Challenges in Basic Life Support and Automated External Defibrillator Training of Deaf People

Matej Strnad (strnad.matej78@gmail.com)
Center for Emergency Medicine https://orcid.org/0000-0002-4505-557X
Zdenko Šalda
Univerza v Novem mestu, Fakulteta za zdravstvene vede
Boštjan Jerko
Japina LCC
Vida Vrečar
Center for Emergency Medicine, Prehospital unit
Vesna Borovnik Lesjak
Center for Emergency Medicine, Prehospital unit
Rok Petrovčič
University Medical Center Maribor

Original research

Keywords: automated external defibrillator, cardiopulmonary resuscitation, deafness, education

DOI: https://doi.org/10.21203/rs.3.rs-57270/v1

Abstract

Background

Basic life support (BLS) with the use of an automated external defibrillator (AED) is a fundamental link to a successful chain of survival of patients with cardiac arrest. However, the BLS protocol is not tailored for deaf people who encounter many challenges during BLS training.

Methods

After an ergonomic analysis and modifications of the BLS and AED protocol, a practical course was conducted. A pre-course BLS and AED knowledge was tested with a questionnaire. After the course, each participant practically solved a cardiac arrest scenario on a manikin and qualitative and quantitative data on BLS and AED performance were collected with a modified Cardiff test and the QCPR mobile application. Results of the knowledge test and performance were presented with frequencies and correlations between pre- and post-course BLS and AED knowledge and performance were analyzed and presented with Spearman's rho.

Results

51 deaf volunteers from seven Slovenian societies for deaf people participated in the study. Results on the pre-course knowledge test were poor (3.5 points out of 10). BLS performance according to the modified Cardiff test post-course was also poor: 52.9 % of the participants used a safe approach, 58.8 % checked responsiveness and 51.0 % sent a text message to the rescue service. Only 43.1 % of them opened the airway and 49.0% checked initial breathing. 80.4% of the deaf rescuers performed chest compressions on the lower half of the sternum but only 52.9 % of them compressed with adequate depth. According to the QCPR application the best performance was achieved with the compression score of 61.1 % and flow fraction 74.9%.

Conclusions

This study shows that a more comprehensive and assidiuous approach is needed for effective BLS and AED training courses for deaf people.

Background

Sudden cardiac arrest is one of the leading causes of death in Europe [1]. The recommended treatment for cardiac arrest is immediate basic life support procedures (BLS) [2]. Teaching lay people BLS is a fundamental link to a successful chain of survival of patients with cardiac arrest [3]. However, guidelines for BLS are not tailored for deaf people. There are several steps that deaf people have difficulties with or cannot perform: listening to check initial breathing, calling 112 or using an automated external defibrillator (AED) with voice instructions [4]. The use of an AED is one of the basic resuscitation procedures as it can be used to stop malignant arrhythmias [5], but the device itself is often not adapted

for use by the deaf people, as it provides only voice instructions for use. The AED must be equipped with pictorial instructions to shorten the time to successful defibrillation [6].

Most deaf people use sign language which is a unique language with its own grammar and syntax and differs markedly from the mother tongue and is not its gestured representation [7]. Therefore, they are not fluent in the language of the surroundings and consequently, low level of reading comprehension in people with hearing loss has been observed [8]. In addition, health literacy and knowledge weaknesses of the deaf were described [9-11]. They are not familiar with the symptoms [9] and vocabulary regarding most common cardiovascular health issues [12]. Therefore, both deaf trainees and their instructors face many challenges during BLS training, from communication issues to inadequate BLS protocols. In this study, we aimed at appraising the distinctions between deaf and general population regarding the BLS and AED protocol and specific hindrances by deaf during the BLS training. Based on those observations we aimed to propose measures to improve BLS and AED courses for deaf people.

