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G. Bellingan
T. Olivier
S. Batson
A. Webb

Comparison of a specialist retrieval team with current United Kingdom practice for the transport of critically ill patients

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G. Bellingan (✉)
Bloomsbury Institute of Intensive Care Medicine, Rayne Institute, University St., London WC1E 6JJ, UK
Tel.: + 44-1 71-2 09 62 08
Fax: + 44-1 71-2 09 62 58

T. Olivier · S. Batson · A. Webb
Department of Intensive Care, UCL Hospitals, Mortimer St., London W1N 8AA, UK

Abstract *Objective*: The inter-hospital transfer of critically ill patients in the United Kingdom is commonly undertaken using standard ambulance under junior doctor escort, despite recommendations for the use of specialist retrieval teams. Patients are transferred into University College London Hospitals (UCLH) intensive care unit (ICU) by both methods. We undertook to evaluate the effect of transfer method on acute physiology (within 2 h of ICU admission) and early mortality (< 12 h after ICU admission).
Design: Retrospective review of all transfers over 1 year.
Setting: UCLH ICU.
Subjects: 259 transfers; 168 by specialist retrieval team (group A) and 91 by standard ambulance with doctor provided by referring hospital (group B).
Interventions: None
Main outcome measures: Acute physiology (pH, PaO_2, $PaCO_2$, heart rate (HR), mean arterial blood pressure (MAP), 24 h severity of illness scores (APACHE II, SAPS II), length of stay and mortality.
Results: There were no differences in demographic characteristics or severity of illness between the two groups; nevertheless significantly more patients in group B than in group A were severely acidotic (pH < 7.1: 11 % vs. 3 %, $p < 0.008$) and hypotensive (MAP < 60: 18 % vs. 9 %, $p < 0.03$) upon arrival. In addition, there were more deaths within the first 12 h after admission with 7.7 % deaths (7/91) in group B transfers vs. 3 % (5/168) in group A.
Conclusions: The use of a specialist transfer team may significantly improve the acute physiology of critically ill patients and may reduce early mortality in ICU.

Key words Transport · Critically ill · Ambulance · Icutransfer · Retrieval team

Introduction

The inter-hospital transfer of critically ill patients is common, with over 11,000 patients being transferred in the United Kingdom in 1994 [1]. This number has since increased steadily [2] and is set to rise further owing to a national shortage of ICU beds [3] and recommendations that ICU services should be centralised [4, 5]. Furthermore the transport of critically ill patients over long distances because of a lack of beds has in particular raised considerable public concern lately.

The transfer of mechanically ventilated patients may be achieved safely [6]; however, problems can arise when escorting staff are insufficiently trained [7, 8]. Most hospitals do not have a specialised transfer ambulance, and few can provide suitably experienced retrieval teams [1]. In the UK the majority of patients are thus transferred by inexperienced junior doctors, many of whom are anaesthetists in the first 6 months of training [9]. Another problem is the lack of suitable mobile monitoring equipment. Mackenzie et al. [1] showed that 5 % of ICUs cannot provide a transport ventilator for transfer, and that during transfer 18 % cannot monitor blood pressure invasively and 38 % cannot monitor central venous pressures. This situation has resulted in persistently poor transfer standards in the UK, with a recent study showing that a quarter of comatose head injury patients have no airway protection during transfer [10]. Many recommendations have been made that specialist retrieval teams should be used to transfer critically ill patients [11, 12, 13, 14]. To date, however, no formal comparison has been made between the current UK practice of transferring critically ill adult patients using standard emergency service ambulances, staffed with a resident doctor, and transfers by a specialist team in a mobile ICU.

As patients at University College London Hospitals (UCLH) are transferred into the ICU by both methods, we are uniquely placed to undertake such a comparison. A dedicated mobile ICU and trained transfer team is generally available for this purpose; however, patients are transferred by standard ambulance with a medical escort provided by the referring hospital when this service is unavailable. In this study the outcomes of these two models of transfer are compared by measuring the acute physiological variables on arrival of these two groups of patients and their early mortality (< 12 h after admission to ICU).

