Risque d'incidents lors des transports intra hospitaliers des patients de réanimation

Risk of mishaps during intrahospital transport of critically ill patients

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RÉSUMÉ

Prérequis : les incidents sont fréquents pendant le transport et peuvent avoir des impacts majeurs sur les patients.

But : les principaux objectifs de notre étude étaient: d'abord de determiner l'incidence des complications pendant les transports intra hospitaliers des patients de réanimation, et d'autre part, de déterminer leurs facteurs de risque.

Méthodes : tous les transports intra hospitaliers, à des fins diagnostiques ou thérapeutiques, des patients admis consécutivement dans une unité de réanimation médico chirurgicale de 18 lits dans un hôpital universitaire, ont été étudiés de façon prospective pendant une période de six mois (1er Septembre 2012 – 28 Février 2013).

Résultats : sur les 184 transports effectués (164 patients), 85 (46,2%) étaient associés à des incidents. Quatre-vingt-deux incidents étaient liés au patient (44,5%). La désaturation (30 cas), l'agitation (24 cas) et l'instabilité hémodynamique (15 cas) étaient les principaux incidents. Un cas d'arrêt cardiaque et trois cas d'extubation accidentelle ont été recensés lors des transports intra hospitaliers. Soixante-treize (39,6%) incidents liées au conditionnement ou à l'équipement ont été notées. Les transports d'urgence, la ventilation mécanique et la pression expiratoire positive (PEEP) ≥ 6 cm H2O ont été des facteurs de risque indépendants d'incidents. Dans notre étude, les incidents n'ont pas augmenté l'incidence de la pneumopathie acquise sous ventilation mécanique.

Conclusion : cette étude confirme que les transports intra hospitaliers des patients de réanimation impliquent toujours des risques considérables don't l'incidence reste élevée

Mots-clés

Transport intrahospitalier; incidents; incidence; ventilation mecanique; reanimation; facteurs de risque

SUMMARY

Background: Mishaps are common during transport and may have major impacts on patients.

Aims: The main objectives of our study are: first to determine the incidence of complications during intra hospital transports (IHT) of critically ill patients, and second, to determine their risk factors.

Methods: All intra hospital transports for diagnostic and therapeutic purposes of patients consecutively admitted in an 18-bed medical surgical intensive care unit in an university hospital, have been studied prospectively during a period of six months (September 1st 2012 to February 28th 2013).

Results: Of 184 transports observed (164 patients), 85 (46.2%) were associated with mishaps. Eighty two mishaps were patient-related (44.5%).Oxygen desaturation (30 cases), agitation (24 cases) and hemodynamic instability (15 cases) were predominantly. One case of cardiac arrest and 3 cases of accidental extubation were occurred during IHT. Seventy three systems-based mishaps were noted (39.6%). Emergency transports, mechanical ventilation and positive end-expiratory pressure (PEEP) ≥ 6 cmH2O were independent risk factors for a higher rate of mishaps. In our study, complications did not statistically increase ventilator-associated pneumonia.

Conclusion: This study confirms that IHT of critically-ill patients still involves considerable risks and mishaps incidence remains high.

Key-words

Intra hospital transport; Mishaps; Incidence; Mechanical ventilation; Critical care; Risk factors

The care of acutely ill patients routinely includes transportation, both inside a given hospital to undergo tests and procedures, and between hospitals, as patients may require transfer to other facilities for specialized services. As such, a mishap during transport (MDT) remains common and may induce a significant risk for patients. This risk has to be evaluated by the physician before ordering a diagnostic or therapeutic procedure, based on a benefit/risk analysis [1].Thus, each decision to transport must be considered carefully.
Practice guidelines have been established in an attempt to define more clearly the standard of care for the intra hospital transport (IHT) of critically ill patients [2-4].
The reported incidence of adverse events or patient harm ranges in the literature from 6 to 70% [5-8]. These discrepancies may be explained at least in part by differences in defining complications.
The main aims of our study are: first to determine the incidence and risk factors for MDT of critically ill patients, and second, to determine what improvements could be introduced into our Intensive Care Unit (ICU).

