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ORIGINAL ARTICLE

Multiple intra-hospital transports during relocation to a new critical care unit

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Abstract
Objective Intra-hospital transport (IHT) of critically ill patients is associated with morbidity and mortality. Mass transfer of patients, as happens with unit relocation, is poorly described. We outline the process and adverse events associated with the relocation of a critical care unit.
Design Extensive planning of the relocation targeted patient and equipment transfer, reduction in clinical pressure prior to the event and patient care during the relocation phase.
Setting The setting was a 30-bed, tertiary referral, combined medical and surgical critical care unit, located in a 570-bed hospital that serves as the national referral centre for cardiothoracic surgery and spinal injuries.
Participants All stakeholders relevant to the critical care unit relocation were involved, including nursing and medical staff, porters, information technology services, laboratory staff, project development managers, pharmacy staff and building contractors.
Main outcome measures Mortality at discharge from critical care unit and discharge from hospital were the main outcome measures. A wide range of adverse events were prospectively recorded, as were transfer times.
Results Twenty-one patients underwent IHT, with a median transfer time of 10 min. Two transfers were complicated by equipment failure and three patients experienced an episode of hypotension requiring intervention. There were no cases of central venous or arterial catheter or endotracheal tube dislodgement, and hospital mortality at 30 days was 14%.
Conclusion Although IHT is associated with morbidity and mortality, careful logistical planning allows for efficient transfer with low complication rates.

Keywords Intra-hospital transport · Critically ill transport · Safe transport

Introduction

Intra-hospital transfer (IHT) of critically ill patients is associated with morbidity [1] and may be associated with mortality [2]. Adverse events occur in up to 70% of IHTs [3]. Many of these events are minor and the risk of IHT must be balanced against the potential benefit of undergoing a diagnostic or therapeutic procedure. The indications for IHT in the critically ill are myriad—some have evolved in recent years, with the improvement of interventional radiology capabilities, but other requirements for IHT remain e.g. the need to perform a procedure in the operating theatre, endoscopy suite or cardiac catheterisation laboratory, as well as indications for CT and/or other imaging modalities [4]. Mass transfer of multiple critically ill patients more typically occurs in the field of disaster medicine or in the event of a catastrophic occurrence (e.g. the evacuation of the critical care unit) [5]. However, the mass IHT of patients in a planned fashion is poorly described in the literature.

In February 2014, the critical care unit in our institution was relocated to a facility in a new building, which was physically attached to the existing hospital. This relocation

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required IHT of a large number of patients between the 'new' and 'old' critical care units. Relocation of the critical care unit posed a number of challenges since the new unit had to be immediately fully functional. As the two units were approximately 950 metres apart, a transition phase would have been impossible with current nursing and medical staffing levels.

Unlike other IHTs described in the literature [6], only six beds in the new unit were fully equipped; so all equipment, stock and pharmacy had to be repopulated from the old to new unit in tandem with the patients. When planning this mass transfer, we found very little in the literature to guide us, particularly in view of the challenges listed above. As a result, we felt it would be useful to record an account detailing our plans, contingencies and the outcomes of patients following the move. Although this experience is related to established critical care patients, many of the logistical issues will be of interest to all practitioners of critical care and emergent transfers.

Methods

The mass transfer was conducted in a 30-bed, university-affiliated, tertiary referral, combined medical and surgical critical care unit, comprising both level-three (intensive care) and level-two (high dependency care) patients. This unit is located in a 570-bed, inner-city hospital that serves as the national referral centre for cardiothoracic surgery (including cardiac and lung transplantation) and spinal injuries.

Relocation of the critical care unit was recognised to be a significant potential cause of morbidity and mortality. In view of this, planning started nine months before the proposed transfer date. This planning involved all stakeholders; nursing and medical staff, porters, information technology services, laboratory staff, project development managers, specific contractors responsible for medical equipment and EPR, pharmacy staff and building contractors. Over the course of nine months, a relocation plan was formulated (Table 1). This dealt with all the different elements of unit relocation, including the transfer of patients, equipment and pharmacy stock as well as staffing of the critical care unit on the day of transfer. Contingencies were also created for the hospital—specifically plans for dealing with emergencies and the potential for heart–lung transplantation during the transfer period.

