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PARAMEDIC STUDENTS NEED MORE TRAINING IN LEFT VENTRICULAR ASSIST DEVICE — A PILOT SIMULATION STUDY

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ABSTRACT

INTRODUCTION: Mechanical Circulation Systems are a promising therapy for patients with end-stage of heart failure. Left ventricular assist device (LVAD) enforces using of concomitant anticoagulant therapy. This may lead to severe complications. LVAD patients are more and more frequent users of the emergency department. There are several differences in cardiovascular function in these patients, as well as on examination. Its interpretation may be challenging and result in potentially fatal conclusions. The aim of this research was to assess the skills of paramedic students in assessing patients with LVAD.

MATERIAL AND METHODS: The study was designed as a simulation study. The aim of this scenario was to provide a full primary survey of an unconscious, spontaneously breathing person with an LVAD pump implanted. Ten groups of paramedic students from Polish medical universities took part in this study.

RESULTS: Four teams started chest compressions unnecessarily. Of them, only one had contacted LVAD local coordinator and discontinued after short instructions. Four teams completed the driveline and device check and six checked only the line without moving the controller. No major errors were noted in the field of airway assessment and management as well as assessment of consciousness, breathing, and circulation.

CONCLUSIONS: More attention should be paid to educating paramedic students in LVAD therapy. Educators should focus mainly on differences in cardiovascular function and pay attention to complete perfusion assessment. Medical simulation seems to be a good tool for assessing difficult clinical cases rarely encountered in practice.

KEY WORDS: mechanical circulation systems; resuscitation; physical examination; simulation study; paramedics

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INTRODUCTION

Due to the aging population, more and more patients suffer from heart failure (HF) [1]. Recent meta-analyses have shown, that almost half of the patients with HF will die within 5 years [2]. Mechanical circulatory systems bring back hope that the quality of life can be restored for patients in the end-stage of this disease. Left ventricular assist device (LVAD) is

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increasingly being used in patients as a bridge to heart transplantation or as a destination therapy [3]. Left ventricular assist device recipients create a specific group of patients. This therapy forces the use of anticoagulation agents continuously. This in turn increases the risk of bleeding. Gastrointestinal hemorrhages and intracranial hemorrhages are the most common complications of LVAD therapy [4]. Shore et all estimated that 16% of patients required hospitalization within the first month and even 98% in the first 2 years after implantation [5]. There is a number of differences in the examination of a patient with implanted LVAD pump [6]. These differences relate primarily to the interpretation of the cardiovascular system examination. Blood flow generated by an LVAD centrifugal pump is different from the physiological. LVAD patients may be pulseless despite adequate perfusion. Conventional methods of assessing blood pressure, pulse, and saturation levels may be misleading. Therefore, their use may contribute to misdiagnosis and poor treatment. European Resuscitation Council recommends beginning chest compressions in every unconscious person without normal respiration [7]. Chest compression related injuries are usually harmless, but also potentially life-threatening may occur [8]. The lack of a correctly conducted primary survey, as well as the incorrect conclusions drawn afterward, can lead to misdiagnosis in many fields. Therefore we believe that emergency healthcare providers must have the appropriate knowledge to provide safe and efficient care. However, the subject of LVAD therapy is not discussed in the Polish paramedics training program.

This study aimed to assess if paramedic students can correctly conclude the results of the initial examination of LVAD patients.

MATERIAL AND METHODS

Legal aspects

According to Polish law, this study did not meet the criteria of a medical experiment and therefore consent from the Bioethical Committee was not required.

Study design

The authors designed a simulation scenario. The goal of the scenario was to correctly examine an unconscious, spontaneously breathing patient with a properly working LVAD device. The scenario was run by 10 teams comprised of paramedic students from 3 different Universities in Poland. The core curriculum for paramedic training in Poland does not provide LVAD skills. The simulation was carried out during outdoor paramedic students, multi-university joint exercise as one of the competitions. The simulation was performed on the Baltic Sea shore. The composition of each team was random and students from different facilities were mixed. The weather conditions for each team was the same. The length of the scenario was 10 minutes. The scenario time was counted from the moment the team entered the room. There was only one evaluator and one simulation technician present during the scenario.

Simulator and devices

MegaCode Kelly (Laerdal Medical AS, Stavanger, Norway) advanced patient simulator was used in the study. The simulator was allowed to provide a complete ABCDE examination including an assessment of breathing, pulse, and electrocardiogram (ECG). All advanced airway management techniques as well as ventilation using bag-valve-mask were possible. Lifepak 12 defibrillator (Physio-Control, Redmond, Washington, USA) was used to monitor the patient's heart. Vital signs of the manikin were set as follows: ventilation rate 24/min; SpO2: 98%; heart rate: 90/min; ECG: normal sinus rhythm; blood pressure: 0/0mmHg (undetectable), pupils: anisocoria (left pupil dilated). The simulator was prepared by the authors to play the role of an LVAD patient. The HeartMate III centrifugal pump (Thoratec Corporation, Pleasanton, California, USA) was prepared and placed in a sealed glass jar containing water. The power line was then led through the skin between the chest and abdomen and connected to the controller. The controller as well as battery supply were placed in a dedicated bag and secured with a belt. The unit was set at 5400 rpm. A flow rate of 2.8 l/min was provided. Sounds of the pump humming could be heard during auscultation. The telephone number of an LVAD local coordinator was clearly presented on the device. Dialing this number connected directly to another instructor playing the role of coordinator.