Methods

Study design

Study design included two steps. In the first step, occupational medicine specialist (Z.Š.) did an ergonomic analysis of the BLS and AED protocol of the latest European resuscitation council guidelines [2]. Based on observations, the following modifications were proposed to enable successful BLS and AED training of deaf people: BREATHING – look and feel for normal breathing; UNRESPONSIVE AND NOT BREATHING NORMALLY - ask a helper to call the emergency services (112) if possible, otherwise activate them yourself by sending a text message or informing call center for deaf people and ask them to call 112; WHEN AED ARRIVES– switch on the AED, put it in the visual field and follow the visual prompts.

In the second step, a practical course for interested deaf volunteers was conducted. In each class there were a maximum of 10 participants, 5 per instructor. At the beginning of the course, each participant filled out a pre-course BLS and AED knowledge test [13].

After the test there was a 30 minutes theoretical lecture and a 45 minutes practical training in ergonomically modified BLS and AED protocol led by a physician accompanied with a certified sign interpreter. Each participant practiced on their own training torso manikin (Prestan CPR Torso, Erler Zimmer GmbH & Co. KG, Lauf, Germany) with a cardboard AED prop with adhesive electrode pads. A real training AED with visual prompts (AED Trainer, Defibtech LLC, Guilford, USA) was used for guidance. Afterwards, each participant was asked to practically solve a cardiac arrest scenario on a manikin (Little Anne QCPR, Laerdal Medical, Stavanger, Norway) using the training AED. A cardiac arrest scenario lasted for 2 minutes, each participant performed one BLS cycle. To evaluate practical skills gained during the course, qualitative and quantitative data on BLS and AED performance were collected with a modified Cardiff test and the QCPR mobile application (QCPR training 4.0.0. by Laerdal Medical, Stavanger, Norway). The Cardiff test was modified to match the modifications of the BLS and AED protocol for deaf people. Items of both instruments were collected together on a joint checklist. Incorrect performance of

the item's task was scored 1 point, whereas partially correct or correct performance was scored with more points (ranging from 2 to 4). In additional analysis every item was graded only as correct or incorrect performance. BLS performance was evaluated by one of the two instructors (V.V. and Z.Š.).

Sample

We contacted all 13 Slovenian societies for deaf people by email and invited them to participate in the study. Deafness was defined as loss of hearing more than 95% by Fowler and using sign language for communication. 51 volunteers from 7 societies for deaf people participated in the study in the period from 30.1.2019 to 15.1.2020 (Table 1).

Table 1:

Sociodemographic characteristics of the sample (n=51).

			N (%)	Mean (SD)	Min	Max
Gender	Male		28 (55)			
	Female		23 (45)			
Age				53,6 (11,23)	32	70
Educational level*				3,9 (1,68)	1	8
	1		4 (8)			
	2		5 (10)			
	3		8 (16)			
	4		22 (43)			
	5		8 (16)			
	6		1 (2)			
	7		1 (2)			
	8		2 (4)			
Previous BLS course attendance	No		11 (22)			
	Yes		40 (78)			
		At school	8 (16)			
		At driving license course	14 (27)			
		Course at work	8 (16)			
		Free course	10 (19)			
Healthcare worker in the family	No		36 (71)			
	Yes		15 (29)			
		Doctor	3 (6)			

	Nurse	4 (8)
	Medical technician	7 (14)
	Laboratory technician	1 (2)

Note: Level of education: 1 -Unfinished primary school, 2 - Primary school , 3 - Vocational secondary education - 2 years, 4 - Vocational secondary education - 3 years , 5 - Technical secondary education, High School Diploma , 6 - Bachelor's Degree before Bologna process , 7 -Bachelor of Arts/Bachelor of Science, 8 -Master of Arts/Master of Science.

Statistical analysis

Frequencies are reported to describe sociodemographic characteristics of the sample and answers on the pre-course knowledge test and post-course performance analysis. Practical performance analyzed by the QCPR Laerdal mobile application is presented as mean values and standard deviation. Correlations among variables were tested and presented as Spearman's rho. SPSS software (version 25, SPSS Inc., Chicago, IL, USA) was used for statistical analysis.

Results

Pre-course

The mean sum of correct answers on the pre-course knowledge test was 3,51 (± 2,22 standard deviation) with a minimum and maximum score of 0 and 8 out of 10, respectively. Percentages of correct answers for each question are presented in Table 2.

