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Methocarbamol use is associated with decreased hospital length of stay in trauma patients with closed rib fractures

Asad E. Patanwala [a, *], Ohoud Aljuhani [a], Brian J. Kopp [b], Brian L. Erstad [a]

[a] Department of Pharmacy Practice & Science, College of Pharmacy, The University of Arizona, Tucson, AZ, USA
[b] Department of Pharmacy Services, Banner University Medical Center, Tucson, AZ, USA

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ABSTRACT

Background: The objective of this study was to evaluate the effect of methocarbamol on hospital length of stay in patients with closed rib fracture injuries.
Methods: This was a retrospective cohort study conducted in an academic medical center in the United States. Adult trauma patients, who sustained closed rib fractures, were included. Patients were categorized based on whether they received methocarbamol or not during admission. The primary outcome of interest was time to hospital discharge in days (i.e. length of hospital stay). A Cox Proportional Hazards Model was constructed to determine if methocarbamol use was associated with a greater likelihood of earlier discharge.
Results: A total of 592 patients were included in the final study cohort. Of these, 329 received methocarbamol and 263 did not receive methocarbamol. In the Cox Proportional Hazards Model methocarbamol use was associated with a greater likelihood of being discharged from the hospital (HR 1.47, 95% CI 1.21 to 1.78, $p < 0.001$). .
Conclusions: The use of methocarbamol after traumatic rib fractures may result in a reduction in the length of hospital stay.

1. Introduction

Patients with rib fractures often have prolonged pain and disability after injury.[1] The intensity of pain in the acute post-injury period is predictive of the development of chronic pain.[1] Although opioids are recommended first line for severe pain, multimodal therapy is suggested after injury, especially during the period when pain intensity is highest.[2] Multimodal therapy involves the use combinations of analgesics from different classes, or which have different mechanisms to target multiple pain pathways. This has been shown to optimize pain control in the perioperative setting.[2] In patients with rib fractures, it is theorized that spasm of the adjacent intercostal muscles contributes to pain.[3] This in turn has the potential to depress breathing, result in pneumonia, complicate post-injury care, and lead to an increased duration of hospital stay.[4] Thus skeletal muscle relaxants may have a role as part of a multimodal regimen by decreasing intercostal muscle spasm, leading to improved outcomes such as reducing complications (e.g. pneumonia) and duration of hospitalization. However, there is a gap in the literature regarding the routine use of muscle relaxants in this setting.

Methocarbamol is a central nervous system depressant that causes muscle relaxation and has previously been evaluated in the trauma population.[5] In this aforementioned study, patients with various types of traumatic injuries were given methocarbamol for acute pain as part of a multimodal regimen. Patients who received methocarbamol did not have better pain control or improved outcomes such as a reduction in hospitalization. However, this was a heterogeneous population and it is possible that only certain subsets of patients may benefit such as those with rib fractures. Patients with rib fractures have intercostal muscle spasm, and thus may be more likely to benefit from a medication that causes muscle relaxation. Other studies in non-trauma patients have also evaluated the effect of single preoperative doses of methocarbamol on

* Corresponding author.
E-mail addresses: patanwala@pharmacy.arizona.edu (A.E. Patanwala), aljuhani@pharmacy.arizona.edu (O. Aljuhani), Brian.Kopp@bannerhealth.com (B.J. Kopp), erstad@pharmacy.arizona.edu (B.L. Erstad).

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post-operative pain.[6,7] In these studies methocarbamol use was associated with diminished post-operative pain and opioid consumption, suggesting that it may have a role for perioperative care when muscle spasm is a concern. At our institution, methocarbamol is commonly used for patients after rib fractures, which enabled us to evaluate its effect in the current investigation. At this time there are no studies of methocarbamol use in trauma patients with rib fractures.

The objective of this study was to evaluate the effect of methocarbamol on hospital length of stay in patients with closed rib fracture injuries. We hypothesized that patients who received methocarbamol would have a decreased time to hospital discharge. The secondary objective was to compare the rates of pulmonary complications occurring during hospitalization. We hypothesized that patients who received methocarbamol would be less likely to have pulmonary complications during their recovery.

2. Material and methods

2.1. Study design and setting

This was a retrospective cohort study conducted in an urban academic medical center in the United States. The institution is designated as a level 1 trauma center by the American College of Surgeons. The hospital does not have a protocol in place specifically for the management of patients with rib fractures. Thus medication selection is based on provider preference. The Institutional Review Board that maintains oversight of the hospital approved the study prior to data acquisition.