Reduction in clinical pressure

In keeping with many critical care units in this jurisdiction [7], our unit routinely operates at occupancies greater than 100%, considerably higher than the international recommendation of 75–80% [8]. Measures were put in place to limit occupancy of the unit in the days leading up to the relocation. Specifically, there was a reduction in major cardiothoracic surgery requiring critical care admission in the week before relocation. The relocation was planned for a Monday, taking advantage of the weekend reduction in elective surgery. These measures resulted in a 13% reduction in occupancy—from 29 to 25 patients. The relocation occurred in tandem with relocation of operating theatres; all elective surgery was cancelled for this day as a result. This further enabled access to skilled anaesthesia staff for support. Inter-hospital transfers ceased, except those requiring specialist services only provided in our unit. All patients fit for discharge to ward level were prioritised ahead of other bed allocations for the hospital. Although we considered placing the hospital off-call for heart and lung transplantation for the duration of the relocation, by transferring services to the new critical care unit early in the day, we felt we would be ready to receive any potential patients post-transplant without undue delay.

Patient transfers

Route planning included selection of lifts and routes for patients, with an alternative route for transfer of equipment to avoid potential obstruction to patient flow. An IHT 'dry-run' was performed to obtain data to enable logistic planning on transfer day. The transfer time for the 'dry-run' was 17 min per patient which included the use of two lifts. When patient preparation and set-up were included, the estimated total transfer time was 49 min per patient.

Each patient was accompanied by a porter, critical care nurse and doctor, under the supervision of a consultant intensivist, with the exception of patients on extracorporeal life support (ECLS) who were also accompanied by one additional critical care nurse as per protocol. Patients were transported in a consecutive manner; a subsequent transfer began only following safe transfer of the previous patient to the new unit. All patients were assessed by an intensivist prior to transfer, and contingencies were in place to bypass an unstable patient and re-enter that patient into the sequence once stabilized. Regular contact was maintained between the new unit, old unit and transfer teams via a 'walkie-talkie' communication system. A member of each patient transfer team prospectively recorded transfer times and complications associated with IHT for each patient on a separate audit sheet. Patients were followed up until either death or hospital discharge.

Transport equipment was standardised and mounted on a support structure at the end of bed (MobiDoc^{TM}). Philips portable IntelliVue MMS monitors were transferred from bedside monitors to transport monitor to minimise the

Table 1 Relocation plan timeline

Unit relocation elements	T—1–12 months	T—3 days	T—1 day	Relocation day
Reduction in clinical pressure	–	Reduce major cardiac surgery Only schedule low-risk cardiac cases Cease inter-hospital ICU transfers	Priority discharge to ward of ICU patients	Cancel elective surgery for relocation day Prioritise ICU patients for ward discharge
Patient transfer	Choose optimal route to minimise obstruction to patient flow and perform 'dry-run' of transfer Standardise transfer equipment Train staff on new equipment and fire training—4 h per staff member, 160 h total	Brief all critical care doctors, nurses and porters on transfer route and equipment	Ensure all transport equipment is functional and fully charged Allocate specific patients to each transport team	Ensure rest station is fully stocked and operational Transfer each patient consecutively so only 1 patient is in transit at any time Use only dedicated transport staff Provide refreshments in old and new ICU
Equipment transfer	Fit boom configuration systems in new ICU patient rooms to accommodate equipment and maximise floor space	Fully equip 6 bed spaces in new ICU with reserve or new equipment	Transfer all reserve equipment to new unit	Technical support dismantle monitoring, interface and other supportive equipment and remount in new unit in tandem with patient transfers to ensure immediate restoration of full service in new unit
IT transfer	IT services fit operational equipment and test functionality to ensure that patient record is retained	IT services arrange move identifiers to facilitate transfer of patient record	Configure 6 ICIP™ stations to accommodate first patients transferred Coordinate with ICIP vendor to provide extra temporary licences	Sequentially reconfigure ICIP in tandem with patient transfers, ensuring reconfiguration six spaces ahead of patient move
Pharmacy	Take full stock of current pharmacy requirements and choose optimal location for pharmacy stores	–	Fully pre-stock pharmacy except for controlled drugs	Transfer controlled drugs and remaining stock, including patient-specific medications, in tandem with patient transfers to ensure continuity
Patient care		Brief critical care doctors on their duties including contingencies for patient referrals during relocation	Roster consultant intensivists and CNMs to each critical care area (both new and old)	Roster critical care staff distinct from relocation team to provide routine care Increase consultant cover to facilitate management of ICU referrals during relocation

