



Research in the Problems of Publicly Accessible Automated External Defibrillators in the Municipality of Příbram

Výskum problémov verejne prístupných automatizovaných externých defibrilátorov v obci Příbram

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Abstract:

Progress today brings a number of improvements - more efficient procedures, devices or support. One of these inventions is the automated external defibrillator (AED) and its extension to public space. A number of programs and grants are underway to address the deployment of the Public Access AED. Their usual goal is to increase the number and availability of these devices and to increase citizens' awareness of their use.

This work aims to evaluate the adequate availability of AEDs in the community and associated spent public and private financial resources for the acquisition of publicly accessible AEDs. At the same time, it evaluates the associated expenses and financial demands of the sustainability of AED projects. The initial survey was conducted in the central Bohemian municipality of Příbram.

The results of the work showed a good level of coverage of Příbram by AED devices, but, however, worse accessibility for lay rescuers. From the point of view of long-term sustainability, a program was created for the acquisition of an AED without a technical



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connection to the possibilities of the emergency medical service. This increases the financial demands on the private and healthcare sectors in the case of using AEDs. In the long term, the city lacks a vision for the further development of the AED program, incl. incentives for private actors and addressing the sustainability of funding.

Keywords: balance sheet; automated external defibrillator (AED); public availability; finance; integrated rescue system

Abstrakt:

Pokrok v súčasnosti prináša množstvo zlepšení – efektívnejšie postupy, prístroje alebo podporu. Jedným z takýchto vynálezov je automatický externý defibrilátor (AED) a jeho rozšírenie do verejného priestoru. Prebiehajú programy a granty, ktoré sa venujú rozmiestňovaniu verejne prístupných AED. Ich obvyklým cieľom je zvýšiť počet a dostupnosť týchto prístrojov a rozširovať povedomie občanov o ich použití.

Práca si kladie za cieľ zjednotiť adekvátnu dosiahnuteľnosť AED v obci a s tým spojených vynakladaných verejných a súkromných finančných prostriedkov na zaobstaranie verejne prístupných AED. Zároveň hodnotí s tým spojené výdaje a finančnú náročnosť udržateľnosti projektu AED. Prvotný výskum bol uskutočnený v stredočeskej obci Příbram.

Výsledky práce preukázali dobrú úroveň pokrytia oblasti Příbrami prístrojmi AED, ale horšiu dostupnosť pre laikov. Z pohľadu dlhodobej udržateľnosti vznikol program na obstarávanie prístrojov AED bez technického prepojenia na možnosti zdravotníckej záchrannej služby. Tým sa zvyšuje finančná náročnosť na súkromný aj zdravotný sektor v prípade použitia AED. V dlhodobom horizonte chýba mestu vízia rozvoja programu AED, vrátane stimulov pre súkromné subjekty a riešenia dlhodobej udržateľnosti financovania projektu.

Kľúčové slová: *rozvaha, automatický externý defibrilátor (AED), verejná dostupnosť, financie, integrovaný záchranný systém*

Introduction

Description of the investigated locality - Příbram is a municipality with extended powers and at the same time a district town in the southwestern part of the Central Bohemian Region. According to statistics from the end of 2019, it has a population of 32.5 thousand. 63.4% of the population is aged 15-64 and 21.8% are in the age group over 65. The territory of the village is relatively small and rugged. The total area of the city is 33.41 km². In general, it can be stated that the population density and the presence of larger objects decrease from the centre towards the borders [1]. Příbram was chosen due to the relatively higher percentage of seniors in the population and with only one registered AED. The purpose of locating the AED in Příbram is to be able to provide adequate and effective first aid to people affected by sudden circulatory arrest (SCA). However, there is no universal key to choosing where the location of the AED is appropriate. The number of variables is unique in each municipality (base of the emergency medical service, places of the highest concentrations of people, access roads, rugged terrain). Despite the fact that we cannot accurately predict the time or place where the emergency will occur. [2]

1. Material and Methods

During the survey in the village of Příbrami, methods of analysis, synthesis and comparison of the obtained data were used. They were also used as complementary hermeneutic methods.

The current state of equipment of the municipality of Příbrami AED was ascertained by its own survey - interviewing public institutions, private entities, field research and local knowledge were used.

The city of Příbram, nor any other important public institution in Příbram, does not have its own analysis of specific places with a quantification of the number of inhabitants occurring in these localities, from which one could directly start. On this basis, the selection of places with the highest concentrations of inhabitants in the city was made by comparing several groups of data: the situation in other similarly large municipalities in the Czech Republic (20-50 thousand inhabitants); the most frequently recommended localities according to the Guidelines for Resuscitation 2015; expert opinion of the Police of the Czech Republic - Territorial Department of Příbram and Municipal Police of Příbram; own local knowledge.

