Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.JournalofSurgicalResearch.com

The outcome of trauma patients with do-not-resuscitate orders

Kazuhide Matsushima, MD,[a,b,*] *Eric W. Schaefer, MS,*[c] *Eugene J. Won, MD,*[a] *and Scott B. Armen, MD*[a]

[a] *Department of Surgery, Penn State Milton S. Hershey Medical Center, Hershey, Pennsylvania*
[b] *Division of Acute Care Surgery, Department of Surgery, University of Southern California, Los Angeles, California*
[c] *Department of Public Health Sciences, Penn State Milton S. Hershey Medical Center, Hershey, Pennsylvania*

ARTICLE INFO

Article history:
Received 8 August 2015
Received in revised form
29 August 2015
Accepted 18 September 2015
Available online 28 September 2015

Keywords:
Do-not-resuscitate
Level 1 *versus* level 2
Trauma center
Outcome

ABSTRACT

Background: Institutional variation in outcome of patients with do-not-resuscitate (DNR) orders has not been well described in the setting of trauma. The purpose of this study was to assess the impact of trauma center designation on outcome of patients with DNR orders.
Materials and methods: A statewide trauma database (Pennsylvania Trauma Outcome Study) was used for the analysis. Characteristics of patients with DNR orders were compared between state-designated level 1 and 2 trauma centers. Inhospital mortality and major complication rates were compared using hierarchical logistic regression models that included a random effect for trauma centers. We adjusted for a number of potential confounders and allowed for nonlinearity in injury severity score and age in these models.
Results: A total of 106,291 patients (14 level 1 and 11 level 2 trauma centers) were identified in the Pennsylvania Trauma Outcome Study database between 2007 and 2011. We included 5953 patients with DNR orders (5.6%). Although more severely injured patients with comorbid disease were made DNR in level 1 trauma centers, trauma center designation level was not a significant factor for inhospital mortality of patients with DNR orders (odds ratio, 1.33; 95% confidence interval, 0.81–2.18; $P = 0.26$). Level 1 trauma centers were significantly associated with a higher rate of major complications (odds ratio, 1.75; 95% confidence interval, 1.11–2.75; $P = 0.016$).
Conclusions: Inhospital mortality of patients with DNR orders was not significantly associated with trauma designation level after adjusting for case mix. More aggressive treatment or other unknown factors may have resulted in a significantly higher complication rate at level 1 trauma centers.

This article was presented at the 72th Annual Meeting of the American Association for the Surgery of Trauma and Clinical Congress of Acute Care Surgery, San Francisco, California, September 18, 2013.

This study was performed at Penn State Hershey Medical Center. K.M. currently works for University of Southern California.

* *Corresponding author*. 2051 Marengo Street, Inpatient Tower, Rm C5L100, Los Angeles, CA 90033. Tel.: +1 323 409 8597; fax: +1 323 441 9907.

E-mail address: mkazu45@gmail.com (K. Matsushima).

0022-4804/$ – see front matter © 2016 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.jss.2015.09.024

1. Introduction

As the population ages, many people are presently admitted to the hospital with advance directives. Patients and families are more commonly involved in making decisions about cardiopulmonary resuscitation during their hospital stay [1,2]. An increasing number of institutions have implemented a protocol to facilitate an end-of-life care discussion with patients and their families in the intensive care unit (ICU) [3,4]. Although do-not-resuscitate (DNR) orders are often placed for acute trauma patients, and especially for the elderly, significant institutional variability in the rates of DNR orders has been described in previous literature [5]. Furthermore, scarce data are currently available regarding the disparity in the outcome of trauma patients with DNR orders.

Trauma centers in the United States are ranked mainly based on available resources and yearly patient volume [6]. Although inhospital mortality of patients admitted to designated trauma centers is significantly lower compared with patients admitted to nontrauma centers, it remains controversial whether there is any difference in patient outcomes between different tiers of trauma centers, that is, level 1 *versus* level 2 trauma centers [7–10]. Of note, these studies have not adjusted for patients' DNR status in their outcome analyses. Because of considerable variation in the outcome of patients with DNR orders, it has been reported that the method to handle DNR status could significantly impact the outcomes of major medical disorders [11,12].