Subjects and methods

This is a retrospective review of all 259 patients who were transferred into the UCLH ICU from 1 October 1996 to 30 September 1997. Patients were transferred either by the UCLH specialist team using a mobile ICU (group A; $n = 168$, 64.9 %) or by standard emergency ambulance with a medical escort provided by the referring hospital (group B; $n = 91$, 35.1 %). Transfer by standard ambulance occurred when the specialist team was busy or unavailable owing to training or maintenance. There was no selection policy determining which mode of transfer was used.

The specialist team consisted of an ICU-trained doctor (senior SPR or consultant), nurse, driver, and medical physics technician, all trained in the transfer of ICU patients. The mobile ICU is a 4.2L Chevrolet ambulance (Wheeled Coach, Braintree, UK) which is equipped to ICU standards (all round stretcher access, piped oxygen and air, nitric oxide, mechanical ventilation, suction, 220-V power supply and multi-channel monitoring). The specialist team spent between 30 and 300 min (mean 70 min) stabilising patients in the referring hospital before transfer.

The following details were recorded: transfer distance, source (ICU/other), type of admission (medical/surgical), diagnosis, age, sex, acute physiology [pH, arterial partial pressure of oxygen (PaO_2), arterial partial pressure of carbon dioxide ($PaCO_2$), fractional concentration of inspired oxygen (FiO_2) to yield the PaO_2/FiO_2 ratio, heart rate (HR), mean arterial blood pressure (MAP)], the first 24 h severity of illness scores [Acute Physiology and Chronic Health Evaluation (APACHE) II and Simplified Acute Physiological Score (SAPS) II], ICU and hospital length of stay and mortality. For deaths occurring within 12 h of admission to UCLH ICU, a medical summary and the decision as to whether to limit or withdraw treatment was recorded. Data were analysed by χ^2 or t test between the two groups as appropriate; in view of the small numbers in the groups Fisher's exact test was used to compare admission diagnoses between groups, and survival data were analysed by the Mantel-Cox log rank test.

Table 1 Patient demographics

	Group A UCLH mobile ICU (Mean ± SD)		Group B Standard ambulance (Mean ± SD)	
Demographics				
Age	54	19	56	19
Sex (% male)	51.8 %		59.3 %	
Acute Physiology				
FiO_2	0.62	0.27	0.58	0.24
PaO_2 (kPa)	19.5	14.6	18	11.7
$PaCO_2$ (kPa)	5.2	3.2	5.7	4.1
PaO_2/FiO_2	33.1	21	35.2	22
HR	106	23	101	23
MAP (mm Hg)	86	21	83	25
Temperature (°C)	36.7	1.4	36.6	2.3
APACHE II	17.2	7.4	17.8	8.0
SAPS II	31.7	13.6	33.7	17.1

Results

No transfer was delayed or cancelled because of the mode of transfer available at the time (for example, transfer delayed to await availability of the specialist transfer service). There were no differences in the demographic characteristics or overall severity of illness (APACHE II and SAPS II scores) between the two groups (Table 1), nor in the admission diagnoses, overall ICU mortality (Table 2) or hospital mortality (Fig. 1). The mean time in the referring hospital was similar between groups (5.1 days for group A and 4.7 days for group B), and both groups were transferred from similar types of institutions. Of group A transfers, 65 % originated from district general hospitals, 20 % from specialist hospitals and 15 % from other teaching hospitals, while the figures for group B were 68 %, 15 % and 17 % respectively. Most of the hospitals transferring patients were common to the two groups. Significantly more patients were transferred by specialist team rather than by standard ambulance from ICUs (rather than from A&E, wards or theatre) – 36.3 % vs. 23.1 % ($p < 0.05$), and more patients were transferred with medical rather than surgical problems 92.8 % vs. 80.2 % ($p < 0.05$). The mean journey distance was 17.5 km (range 1.5–123) for transfer by the mobile ICU and 19.2 km (range 1.5–90) for standard ambulance; there was no difference in the time of day at which patients were transferred.