METHODS

Patients and Data Collection

The approval of the ethics committee was not necessarily given the strictly observational nature of the study.
All intra hospital transports for diagnostic and therapeutic purposes for patients admitted in an 18-bed medical surgical intensive care unit at Tunis Military Hospital were studied prospectively during a period of six months extending from September 1st, 2012 to February 28th, 2013.
When a patient was cleared for intra hospital transport, the following standard transport regiment was applied. Our nurses' policy is to prepare patients, together with the necessary equipment and medication, and to escort them during the transport. All patients were transported in their own ICU bed, in order to decrease the risk of equipment-related complications, and to minimize hemodynamic instability associated with bed-to-bed transfers.
All essential medications, including sedation, were continued with battery-operated perfusor pumps. Muscle relaxants for mechanical ventilation tolerance were administered when necessary.
Monitoring included a portable device for measuring pressure (arterial, central venous, pulmonary arterial and intracranial when necessary), pulse oximetry, and respiratory rate. A standard package of airway management equipment, a resuscitation bag adapted to the patient, defibrillator, and a suction device were also carried along. Emergency drugs were taken along as recommended [9]. The mechanically ventilated patients were accompanied by a transport team composed of a resident and a nurse. The resident is the junior physician directly involved in the daily care of the patient. All residents receive specific training regarding IHT when they start their 6-month training period in the ICU.
The total time including the establishment of regular monitoring and ventilation was regarded as the transport time. If patients were previously on mechanical ventilation, this would be maintained during transport by a gas-powered portable ventilator (Osiris 2, Air Liquid Medical Systems). Respiratory rate, positive end-expiratory pressure (PEEP) and tidal volume during transport were set to the same adjustments as were used in the ICU, with the exception of the inspired oxygen fraction (FiO2), where only "air mix" (FiO2= 60%) and "no air mix" positions (FiO2 = 100%) could be chosen. If nitric oxide therapy was required and had to be continued during transport, the necessary equipment would be taken along.
For each transport, a case report form would be prospectively filled in. It consisted of two parts: one for patients' clinical characteristics, and the other for IHT characteristics and mishaps. All mishaps were noted for all IHT, regardless of whether or not an intervention was necessary. Mishaps during transport are categorized as patient-based or system-based mishaps. Patient-based mishaps refer to physiological deterioration related to critical illness and defined as significant changes in physiologic variables: oxygen desaturation (pulse oximetry (SpO2) <95% or >5% decrease in SpO2 for more than 1 minute), severe hypotension (systolic blood pressure inferior to 90 mmHg or 20 mmHg decrease in systolic or diastolic blood pressure for more than 1 minute), arrhythmia, cardiac arrest, increased vasopressor dose, agitation and vomiting. System-based mishaps may be further subdivided into 2 groups: human-based and equipment- based mishaps. Human-based mishaps include accidental pulling out of nasogastric tube, peripheral venous catheter incident (accidental dislodgment, disconnection), central venous catheter incident (disconnection, removal or thrombosis), arterial line incident (disconnection, removal or thrombosis), accidental dislodging of urinary catheter, disconnection of end tracheal tube, accidental extubation, disconnection of chest tube and accidental disconnection of intracranial pressure monitoring. Incidents with airway equipment (transport ventilator malfunction, or problems with oxygen supply), battery supply problems with the monitor or with infusion pumps were considered as equipment-based mishaps [4-6,10]. Emergency transports were defined as transport required because of the immediate need for diagnostic or therapeutic intervention. Fluid challenge was defined by 500 ml of crystalloid or colloid administration.
Patients were excluded if the data collection document was missing or inadequately completed or if all demographics and baseline parameters were not recorded in the medical chart.

Data analysis

Statistical analysis was performed using SPSS 20.0 statistical software. Quantitative values were expressed as means and standard deviations. Qualitative data were expressed as values and percentages and compared with Chi-square test. For discrete numerical values, such as positive end-expiratory pressure (PEEP) level and number of infusion pumps, the optimal threshold value was determined by Receiver Operating Characteristic curve (ROC curve). Risk factors for mishaps IHT were tested first by a univariate analysis. Those with a significance level of $p < 0.1$ were included in a logistic regression with Wald method analysis as independent variables. Results were reported as odds ratios (OR), 95% confidence interval. Tests were two-tailed, with $p < 0.05$ being considered significant.