Scoring form

We prepared our own scoring form for the evaluation of this scenario. Performance of the following interventions was evaluated: consciousness level, airway assessment, breathing assessment (including rate, depth, auscultation, SpO_2), circulation assessment [including heart rate (HR) and noninvasive blood pressure (NIBP), perfusion assessment (including skin and capillary refill time), disabilities assessment, full body exposure, contacting the LVAD coordinator]. There were two critical errors defined: 1) initiation of chest compressions and maintaining this decision for at least 30 seconds, 2) Cutting the driveline. Each team was evaluated by the same instructor.

RESULTS

All teams performed and completed the scenario on time. Six teams did not start chest compressions. All of them had contacted the LVAD coordinator. Four teams started chest compressions. Of them, only one had contacted the LVAD coordinator and discontinued after instructions. For the students who took part in the study, no major errors were noted in the field of airway, breathing, and circulation. All teams achieved full or nearly full results in these categories. The only exception was the perfusion assessment, Only one team performed a full evaluation. Four teams completed the driveline and LVAD device check and six checked only the line without moving the controller. The scoring form as well as the exact scores for each team were presented in Table 1.

DISCUSSION

The aim of this study was to perform an analysis of paramedic students' skills in the examination of a patient with LVAD. This therapy is becoming more widely used today. According to recent European Society of Cardiology recommendations, LVAD should be considered as bridging or destination therapy for patients with advanced heart failure.

Table 1. Scoring checklist and results of the study

Evaluated procedures	Team number									
	1	2	3	4	5	6	7	8	9	10
Examination and interventions										
Assessment of consciousness *(0 for none, 1 if completed)*	1	1	0	0	1	1	1	1	1	1
Assessment of airway *(0 for none, 1 if completed)*	1	1	1	1	1	0	1	1	1	1
Assessment of breathing (rate, depth, auscultation, SpO_2) *(0 for none, 1 for one or two items, 2 if completed)*	2	1	2	1	2	2	1	1	2	2
Assessment of circulation (HR, BP) *(0 for none, 1 for one item, 2 if completed)*	2	0	1	0	2	2	1	1	2	2
Assessment of perfusion (CRT, skin) *(0 for none, 2 for one item, 5 if completed)*	5	0	0	0	0	1	0	0	2	0
Assessment of disabilities (glucose level, pupils, AVPU) *(0 for none, 1 for one item, 2 for two items, 3 if completed)*	3	1	2	1	3	3	1	1	1	2
Exposure (driveline, alarms) *(0 for none, 1 for one item, 3 if completed)*	1	1	3	3	1	3	1	3	1	1
Contact with LVAD coordinator *(0 for none, 2 if completed)*	2	0	2	2	0	2	0	2	2	0
Interview with bystander *(0 for none, 1 for one, two or three questions from SAMPLE, 2 for full SAMPLE interview)*	2	1	2	2	1	2	2	1	2	2
Airway management *(0 for none, 1 for basic interventions, 2 for advanced interventions)*	1	2	1	1	1	1	2	1	1	2
Critical errors										
Compression started and continued for at least 30 sec.	Y	Y	N	N	N	N	Y	N	N	Y
Driveline cut	N	N	N	N	N	N	N	N	N	N

AVPU — level of consciousness scale; CRT — capillary refill time; HR — heart rate; LVAD — left ventricle assist device; N — no; NIBP — blood pressure; SAMPLE — medical interview; SpO_2 —oxygen saturation; Y — yes

