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Clinical paper

Prehospital Trauma Life Support (PHTLS) training of ambulance caregivers and impact on survival of trauma victims☆

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ABSTRACT

Background: The Prehospital Trauma Life Support (PHTLS) course has been widely implemented and approximately half a million prehospital caregivers in over 50 countries have taken this course. Still, the effect on injury outcome remains to be established. The objective of this study was to investigate the association between PHTLS training of ambulance crew members and the mortality in trauma patients.
Methods: A population-based observational study of 2830 injured patients, who either died or were hospitalized for more than 24 h, was performed during gradual implementation of PHTLS in Uppsala County in Sweden between 1998 and 2004. Prehospital patient records were linked to hospital-discharge records, cause-of-death records, and information on PHTLS training and the educational level of ambulance crews. The main outcome measure was death, on scene or in hospital.
Results: Adjusting for multiple potential confounders, PHTLS training appeared to be associated with a reduction in mortality, but the precision of this estimate was poor (odds ratio, 0.71; 95% confidence interval, 0.42–1.19). The mortality risk was 4.7% (36/763) without PHTLS training and 4.5% (94/2067) with PHTLS training. The predicted absolute risk reduction is estimated to correspond to 0.5 lives saved annually per 100,000 population with PHTLS fully implemented.
Conclusions: PHTLS training of ambulance crew members may be associated with reduced mortality in trauma patients, but the precision in this estimate was low due to the overall low mortality. While there may be a relative risk reduction, the predicted absolute risk reduction in this population was low.

1. Introduction

Trauma is the leading cause of death among persons below 60 years of age.[1] It is a well-established belief that optimal treatment in the early phase after trauma has a major impact on mortality.[2] Therefore, over the years, raising the educational level among prehospital caregivers and the implementation of specific educational programs that target trauma care have been two widely adopted strategies aimed at improving the outcome for trauma victims. This strategy has high face validity, but the underlying evidence is poor.[3]

In the late 1970s, the American College of Surgeons Committee on Trauma developed the Advanced Trauma Life Support (ATLS) course for physicians.[4,5] Although implemented worldwide, there is still no strong evidence that ATLS lowers mortality in trauma victims.[6,7] According to a recent study, ATLS-training might even impair outcome.[8] The Prehospital Trauma Life Support (PHTLS) program was introduced in 1983 to integrate prehospital trauma care with the ATLS program.[9] PHTLS has been recognized as one of the leading educational programs for prehospital emergency trauma care and approximately half a million prehospital caregivers in over 50 countries have taken this course.[9] However, the scientific support for improved patient outcome is limited, and there is no evidence to recommend advanced life-support (ALS) training for ambulance crews.[10–12] Substantial effort and money are put into the PHTLS training program and

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there is an obvious need to evaluate the possible benefits for patients.

The aim of this study was to investigate the association between PHTLS training of ambulance crew members and the outcome in trauma patients.

2. Methods

2.1. Source population

Uppsala County is an administrative region for health care in Sweden, with a population of 302,564 and a population density of 43 inhabitants/km^2 in 2004. There are two hospitals in the county; Uppsala University Hospital, a 1100-bed tertiary care facility, and Enköping Hospital, a small local hospital handling only minor trauma.

2.2. Emergency Medical Service (EMS)-system

The ambulance staff consisted of registered nurses and emergency medical technician (EMT) equivalents (nursing assistants with special ambulance training). During the study period the number of registered nurses employed as ambulance crew members increased rapidly. Prior to and during the study period all ambulance crew members were, as part of their regular skill practice, annually trained and authorized to provide ALS in medical emergencies and trauma, with the exception of endotracheal intubation (only performed in cardiac arrest) and chest drainage.