Table 2:

Analysis of the items on pre-course knowledge test (N = 51).

Question	% Correct answers (N)
1. How do you recognize a person in cardiac arrest?	43,1% (22)
2. Who can help in a case of cardiac arrest?	47,1% (24)
3. A person suddenly loses consciousness and collapses. What do you do?	33,3% (17)
4. How do you check if a person is breathing normally?	47,1% (24)
5. What kind of breathing is NOT a sign of life?	33,3% (17)
6. How is basic life support correctly performed?	25,5% (13)
7. On the sketch of the torso below mark with a cross the correct site for chest compressions during basic life support	43,1% (22)
8. How do you perform artificial breaths in an unconscious person?	49,0% (25)
9. What do you do if you are unsure whether a person is in cardiac arrest or not?	39,2% (20)
10. What is an AED (automatic external defibrillator)?	29,4% (15)

Post-course

The mean score on the post-course modified Cardiff test was 42,16 (± 7,22 standard deviation) with a minimum and maximum score of 28 and 55 out of 55, respectively.

Percentages of correctly performed BLS and AED tasks are presented in Table 3. Score range, means with standard deviation, minimum and maximum scores achieved on individual BLS steps on the modified Cardiff test are presented in Table A in Supplementary material.

Table 3:

Performance of individual tasks of BLS and AED steps on the modified Cardiff test (N = 51).

BLS Step	BLS Task	% Performed Correctly (N)
Step 1:	Safe approach	52,9% (27)
Step2: Check responsiveness	Check responsiveness - shake	58,8% (30)
	Indicate looking for help	29,4% (15)
Step 3: Airway and breathing	Initial airway opening	43,1% (22)
	Initial check/clear airway	49,0% (25)
	Initial breathing check	31,4% (16)
Step 4:	Send SMS to rescue service	51,0% (26)
	Send someone to find help and AED	31,4% (16)
Step 5: CPR sequence	Hand position	80,4% (41)
	Average number of compressions (100–120/min)	37,3% (19)
	Average depth of compressions	52,9% (27)
	Open airway for rescue breaths	43,1% (22)
	Close the nose	66,7% (34)
	Perform rescue breaths, check for moving of the thorax	33,3% (17)
Step 6: AED usage	Open and turn on AED	84,3% (43)
	AED electrode on right position	92,2% (47)
	AED in visual field	78,4% (40)
	Hands-off check during analysis	64,7% (33)
	Check for safety and push shock button	45,1% (23)
Step 7:	Continue with BLS	72,5% (37)

Qualitative assessment of BLS performance with the QCPR application is presented in Table 4.

Table 4:
QCPR analysis of overall performance scores on a manikin (N = 51).

	Mean	Standard Deviation
Overall score	53,8 %	27,94
Compression score	61,06 %	31,61
Flow fraction	74,94 %	12,84
Ventilation score	41,16 %	42,90

Correct performance of chest compressions and ventilations assessed by the QCPR application is shown in Table 5.

Table 5.
Qualitative analysis of BLS performance with QCPR application (N = 51).

BLS Step	**BLS Task**	**% Performed Correctly (N)**
Chest Compressions	Average rate 100 – 120 / min	41,2% (21)
	100% correct chest compressions	2,0% (1)
	Average depth 50 – 60 mm	23% (12)
	Total number: 140 – 190	23,5% (12)
	Flow fraction > 70 %	47,1% (24)
Ventilations	Total number: 12	2,0% (1)
	Ventilations with adequate chest rise: > 50 %	49,0% (25)
	Chest compression to rescue breath ratio: 30:2	21,6% (11)

Analysis of correlations between sociodemographic characteristics of the sample, pre-course knowledge of BLS and AED, and post-course BLS and AED awareness gain is presented in Table 6.

Table 6.

Correlation coefficients between baseline characteristics, pre-course and post-course test scores.