RESULTS

During the inclusion period, 180 patients were hospitalized in our ICU, for whom 212 IHT were carried out. We recorded and analyzed 184 IHT of 164 patients because data in sixteen patients were inadequately completed. General characteristics of patients and transports are summarized in Table 1.

Table 1: Global characteristics of patients and transports

	Mean ± SD [e]	Absolute values (%)
Age (years)	54± 16	
Males		110 (67)
APACHE II[a] at admission	17±5	
Main reason for ICU admission		
Septic shock		44(26.8)
Other etiologies of shock		24(14.6)
CAP[b]		22(13.4)
Exacerbations of COPD [c]		30(18.3)
Coma		18(11)
Trauma		26(15.9)
Length of stay in ICU[đ] (days)	29±8	
Spontaneous breathing		34(20.7)
Ventilatory support		130(79.3)
Ventilator-associated Pneumonia		67(40.8)
Mortality in ICU		44(26.8)
Transport type		
Emergency transports		84(45.7)
Planned transports		100(54.3)
Transport For		
Diagnostic procedure		143(77.7)
Therapeutic procedure		41(22.2)
Destination		
Computed Tomography Scan		99(53.8)
Magnetic resonance imaging		15(9.8)
Operating room		27(14.7)
UGE [f] or Colonoscopy		29(15.5)
Hyperbaric Oxygen Therapy		14(6.2)
Mishaps		85(46.2)
Patient-based mishaps		82 (44.5)
Systems-based mishaps		73 (39.6)

[a]APACHE II: Acute Physiology And Chronic Health Evaluation; [b] CAP: Community-Acquired Pneumonia; [c] COPD: chronic obstructive pulmonary disease; [đ] ICU: intensive care unit; [e] SD: standard deviation; [f] UGE: Upper Gastrointestinal Endoscopy.

A total of 148 patients underwent only one IHT during their hospitalization in ICU, 12 patients underwent two transports and 4 patients underwent three transports. Patients data before and during IHT are shown in Table 2.

One or more mishaps occurred in 85 IHT (46.2%) (Table 3). Eighty two mishaps were patient-related (44.5%). Oxygen desaturation (30 cases), agitation (24 cases) and hemodynamic instability (15 cases) were predominantly observed. A case of cardiac arrest, and 2 cases of arrhythmia, occurred during IHT. Seventy three system-based mishaps were noted (39.6%). Aiming to examine which parameters before transport could predict mishaps during IHT, we performed a univariate and a multivariate analysis including all collected data considered as potential risk factors.

The optimal threshold value determined by ROC curve was 6 for PEEP level (sensibility = 0.62, specificity = 0.84) and 3 for a number of infusion pumps (sensibility = 0.42, specificity = 0.93).

In univariate analysis, mishaps during IHT were associated with the type of transport, particularly emergency transports, ventilatory support, sedation before transport, PEEP ≥ 6 cmH2O, use of more than 3 infusion pumps, and the fluid challenge for transport. In multivariate analysis, the increasing risk of complications was associated with the type of transport, particularly emergency transports, ventilatory support, sedation before transport and PEEP ≥ 6 cmH2O (Table 4).