potential for cross-contamination, and ventilator tubing was changed for each patient. LTV 1200 portable ventilators were used, which require 10 L/min bias flow in addition to minute ventilation, and which provide efficient and effective ventilation for critically ill patients. Size E oxygen cylinders were provided, with a capacity of 680 L. With an FiO2 of 1.0 and a minute ventilation of 6 L/min, we estimated that each cylinder would last for 42.5 min, requiring a cylinder change after each patient transfer [9]. A 'safety stop' was provided half way between the old and new units to afford an opportunity to address any difficulties that might arise in patient care during the transfer. This stop was staffed by a critical care nurse and was stocked with medications and reserve equipment including resuscitation equipment. Further details of the standardised bed set-up and safety stop equipment can be found in online supplementary data.

Equipment transfers

All reserve equipment, such as extra ventilators and infusion pumps, was transferred in the days prior to relocation. Also, the new unit was pre-stocked with routine stores and full pharmacy. This transfer required extra personnel and contingencies to deal with breakages. As only six bed spaces in the new ICU were fully equipped, all other spaces

had to be fitted with existing equipment in tandem with relocation of patients. This involved transferring and remounting all ventilators, monitors and computer hardware. In addition, the electronic patient record (EPR), ICIP™, had to be dismantled at each bed space and re-established at each patient destination retaining patient identity and record. Dedicated move identifiers were employed to ensure a seamless patient record. Point-of-care testing machines for arterial blood gas analysis were transferred from the old unit and recalibrated prior to relocation. Additionally, remote radiology workstations were installed and configured prior to relocation to ensure timely access to imaging.

Patient care

In addition to the relocation, critical care staff also had to provide services to the hospital and emergency department consistent with our normal level of service to critically ill patients. To allow for service of both units, four consultants were rostered for the relocation day, rather than the norm of two. Four other critical care doctors were rostered for the provision of patient care, distinct from the five doctors directly responsible for patient transfers. As a result, doctors responsible for patient care were maintained at the normal ratio and were not subsumed into taking on transfer responsibilities. Four critical care clinical nurse managers (CNMs) staffed the old and new units, rather than the norm of two, providing patient care and assisting in organising relocation. In addition, staff nurse numbers increased approximately 20% to deal with the extra workload of the day. An extra NCHD was rostered to the night shift for the first night and an extra five critical care staff nurses per shift for the remainder of the first week to support staff in the new environment. Full staffing requirements can be found in Table 2.

Results

Twenty-five patients were in the critical care unit on the morning of relocation. Any patient fit for discharge was transferred to a ward or lower dependency environment and the remainder were transferred to the new critical care facility. As a result, twenty-one patients underwent IHT over the course of 6 h 43 min. These patients comprised twelve level-three patients and nine level-two patients. Mean APACHE II score was 20.7 (range 11–40). Fifteen patients (71%) were mechanically ventilated, seven (33%) required vasoactive support and one (5%) required ECLS.

Median transfer time was 10 min (range 7–30 min). Mean transfer time was 11 min 14 s. The longest transfer time involved a patient on ECLS, transferred by a critical care consultant. The mean FiO2 was 0.49 for ventilated patients. However, oxygen cylinders were still changed after each transfer to ensure an adequate supply in case of delays or deterioration. Two transfers were interrupted due to equipment failure (two arterial catheter transducer cable failures). Hypotension requiring change in vasopressor dose and/or fluid bolus occurred in three (14%) cases. One transfer was temporarily delayed, for 3 min, by a lift malfunction. There were no significant changes in haemodynamic or respiratory stability during IHT, nor were there any accidental extubations or vascular catheter dislodgements. Hospital mortality at 30 days was 14%, consistent with our baseline rate for critically ill patients.

Discussion

Relocation of critical care services is recognised to be a stressful and potentially hazardous event for patients and staff [1, 9]. As we moved to a new critical care unit which was largely unequipped, we had to plan both for relocation of patients and services. This required extensive involvement of clinical engineering, laboratory and information technology staff as well as medical and nursing staff in order to ensure that auxiliary services were operational in tandem with patient relocation. IT staff were heavily involved in ensuring continuity of the patient record, and much of our initial planning was related to this aspect of the relocation.

