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Are we well prepared to examine patients with left ventricular assist device in emergency conditions? — a simulation-based pilot study

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ABSTRACT

Introduction: Left ventricular assist device (LVAD) therapy is becoming more and more important. There is now increasing number of patients on LVAD therapy. This means that they will also be more frequent patients in emergency departments. There are several differences in cardiovascular function in these patients. An examination performed according to the well-known ABCDE algorithm, can be difficult to interpret and result in incorrect decisions. The aim of this pilot study was to preliminarily assess the ability of medical university students to examine a patient with LVAD.

Material and methods: The authors designed a simulation study. The aim of the scenario was to assess the unconscious, spontaneously breathing patient with LVAD and provide assistance appropriate to the patient's condition. Ten groups of students from different polish medical universities participated in the study.

Results: All teams implemented the ABCDE examination protocol. Seven teams started chest compressions due to absence of pulse despite spontaneous breathing. Out of seven teams that started compressions, two terminated after discussion within the team. Half of the teams completed the driveline and LVAD device check. Four teams contacted the LVAD coordinator. Three teams in the study did not perform perfusion assessment.

Conclusions: An examination according to the ABCDE algorithm can be performed in a patient with LVAD. However, there is a need to modify the standard algorithm to adjust for the characteristics of an LVAD patient. Consideration should be given to inadequate skills in interpreting the results ABCDE examination. Simulation-based learning should be an important part of pre- and postgraduate education

Key words: Heart-assist devices, resuscitation; physical examination; simulation study

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Introduction

Left ventricular assist devices (LVAD) bring back hope of restoring quality of life to patients with end-stage heart failure. This innovative technology is increasingly being used in patients as a bridge to heart transplantation or in whom a heart transplant is not possible as destination therapy. In recent years, this kind of heart support has been gaining more and more allies and number of patients receiving this device is increasing [1]. Natural consequence of this is increasing risk of sudden life-threatening conditions for LVAD patients. Although LVAD support itself is kind of inconvenient for patients, the presence of an implanted device is associated with some risks. Currently, one of the most common complications is driveline infection or consequences related to anticoagulation therapy [2]. Some studies have shown that even 91% of patients with an implanted device will require hospitalization in the first year after implantation [3]. Therefore, it is important that both ambulance and emergency department personnel have knowledge and skills to provide assistance in life-threatening emergencies. Unfortunately, the subject of LVAD patients has not found any place in the training of paramedics and is marginal in medical student education.

There is number of differences in the examination algorithm of an LVAD patient [4]. An implanted centrifugal pump provides continuous blood flow. This type of flow differs from the pulsatile flow that occurs physiologically. Therefore pulse or blood pressure assessment should be replaced by skilled assessment of cardiovascular efficiency. Pulse examination performed especially by inexperienced providers is subject to the risk of error. This mistake may result in an incorrect decision to start chest compressions. At present, it is not known whether chest compressions carried out in people with LVADs contribute to major harm. However, European Resuscitation Council guidelines recommend, that chest compressions should be undertaken in every case of an unconscious person without normal breathing [5]. Chest compression related injuries are usually harmless, but also potentially life-threatening may occur [6].

Lack of properly performed examination or wrong conclusions may consequently lead to unrecognized other equally important conditions.

Aim of the study

The aim of this pilot study was to assess skills in examination an LVAD patient among medical university students.

Material and methods

Study design

The authors conducted a pilot simulation study. The goal of the scenario was to correctly examine an unconscious, spontaneously breathing patient with a properly working LVAD device. The scenario was completed by 10 teams from different Medical Universities in Poland. The composition of each team by the level of experience of each member was presented in Table 1. The conditions for each team were the same. The simulation was performed at Medical Simulation Centre of Poznan University of Medical Sciences. The simulation room designed as flat was chosen as suitable place to run the scenario. The length of the scenario was 10 minutes. The scenario time was counted from the moment the team entered the room. One evaluator was present in the toom during the simulation.

The simulation was run during National Championship of Medical Simulation — SimChallenge 2021.