Despite the similarity in demographic characteristics and severity of illness between the two groups there were significantly more patients in group B who were

Table 2 Admission diagnoses and ICU mortality per diagnostic category

(Other includes: burns, oncological, endocrine/metabolic and obstetric causes; all are < 3 % of the total.
There are no significant differences between groups in the distribution amongst diagnostic categories, the number of deaths within each diagnostic category, or in the overall number of ICU deaths)

Diagnosis	Group A UCLH mobile ICU			Group B Standard ambulance			
	No. of patients	as % of 168	No. of deaths	No. of patients	as % of 91	No. of deaths	p
Respiratory	40	23.7	10	16	17.6	5	n/s
Cardiac	31	18.4	13	15	16.5	8	n/s
Gastrointestinal	19	11.3	5	12	13.1	3	n/s
Neurological	11	6.5	3	7	7.7	2	n/s
Poisoning	11	6.5	2	3	3.3	1	n/s
Sepsis	10	6	5	5	5.5	2	n/s
Vascular	9	5.4	3	13	14.3	5	n/s
Trauma	8	4.8	1	7	7.7	2	n/s
Malaria	8	4.8	1	4	4.4	0	n/s
Other	21	12.6	4	9	9.9	4	n/s
Total	168	100	47	91	100	32	n/s

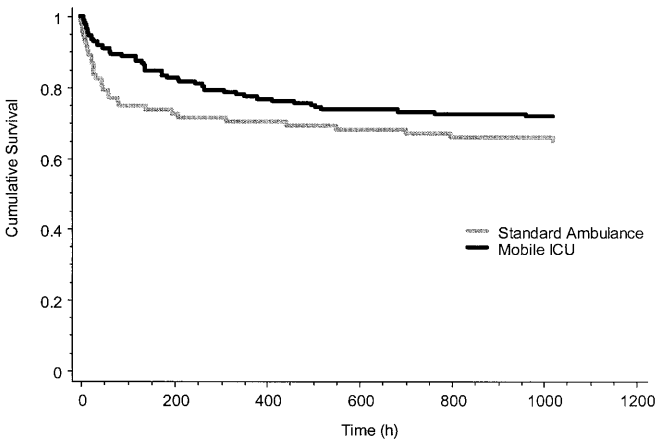

Fig. 1 Survival curves for patients transferred into ICU by UCLH mobile ICU and by standard ambulance

severely acidotic and hypotensive upon arrival than in group A (Table 3). Accompanying this, group B had more deaths within 6 h of admission – 4 deaths, including one en route, of the 91 transferred (4.4 %) than group A, with only one death amongst the 168 transferred (0.6 %). This difference was maintained up to 12 h after admission, with 7.7 % of group B patients dying over this time compared with only 3 % of those in group A. All seven deaths in group B occurred despite full active treatment, while two of the five deaths in group A occurred after treatment limitation decisions had been made. The mean journey distance for those who died in the first 12 h after arrival was longer for patients in group B (20.5 km) than in group A (9.0 km). The patients in group A who died in the first 12 h, however, had higher admission APACHE II and SAPS II scores than group B patients (group A deaths in the first 12 h: admission APACHE II 31, SAPS II 64.8, group B = 25.8 and 53.7). The overall ICU survival is shown as a Kaplan-Meier plot (Fig. 1).

Discussion

This is the first study to compare the outcome in critically ill adult patients transferred between hospitals by standard emergency ambulance and the use of a specialist transfer team and ambulance. Our data clearly demonstrate that a fully trained and equipped team results in improved patient resuscitation post-transfer, with a 50 % reduction in the number of patients arriving in a dangerously hypotensive state ($p \leq 0.008$) and a 70 % reduction in those with a serious metabolic acidosis ($p \leq 0.03$).