For comparison, the municipalities of the Czech Republic were selected according to the current data of the Czech Statistical Office with the selection criterion of the number of inhabitants in the range of twenty to fifty-thousand. There are a total of 44 municipalities, including Příbram. From the largest publicly available AED database in the Czech Republic, the AED Map, managed by the Rescue Application (www.zachrankaapp.cz), data on the number and location of AEDs in these municipalities and on the specific types of defibrillators used were obtained.

The analysis of the financial costs associated with the acquisition and sustainability of selected AEDs was determined on the one hand on the basis of data obtained in the AED database, where a list of the most frequently used devices was created. An analysis of the approximate financial costs associated with the acquisition and operation of the AED was prepared for this list. Common, publicly available offers on the market were used in setting the prices. Manufacturers have chosen different solutions for the design and distribution of the device, the price of the device itself may not reflect its quality or cost in the long term. For this reason, two areas of cost savings have been identified:

1. acquisition costs AED and its ten-year operation without the use of instruments - Apart from the acquisition costs are added to the cost of buying new electrodes and power sources after their expiration;
2. disposable (per use) cost of AED - determines the cost of replacing the source electrode and after using the device.

Two subcategories have been identified for both areas, namely the basic set, which means standard equipment for the adult patient. The extended set consists of a device configured for paediatric patients.

2. Results and discussion

During the investigation, it was found that there are currently 12 AEDs in the cadastre of the municipality of Příbram. Of the total number of 12 pieces, only 3 are located in a specific place (stationary) - 2 pcs Philips HeartStart FRx AED and 1 AED HeartSine PAD 350P AED. The remaining 9 Philips HeartStart FRx devices are

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mobile. However, the publicly traceable AED is only 1 piece, which is registered in the "Záchranka" application.

The city has no program or concept of publicly available AEDs. The only AED registered in the "Záchranka" application is an AED located in the infirmary of the Příbram Aquapark.

The municipal authority, the Police and the municipal police have no precise analysis that would specifically describe or determine the places with the highest concentrations of people in the municipality.

None of the listed AEDs are fully publicly accessible - limited to the departure of the component or opening hours. Today's AEDs are modern devices, designed to be highly reliable and tolerate rough handling. Their development and production are expensive, which is naturally reflected in their price. However, the price of the device itself is not final and the cost of operating it must be considered when purchasing these devices. Table 1 shows the approximate prices of selected devices and spare main parts that need to be changed after expiration.

Table 2 elaborates the costs of ten years of operation without the use of the device and separately the costs associated with one use of the device. The cost of disposing of the device considers the replacement of electrodes and power source. However, it is not necessary to replace the power supply after each use. It should be emphasised that prices are obtained from publicly available sources and do not reflect any contract prices.

Tab. 1 - Overview of approximate costs of acquisition of selected AEDs and spare main components (own source)

AED		Power source		Electrodes		Paediatric electrodes	
Manufacturer and type	Informative price [EUR] *	Informative price [EUR] *	Lifespan [years]	Informative price [EUR] *	Lifespan [years]	Informative price [EUR] *	Lifespan [years]
Philips HeartStart FRx	1 460	150	4	75	2	140 *****	-
Zoll AED Plus	1 830	30 **	10 **	170	5	170	5
Zoll AED 3	2 510	150	5	170	5	0 *****	-
Physio Control Lifepak 1000	2 090	310	5	40	2	150	2
Physio Control Lifepak CR	1 650	0 ***	2	220	2	150 ***	2
Physio Control HeartSine Pad 350P	1 140	0 ***	4	200	4	220 ***	4

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Physio Control HeartSine Pad 500P	1 740	0 ***	4	200	4	220 ***	4
METsis LifePoint PRO	1 020	120	5	100	2	100	2

* Rounded to tens, including VAT according to the conditions of the Czech Republic, from publicly available offers on the market (www.alfarescue.cz, www.happyend.cz).

** Uses 10 pcs of commonly available 123A batteries, the specific price varies, on average 60 CZK / piece; stated service life approx. 10 years.

*** Replacement power supply and electrodes are sold together.

**** The same electrodes for adult and paediatric patients, switching to paediatric mode using a special key (one-time investment).

***** The same electrodes for adult and paediatric patients, switching to children's mode by pressing the button on the device.

