American Journal of Emergency Medicine 34 (2016) 980–984

Contents lists available at ScienceDirect

American Journal of Emergency Medicine

journal homepage: www.elsevier.com/locate/ajem

Original Contribution

Impact of an emergency medicine pharmacist on antibiotic dosing adjustment☆,☆☆

Kyle M. DeWitt, PharmD [a], Steven J. Weiss, MD [b], Shannon Rankin, PharmD [a], Amy Ernst, MD [b], Preeyaporn Sarangarm, PharmD [a]

[a] Departments of Pharmacy, University of New, Mexico, Albuquerque, NM
[b] Department of Emergency Medicine, University of New, Mexico, Albuquerque, NM

ARTICLE INFO

Article history:
Received 26 November 2015
Received in revised form 1 February 2016
Accepted 10 February 2016

ABSTRACT

Objective: Overall medication-related errors in the emergency department (ED) are 13.5 times more likely to occur in the absence of an emergency medicine pharmacist (EMP). Although the effectiveness of pharmacist-driven renal dosing adjustment has been studied in the intensive care unit, data are lacking in the ED setting. The aim of our study was to evaluate the appropriateness of antibiotic dosing when an EMP is physically present in the ED compared to when absent.

Methods: This was a retrospective cohort study of patients treated in a level I trauma center with 75 adult and 12 pediatric beds and an annual census of 90 000 patients. The study period was from March 1 to September 30, 2014. An EMP was physically present in the ED from 11:00 to 01:30 and absent from 01:31 to 10:59. Male and female patients 18 years and older were considered for inclusion if cefazolin, cefepime, ciprofloxacin, piperacillin-tazobactam, or vancomycin was ordered. The primary outcome was the composite rate of correct antibiotic dose and frequency. Statistics included a multivariable logistic regression using age, sex, presence of EMP, and creatinine clearance as independent predictors of correct antibiotic use.

Results: A total 210 cases were randomly chosen for evaluation, half during times when EMPs were present and half when they were absent. There were 130 males (62%) with an overall mean age of 54 ± 18 years. Overall, 178 (85%) of 210 of the antibiotic orders were appropriate, with 95% appropriate when an EMP was present compared to 74% when an EMP was absent (odds ratio, 6.9; 95% confidence interval, 2.5-18.8). In a logistic regression model, antibiotic appropriateness was independently associated with the presence of the EMP and creatinine clearance.

Conclusion: Antibiotics that require renal and/or weight dosing adjustment are 6.5 times more likely to be appropriate in the ED when an EMP is present. Prevalence of antibiotic dosing error is related to both the presence of EMPs and the degree of renal impairment.

1. Introduction

The role of the pharmacist within the emergency department (ED) was first documented in the 1970s and has since transitioned from basic inventory management to the provision of comprehensive clinical services [1]. Emergency medicine pharmacist (EMP) participation in cardiac arrest and trauma resuscitations, therapeutic formulary interchanges, provision of drug information responses, and dosing of medications is attributed with improving economic, humanistic, and clinical outcomes [2]. Thus, the American Society of Health-Systems Pharmacists supports further clarification of the issue of hospital pharmacy department providing ED with the pharmacy services that are necessary for safe and effective patient care [3].

Frequent interruptions, in combination with the often overcrowded and fast-paced environment of the ED, make this setting prone to medication errors [4]. With an estimated 129.8 million patients treated in EDs annually, it is crucial that these errors be minimized to prevent further patient harm and unnecessary health care costs [5]. In a previous study, medication-related errors were 13.5 times less likely to occur when a pharmacist was present in the ED. This difference in errors represented significant issues such as medications given but not ordered, mediations ordered and not given, incorrect rate of administration, and late administration of medications [6].

The effectiveness of pharmacist-driven renal dosing adjustment has been previously evaluated in intensive care units; however, on the subject of renal dosing, there is a paucity of literature within the ED setting [7,8]. To our knowledge, this study is the first to quantify the impact

☆ The authors report no conflicts of interest in this study.
☆☆ KD conceived the study, designed the trial, and obtained the data. SW managed the data, provided statistical advice, and analyzed the data. KD, SR, PS, AE, and SW provided oversight to the study design and data collection and drafted the manuscript. All authors contributed substantially to its revision. KD takes responsibility for the manuscript as a whole.

http://dx.doi.org/10.1016/j.ajem.2016.02.004
0735-6757/

of a clinical pharmacist on optimization of antibiotic dosage adjustment within the ED. The aim of our study is to evaluate the appropriateness of antibiotic dosing which requires renal and/or weight adjustment when a pharmacist is physically present in the ED compared to when absent. Our hypothesis was that the presence of EMPs led to more appropriate antibiotic renal/weight dosing adjustment.

2. Methods

2.1. Study design and setting

We conducted a retrospective cohort study of patients treated in an academic level I trauma center with 75 adult and 12 pediatric bed over a 7-month period from March 1 to September 30, 2014. The hospital has residencies in all major fields that rotate through the ED, a program for mid-level providers and is a certified stroke center. Emergency medicine pharmacists were physically present in the ED from 11:00 to 01:30 and responsible for prospective verification of all antibiotic orders. When absent (01:31-10:59), antibiotic orders were verified remotely by a pharmacist located outside the ED. The ED has an annual census of approximately 90 000 patients. Computerized physician order entry was used during the study period and had been in use for approximately 4 years at the time of study initiation. All medications ordered through computerized physician order entry require verification by a pharmacist but are not automatically verified at the time of use. Nurses may override the verification function and obtain medications from automatic dispensing systems before pharmacist review.