Our main concern was that patient safety not be compromised by IHTs. Our low complication rate is consistent with satisfactory achievement of this goal. Given the limited amount of transfer equipment, there was potential for cross-contamination between patients. However, follow-up of microbiology samples has not suggested any transfer of pathogens between patients. Previous literature on IHT suggests that many adverse incidents that occur are of low impact [3, 4], and this is in keeping with our findings. Informal feedback from all stakeholders following the transfers was broadly positive. Key, in our minds, to the success of this venture, was the allocation of adequate staffing resources to patient transfers and the reduction in elective surgical work in the days pre-transfer. Also, the 'buy-in' of *all* staff to the reasons behind the need for a new critical care unit created a momentum to ensure that all stakeholders were proactive in problem-solving any potential issues prior to and during transfer day.

The transfer time for patients was markedly shorter than the estimated time (10 vs 17 min). This may reflect the fact that the practice run was performed by an intensive care consultant with a mannequin, and, hence, lacked the pressure of transferring a critically ill patient. Despite this, staff did not describe any concerns during or after the

Table 2 Staffing requirements for relocation

Profession	Role on relocation day	Total (% increase above normal)	Staff increase for subsequent 5 days (% increase above normal)
Consultant	1 per unit	4 (100%)	–
Non-consultant hospital doctor	1 per transfer; 5 for routine care	10 (100%)	6 (20%)
Clinical nurse manager	1 per unit and 4 to supervise transfer of patients and equipment	8 (100%)	–
Critical care staff nurse	1 per patient (2 for ECMO patient), 1 for safety stop, 8 to ensure adequate cover in both sites	31 (19%)	31 (19%)
Health care assistants	2 per unit	4 (100%)	–
Porter	1 per transfer	4 (400%)	–
Clinical engineer	1 per transfer	4 (300%)	–
Pharmacy	1 per unit	2 (100%)	–
Laboratory	1 per unit	2 (100%)	–
IT contractor	1 per bed space	3 (300%)	–
Security	1 for safety stop	4 (400%)	–
	3 to ensure unobstructed transfer route		
Administration staff	3 staff split between both units—shift extended by 30 min	3 (4%)	3 (4%)

event. The one outlying transfer time of 30 min involved a patient on ECLS. This transfer was delayed by a failure of a monitor cable but was otherwise uneventful.

Although it was not, at that time, standard practice in our critical care unit, the use of transport checklists to aid IHTs is well described and is routine practice in many critical care units [10]. The theory behind checklists is to provide a structured framework to guide treating staff in an unfamiliar environment, to reduce error, improve performance and to enable a consistency of practice. There are also a number of published transport guidelines available [11–17].

There are a number of limitations to our study. First, it is conducted in a single critical care unit, and thus, the findings are somewhat specific to our unit. Second, although we had a very low incidence of adverse events, it should be noted that these data should not be extrapolated to other IHTs. These patients were "established" critical care patients and were not being transferred for the purposes of managing an acute event. However, this study does suggest that mass transfer of critically ill patients can be accomplished safely and effectively when planning is meticulous and organised. We feel that the principles of the logistical planning that were applied to this relocation could be extrapolated to more acute patients in emergency and critical care environments.

In summary, IHT is necessary to facilitate the movement of critically ill patients for various diagnostic and/or therapeutic interventions. However, IHT of multiple critically ill patients to facilitate transfer to a new critical care unit, particularly with tandem transfer of all significant bed-space technology, is a relatively rare event and is poorly described in the literature. We describe one such event in our critical care unit, along with the associated pre-transfer logistical planning, the transports themselves and associated events, with the aim of aiding and informing future unit relocations. IHTs were efficient, rates of complications were low and anecdotal staff satisfaction rates were high.

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Compliance with ethical standards

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Conflict of interest Dr O'Leary declares that she has no conflict of interest. Dr Conrick-Martin declares that he has no conflict of interest. Dr O'Loughlin declares that he has no conflict of interest. Ms Curran declares that she has no conflict of interest. Dr Marsh declares that he has no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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