



Evaluation of Parenteral Electrolyte Solution Utilization and Fluid Therapy in Surgical Department of Imam Reza, Mashhad, Iran

Mitra Momken¹, Amirhooshang Mohammadpour^{1,2}, Haniye Elahifard³, Atlas Haddadi Avva³, Behnaz Rohani³, Farideh Rezaei⁴, FatemehNazemian¹, Sepideh Elyasi^{1*}

¹Department of Clinical Pharmacy, School of Pharmacy, Mashhad University of Medical Sciences, Mashhad, Iran

²Pharmaceutical Research Center, Mashhad University of Medical Sciences, Mashhad, Iran

³Student Research Committee, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran

⁴ Student Research Committee, School of Pharmacy, Mashhad University of Medical Sciences, Mashhad, Iran

Received: 2018-09-12, Revised: 2018-11-20, Accept: 2018-11-24, Published: 2018-12-01

ARTICLE INFO

Article type:

Original article

Keywords:

Fluid Therapy;
Medication Errors;
Surgery;
Drug Use Evaluation

ABSTRACT

Background: Intravenous fluid therapy is frequently used for hospitalized patients but it is overused in many cases. This can lead to economic burden in addition to complications. Few studies have investigated fluid therapy cost-related errors. Drug Use Evaluation (DUE) can be used to evaluate these errors. The aim of our research is to evaluate fluid therapy errors in surgery ward of Imam Reza Hospital, Mashhad, Iran.

Methods: During this cross-sectional study, patients selected by simple randomization method from surgical ward of a teaching hospital in Mashhad, Iran. Intravenous fluid therapy information including indication, type, volume and rate of fluid administration was recorded for each patient. An internal protocol for intravenous fluid therapy was designed based on literature review and available recommendations by clinical pharmacists. The data related to patients' fluid therapy were compared with this protocol. Main outcome measure of this study was any mistake in the selection of fluid type, content, volume and rate of administration.

Results: One hundred patients were observed during study. Errors in the rate of fluid administration (85%), incorrect fluid volume calculation (83%) and incorrect type of fluid selection (1%) were the most common types of errors.

Conclusion: Our result showed that intravenous fluid therapy errors occurred commonly in the hospitalized patients especially in the medical wards. Improvement in knowledge and attention of health-care workers about these errors are essential for preventing of medication errors in aspect of fluid therapy.

J Pharm Care 2018; 6(3-4): 58-61.

► Please cite this paper as:

Momken M, Mohammadpour AH, Elahifard H, Haddadi Avva A, Rohani B, Rezaei F, Nazemian F, Elyasi S. Evaluation of Parenteral Electrolyte Solution Utilization and Fluid Therapy in Surgical Department of Imam Reza, Mashhad, Iran. J Pharm Care 2018; 6(3-4):58-61.

Introduction

Intravenous fluid therapy is an important treatment used for maintenance of the hospitalized patients' physiologic conditions (1). Errors commonly happen in intravenous fluid therapy and most common of them are incorrect volume calculation, type of fluid, rate and concentration (2). For instance, incorrect infusion rate was the most

happening error in a surgical ward of an Australian hospital (3). Drug Use Evaluation (DUE) is a method that evaluates the qualification, safety and effectiveness of a drug (4). In case of detecting errors, DUE is mostly used for either expensive or frequently used drugs. The costs of hospitalization for the inappropriate use of medications

*Corresponding Author: Dr Sepideh Elyasi,

Address: Department of Clinical Pharmacy, School of Pharmacy, Mashhad University of Medical Sciences, Mashhad91775-1365, Iran. Tel:+985131801588, Fax: +985131801592.

Email: Elyasis@mums.ac.ir

amounted to \$2 billion (5). In addition, More than 7000 deaths per year are attributable to medication errors which are responsible for an estimated \$3.5 billion in annual health care spending in the US (6).