Table 2 : Characteristics ofpatients before and during IHT

All intrahospital transports (n = 184)	Absolute values (%)	Mean ± SD [đ]
Characteristics of patients before IHT[a]		
Endotracheal tube	117(63.5)	
Tracheotomy	22(12)	
Central venouscatheter	151(82)	
Arterial line	77(41.8)	
Nasogastric tube	75(40.7)	
Urinarycatheter	182(98.9)	
Chest tube	9(4.9)	
Inhalednitricoxide	6(3.2)	
Ventilatory mode before IHT		
VAC[b]	92(50)	
PS[c]	54(29.4)	
FiO2[e] before IHT (%)		40±10
PEEP [f] before IHT (cmH2O)		4±2
Treatments before IHT		
Sedation	124(67.3)	
Neuromuscular blockers	20(10.8)	
Vasoactive drug therapy	82(44.5)	
Characteristics of patients during IHT		
Duration of transport (min)		68±47
Number of infusion pumps		2±1
Ventilatory mode during transport		
VAC	105(57.1)	
PS	41(22.3)	
Ventilatory mode change for transport	13(7.1)	
PEEP during IHT (cmH2O)		4±2
Treatment modification for transport		
Change of PEEP for transport	12(6.5)	
Neuromuscular blocker use for transport	12(6.5)	
Fluid challenge for transport	10(5.4)	
Vasoactive drug therapy for transport	1 (0.5)	
Sedation for transport	18(9.7)	

[a] IHT :intrahospital transport; [b] VAC :volume assist–control; [c] PS Pressure support; [đ] SD : standard deviation ; [e] FiO2 : fraction of inspired oxygen; [f] PEEP : positive end-expiratory pressure

Regarding patient-based mishaps during IHT, we counted 82 (44.5% of IHT) events. With univariate analysis, risk factors for these mishaps were; the type of transport, particularly emergency transports, PEEP ≥ 6 cmH2O, the use of more than 3 infusion pumps, and the fluid challenge for transport. With respect to multivariate analysis, only the type of transport, particularly emergency transports (OR=0.18[0.03-0.94]; p = 0.040) and PEEP ≥ 6 cmH2O (OR = 0.14 [0.02-0.75]; p = 0.020) was found to be significant. Regarding hemodynamic instability, we counted 15 cases (8.1%) requiring increased vasopressor doses in 4 cases (2.1%), the introduction of vasopressor support (norepinephrine) in one cases (0.5%), and fluid challenge in 10 cases

(5.4%). Concerning system-based mishaps during transport, we recorded 73 (39.6%) events of which 27 (14.6%) were cases of human-based mishaps and 46 (25%) were cases of equipment-based mishaps.

In univariate analysis, system-based mishaps during IHT were associated with: the type of transport, particularly emergency transports, ventilatory support, volume assist–control as ventilatory mode before IHT, PEEP ≥ 6 cmH2O, the use of more than 3 infusion pumps, and the neuromuscular blocker use for transport. In multivariate analysis, only ventilatory support (OR = 0.08 [0.01-0.34]; p = 0.001), PEEP ≥ 6 cmH2O (OR =0.13 [0.02-0.75]; p = 0.023) and the use of more than 3 infusion pumps (OR =0.10 [0.20-0.53]; p = 0.020) were found to be significant. Severity score (APACHE II at admission) and age were not found to predict any kind of complications during transport. Compared with patients without mishaps during IHT, for those patients with mishaps, there was no increased incidence of ventilator-associated pneumonia (OR =1.61 [0.24-2.92] p=0.410).

Table 3 : Complications during transport

All intrahospital transports (n = 184)	**Absolute values (%)**
Transports with mishaps	85 (46.2)
Patient-basedmishaps during transport	82(44.5)
Oxygen desaturation	30 (16.3)
Hemodynamic instability	15 (8.1)
Arrhythmia,	2 (1)
Cardiac Arrest	1 (0.5)
Increased vasopressor dose	4 (2.1)
Agitation	24(13)
Vomiting	6 (3.2)
Systems-based mishapsduring transport	73(39.6)
Human-based mishaps	27(14.6)
Extubation	3 (1.6)
Accidental nasogastric tube pull out	1 (0.5)
Arterial line incident	1 (0.5)
Central venous catheter incident	3(1.6)
Peripheral venous catheter incident	2 (1)
Disconnection of endotracheal tube and airway equipment	4 (2.2)
Accidental dislodging of urinary catheter	10 (5.4)
Accidental dislodging of chest Tube	1 (0.5)
Accidentaldisconnection of ICPM[a]	2 (1)
Equipment-based mishaps	46 (25)
Incident with airway equipment (alarm)	20 (10.5)
Incident with infusion pumps (battery, alarm)	12 (6.5)
Incident with monitor (battery, alarm)	14(7.6)

[a] ICPM : Intracranial pressure monitoring

DISCUSSION

We analyzed 184 intra hospital transports of 164 ICU patients. The rate of mishaps was 46.2%. The incidence and the severity of mishaps vary according to studies from 6% to as high as 70% [5-8].