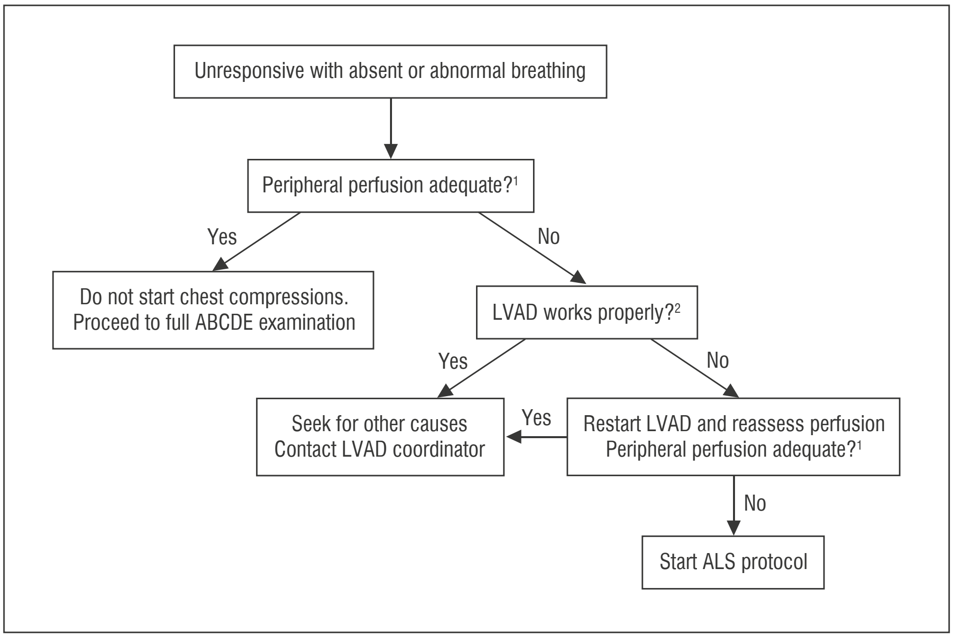

FIGURE 1. Management of unresponsive left ventricle assist device (LVAD) patient with absent or abnormal breathing; ALS — Advanced Life Support; [1]assess skin colour, moisture, temperature, capillary refill time; [2]check pump humming, power source, line, alarms

Kirkling et al. [9] estimated the overall; the survival rate of LVAD patients as high as 80% in the first year after implantation. These results are encouraging, especially at a time when the demand for transplantation is greater than the availability of transplants.

Stroke is a major cause of death in patients with LVADs. According to the literature, about 10% suffered at least one hemorrhagic stroke and one-third of cases are fatal [10–11]. It is therefore essential, that providers focus on ruling out stroke in any patient with neurological manifestations, and with altered mental status as well as unconscious.

The main role of any emergency clinician is to provide the best possible care to every patient. The recognition of a life-threatening condition is usually a result of a thorough physical examination and medical history. Assessing vital functions in a patient with an LVAD can be confusing, especially for an inexperienced provider. There are some major differences when examining the cardiovascular system. This is a result of the implanted pump providing continuous blood flow. Hence, the absence of a normal pulse, the difficulty in blood pressure measurement, and unreliable saturation readings should be taken into account when assessing cardiovascular function.

The results of this study revealed that students demonstrated good patient examination skills. Nonetheless, their decisions were incorrect. Most groups did not perform a perfusion assessment. In the absence of a palpable pulse, resuscitation was undertaken — according to standard protocol. During the scenario, the authors carefully observed the students. There was widespread discussion about the doubts regarding the need to perform chest compressions. Some groups interrupted cardiac compressions even a few times. In our opinion, this may be due to insufficient knowledge or lack of experience. Although no high-quality clinical trials assessing the efficacy and safety of chest compressions in LVAD patients were published, retrospective studies have shown that performing this procedure is safe and no significant pump or internal organs are observed [12–14].

In the literature, a number of protocols for examining a patient with LVAD can be found [6]. When analyzing these papers, one can see that the indications for resuscitation are the absence of normal breathing and the absence of pump humming. This modification of the standard algorithm, in our opinion, requires appropriate training. It is important to emphasize the role of assessing perfusion in a comprehensive manner and not just by evaluating the presence or absence of a pulse. As differences regarding the initiation of chest compressions may raise concerns, especially for less experienced professionals, in Figure 1 we have proposed an algorithm that clearly presents the procedure. In this study, only four of ten teams assessed both the driveline and the device itself. In one of our previous papers, we proposed a protocol to modify the entire ABCDE survey with an emphasis also on assessing critical technical aspects [15]. Although, as written in the introduction, the number of patients will increase, at the moment exposition of paramedics to LVAD patients is still low. Support of the dispatcher and medical control may be crucial for ambulance teams. Clear information on the device and contact with the coordinator as well as emergency reference cards are recommended [16].

In the study by Municino and colleagues, only 4% of paramedics presented knowledge concerning the influence of LVAD on the circulatory system and its impact on findings in the examination. In another study it was found that more than 40% of respondents have never heard about LVAD and more than 80% have never had any training. Interestingly, this research was done in the USA, where the number of LVADs was relatively high with 2,500 implants per year [17]. Therefore, it is to be expected that in countries where fewer devices are used, the level of knowledge may be even lower.

High-fidelity medical simulation is not the only effective method of education. It is also used for verifying new strategies of treatment, and multilevel procedures before implementation in real life [18, 19]. Therefore, in our opinion, training through medical simulation also in this field is needed. Students who took part in our study were previously unfamiliar with LVAD devices, but knew simulation as an education technique. By using simulation, we were able to identify gaps in knowledge and investigate how these affect the management compliant with standard protocols. This suggestion stands in agreement with other authors who have studied the feasibility of medical simulation in improving adherence to critical processes of care and reducing errors in management [20]. Regardless of the poor results of most teams, we received very positive feedback on this scenario. Participants expressed their appreciation for this scenario, as it allowed them to get acquainted with a previously unknown device and algorithm.

CONCLUSIONS

More attention should be paid to LVAD patients in the undergraduate training of paramedics. Medical simulation may be a useful educational tool in the implementation of previously unknown subjects and procedures into paramedics practice.

Conflict of interests

The authors declare no conflicts of interest.

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