2.2. Patient selection

Before the initiation of the study, a retrospective evaluation over the previous 3-month period of all antibiotics used in our ED was used to identify the most commonly ordered antibiotics which required renal and/or weight adjustment. Cefazolin, cefepime, ciprofloxacin, piperacillin-tazobactam, and vancomycin were selected based on the frequency of orders. Male and female patients 18 years and older were considered for inclusion if any of these antibiotics were ordered during the study period. Patients were excluded if younger than 18 years, pregnant, incarcerated, missing data required for calculation of creatinine clearance (CrCl), or the antibiotic was ordered as a take home prescription for outpatient use. In addition, patients were excluded if they received “once then discontinue” orders, with the exception of vancomycin due to the high occurrence of loading doses ordered within the ED. Random selection was done using izmm.com/random.pl which was accessed on February 1st, 2015, to provide a random table of patients for inclusion.

2.3. Methods of measurement

The study compared appropriateness of antibiotic dose adjustments for decreased renal function and/or weight between times when an EMP was present in the ED vs times when orders were verified remotely by a pharmacist located outside the ED. Height, weight, and serum creatinine (SCr) values available at the time of order validation were used to assess appropriateness of antibiotic dosage and frequency of administration. For the purpose of this study, all creatinine clearance values were calculated using the standard Cockroft-Gault formula: $\mathrm{CrCL\ (mL/min)} = [(140 - \mathrm{age}) \times \mathrm{IBW}]/(\mathrm{SCr} \times 72)$ ($\times$ 0.85 if female). Serum creatinine was rounded up to 1 mg/dL if an individual was 65 years of age or older per institutional protocol. Ideal body weight (IBW) was used for calculation of CrCl unless an individual's total body weight (TBW) was less than IBW. In this circumstance, TBW was used. An adjusted body weight was used for the calculation of CrCl and vancomycin dosing for individuals with a TBW greater than 130% of IBW. An institutional renal dosing protocol allows pharmacists to automatically adjust the dosage and frequency of several medications, including the antibiotics within this study, for patients with renal impairment without physician approval.

2.4. Outcome measures

The primary outcome was the rate of correct antibiotic dose and frequency for the presumed diagnosis compared when an EMP is present in the ED vs when absent. *Appropriateness* was defined as compliance with institutional renal dosing guidelines. Secondary outcomes included the percentage of appropriate orders stratified by antibiotic agent and incidence of errors related to dose, frequency, or both. In addition, the investigators evaluated if an EMP's presence had the potential to improve the time to antibiotic order verification and time to administration.

Investigation review board approval was obtained from the University of New Mexico Health Sciences Center before initiation of the study.

2.5. Data collection and processing

2.5.1. Data collected

Data were extracted from Cerner PharmNet and Cerner PowerChart and included age, race, sex, height, weight, SCr, time SCr was obtained, antibiotic dosage and frequency verified, presumed indication for antibiotic use, time antibiotic was ordered by physician, time order was verified by a pharmacist, and time antibiotic was administered to the patient. Cerner Power Chart will calculate glomerular filtration rate, and most providers are aware; however, the calculated value may differ from true CrCl as the program does not round SCr up to 1 mg/dL for elderly patients. Prepopulated antibiotic orders exist but fail to incorporate loading doses, individual patient weight, or CrCl. Therefore, traditional standardized orders such as vancomycin 1 g every 12 hours may precipitate dosing error if not ordered carefully.

2.5.2. Data analysis

Continuous data were analyzed using a 2-tailed Student *t* test. Statistical analyses of discrete variables were performed by the χ^2 test. Factors associated with appropriate dosage adjustment were evaluated via a multivariable logistic regression using appropriateness of antibiotic dosing (both frequency and dose) as the main outcome variable. A priori, it was decided to include age, sex, presence of the EMP, and creatinine clearance as predictor variables. A Hosmer-Lemeshow statistic was used to determine goodness of fit.

An a priori power analysis was performed assuming a prevalence of medication errors based on a prior study in ED in which there was a greater than 20% difference in groups based on the presence of ED pharmacists [6]. Assuming 80% power to detect a difference of 20% between the 2 study groups in percentage of appropriate orders, approximately 85 patients were required to be enrolled in each arm for a total inclusion of 170 patients.

3. Results

There were a total of 3163 of the selected antibiotic orders verified within the 7-month study period. Of 500 randomly selected orders considered for inclusion, 105 orders were verified when an EMP was absent from ED and met inclusion criteria. Orders verified when an EMP was present were then considered for inclusion from remainder of the 500 orders until a total of 105 met inclusion criteria. Eighty-five orders were excluded based on exclusion criteria leaving a total of 415. Of these, 105 were from times when EMPs were absent. To match the groups, 105 of the orders verified when an EMP was present were randomly selected for inclusion to match sample sizes between study arms (Figure).

Both groups were compared on demographics. There were a total of 130 males (62%) and 80 females (38%); more males were included in the EMP present group (72 [69%] vs 58 [55%]; odds ratio [OR], 1.8; 95%