	Sum of correct answers on pre-course test	Sum of correct answers on Cardiff	Overall score on QCPR
Gender	-0,068	0,042	-0,095
Age	-,385**	-0,102	0,01
Education	,452**	0,24	0,225
Healthcare worker in family	0,021	-0,104	,325*
Sum of correct answers on pre-course test	1	0,143	0,11

Note: **, correlation significant at the 0.01 level (2-tailed); *, correlation significant at the 0.05 level (2-tailed).

Discussion

The current study revealed that mere adjustments of the BLS and AED protocol originally designed for hearing people do not suffice for effective training of the deaf. Three crucial tasks of the BLS and AED protocol were modified during an ergonomical analysis: breathing check, alerting emergency services and using an AED. Similar limitations were pointed out in research by Unnikrishnan et al. [4].

In the present study, BLS and AED knowledge was tested before the course using a previously developed questionnaire for schoolchildren [13]. The results suggest that BLS knowledge by deaf is poor (an average score of 3.5/10) compared to hearing peers (7.8/10) [14] and schoolchildren (an average score of 6.0/10, data not published yet). The most incorrect answers were to the basic questions representing the core of BLS, supporting the observation of insufficient BLS and AED knowledge by deaf.

Our study showed that BLS and AED performance was also poor as scored and assessed with the modified Cardiff test and a manikin with feedback data. In our observation, merely half of the participants would use safe approach to the cardiac arrest victim, check responsiveness, and send a text message to the rescue service. Less than half of them would open the airway and check initial breathing or send someone for help or an AED. Regarding chest compressions, more than 80 % of participants would perform chest compressions on the correct position with nearly 53 % of them compressing one third of the diameter of the chest, but less than half of them with an adequate rate. Better results were observed by Tomasetti et al. [15] where the deaf participated in the standard American National Red Cross 4-hour course using a videocassette signed by the course instructor and achieved 40/46 points on immediate post-test score. The best performance scores yielded on the manikin in the present study were compression score and flow fraction representing “low-flow” state in cardiac arrest. Overall performance score on the manikin was reduced on account of poorer results in ventilation score. There were some score discrepancies in BLS performance between modified Cardiff test and feedback data from the

manikin. According to the manikin data, only 23 % of participants compressed the chest with the correct average depth of 50 to 60 mm compared to 52,9 % according to the modified Cardiff test. This fact could be due to more accurate and sophisticated measurements made by the manikin software, whereas the depth of the compression on the modified Cardiff test was estimated by observation.

Using the AED can be a challenge for a deaf person, as many AEDs provide only voice prompts [16]. On the other hand, the untrained deaf rescuers are capable of using AED appropriately with visual prompts after basic training [6]. Only four participants in our study failed to attach the AED pads in correct position and eight of them forgot to turn on the AED. Nearly 80 % of deaf rescuers put the AED into the visual field to be guided with visual instructions from the AED. They perform less successfully on the safety check and pressing the shock button. Also, Sandroni et al. described that 22 % of participants did not deliver shock. The reason was because they expected the defibrillator to do it automatically [6].

Communication is the basic challenge for educators of deaf people. The major differences between BLS instructions for deaf and non-deaf are the need for a sign interpreter, the need to modify the terminology of BLS instructions and the careful explanation of terminology [17]. During the pre-test we observed an extensive effort from the sign language interpreter to explain the meaning and the purpose of the questions. This observation together with the low score on pre-test could be due to low level of reading comprehension by deaf. It was shown that an average student with hearing loss graduates from high school with reading comprehension skills at about fourth grade level [8].

In addition, there is growing evidence in the literature regarding health literacy weaknesses by deaf [9, 10]. Findings from several studies indicate that deaf individuals have weaker functional health literacy and smaller found of cardiovascular health knowledge [9-11]. Nearly 40 % of deaf could not list any of the most common symptoms of a heart attack, while over 60 % of them could not list a single stroke symptom [9, 12]. Moreover, more than one third of deaf people would not call the emergency medical number if they thought they were having a heart attack or stroke, thinking that it is not deaf-accessible [9]. This observation is similar to our study where half of the participants wouldn't send a message to the rescue service in the case of cardiac arrest although it could be activated through a text message. Although neither reading comprehension nor health literacy were analyzed in the present study, we assume that low level of both in our study group could contribute to the low scores on the pre-test.

