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Original Contribution

Prediction of en-route complications during interfacility transport by outcome predictive scores in ED

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ABSTRACT

Objective: The objective was to determine the accuracy of the outcome predictive scores (Modified Early Warning Score [MEWS]; Hypotension, Low Oxygen Saturation, Low Temperature, Abnormal ECG, Loss of Independence [HOTEL] score; and Simple Clinical Score [SCS]) in predicting en-route complications during interfacility transport (IFT) in emergency department.
Design: This was a retrospective cohort study.
Methods: All IFT cases by ambulances with either nurse-led or physician-led escort, occurring between 1 January 2011 and 31 December 2012, were included. Obstetric and pediatric cases (age < 18 years) were excluded. The condition of patients was quantified by using the predictive scores (MEWS, HOTEL, and SCS) at triage station and on ambulance departure. The accuracy of predictive scores was compared by the receiver operating characteristic (ROC) curves.
Results: A total of 659 cases were included. Seventeen cases had en-route complications (2.6%). The complication rate in physician-escorted transport (2.2%) was similar to that in nurse-escorted transport (2.6%). None of the 57 intubated cases had en-route complications. The area under the ROC curve for MEWS was 0.662 (triage) and 0.479 (departure). The accuracy of MEWS at triage was better than that at departure ($P = .049$). The area under the ROC curve for HOTEL was 0.613 (triage) and 0.597 (departure), and that for SCS was 0.6 (triage) and 0.568 (departure). In general, the predictive scores at triage were better than those on departure.
Conclusion: None of the scores had good accuracy in prediction of en-route complications during IFT. MEWS at triage was among the best one already but was not ideal.

1. Introduction

The demand for interfacility transport (IFT) is increasing because of regionalization of health care system in recent years. The decision to transfer is complex and depends on many factors including the capabilities of the presenting hospital, capacity at the receiving hospital, and financial and geographic factors. Most transfers are initiated because of condition-specific recommendations such as care for patients with major trauma, stroke, or acute myocardial infarction, conditions in which the patient requires a higher level of care or specialized service not available in the current hospital, and unavailability of beds [1,2].

Interfacility transport is not without risk. The transport is initiated when the benefits to the patient outweigh the risks of the transport. These risks include clinical deterioration, limited resource availability during transfer, transportation risks, time delay in time-sensitive care, poor communication between facilities, inexperienced personnel, and neglect of patient's preferences [1]. A recent study found that the complication rate of land-based IFT was 6.5% [5]. To minimize the transportation risks, it is important to anticipate the potential en-route complications so as to arrange suitable accompanying personnel and equipment to optimize patients' outcomes. In this situation, an effective clinical predictive scoring system is needed.

There are numerous predictive scoring systems developed in previous studies for risk stratification and outcome prediction of emergency patients, for example, the Modified Early Warning Score (MEWS); Hypotension, Low Oxygen Saturation, Low Temperature, Abnormal ECG, Loss of Independence (HOTEL) score; Simple Clinical Score (SCS); Simplified Therapeutic Intervention Scoring System (TISS-28); Acute Physiology and Chronic Health Evaluation Score; Simplified Acute Physiology Score; and Risk Score for Transport Patients. However, these scores were designed for risk stratification of patients in the setting of the emergency department (ED) and in-patient and critical care unit, and the outcomes predicted were mortality or surrogate outcomes of in-hospital deterioration. There is no dedicated predictive

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score for determination of en-route complications during IFT [6]. This study evaluated MEWS, HOTEL, and SCS in predicting en-route complications during IFT departed from the ED.

2. Methods

2.1. Study design and setting

This is a retrospective cohort study. We compared the accuracy of various clinical predictive scoring systems based on bedside clinical parameters and chronic health status on predicting en-route complications during IFT in ED.

The study took place in the Accident & Emergency Department of Pok Oi Hospital (POH) in Hong Kong. In 2012, POH was a 392-bed local hospital in the New Territories West Cluster of Hong Kong, which served a population of more than a million. The ED had an annual attendance of 129,814 patients in 2012. It provided clinical services including 24-hour emergency service, acute medical service, as well as the Combined Coronary and Intensive Care Unit, which provided critical care and emergency cardiac care, except for those who needed surgical interventions or pediatric patients. There was no emergency obstetric, gynecological, and surgical service in POH. In this cluster, the emergency operations are provided in Tuen Mun Hospital, which is a referral center with support of various specialties. Surgical patients are initially stabilized and transferred to Tuen Mun Hospital for further care. All mental patients who require admission would be admitted to the local short-stay ward for psychiatric assessment without primary transport.