Defining mishaps is the most important confounding factor. In our study, we followed the most common definitions of mishaps [4]. When the definition of mishaps is restricted to clinically significant events such as changes in vital signs, unplanned extubations, or cardiac arrest, the adverse event rates reported have been as high as 8% [5,11,12].

Only three published series are larger: Lahner studied a cohort of 452 IHT of adults and children, the overall rate of critical incidents was low (4.2%) [7], Kue reported in a retrospective study of 3,358 IHT a few rate of mishaps (1.7%) [8]. But in the two studies only very serious patient complications were recorded. Recently Decrucq published a cohort of 262 IHT [13] and showed that mishaps occurred during 45.8% of IHT. In this last study authors followed the most common definitions of complications based on the recommendations published in 2010 [4]. In our study we have adopted the same definition and we found a similar result (46.2%).

Our high incidence of complications may be explained by the lack of a specific protocol for managing IHT in our ICU and the exhaustive recording of complications (including “line, tube, and drain” incidents). Many are preventable through proper preparation [14].

Patient-based mishaps during transport represented the majority of incidents, but mishaps with an impact on the patient still occurred in 30.5% of IHT, which is similar to the literature data (17-33% of transports) [7,13,15].

Our series included three accidental extubation and two arrhythmia during IHT, like other studies [6,10,15]. In addition, cardiac arrest ranges from 0.34% to 1.6% in the different studies [6,10,15]. In our study, it was 0.5%.

Risk factors for complications were the type of transport, particularly emergency transports, ventilatory support, sedation before transport and PEEP ≥ 6 cmH2O.

The concept of a careful equipment check and patients’ stabilization before transport has led to a lower incidence of physiologic deteriorations, as reported by Runcie et al. in the setting of interhospital transports [16].However, long-lasting stabilization before transport might not be feasible in emergency situations. This could explain the significant increase of complications in emergency transports in our case. Interestingly, Smith et al. found the opposite in a smaller investigation of 125 transports [11] and Lovell et al. did not observe any difference in the incidence of complications between emergency and elective transfers [12]. In our study, a significantly higher risk for mishaps was identified with artificially ventilated patients. This risk factor has been identified in some studies [7] but not in others [13]. Equipment-based mishaps during transport were significantly higher for artificially ventilated patients. This can be explained by the use of second generation respirators, recently introduced in our ICU as transport teams have never been familiar with the equipment used and could not anticipate potential problems with these devices.

High PEEP is a known risk factor in the literature [6,7,10,13,15,17].

Table 4 : Risk factors of mishaps during IHT.

Risk factors	Univariate analysis OR [95% CI] [f]	p	Multivariate analysis OR [95% CI]	p
Ventilatory support	5.20 [2.39-11.3]	0.001*	3.37[1.05-10.83]	0.041*
Emergency transports	36.3 [15.5-58.6]	<0.001*	2.28[2.62-8.69]	0.048*
Ventilatory mode before IHT[a]				
VAC[b]	1.26 [0.69-2.30]	0.444		
PS[c]	1.73 [0.86-3.46]	0.117		
FiO2[d] before IHT ≥ 60%	1.56 [0.74-1.94]	0.681		
PEEP[e] before IHT ≥ 6 cmH2O	35.6 [15.3-84.5]	<0.001*	7.65 [1.35-43.4]	0.021*
Treatments before transport	2.61 [1.38-4.94]	0.003*	2.66[1.02 -6.99]	0.045*
Sedation	0.84 [0.32-2.17]	0.724		
Neuromuscular blockers use	0.95 [0.53-1.80]	0.965		
Vasoactive drug therapy				
More than 3 infusion pumps for transport	1.14 [5.14-23.1]	0.019*	2.4 [0.33-17.36]	0.386
Ventilatory mode change for transport	0.45 [0.14-1.40]	0.113		
Change of PEEP for transport	0.53 [0.25-1.84]	0.203		
Treatment modification for transport	1.24 [0.54-3.63]	0.598		
Sedation for transport	0.88 [0.32-2.34]	0.818		
Neuromuscular blocker use for transport	0.95 [1.20-2.34]	0.087	0.26 [0.04-1.68]	0.155
Fluid challenge for transport	0.61 [0.54-0.69]	0.014*		