Family conversations about family medical history and other incidental source of health knowledge are crucial for developing strong health literacy skills [11, 12]. In the present study the family member working as a healthcare provider is related to better results after the course. It is likely that a healthcare worker stimulates the conversation with other family members about the medical issues and through family communication promotes healthy life style including attaining BLS skills.

Deficits in reading comprehension and low level of health literacy have an impact on the BLS course. Presentation designed for deaf adults should use simpler English grammar and vocabulary, and more visual information [11]. Our BLS course was led by a physician accompanied with a sign language interpreter from non-medical field. It was shown that a signed interpretation appears to have been a better

means of communicating BLS information to the deaf learners. The signed interpretation may eliminate poor reading comprehension as a potential barrier in learning and retention of BLS skills [15]. Changing position of the instructor during the presentation distract the deaf participants. This fact is due to the enhanced peripheral visual attention [18, 19] resulting in that the deaf subjects are more susceptible to peripheral distracters [20]. We also observed that attention duration by deaf people during the course was shorter than expected (it lasted between 25-30 minutes). This observation is supported by studies reporting that poor sustained attention in deaf children improved little with increasing years [21, 22].

The study has several limitations. Firstly, our method of obtaining participants through invitation send to the members of deaf associations resulted in a very small sample size. Secondly, the pre-test was designed for schoolchildren and not for deaf individuals. Due to reading comprehension and health literacy issues a specific pre-test should be developed for deaf adults. Thirdly, we used different measuring instruments before and after the course which made comparison of the results before and after an intervention inconvenient. Finally, we have not tested the retention of BLS and AED skills.

Conclusions

This study shows that a more comprehensive approach is needed in BLS and AED training for deaf people. Challenges in this specific population require specific adjustments of BLS and AED courses, extending beyond modifications of the BLS algorithm. Further studies are needed to determine an effective approach to BLS and AED training courses for deaf people.

List Of Abbreviations

BLS: Basic life support

AED: Automated external defibrillator

Declarations

Ethics approval and consent to participate

The study was approved by the National Medical Ethics Committee of the Republic of Slovenia (No. 0120-541/2017/6). Before the beginning of the course the participants received a letter describing the purpose and content of the study, informed consent form and data administration consent form, consistent with Global data protection regulation (EU) 2016/679. If needed, the participants were able to obtain a further explanation of the study by the research coordinator. All the information was translated to sign language by a certified sign interpreter.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

Design of the study, collection, analysis, and interpretation of data and writing the manuscript was done by the authors without any funding sources to be declared.

Authors' contributions

MS has contributed in the conception and design of the work, acquisition, analysis and interpretation of the data and has substantively revised the drafted work. ZŠ has contributed substantially to the conception and design of the work, the acquisition and interpretation of the data. BJ has contributed in the design of the work, acquisition, analysis and interpretation of the data. VBL contributed to the design of the work, analysis and interpretation of the data and has substantively revised drafted the work. VV has contributed substantially in acquisition, analysis and interpretation of the data. RP has contributed in the conception and design of the work, acquisition and interpretation of the data and has revised the drafted work. All authors read and approved the final manuscript.

Acknowledgements

We would like to thank all participating deaf societies in Slovenia for making the sampling possible.

References

1. Grasner JT, Lefering R, Koster RW, Masterson S, Bottiger BW, Herlitz J, et al. EuReCa ONE-27 Nations, ONE Europe, ONE Registry: A prospective one month analysis of out-of-hospital cardiac arrest outcomes in 27 countries in Europe. Resuscitation 2016;105:188-95.
2. Perkins GD, Handley AJ, Koster RW, Castren M, Smyth MA, Olasveengen T, et al. European Resuscitation Council Guidelines for Resuscitation 2015: Section 2. Adult basic life support and automated external defibrillation. Resuscitation 2015;95:81-99.
3. Greif R, Lockey AS, Conaghan P, Lippert A, De Vries W, Monsieurs KG, et al. European Resuscitation Council Guidelines for Resuscitation 2015: Section 10. Education and implementation of resuscitation. Resuscitation 2015;95:288-301.
4. Unnikrishnan R, Babu AS, Rao PT, Aithal V, Krishna HM. Training individuals with speech and hearing impairment in basic life support: A pilot study. Resuscitation 2017;117:e23-e24.