Table 1. Team members and their level of undergraduate training

No.	Team composition
1	5thMD*, 5thMD, 5thMD, 3rdPM, 2ndPM
2	6thMD*, 5thMD, 5thMD, 5thMD, 5thMD
3	5thMD*, 5thMD, 5thMD, 5thMD, 3rdPM
4	6thMD*, 6thMD, 5thMD, 5thMD, 2ndNR
5	6thMD*, 6thMD, 5thMD, 5thMD, 4thMD, 4thMD
6	6thMD*, 6thMD, 6thMD, 6thMD, 6thMD
7	6thMD*, 4thMD, 4thMD, 4thMD, 4thMD
8	6thMD*, 6thMD, 6thMD, 6thMD, 6thMD
9	6thMD*, 6thMD, 5thMD ̧5thMD, 5thMD
10	4thMD*, 5thMD, 3rdPM, 3rdPM, 3rdNR

*Team leader was marked with asterisk. The number defines year of study
MD — medicine student; NR — nursing student; PM — paramedic student

Equipment

MegaCode Kelly (Laerdal Medical AS, Stavanger, Norway) human simulator was used in the study. The simulator allows generating pulse on carotid arteries, respiration, heart rhythm, and lung sounds during breathing. Airway management with supraglottic devices and ventilation with bag-valve-mask was possible. ZOLL M-Series® defibrillator (ZOLL Medical Corporation, Chelmsford, Massachusetts, USA) was used to monitor the patient's heart. Basic simulated vital signs were set as follows respiratory rate 15/min; SpO2: 95%; heart rate: 70/min; ECG: normal sinus rhythm; blood pressure: 0/0mmHg (nondetectable), pupils: anisocoria (left pupil dilated). The simulator was modified by authors of the scenario. The HeartMate III centrifugal pump (Thoratec Corporation, Pleasanton, California, USA) was used. The pump was placed in a sealed plastic container with water. The power line was led through the skin of the simulator and connected to the controller unit. The controller and batteries were placed on the patient's side in a dedicated bag and secured with a belt. The unit was set at 5900 rpm. A flow rate of 3l/min was provided. Sounds of the pump humming could be heard during auscultation.

Scoring checklist

The authors created their own scoring form for this scenario. Performance of all listed elements was assessed. The following activities were included in the checklist: assessment of consciousness, initial airway maneuvers, assessment of breathing, assessment of circulation, assessment of perfusion, disabilities,

Table 2. Evaluation checklist and scoring criteria

Evaluated activities	Team number									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Examination and critical interventions										
Check responsiveness *(0 for none, 1 if present)*	1	1	1	1	1	1	1	1	1	1
Open airway *(0 for none, 1 if present)*	1	1	1	1	1	1	1	1	1	1
Breathing assessment (rate, depth, auscultation, SpO_2) *(0 for none, 1 for one or two items, 2 for full assessment)*	1	2	2	1	1	1	2	2	2	2
Circulation assessment (HR, NIBP) *(0 for none, 1 for one item, 2 for full assessment)*	2	2	2	2	2	2	2	2	1	2
Perfusion assessment (CRT, skin) *(0 for none, 2 for one item, 5 for full assessment)*	5	2	2	0	0	5	0	5	5	2
Disabilities (glucose level, pupils, AVPU) *(0 for none, 1 for one item, 2 for two items, 3 for full assessment)*	3	2	3	2	2	2	3	3	2	3
Exposure (driveline, alarms) *(0 for none, 1 for one item, 3 for full assessment)*	3	0	3	0	0	0	3	0	1	3
Contact with LVAD coordinator *(0 for none, 2 if present)*	2	0	2	0	0	0	2	0	0	2
Interview with bystander *(0 for none, 1 for one, two or three questions from SAMPLE, 2 for full SAMPLE interview)*	2	2	2	2	2	1	2	1	1	2
Airway management *(0 for none, 1 for basic airway, 2 for advanced airway)*	2	2	0	2	2	2	2	2	2	2
Critical errors										
Compression started and continued for at least 30 sec.	N	Y	Y	Y	Y	Y	N	N	Y	Y
Driveline cut off	N	N	N	N	N	N	N	N	N	N

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

exposure, contacting the LVAD coordinator. Details of the evaluation form and scoring method are presented in Table 2.

A critical error was defined as undertaking CPR and maintaining that decision for more than 30 seconds. Each team was assessed by the same person.

Results

All teams completed the scenario in required time. Only 3 teams did not make the critical error and did not start chest compressions. Out of seven teams that started compressions, two terminated after discussion (one in fifth and one in seventh minute of the scenario). For students who took part in the study, assessment and securing of the patient's airway as well as assessment of consciousness, breathing and circulation was not a major problem. All teams scored full or near full in these categories. Half of teams completed the driveline and LVAD device check. Four teams contacted the LVAD coordinator. Three teams in the study did not perform the perfusion assessment. Table 2 presented exact scores for each team.