[a] IHT :intrahospital transport; [b]VAC :volume assist–control; [c] PS : Pressure support
[d] FiO2 : fraction of inspired oxygen; [e] PEEP : positive end-expiratory pressure
[f]OR : odds ratio and CI : confidence interval; * significance values

The optimal threshold value determined by ROC curve was 6 for PEEP level, so in our study patients with PEEP ≥ 6 cmH2O are said to carry a higher risk of mishaps during IHT.

The number of infusion pumps was predictive of mishaps during IHT in univariate but not in multivariate analysis, which was also shown in other studies (13,18). But the use of more than three infusion pumps was significantly associated with equipment-based mishaps during transport. This fact should lead us to limit the number of infusion pumps during transport in our protocol. Mishaps during transport were not significantly associated with a higher risk of ventilator-associated pneumonia, perhaps because of the small number of patients included in our study. This result differs from that of the study conducted by Bercault, in which the risk of ventilator-associated pneumonia was associated with IHT [19]. However, this association is particularly difficult to interpret because patients, who require IHT, have been shown to be much worse and to have a longer ICU and hospital length of stay, which are well-known risk factors of ventilator-associated pneumonia [20,21].

According to Link et al. [22], when a dedicated transport team was involved, major mishaps such as intracranial hypertension, significant changes in blood pressure, and accidental extubations were eliminated. Kue et al. [8] in a recently conducted study also showed that the rate of clinically significant mishaps during patients transport by a specialized team is relatively low. Further studies are needed to compare the effectiveness and mortality benefits between intra hospital transport teams and traditional transport teams. Since our study was designed to have the same number of personnel on all transports, (the resident directly involved in the daily care of the patient and a nurse) it would be impossible to examine that possibility in this study.

In our study, we have not found that mishaps during IHT entailed consequences for ICU length of stay.

Our study has had a direct impact on our practices. It allowed us to identify most common mishaps and to focus on the fact that adapted IHT equipment and comprehensive training programs for all personnel involved are crucial for ensuring a correct anticipation and management of risk factors

CONCLUSION

Despite its single-centre feature, this study confirms that IHT is a procedure at risk of complications. Emergency transports, mechanical ventilation with PEEP ≥ 6 cmH2O and sedation were independent risk factors for a higher rate of mishaps. The decision to undertake a « road trip » for necessary diagnostic testing or operative intervention requires an analysis of the risk of transport, such as that reported in the present study. The risk-to-benefit analysis must also consider the risk of the procedure itself, as well as the potential benefit from diagnosis or therapy. Our study emphasizes the importance of developing in each ICU a standardized procedure for the management of IHT. In this context, we are performing a prospective study to evaluate the impact of implementation of a reproducible protocol for IHT on the occurrence of complications during IHT in our ICU. We hope that with the use of appropriate equipments, standardized protocol and well- trained personnel the expected benefits exceed the risks of transportation.

Competing interests: The author(s) declare that they have no competing interests.