Although group B had significantly more patients with a MAP lower than 60 mmHg (17.6 % vs. 8.9 %) the overall MAP of the two groups was similar. This is easily explained by the range of MAP, especially in group B, where the standard deviation for the group was 25 mmHg. Thus a number of patients in this group were also hypertensive, possibly also reflecting poorer control. Differences in pH and MAP reflect the degree to which patients are resuscitated [15], which is influenced both by the sophistication of available monitoring and by the experience of staff interpreting these data. The fact that no differences were seen between groups in the oxygenation suggests that pulse oximetry monitoring, which is almost universally employed and easily interpreted [13], is of positive benefit. Invasive monitoring of arterial and central venous blood pressures are not so widely available and are more difficult to respond to appropriately [1]; hence these factors may contribute to our findings.

In addition to the differences in acute physiology between groups there were fewer early deaths amongst patients in group A. We examined survival up to 12 h after admission as this is the period during which consequences of transfer practice might be reasonably expected to influence mortality. A Mantel-Cox log rank test showed a statistically significant difference at 6 h ($p = 0.03$, with $p = 0.07$ at 12 h), but we have not reported these data

Table 3 Frequency of severe disturbances in acute physiology upon admission to UCLH ICU

		Group A UCL mobile ICU		Group B Standard ambulance		*p*
		n	%	*n*	%	(χ^2)
pH	< 7.1	5	3.0	10	11.0	0.008
MAP	< 60 mm Hg	15	8.9	16	17.6	0.03
$PaCO_2$	> 8.0 kPa	7	4.2	9	9.9	n/s (0.06)
Heart rate	> 100	67	39.9	43	47.2	n/s
PaO_2/FiO_2	< 40	101	60.1	53	58	n/s
PaO_2/FiO_2	< 27	72	42.9	36	39.6	n/s

[PaO_2/FiO_2 < 40 as used in the definitions of acute lung injury and < 27 for the acute respiratory distress syndrome]
Similar differences exist for multiple pH and MAP cut-off values (pH <7.2 and < 7.15 and MAP < 65 and < 55, all p < 0.05 or less)

in the results due to the small number of deaths involved.

The groups in our study were indistinguishable in terms of demographics, distance transferred, severity of illness, diagnosis, time in referring hospital prior to transfer or in type of referring hospital. In addition, no selection procedure was applied to patients in terms of transfer mode; hence these factors cannot be held accountable for differences observed in the numbers of acidotic and hypotensive patients. Only the source and type of referrals differed between the two groups. Group A included more medical patients and more patients transferred directly from other ICUs; both of these categories known to have a worse prognosis [16] and should have counted against the specialist team.

This study supports the findings for transfer of critically ill children. Edge et al. [17] demonstrated that a specialised paediatric retrieval team reduced morbidity in children during transfer in the United States. Likewise Britto et al. [18] have shown that specialised paediatric transfer teams can resuscitate and stabilise patients more effectively prior to transfer. The ICU mortality of adult patients transferred using the UCLH mobile ICU is similar to that reported by the West of Scotland Transfer Team, another UK specialist transfer team [13, 16].

Inter-hospital transfer of critically ill patients is increasingly common in the UK. If the survival trends recorded are applied to the 11,000 patients transferred in 1994, an estimated 484 would have died within 12 h of transfer using standard ambulance but only 66 using a dedicated transfer team, i.e. over 400 lives could have been saved each year simply due to differences in the training and equipment of the transfer teams! This study thus confirms previous reports that critically ill patients can be safely transferred if those involved are appropriately trained and equipped [6, 17, 18]. Where transfer is effected on an ad hoc basis, serious complications can arise [7, 10]. This provides further weight to the recommendations that the transfer of critically ill patients should only be undertaken by appropriately trained retrieval teams.

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