2.2. Patient selection

An electronic hospital administrative database (University HealthSystem Consortium Clinical Database Resource Manager) was used to obtain the patient cohort of interest at our institution. This database has been previously validated for accuracy.[8] The database was queried for patients admitted between April 1st, 2014 and December 31st, 2015. This represented the full range of dates for which data were available. All adult trauma patients (age $\geq$18 years) with closed rib fracture injuries were included. Patients with closed rib fractures were identified based on International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) diagnoses codes. The following codes were used to identify patients with rib fractures: 807.0, 807.00, 807.01, 807.02, 807.03, 807.04, 807.05, 807.06, 807.07, 807.08, and 807.09.

2.3. Study variables and measurements

The following variables were considered to be relevant to the study: age, sex, race, ethnicity, need for endotracheal intubation, need for blood component transfusion, need for chest tube, in-hospital mortality, discharge status, hospital length of stay, ICD-9-CM diagnosis codes, Charlson Comorbidity Index (index of comorbid conditions calculated as a sum of pre-specified conditions),[9] Injury Severity Score (range from 0 to 75; higher value indicating greater overall severity of injury), and Abbreviated Injury Severity for the chest region (chest AIS) and head region (Head AIS) (range from 0 to 6; higher value indicating greater injury).[10] Severe head injury was defined as a Head AIS of >3, similar to a previous investigation.[11] Injury severity scores were derived from ICD-9-CM codes similar to the Agency for Healthcare Research and Quality, which has been validated as an accurate predictor of survival.[6,12] The ICDPIC package in STATA 13 was used to derive Injury Severity Scores (body regions and total). Patients were categorized based on whether they received oral methocarbamol during hospital admission or not. Data regarding methocarbamol obtained were dose per day and number of days of treatment. The secondary outcome was pulmonary complications. This was defined as occurrence of any one of the following: bacterial pneumonia (481, 482 [482.0–482.9], 483 [483.0, 483.1, 483.8]), ventilator associated pneumonia (997.31), atelectasis (518.0), or aspiration pneumonia (measured as a complication in the database thus ICD-9-CM code was not needed).

2.4. Outcomes and data analysis

The primary outcome of interest was time to hospital discharge in days (i.e. length of hospital stay). This variable was right censored if patients were transferred to another hospital or died during hospitalization. Kaplan Meier curves were compared between the methocarbamol and no methocarbamol groups using the log-rank test. A Cox Proportional Hazards Model was constructed to determine if methocarbamol use was associated with a greater likelihood of discharge after adjusting for pertinent confounders. The intent was not to develop a parsimonious or a predictive model, but rather to adjust for potential confounding. The following confounders were considered to be pertinent based on our clinical experience and were added to the model: age, sex, race/ethnicity, need for endotracheal intubation, need for blood component transfusion, need for chest tube, Charlson Comorbidity Index, Injury Severity Score, and Abbreviated Injury Severity for the chest region, and severe head injury (injury severity variables were ICD9 derived). We tested for interactions between injury severity and methocarbamol because it is possible that the effect of methocarbamol may be more effective with higher severity of injury. To minimize the potential for selection bias, a propensity score analysis was conducted by calculating propensity scores using all available covariates. The effect of methocarbamol on the primary outcome was then evaluated after adjusting for this propensity score. The proportional hazards assumption was tested using the time-dependent covariate method. The goodness-of-fit of the model was assessed by Cox-Snell residuals. Influential observations were identified visually by likelihood displacement values. A sensitivity analysis was conducted by excluding influential observations to determine if it changed the results.

Categorical variables, including our secondary outcomes were compared between the methocarbamol and no methocarbamol group using the Fisher's exact test. Normally distributed continuous variables were compared between the two groups using an unpaired student's t-test. Non-normally distributed continuous variables were compared using the Wilcoxon rank-sum test. If there were missing values in <5% of a variable than is was replaced with the most common value for categorical variables. There were no missing data in continuous variables and the only variable with some missing data was race. This was in <5% of the sample.

It was estimated that using a hazard ratio of 1.5 (increased likelihood of discharge home in the methocarbamol group), standard deviation of 0.5, probability of failure of 80%, alpha of 0.05, and power of 80%, a total of 239 patients would be required in the study (approximately 120 in each group). All analyses were conducted using STATA 13 (College Station, Texas) and a two-tailed alpha of 0.05 was considered to be statistically significant.

3. Results

3.1. Study cohort

There were 613 patients overall who had closed rib fractures