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Usage of cardiotonic drugs at the intensive care units

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Abstract

Background: Circulation insufficiency is one of the most common dysfunctions in the patients admitted to the intensive care units (ICU) [1]. These patients need an intravenous (IV) vasoactive drug administration to optimize or support cardiovascular system (CVS). Emergency situations, hard work conditions, difficult devices' usage and a lot of other specific factors of complex environment of ICU create favorable conditions for the occurrence of medical errors (ME).

Material and methods: Within this prospective study were examined the methods of administration and the types of the errors that were found during the administration of the following drugs: epinephrine, noradrenaline, dopamine and dobuthamine. In the period of time May – September 2016, were examined 50 patients from ICUs from 4 different hospitals. The age limits were between 31-100 years old. The data collection was accomplished on the base of a questionnaire prepared beforehand.

Results: From all the number of examined patients, 33 (66%) were men and 17 (34%) – women. The body weight was indicated in the medical notes of 21 (42%) patients. To 15 (30%) of them was administrated the adrenaline, noradrenaline had the incidence in 15 patients (30%) and dopamine – 17 patients (34%).

Conclusions: Tracked dosage errors in 20% of cases, 4% of them were found at dilution administration of the drugs. The inscription of administered drug in medical notes was lacking in 2 uses.

Key words: cardiotonic medication, medication error, automatic syringe pump, dilution.

Introduction

Circulatory failure is one of the most common disorders in patients admitted to the intensive care units (ICU) [1]. These patients often need intravenous (IV) vasoactive drug administration to optimize or support the function of cardiovascular system (CVS).

Cardiac output together with the blood elements ensure the fundamental necessity of the tissues, that is adequate transport of oxygen to maintain their functionality. Sequelae or their functional decompensation may occur in vital organs with limited capacity to compensate the hypotensive flares (brain, heart, kidneys, etc.). Blood pressure (BP) management is one of the main tasks of intensivist physicians and a number of actions are used for this purpose. Removing of cause (eg. hemorrhage, combustion treatment etc.) is the first task which most often is done in teams with specialists in other fields. Another vital intervention is the fluid-responsiveness, which is performed with crystalloid solutions (sol. of NaCl 0.9%, Ringer's sol., etc.) or colloids (prepared from starch, gelatin, etc.). If the infusion therapy is inefficient and the cardiac output does not ensure the needs of tissues, cardiac drugs are chosen.

Cardioverter and vasoconstrictor preparations are frequently used in the ICU and resuscitation department in order to maintain a working blood pressure and satisfactory cardiac output in patients.

It is extremely important to dose those preparations with vigilance in critically ill patients, who typically have more concomitant diseases. Taking into account that the doses are expressed in mc/kg/min., they are extremely small, and serious or even lethal side effects may occur even in case of a minor dosage error. Emergency situations, the harsh working conditions, the use of sophisticated equipment and many other factors specific to the complex environment of the ICU create a favorable ground for medication errors (ME).

Health care system is not infallible. Errors are common in most of the health care system and are reported as the seventh most common cause of death [2].

In the ICU, on average, 1.7 errors per day refer to a patient [3] and all have a life-threatening potential. Medication errors represent 78% of serious medical errors in the ICU [4]. The most common ME have been identified at the nurse level, which is 19% of all adverse events and representing more than 7,000 deaths annually in the USA [5].

Besides that the patient's safety is endangered. It should be noted that ME, which have not resulted in death, but caused damages, required additional drug administration. Respectively, it increases directly or indirectly the cost and length of hospitalization. Epiphenomenally, the risk of other ME occurrence increases. Although not all ME result in damage and often remain unnoticed.

Material and methods

The method of administration and the types of errors we encountered during the administration of the following preparations: epinephrine, noradrenaline (norepinephrine), dopamine and dobutamine were researched during this prospective study.

Epinephrine, delivery form: adrenaline hydrotartat, 0.18% solution for injection in 1 ml ampoules. Indications: cardiac arrest, status asmaticus, heart failure, shock. Dose: 2 mcg/min bronchodilator effect, 2-10 mcg/min inotropic effect, more than 10 mcg/min vasopressor effect. Side effects: hypertension, tachycardia, arrhythmias, skin necrosis in case of perivenous administration, vasoconstriction on splanchnic vessels. Noradrenalin is a 0.2% solution for injection in 1 ml