Despite the importance of these errors, researchers have not paid enough attention to study them (7) and a search of the literature revealed that those few previous studies are mainly about the impact of fluid therapy errors in mortality, morbidity and other clinical complications (2,3). Additionally, there is no study conducted in east of Iran to obtain localized data.

We intended to evaluate fluid therapy in pre and post-operative hospitalized patients in surgery department of Imam Reza Hospital, Mashhad, Iran to determine whether it is based on evidence-based protocols or not.

Methods

In this cross-sectional study, we reviewed 100 patients' files collected from the surgical ward of Imam Reza Hospital affiliated to Mashhad University of Medical Sciences (MUMS), Mashhad, Iran from March 2015 to September 2016, as a pilot study. In September 2014, a consensus was reached in our center regarding the need to control cost of expensive medicines. So, the DUE center began to work in December 2014 by employing two pharmacists who worked under the supervision of two clinical pharmacists. It would have been better to evaluate all patients who received fluid therapy in this period of time, but it was not feasible since only two pharmacists worked on a part-time basis in DUE center. Moreover, the patients' records were only available as hard copy in wards. This study was approved by Mashhad University of Medical Sciences Ethics Committee. Participants were selected by simple randomization method. We classified patients with hepatic, renal, and heart failure and also patients with baseline electrolytes disturbances as complicated patients and we excluded them from our study populations,

A standard protocol on fluid therapy was designed by some clinical pharmacists based on some updated international consensus guidelines in literature that best matched such local conditions (8,9). A form for collection of fluid therapy data was also developed by the clinical pharmacists that included age, sex, type of surgery, weight, renal function status, the reason of electrolyte solution prescription, type and volume of solution, patients' hydration and nutrition condition, specialty of the physician, serum level of alanine aminotransferase (ALT) and aspartate aminotransferase (AST), glucose, total protein and creatinine, level of fluid input and output, serum electrolyte condition, central vein pressure and co-morbidity. Type, volume and rate of the administered

fluid and electrolytes were evaluated by using the information on files including medical history and laboratory test results. The medical records of patients who had been prescribed fluid therapy in surgical ward, were reviewed by two pharmacists working in DUE unit of hospital. The correctness of fluid type, volume, and rate of administration based on developed guideline were evaluated by pharmacists working in DUE unit. Finally, the percentages of errors and the significance of the difference between calculated and administered volumes were defined and reported by the clinical pharmacist based on collected data.

Data were analyzed by The Statistical Package for Social Sciences (SPSS) version 16. For descriptive assessment, mean \pm standard deviations of continuous variables and number (percentages) for nominal variables were provided. Normality of variables was determined by using Kolmogorov-Smirnov statistical test. Independent Samples T test was used for comparing the significant difference between the administered and calculated fluid volumes. P values less than 0.05 were considered as significant.

Results

One hundred patients admitted to the surgery ward were included in the study. The mean age of study participants was 52 ± 14 years. Male to female ratio was 55:45 while the mean weight was 60 ± 12 kg. In 99% of cases, the type of administered fluid was exactly based on the standard protocol, but the remaining 1% were given dextrose 5% instead of normal saline 0.9%. We detected 85% and 83% errors in administration rate and volume, respectively.

In the first day post-operation, the administered volume was significantly higher than the calculated one (2805 ± 738 ml vs. 1965 ± 633 ml, respectively. $P=0.001$). Table 1 shows the further breakdown of volume and rate quantities. This table illustrates that the difference between administered and calculated volume was significant in first 3 days after operation ($P=0.001$). Furthermore, a slightly significant difference was observed between the volumes in the 4th day post-operation ($P=0.06$). The rate for maintenance therapy based on the protocol was 1-2 ml/kg/h. The rate adjustment should be done depended on the dehydration severity. Administered rate for patients with no dehydration and the ones with mild dehydration was 1 ml/kg/h and it was 2 ml/kg/h for severely dehydrated patients. The rate of administration was approximately 2 times more than the calculated rate in post-operation while there was no significant difference in pre-operation ($P=0.001$ vs. 0.8, respectively). Further information about the calculated and administered parameters is summarized in Table 1.