For those patients who require IFT, the escort personnel could be paramedics (ambulance crew), a nurse, or the attending emergency physician. There were local departmental recommendations on the escort personnel. All patients with artificial airways and those hemodynamically unstable or critically ill with life-sustaining devices would require a physician to escort. All obstetric cases in active labor, unless a nurse with midwifery skills is available, would require the attending physician to escort to labor ward. Those cases which were considered to have a higher risk of complication or required nursing care would be escorted by nurses. All transports were carried out on ground by ambulances.

2.2. Data collection

All IFT cases with either nurse-led or physician-led escort that departed from the ED between 1 January 2011 and 31 December 2012 were included. Eligible cases were retrieved from the local interfacility transfer registry which included all interhospital transfer data. Obstetric and pediatric cases (age < 18 years) were excluded. All included cases were transported by ambulances. Those patients who had been admitted to wards in local hospital before secondary transport were excluded.

Information collected included demographic data, physiological status, preexisting disease, chronic health condition, and en-route physiological deterioration. Vital signs, including blood pressure, heart rate, respiratory rate, consciousness level and Glasgow Coma Scale (GCS), at both triage and just before departure from ED were retrieved. Relevant variables of premorbid conditions and the information about the present illness, which were components of the scores, were retrieved and presented. These included whether the patient was intoxicated, whether the patient was a trauma victim, the ambulatory status, a nursing home resident, history of diabetes, present illness of new-onset stroke, abnormal ECG results, and breathlessness on presentation. *Abnormal ECG result* was defined as any ECG abnormalities that were identified by the algorithm of the ECG machine, excluding simple sinus bradycardia and tachycardia. *New-onset stroke* was defined as new-onset focal neurological symptoms together with the provisional diagnosis of stroke by the attending physician (Table 1).

The condition of the patient was quantified by calculating the predictive scores with initial vital signs at triage station and the vital signs after ED resuscitation and treatment just before ambulance departure (Table 2). The data handling and score calculation were performed by an independent data analyst who was blinded to patients' outcome. A modified SCS was adopted in the study, with exclusion of the item "Prior to current illness, spent some part of daytime in bed" because it appeared irrelevant to the prediction of en-route complications. En-route clinical status was recorded by escort personnel on a specially designed IFT form in a prospective manner.

Table 1
Definition of en-route deterioration

Definitions
Physiological deterioration
Respiratory arrest or cardiac arrest
Desaturation (Spo_2 drop ≥5% or Spo_2 < 90%)
Systolic hypotension
Cardiac arrhythmia
Bradyarrhythmia (<50/min)
Tachyarrhythmia (>140/min)
Neurological deterioration (drop in GCS ≥3 except intubated)
Hypothermia (<35°C)

2.3. Definition of en-route deterioration

En-route deterioration was defined according to the previous study by Kanter et al, as follows: (1) respiratory arrest or cardiac arrest, (2) desaturation (Spo_2 drop ≥5% or Spo_2 <90%), (3) systolic hypotension, (4). cardiac arrhythmia (pulse <50/min or >140/min), (5) neurological deterioration (drop in GCS ≥3 except intubated), and (6) hypothermia (<35°C) [2,3,4] (Table 1).

2.4. Statistical analysis

The statistical software adopted was IBM SPSS Statistics for Windows, Version 22.0 (IBM Corp, Armonk, NY). Continuous data were expressed as means and standard deviation with comparisons performed by independent-sample t test. Categorical variables were expressed as frequencies and percentages. Parameters were compared between the group with en-route complications and without complications by Fisher exact test or χ^2 test where appropriate. Boxplots were created to illustrate the difference in 3 scores in complicated vs uncomplicated cases and for the scores calculated from vital signs in triage vs at ambulance departure.

The comparison of accuracy of predictive scores was assessed by receiver operating characteristics (ROC) curves. The true-positive rate was plotted against the false-positive rate with nonparametric method, and the area under the curve (AUC) was calculated along with its 95% confidence interval (CI). By comparing the AUC of different scoring systems based on vital signs at triage and at departure, discriminatory capacities of these scores on predicting en-route complications could be evaluated. The level of significance was set at 5%.

The study was exempted from ethical approval because it was a retrospective study with no impact on patient management.

3. Results

During the study period, 659 cases were included. The mean age was 59.8 years. Ninety-one (13.8%) cases were physician led, whereas 568 (86.2%) cases were nurse led. Endotracheal intubation was performed in 57 (8.6%) cases. Among the 659 cases, 17 (2.6%) cases had en-route complications. The complication rate in physician-led transport (2.2%) was similar to that in nurse-led transport (2.6%). All intubated cases had no en-route complications during transport. Physiological characteristics at triage and at departure showed no significant difference between cases with en-route complications and uncomplicated cases, except that the mean diastolic blood pressure at triage was significantly different (complicated case, 56 ± 5 mm Hg; uncomplicated case, 80 ±