2.3. Study population

All primary incident hospital admissions for injury in the county of Uppsala from 1998 through 2004 were extracted from the Swedish National Patient Registry (NPR).[13] Injury deaths, where the underlying cause of death was V01-Y36 according to ICD-10,[14] were extracted from the Cause of Death Registry (CDR). These codes include all external causes of injury except those referring to "Complications of medical and surgical care", "Sequelae of external causes of morbidity and mortality", and "Supplementary factors related to causes of morbidity and mortality classified elsewhere". These datasets were combined using the unique personal identification number for person-based linkage.[15] Admissions resulting in a hospital stay of one day or less and discharge alive were excluded to reduce the number of minor injuries included.[16] Dispatch information, prehospital time intervals, medical information, and the identity of the ambulance crew members were added from prehospital electronic patient records.[17] For each individual ambulance crew member the following information was collected: years of employment in health care services and in ambulance services; the date for exam as a registered nurse and the date for PHTLS training. The final dataset consisted of 2830 injury events with complete data (Fig. 1). The study was approved by the regional Human Ethics Committee.

2.4. Exposure

The PHTLS program is a standardized curriculum for prehospital caregivers. The core component is a 16-h course with a mixture of lectures and interactive skill stations.[18] If at least one ambulance crew member was PHTLS certified (had passed the final examination in PHTLS), the injured patient was considered exposed. Exposure status was not dependent on whether the certified crew member was in charge of the crew or not. The time elapsed since PHTLS certification was considered in a sensitivity analysis. No refresher courses were performed during the study period.

There were no major changes in the standard of pre-hospital trauma care or equipment used during the study period. All ambulance crew members in the organisation were trained and authorized to perform trauma care according to international standard treatment, except from endotracheal intubation. A PHTLS certification did not change the authorization to use any equipment or perform any specific intervention.

2.5. Outcome

Prehospital injury deaths were defined as autopsied injury deaths not associated with a hospital admission.[19] Only prehospital deaths with documented involvement of ambulance services were included. Hospital death was defined as death during a hospital stay with a principal discharge diagnosis indicating injury. The composite outcome of either prehospital or hospital death was studied.

2.6. Possible confounders

The International Classification of disease Injury Severity Score (ICISS) was calculated based on diagnosis-specific survival probabilities for individual injury ICD-10 codes.[20–22] For descriptive purposes, ICISS was categorized as critical (0–0.219), severe (0.220–0.354), serious (0.355–0.664), moderate (0.665–0.940), or minor (0.941–1.0). Injury severity estimates based on the Revised Trauma Score (RTS) were also available.[23]

Each victim's injuries were categorized according to the injury mortality diagnosis matrix for ICD-10.[24] Five categories of major injury regions (head, spinal cord, thorax, abdomen, and pelvis) were defined from the matrix.

Causes of injury were classified according to the matrix developed by the National Center for Health Statistics, Centers for Disease Control, USA.[25] Data was collapsed to three categories: traffic injuries, falls, and other injuries.

The basic educational level (nurse or EMT equivalent) and employment time of the ambulance crew members were also considered as potential confounders. Exposure status was determined from the highest educational level and the longest work experience in the ambulance crew. To account for a possible period effect (such as changes in trauma care over time during the study period), the calendar year of the injury was included in the multivariable models. The patients' age and sex were also considered as potential confounders.

2.7. Statistics

Multivariable logistic regression analysis was used to model the composite outcome of prehospital or hospital death using all the possible confounders described above. Collinearity was assessed from variance inflation factors. Both age and calendar year of injury were entered as linear effects in the models based on inspection of a logit plot of each variable. ICISS was used after logit transformation.[26] Effect-measure modification was evaluated by including product terms between the exposure variable and injury severity (ICISS) and year, respectively. The multivariable logistic regression model was also used to calculate the predicted mortality for each injury event. The difference in mean predicted mortality between the PHTLS group and the non-PHTLS group estimated the absolute risk reduction.

Population-averaged models using generalized estimation equations (GEE) were used to handle correlations from ambulance crews appearing multiple times in the dataset and patients appearing multiple times in the study population.[27,28] The number of lives potentially saved annually was estimated by the proportion of eligible patients corresponding to the estimated absolute risk