Our goal in the present study was to compare the outcomes of trauma patients with DNR orders between level 1 and level 2 trauma centers. We sought to test our hypothesis that patients with DNR orders would be managed more aggressively at level 1 trauma centers. Thus, the inhospital mortality would be significantly lower but major complications would be more frequently seen at level 1 trauma centers than level 2 trauma centers.

2. Materials and methods

After approval by the Institutional Review Board of the Penn State Milton S. Hershey Medical Center, we conducted a retrospective study using the Pennsylvania Trauma Outcome Study (PTOS) database. The PTOS database is a statewide trauma registry in the commonwealth of Pennsylvania maintained by the Pennsylvania Trauma Systems Foundation. The PTOS registry includes trauma patients who meet one of the following criteria: (1) hospital stay >48 h, (2) transfer from another institution, (3) admission to the ICU, and (4) inhospital mortality [13]. Patients with isolated hip fracture, asphyxia, drowning, and hyperthermia and/or hypothermia are excluded. In this study, we included patients aged ≥16 y at state-designated level 1 or level 2 trauma centers. Subsequently, we identified patients for whom DNR orders were placed during the hospital stay.

Our primary outcome for this study was the inhospital mortality rate. A secondary outcome was the major complication rate. Major complications included acute respiratory distress syndrome, acute respiratory failure, pneumonia, aspiration and/or aspiration pneumonia, pulmonary embolism, fat embolus syndrome, myocardial infarction, acute renal failure, sepsis, septicemia, gastrointestinal bleeding, postoperative hemorrhage, liver failure, progression of original neurologic insult, small-bowel obstruction, empyema, acute arterial occlusion, dehiscence and/or evisceration, central nervous system infection, and extremity compartment syndrome [14].

We used multilevel logistic regression to model each outcome by level of trauma center after adjusting for a number of potential confounders. Multilevel logistic regression is an extension of regular logistic regression that accounts for correlation among patients treated at the same trauma center using a random effect for each center. We included this random effect in all models. The models also included the following variables: age, sex, race (white *versus* other), year of admission, injury severity score (ISS), mechanism of injury (accidental falls, motor vehicle accidents, other blunt injury, and penetrating injury), type of insurance (Medicare, Medicaid, commercial, self insured, and other), transfer status, admission systolic blood pressure <90 mm Hg, Glasgow coma scale (≤8, 9–12, and 13–15), and preexisting conditions. We used natural splines with 3° of freedom to allow for nonlinear relationships of ISS and age with outcomes [15]. Linearity was assumed reasonable for year of admission. All other variables were categorical. Based on exploratory plots and analyses, we evaluated an interaction between ISS and trauma level in all models. We retained the interaction term only when significant. We reported odds ratios (ORs) and 95% confidence intervals (CIs) for all variables. For the nonlinear effects of ISS and age, we reported ORs for the 75th *versus* 25th percentile.

3. Results

We queried the Pennsylvania Trauma Systems Foundation for the PTOS data from 2007–2011. A total of 106,291 patients were admitted to 25 level 1 or level 2 trauma centers. Of those, 1233 patients with missing DNR status were excluded. Of the remaining 105,058 patients, 72,790 patients were treated in level 1 centers (69.3%) and 32,268 patients were treated in level 2 centers (30.7%). DNR orders were placed for 5953 patients (5.7%) during their hospital stay, with 3864 patients with DNR orders in level 1 centers compared with 2089 patients with DNR orders in level 2 centers (5.3% *versus* 6.5%; $P < 0.001$). Age was an important confounder because level 2 centers treated a larger number of older patients (median age of 54; 20.6% were aged ≥80 y) than level 1 centers (median age of 50; 17.2% were aged ≥80 y). In a multilevel logistic regression model that included trauma level and age, the level of trauma center was not a significant factor for DNR status (OR, 0.93; 95% CI, 0.67–1.30; $P = 0.68$). Patients with DNR orders were more likely to have a major complication (19.2% *versus* 5.9%, $P < 0.001$). DNR status was significantly associated with a higher number of major complications.

Patient demographics and severity of injury stratified by trauma level for patients with DNR orders are listed in Table 1. DNR patients in both level 1 and level 2 trauma centers were