transportation, we outline a wider range of risks than previously described. Providers should consider these additional risks, as should future studies.

We found that the majority of transportation-related incidents involved transportation between the ICU and the operating theatre or the radiology department. This is consistent with other data from the literature [33, 34, 35, 37, 38, 39]. Smith et al. [33] showed that the majority of 'mishaps' occurred either before or during the procedure. Our study did not address the issue of timing, but indicated that in 42.5% of incidents the transport was part of the initial admission to ICU or the result of a sudden change in the condition of the ICU patient. In 44% of incidents the transport was part of the ongoing care being provided, such as a follow-up computerized tomography examination following craniotomy.

The use of portable equipment is necessary in the transport of the critically ill patient to provide monitoring, continuous infusions and ventilation. Here many incidents identified equipment failure as a major problem during transport. Battery failure in monitors and/or infusion pumps was commonly identified. An example would be the loss of deliverance of inotropes and subsequent hypotension when the infusion pump fails due to an inadequate battery charge. Smith et al. [33], who identified monitor power failure in 14% of transports, support our findings.

Transport of the ventilated patient outside the intensive care environment removes the patient from a secure environment where emergency airway equipment is readily available. Previous studies assessing respiratory and ventilation components of intra-hospital transportation have either compared manual versus transport ventilator ventilation or have assessed changes in respiratory parameters as outcome measures [27, 33, 34, 40, 41]. Our study identified additional specific ventilator or airway management problems. Oxygen supply problems were important precipitants of ventilation failure as portable ventilators rely on the continuous flow of oxygen from a small portable cylinder. Other reasons for ventilation failure included the selection of inappropriate settings permitted by some portable ventilators and faulty valves. Transported patients are usually heavily sedated or paralyzed, and accidental extubation and occlusion or dislodgment of the artificial airway can be life-threatening. Endotracheal tube malpositioning and accidental extubation were frequent incidents, with inadequate securing of the artificial airway as a contributing factor. Beckmann et al. [45] identified a similar association in their review of incidents related to unplanned reintubation.

The most common patient/staff management issues identified from our study were communication and liaison issues between the ICU and sites of destination or origin. Transportation of the critically ill patient requires careful communication between the two locations involved. Effective planning and communication aid in reducing unnecessary waiting periods and ensure the time required for transportation is kept to a minimum. They can also ensure that equipment required for the patient is readily available. Smith et al. [33] identified an increased risk for complications as the duration of transportation increased.

Transportation of the critically ill patient requires staff with appropriate skills and knowledge. Early detection through continuous monitoring by staff was important in limiting the harm of an incident. Many of the human-

based contributing factors identified here suggest that personnel involved may not have had adequate training. This was found for all levels of ICUs. We suggest that not only should all staff involved in intra-hospital transportation be skilled in airway management and critical care, but that they also undergo specific training for patient transportation. Inter-hospital transport is now increasingly performed by specialized teams [4, 6, 10, 12, 20]. Edge et al. [6], for example, identified a ten-fold reduction in preventable morbidity when specialized staff undertook the transportation. Although a number of articles have advocated that specially trained nurses should lead such transport teams without direct medical attendance [20, 34], the need for skilled medical involvement was apparent in our results.

An important strength of incident monitoring includes the systematic gathering of information from staff involved in the event about factors contributing to and limiting the incident [42, 43]. We identified over 900 contributing factors identified in 176 reports, suggesting the cause of most incidents is multifactorial. Many of the prominent factors identified here have not been adequately assessed by other studies. Previous observational studies have either focused on documenting the outcomes of intra-hospital transportation or on equipment-related mishaps [9, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41]. The former group did not evaluate the causes for the poor outcome or identify factors that may have contributed to it. These contributing factors need to be addressed and monitored regularly if the safety of intra-hospital transfers is to be improved.

This study highlights the potential to use checklists to reduce the risk for harm when transporting patients. In nearly all incidents (91%) staff stated that the incident was limited by rechecking the equipment (35%), rechecking the patient (34%) or by the appropriate use of protocols (21%). Future research should evaluate the role of checklists in reducing the morbidity and mortality associated with transportation of the critically ill patient.

This study has several limitations. Since we relied on anonymous incident monitoring, the information gathered does not provide a numerator or denominator, so that the true incidence of problems cannot be assessed. It is likely that many more incidents occurred than were reported. Also, the possibility of volunteer bias or selection bias needs to be considered for both the ICUs electing to join the study as well as for individual staff members choosing to participate. Despite these limitations, voluntary incident monitoring systems provide important information not found in prospective and retrospective studies.

A number of professional societies have developed guidelines for the transfer of the critically ill including inter- and intra-facility transfers. They provide a first step in improving the safety of intra-hospital transport of critically ill patients [17, 18, 19, 46]**.** We suggest that providing details for the process of transportation could further enhance these guidelines (please see the ESM)**.** Additional areas requiring further development include ongoing staff training, improved documentation during transfer and the broad implementation of an incident monitoring system. Table 3 outlines our recommendations from this study.

Table 3 Recommendations from this study

Recommendations for transportation
a. The decision to move a critically ill patient within the hospital should be made by a senior medical practitioner after careful consideration of the benefits to be gained weighed against possible risks.
b. A dedicated team should be available for the entire duration of the transport. The team members need to be familiar with the transportation of critically ill patients, skilled in airway management and resuscitation, patient monitoring and moving, and be familiar with all equipment.
c. Adequate monitoring of the critically ill patient should include ECG, BP, oxygen saturation and, if ventilated, end-tidal carbon dioxide monitoring.
d. Careful preparation for transportation is essential, including patient and equipment checks and liaison with staff at the destination. A checklist should be used to assist in preparation. Oxygen supply, including the amount of oxygen in cylinders, and battery-life assessments are imperative. Transferring the patient to or from his/her bed must be carefully planned and appropriate equipment used by trained staff. All lines and tubes should be checked and simplified if possible.
e. All battery-operated transport equipment should have charge indicators and back-up batteries. Regular servicing and checking of transport equipment is essential. The use of specialized transport trolleys, which include improved power supply, have been advocated [32].
f. Patient observations should be documented during the transport.
g. Guidelines by professional bodies need to be updated in line with our above recommendations. They should also develop a pre-transport checklist (Table in ESM).
Recommendations for monitoring outcomes
Local units need to be able to monitor compliance with these standards, including adequate in-servicing/training of staff, enhanced communication between destination sites, as well as monitoring the occurrence of incidents and their contributing factors.
Other recommendations
Because of the documented hazards and the expense of intra-hospital transport, it is important to continue to develop the technology with which to perform diagnostic and therapeutic procedures at the bedside [28].

In conclusion, our findings suggest that intra-hospital transportation of the critically ill poses important risks and that such a transport should only be undertaken where the benefits of the procedure or investigation to be undertaken outweigh the risks of the transport. Highly qualified staff, specially designed and well maintained equipment, as well as continuous patient monitoring are essential for the avoidance or minimization of these incidents. Professional societies/units should develop/edit guidelines for this procedure. Incident monitoring systems provide important information about the risks of transportation and identify opportunities to improve patient safety.

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