Table 1

Indications according to the diagnosis

	Adrenaline	Noradrenaline	Dopamine	Dobutamine	Adrenaline +Dopamine	Noradrenaline + Dopamine
Sepsis (septic shock)	1	7	2	-	-	-
Massive surgeries	4	5	8	-	1	-
Massive injuries	7	1	4	-	-	1
Cardiogenic shock (heart failure)	1	2	3	-	-	1
Hemorrhages	2	-	-	-	-	-
Total	15	15	17	-	1	2

ampoules. By the chemical structure, it distinguishes from adrenaline by the lack of methyl group to the nitrogen atom of the amino group of the side chain. Indications: hypotensive states (sepsis, shock) mainly due to its predominant vasoconstrictor effect. Dose: 1-30 mcg/min produces vasoconstriction without significant change in cardiac output and heart rate. Side effects: bradycardia, arrhythmia, anxiety, headache, hypertension, necrosis in case of perivenous injection. Dopamine is a 4 mg solution for injection in 5 ml ampoules. Indications: heart failure, shock conditions (except hypovolemic shock). Dose: 2-10 mcg/kg/min inotropic action prevails, 10-20 mcg/kg/min vasopressor effect prevails. Side effects: hypertension, tachycardia, arrhythmias, skin necrosis in case of perivenous administration, vasoconstriction on splanchnic vessels. Dobutamine is a 0.5% solution for injections in 50 ml ampoules and 1.25% in 20 ml ampoules; freeze-dried powder for injection solutions in 0.25 and 0.53 g. By the chemical structure, it is a dopamine catecholamine and differs from dopamine by the fact that a hydrogen atom of the amino group is replaced by paraoxyphenylmethylpropyl radical. Indications: heart failure, inotropic effect, increasing the heart rate to a lesser extent than dopamine, decreases the ventricular filling pressure, it is preferred in the treatment of decompensated heart failure. The peripheral vascular resistance remains unchanged or falls slightly. Dose: 5-20 mcg/kg/min. Side effects: arrhythmias, hypertension, angina pectoris, phlebitis [6-7]. 50 patients were collected from the ICU, in the period May-September, 2016. The lower age limit was 31 years and the upper one – 100 years. Data collection from patients was based on a questionnaire drawn up in advance.

Results and discussion

From all the number of examined patients, 33 (66%) were men and 17 (34%) were women.

The body weight was indicated in the medical card of 21 (42%) patients. This fact indicates a potential medication error. This problem is caused by poor equipment in triage points, on the one hand, or by beds in specialized departments that are old and scales are not fitted in their construction.

Age limits were between 31-100 years.

According to the obtained results, we can see that the dose in patients, whose body weight was not indicated, was calculated empirically by the doctor. But most often the dose was corrected depending on changes in BP.

Cardiotonic medication was indicated in the following diagnoses: sepsis (or septic shock), massive surgeries, cardiogenic shock (heart failure), massive injuries and hemorrhages (tab. 1).

Statistical analysis of data

From the total number of patients, the adrenaline was administrated in 15 (30%) of them. In 9 (18%) of cases was indicated the amount of solute in the medical cards and in 6 (12%) of the cases was noted the dose. The way of administration was represented by 9 (18%) of the cases of administration by dilution and 6 (12%) of the cases of administration by automatic syringe pump. The recording of medication in the medical card did not correspond to the way of administration. Dosage errors were detected in three cases, two of which were administered by automatic syringe pump.

The administration of noradrenaline had an incidence in 15 patients (30%). The dose administration was noted in the medical card in 14 patients (28%). Of these, only one case (2%) represented the way of administration by dilution. Dosage error was attested in two cases. The drug administration was not indicated in the medical card in one patient.

The subjects who received permanent medication of dopamine represented a group of 17 patients (34%) and in 5 patients (10%) of these was noted the substance quantity in the volume of injection and in 12 patients (24%) was noted the dose of administration. The way of administration was dominated by the automatic syringe pump – 13 cases (26%). Dosage error was proven in five cases.

3 patients (6%) received combined medication, of which 2 patients were administered noradrenaline associated with dopamine, and one patient was administered adrenaline associated with dopamine. The dose of administration was noted in the medical cards in patients who received the combined medication (6%) of cardiotonic (tab. 2).

Unfortunately, we have not encountered patients receiving dobutamine during the study.

Variations in blood pressure (BP) and heart rate (HR) were

Table 2

Recording of drug in the medical card and administration type

	Adrenaline	Noradrenaline	Dopamine	Dobutamine	Adrenaline +Dopamine	Noradrenaline + Dopamine
Substance quantity	9	1	5	-	-	-
Dose (mcg/kg/min.)	6	14	12	-	1	2
Administration by dilution	9	1	4	-	-	-
Administration automatic syringe pump	6	14	13	-	1	2
Dose error	3	2	5	-	-	-

indicated in the medical card at a rate of 100%. This shows that these two values serve as landmarks at the administration of cardiotonics in emergency cases. This fact explains the incidence of cases when the drug administration (2%) was not noted in the medical card or the incorrect dose recording during the data collection (20%).

The nurse knows only the amount of solute and the infusion in proportion of 98%. This can be a source of errors even if the doctor performed correctly all procedure maneuvers.

Cardiotonic drugs were administered through the central catheter in a proportion of 98%, most often simultaneously with the secondary solution.

A label written by hand was attached in the absolute majority of studied cases, and the type of drug and quantity of administered substance were indicated on it.

A medical error becomes a medication incident only when the patient is harmed. Not all the incidents connected with the medication are caused by the medication errors. In an analysis of the 2000 anesthetic incidents, 7.2% were caused by the medication errors and not one of them was fatal [8].