Table 1. Administered and Calculated Amounts of Parameters Comparison

		Calculated Volume (ml) (mean±SD)	Administered Volume(ml) (mean±SD)	P Value* (Volume)	Calculated Rate(ml/kg/h)	Administered Rate(ml/kg/h)	P Value* (Rate)
Pre- operation		2193.00±1352.0	2358.00±1668.0	0.42	100.00	96.00±7.60	0.8
Post-operation (days)	1	1965.00±633.0	2805.00±738.0	0.001	1.00	2.00±0.68	0.001
	2	1937.00±617.0	2813.00±662.0	0.001	1.00	1.99±0.57	0.001
	3	1853.00±666.0	2807.00±607.0	0.001	1.00	2.00±0.50	0.001
	3	2782.00±606.0	2343.00±658.0	0.06	1.00	1.97±0.35	0.001

SD: Standard Deviation

*Data were collected with independent sample T test.

Discussion

We found that fluid therapy errors commonly happen in volume and rate in the surgical ward of this teaching hospital. Our study revealed that 85%, 83% and 1% of administrations had errors in rate, volume and type of fluid, respectively. As Han et al, (3) found in 2005, at least one error occurred in almost one fifth of continuous intravenous infusion administered to patients in an Australian hospital. This difference between results may be due to the different regions, since it seems that DUE is more used in developed countries including Australia than developing countries like Iran. Additionally, Mousavi et al., (2) studied 596 patients in 2008-2010 in Imam Khomeini Hospital Complex, Tehran, Iran. This study reported that 29.8%, 26.5% and 24.6% of errors exist in administration rate, volume and type of electrolyte, respectively. However, our results showed higher error occurrence. This can be resulted from the different sample sizes, time periods and hospital policies. Imam Khomeini is one of the first hospitals in Iran who had clinical pharmacists and medical care department that performed DUE and supervised consumption of expensive and critical medications. However, in our center there is a short time from the presence of clinical pharmacists and setting up DUE unit.

Considering available literature, one of the reasons of fluid therapy errors can be the absence of clinical pharmacists who can increase the awareness of the physician and staff about probable errors (1, 10). Furthermore, because of the high number of patients and busy inpatient care, the incidence of errors becomes higher (1). In addition, the physician may not be aware of the possible complications of extra fluid administration in long-term. Everyone affected by the DUE process should understand its importance to the health system, its goals and procedures. Holding educational meetings for the medical staff may be useful to reduce fluid and electrolyte improper use more efficiently.

Medication errors have not been studied adequately in developing countries including Iran (11). In terms of fluid therapy, the only study available is Mousavi et al., (2), who has only discussed the complications. Fluid therapy is inexpensive, but it causes a big economic burden because of the rife errors (12). As discussed in a review article, “fluid therapy is a complex area of care that has been rarely studied from a cost-effectiveness perspective” (13).

Our study suffered from a number of limitations. We were not able to reach the exact amount of extra cost because we did not have access to the complete data of fluid therapy expenses in the mentioned year. Moreover, we did not have access to the operation room, so we failed to evaluate administered fluid in the earliest moments after operation.

In conclusion, we proved that noticeable errors occur in the surgical ward of Imam Reza Hospital. Besides causing complications, these errors affect patient and health-care system costs. Consequently, reducing these errors can result in big positive changes in health-care system in several aspects such as better investments in health-related issues. For reducing these errors, holding training courses for interns, residents and nurse staff is recommended in order to increase their knowledge of errors in fluid therapy.

Further research should be undertaken to investigate the exact extra cost and cost-related harms through a prospective controlled study to prevent these limitations. Using rate control device and mentioning start and finish time of fluid administration in prescription is also recommended for accuracy. In addition, due to probable staff mistakes, the prescribed fluid should be compared with the administered fluid to determine whether a significant difference can be found or not.

Acknowledgments

This study is part of a research thesis for a Pharm.D. degree at Mashhad University of Medical Sciences.

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