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References

1. Marques A. Avoiding harm during intra- and inter-hospital transport. In Patient Safety and Quality of Care in Intensive Care Medecine. Edited by Chiche JD, Moreno R, Putensen C, Rhodes A, Chiche JD, Moreno R, Putensen C, Rhodes A. Berlin: MedizinischWissenschaftlicheVerlagsgesellschaft2009:405–418.
2. Quenot JP, Milési C, Cravoisy A, Capellier G, Mimoz O, Fourcade O.Intrahospital transport of criticallyill patients (excludingnewborns) recommendations of the Société de Réanimation de Langue Française (SRLF), the Société Française d'Anesthésie et de Réanimation (SFAR), and the Société Française de Médecine d'Urgence (SFMU).Ann Intensive Care 2012 ;2:1.
3. Australasian College for Emergency Medicine, Australian and New Zealand College of Anaesthetists; Joint Faculty of Intensive Care Medicine. Minimum standards for intrahospital transport of critically ill patients. Emerg Med (Fremantle) 2003; 15:202–204.
4. Fanara B, Manzon C, Barbot O, Desmettre T, Capellier G. Recommendations for the intra-hospital transport of critically ill patients. Crit Care 2010 ;14: R87.
5. WaydhasC. Intrahospital transport of critically ill patients. Crit Care Med1999; 3:83–89.
6. Beckmann U, Gillies DM, Berenholtz SM, Wu AW, Pronovost P. 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. Intensive Care Med 2004;30:1579–1585.
7. Lahner D, Nikolic A, Marhofer P, Koinig H, Germann P, WeinstablC.Incidence of complications in intrahospital transport of critically ill patients–experience in an Austrian university hospital. Wien Klinochenschr 2007 ;119:412–416.
8. Kue R, Brown P, Ness C, ScheulenJ .Adverse clinical events during intrahospital transport by a specialized team: a preliminary report. Am J Crit Care 2011;20:153–161.
9. Warren J, Fromm RE , Orr RA, Rotello LC, Horst HM.Guidelines for the inter- and intrahospital transport of critically ill patients. Crit Care Med 2004;32: 256–262.
10. Damm C, Vandelet P, Petit J, Richard JC, Veber B, BonmarchandG .Complications during the intrahospital transport in critically ill patients. Ann Fr AnesthReanim 2005;24:24–30.
11. Smith I, Fleming S, CernaianuA . Mishaps during transport from the intensive care unit. Crit Care Med1990;18:278–281.
12. Lovell MA, Mudaliar MY, KlinebergPL.Intrahospital transport of critically ill patients: complications and difficulties.Anaesth Intensive Care 2001;29:400–405.
13. Decrucq EP, Julien P, Raphaël F, Saad N, Thierry O,Guerry MJ. Adverse events during intrahospital transport of critically ill patients: incidence and risk factors. Annals of Intensive Care 2013;3:10.
14. Needham DM, Sinopoli DJ, Thompson DA, Holzmueller CG, Dorman T, Lubomski LH .A system factors analysis of "line, tube, and drain" incidents in the intensive care unit. Crit Care Med2005;33:1701–1707.
15. Papson JPN, Russell KL, Taylor DM .Unexpected events during the intrahospital transport of critically ill patients. AcadEmerg Med2007; 14:574–577.
16. Runcie CJ, Reeve WR, Wallace PGM. Preparation of the critically ill for interhospital transfer. Anaesthesia1992 ;47: 327–331.
17. Gillman L, Leslie G, Williams T, Fawcett K, Bell R, McGibbonV.Adverse events experienced while transferring the critically ill patient from the emergency department to the intensive care unit. Emerg Med J2006; 23:858–861.
18. Doring BL, Kerr ME, Lovasik DA, Thayer T.Factors that contribute to complications during intrahospital transport of the critically ill. J NeurosciNurs 1999; 31:80–86.
19. Bercault N, Wolf M, Runge I, Fleury J-C, BoulainT. Intrahospital transport of critically ill ventilated patients: a risk factor for ventilator-associated pneumonia–a matched cohort study. Crit Care Med2005; 33:2471–2478.
20. Fan E, MacDonald RD, Adhikari NKJ, Scales DC, Wax RS, Stewart TE .Outcomes of interfacility critical care adult patient transport: a systematic review. Crit Care2006; 10 :R6.
21. Voigt LP, Pastores SM, Raoof ND, Thaler HT, Halpern NA . Review of a large clinical series: intrahospital transport of critically ill patients: outcomes, timing, and patterns. Intensive Care Med2009; 24:108–115.
22. Link J, Krause H, Wagner W .Intrahospital transport of critically ill patients. Crit Care Med1990; 18:1427-1429.