Incorrect written prescription represents a frequent cause of medication errors. At a University hospital, from all the amount of the errors, 57% of them were mistakes or lapses, 39% - were the errors, caused by unconscious deviation from the rules and only 4% were conscious deviations from the rules. None of the involved staff could explain what had happened, although the main causes are: hurry, tiredness, interruption by somebody else, insufficient knowledge of the specific medication, confusion while watching another patient. Inexperienced doctors and unsupervised residents have the predisposition to make the clinical errors [9].

Medication transcription or some numeral dates are susceptible to errors. Doctors sometimes transcribe medication records. The error rate of the transcription is approximately 1%, but a third part of them could be fatal. The usage of computer systems in medical indications reduces this risk [10].

Dosage and incorrect rates, including unintentional bolus administration, are frequent errors found in intervenous administration [11].

Medication errors represent an important cause of patients' morbidity and mortality. Therefore, only 10% of the errors represent the RA and have severe consequences for the patients. The Institute of Medicines' rate from USA has shown that from 44 000 to 98 000 patients die annually as a consequence of ME and a significant part is caused by the drugs [12].

In ICUs the majority of the drugs are administered in perfusions based on the weight of the patient. Weight estimation and the dose calculation by math's searching increase the risk of the ME apparition. Because of that for the drug administration are often used difficult devices, but devices' defects could lead to drug administration with the wrong speed. We must be aware of the fact that the administration with the inappropriate speed such drugs as cardiotonics and anticoagulants can lead to some consequences with the lethal end [13].

Financial costs of adverse events, speaking about the additional treatment and additional hospitalization period, are considerable. One of the most consistent findings of reviews of registration is that, in average, a patient suffering an adverse event stays an additional six to eight days in the hospital. When the prices are established and the findings are extrapolated at the national level, the prices are reasonable.

Nurses play a very important role in patients' security, because these are the providers of the medical system, whom the patients spend the majority of time with. This fact has important implications. In case of decreasing the rate of nurse-patient, the staff rates could be associated with a high risk level of medical errors, the rates of 1:1 or 1: 2 seem to be the safest in ICU [14].

Strategies of the prevention

Incident Reporting System supports the necessity of an organizational commitment to improve general patient's safety, including the medication errors. The studies have discovered that the safety climate in a unit could predict the incidence of the ME. A more positive culture is associated with fewer errors [15].

The mechanisms suggested for the improvement of the results are various. The fear of adverse consequences can be major obstacle to the accurate reporting of errors, from 50% to 96% of them are unreported [16].

The usage of checklists is well-spread not only in ICUs, but at Emergency medicine, as well. The steadiness is caused by the low cost of the usage, easiness and high efficiency. Check-

lists have the role of the direction of the doctors for the successful actions that need quick and productive decisions in critical situations. Respectively is omitted a part of the ME that could be caused by the situations associated with a high stress rate.

The system of medical prescriptions is computerized. This system has the role to help and inform the doctor about the possible adverse reactions using the data base of the patient. In this base are available the results of all the investigations and medication got from the hospitalization.

Computer System presents all the general steps of the prescription and transcription of the drug [17].

The System of administration through a bar cod (SABC) is a system of the bar codes built to prevent ME and to improve the quality and safety of drug administration. General objectives of the SABC are to improve accuracy, prevent errors and generate online medication administration. It consists of Bar-Code reader, a portable computer or an office PC, a server and software. When a nurse is administrating a drug to a patient, she could scan the code from the breastplate of the patient and from the package of the drug. The appropriate software could check it and then, if it is the corresponding patient, the corresponding drug at the appropriate dosage at appropriate moment by the appropriate way is administered ("Five rights") [18]. SABC was created as an additional control to help the nurse at drug administration. At the same time, it can not replace the experience and professional judgment of the nurse.

The usage of intelligent pumps, that were evaluated, has shown the incidence rate of ME was 4% less than the pumps of the previous generations [19]. As well, there are used more types of procedures to optimize the rate of the perfusions, using the same syringe or 2 syringes with or without the period of superposition [20].

Conclusions

1. As a result of analysis of the above data, dosage errors have been ascertained in proportion of 20%, of which 4% of errors were encountered at the drug administration by dilution. The drug administration was not registered in the medical card in one case.

2. The exact body weight is known exactly in 21 patients (42%), which suggests that the medical personnel is facing limited technical opportunities.

3. The recommended doses for cardiotonic drugs investigated in this study have an orientation character. From the beginning of administration till the establishment of constant infusion speed, the dose undergoes many changes until it reaches the reference values of BP.

4. Mean arterial pressure and heart rate are the key indicators starting with the initiation of medication and subsequent continuous monitoring of patients. ECG also has an important role during monitoring, particularly in cardiac patients.

5. The incidence of four cases of dose errors in patients receiving cardiotonic drugs by the automatic syringe pump indicates that the use of modern equipment, not only does not limit the incidence of ME, but it may be even a source.

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