Discussion

The aim of this study was to provide a preliminary analysis of students' skills in patient with LVAD examinations. LVAD therapy is becoming more widely used today. According to the 2021 recommendations of the European Society of Cardiology, LVAD can be considered as bridging therapy to candidacy, transplantation, recovery, decision, or considered destination therapy [7]. It has been estimated that survival rate of patients with LVAD after the first year of therapy was 80% [8]. These results raise hope, especially at time when there are far fewer organs available for transplant than demanded.

Stroke is afeasible condition that can occur in a patient with LVAD. According to literature, 11% of patients had at least one stroke and 51.38% had an ischemic origin. The median mortality rate for LVAD-associated ischemic stroke has been estimated to be 31% [9–11]. Therefore, it is crucial for healthcare providers to focus on ruling out stroke in every patient with neurological symptoms especially those unconscious or with altered mental status.

It is the responsibility of every medic attending to a patient in life-threatening condition to ensure the best possible care. The diagnosis of a life-threatening condition is based on findings on examination and medical history. In a patient with LVAD there are number of differences in physical examination in ABCDE algorithm. The implanted pump provides continuous blood flow. Therefore, when assessing cardiovascular function, consideration should be given to absence of pulse, difficulty in determining blood pressure using conventional methods, and potential lack of saturation reading.

In the study, students demonstrated good examination skills. However, conclusions were incorrect. In most patients, resuscitation was started on a patient with spontaneous breathing. Students made this decision based on lack of pulse on carotid artery. In our opinion, this indicates a lack of relevant knowledge. Authors' direct observations during the study revealed that most students were confused and uncertain about CPR. They had discussions among themselves, some of which led them to change their decision and stop chest compressions.

To the best of authors' knowledge, there are no high-quality clinical trials that have confirmed the efficacy and safety of chest compressions in LVAD patients [12, 13]. However, retrospective studies and case reports have shown that performing this procedure is not as dangerous as commonly thought and no significant changes in the functioning of a pump after return of circulation are observed [14].

There are several proposed algorithms for management of an unconscious patient with LVAD in the available literature [4]. According to these, the decision to start chest compressions should be based on absence of normal breathing, assessment of perfusion, and listening for pump humming. This is a substantially different approach from common resuscitation protocols, which base the decision on presence of pulse. Thus, LVAD patients require unique consideration. Authors of this manuscript have previously proposed the modified version of the commonly known ABCDE examination protocol with special consideration for equipment checks [15].

The information that a patient is on LVAD therapy should already be communicated during first contact with the healthcare provider ideally dispatcher. Emergency reference cards are recommended [16]. The patient should also have telephone number to LVAD coordinator. This information should also be visible on the controller. This is a medical professional trained to use LVAD and deal with troubleshooting available 24/7.

Unfortunately, medical professionals' knowledge about LVADs is disappointingly low. There is very little research addressing this issue. Hryniewicz et al. found that only a half of surveyed paramedics answered that chest compressions are indicated in cardiac arrest settings [17]. In another study, only 4% of respondents knew that LVAD patients are pulseless [18]. These results show how much there is still to be done to raise awareness among medical professionals. Education appears to be the key to safe and high-quality care.

Continuous training of healthcare professionals is extremely important. High-fidelity medical simulation is a valuable and cornerstone of modern education. Its success also seems to be useful in areas where new technologies and complex procedures are just being implemented [19]. That is the case with LVAD patients in Poland. It is still a rarely used therapy, therefore for some medics, it is impossible to examine a patient themselves. Barnicle et al. confirmed the effectiveness of medical simulation in the education of emergency medicine residents [20]. To the best of our knowledge, this was the first scenario in Poland that touched the field of LVAD therapy. Despite the unsuccessful performance of most teams, we met with very positive feedback This gives us hope that medical simulation with LVAD patient scenarios may bring many benefits and be accepted by participants.

Conclusions

The field of LVAD-related life-threatening situation requires considerable attention. A strong effort should be made to enhance the position in this subject in both pre-graduate and post-graduate education. Medical simulation may be a good and effective tool that can be used to achieve this purpose.

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