5. Kerber RE, Becker LB, Bourland JD, Cummins RO, Hallstrom AP, Michos MB, et al. Automatic external defibrillators for public access defibrillation: recommendations for specifying and reporting arrhythmia analysis algorithm performance, incorporating new waveforms, and enhancing safety. A statement for health professionals from the American Heart Association Task Force on Automatic External Defibrillation, Subcommittee on AED Safety and Efficacy. Circulation 1997;95:1677-82.
6. Sandroni C, Fenici P, Franchi ML, Cavallaro F, Menchinelli C, Antonelli M. Automated external defibrillation by untrained deaf lay rescuers. Resuscitation 2004;63:43-8.
7. Valli C LC, Mulrooney K. Linguistic of American sign language. 4 ed. Washington DC: Gallaudet University Press; 2005.
8. Holt JA. Stanford achievement test-8th edition: reading comprehension subgroup results. Am Ann Deaf Ref 1993;138:172-75.
9. Margellos-Anast H, Estarziau M, Kaufman G. Cardiovascular disease knowledge among culturally Deaf patients in Chicago. Prev Med 2006;42:235-9.
10. Pollard RQ, Barnett S. Health-related vocabulary knowledge among deaf adults. Rehabil Psychol 2009;54:182-5.
11. Smith SR, Samar VJ. Dimensions of Deaf/Hard-of-Hearing and Hearing Adolescents' Health Literacy and Health Knowledge. J Health Commun 2016;21:141-54.
12. Smith SR, Kushalnagar P, Hauser PC. Deaf Adolescents' Learning of Cardiovascular Health Information: Sources and Access Challenges. J Deaf Stud Deaf Educ 2015;20:408-18.
13. Borovnik Lesjak V, Sorgo A, Strnad M. Development, validation and assessment of the test on knowledge about basic life support and use of automated external defibrillator among schoolchildren. Scand J Trauma Resusc Emerg Med 2019;27:114.
14. Rihtar A. Level of knowledge of basic resuscitation procedures with the use of the automated external defibrillator at lay persons before and after 2-hour education. Maribor: University of Maribor; 2019.
15. Tomasetti JA, Beck KH, Clearwater HE. An analysis of selected instructional methods on cardiopulmonary resuscitation retention competency of deaf and non-deaf college students. Am Ann Deaf 1983;128:474-8.
16. Muller MP, Poenicke C, Kurth M, Richter T, Koch T, Eisold C, et al. Quality of basic life support when using different commercially available public access defibrillators. Scand J Trauma Resusc Emerg Med 2015;23:48.
17. Beck KH, Tomasetti JA. A national survey of cardiopulmonary resuscitation training for the deaf. Am Ann Deaf 1983;128:909-12.
18. Bavelier D, Tomann A, Hutton C, Mitchell T, Corina D, Liu G, et al. Visual attention to the periphery is enhanced in congenitally deaf individuals. J Neurosci 2000;20:RC93.
19. Dye MW, Hauser PC, Bavelier D. Is visual selective attention in deaf individuals enhanced or deficient? The case of the useful field of view. PLoS One 2009;4:e5640.

20. Dye MW, Baril DE, Bavelier D. Which aspects of visual attention are changed by deafness? The case of the Attentional Network Test. Neuropsychologia 2007;45:1801-11.
21. Dye MW, Hauser PC. Sustained attention, selective attention and cognitive control in deaf and hearing children. Hear Res 2014;309:94-102.
22. Horn DL, Davis RA, Pisoni DB, Miyamoto RT. Development of visual attention skills in prelingually deaf children who use cochlear implants. Ear Hear 2005;26:389-408.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplTableA.docx