Tab. 2 - Indicative costs of acquiring the AED and its 10 years of operation and indicative costs associated with one use of the AED (own source)

AED	Cost of basic set ** for 10 years without use [EUR] *	Extended set cost ** for 10 years without use [EUR] *	Disposable costs - adult patient [EUR] *	Disposable costs - paediatric patient [EUR] *
Philips HeartStart FRx	2 260	2 390	220	220
Zoll AED Plus	2 200	2 540	200	200
Zoll AED 3	3 140	3 140	320	320
Physio Control Lifepak 1000	2 890	3 630	350	460
Physio Control Lifepak CR	2 740	3 480	220	370
Physio Control HeartSine Pad 350P	1 720	2 380	200	220
Physio Control HeartSine Pad 500P	2 330	2 990	200	220

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METsis LifePoint PRO	1 720	2 190	210	210
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* Rounded to tens, including VAT according to the conditions of the Czech Republic, from publicly available offers on the market (www.alfarescue.cz, www.happyend.cz).

** The basic set is the AED in the basic configuration, in most cases intended for adult patients; An extended set is a device in a configuration for paediatric patients.

The devices that most often occur in the compared municipalities were selected for the overview of financial costs. The only device that does not occur in the compared municipalities, but was included in the analysis of financial costs is the Zoll AED 3. This device was included because it offers a very practical solution. As the only available defibrillator that is adapted for use on both adult and paediatric patients without the need for additional equipment, such as special baby pads or a means of switching the device to paediatric mode.

From a purely financial point of view, the cheapest of the selected AEDs is LifePoint PRO from METsis. In the horizon of ten years of costs without the use itself, the cheapest solution is again LifePoint PRO, closely followed by the HeartSine PAD 350P defibrillator from Physio Control. If we count ten years of operation with one use of the device, the cheapest variant of the HeartSine PAD 350P is closely followed by LifePoint PRO.

When selecting a specific AED, it is also a good idea to choose a device whose electrodes are compatible with the defibrillators and vital signs monitors that the emergency system is equipped with. When this condition is met, the patient can be quickly connected to professional emergency medical equipment without the need to connect other electrodes. This will allow care to be provided without unnecessary time delays. By using compatible devices, it is also possible to reduce operating costs. Therefore, it is necessary to take the expansion of stationary AEDs in the context of safety economics and to take into account these elements of population protection in the context of disaster economics. [3]

According to the Guidelines for Resuscitation 2015 – Czech abridged translation published in a special issue of the journal *Urgentní medicína* [4] the number of patients with heart failure with shockable rhythms is generally higher in public places and at the same time more potentially rescue patients are in households. However, the use of AEDs in the home environment is very limited, so most programs and research focus on publicly available AEDs. [5]

According to the experience of the capital city of Prague, it is possible to approximately determine the actual use of publicly available AEDs. Hanko (2018) states that there are approximately 600 sudden cardiac arrest a year in the territory of Prague, and only one third of them have a public access defibrillator available nearby that can be used. In the vast majority of cases, defibrillation in Prague is performed directly by emergency medical services. Use by lay rescuers is rare, in units of cases per year. According to rescuers in Prague, mobile defibrillators make the most sense. Their experience shows that SCA occurs more in places outside the reach of stationary

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AEDs. [6] In SCA, the decisive factor is the speed of assistance, so the AED, which is only 500 m away from the scene, is far away. [7] However, it is necessary to realise that Prague and other large cities have a very dense network of emergency services bases and a high number of emergency services groups. In large cities, the validity of the location of stationary AEDs arises in the rugged and less accessible terrain, for example, the subway, technical areas, zoos, parks.

A similar finding as stated by Hanco can be found in the case of Brno and large cities in the South Moravian Region. In the entire South Moravian Region, approximately 700 people outside the hospital are affected by SCA every year, and approximately half of them die in the field. Only about 10% of those affected return to normal life. In Brno, according to Krejčí (2020), the rate of SCA in the home environment is approximately 80%. In Brno practice, as in Prague, it has been proven that if an AED is used, it is in most cases a mobile AED. The use of stationary is again only in units of cases. [8]

Data on the rate of SCA in the home environment are also described in Weitsfeld's study (2011), according to which most circulatory arrests take place in the home environment, which was also confirmed in Prague and Brno practice. These findings are also applicable in the case of Příbram. However, as mentioned in the 2015 Resuscitation Guidelines, the possibilities of using AEDs in the home environment are very limited, and most AED placement programs thus focus on public locations. [5, 9]

According to Krejčí (2020), Brno prepared and implemented a project to locate the AED in several phases. In the first phase, 13 AEDs were deployed in public places. The selection of specific places was based on the statistics of emergency medical service departures to the SCA and further the reach of the emergency medical service to specific places, similarly as in this work. The deployment was connected with a promotional campaign aimed at raising the company's awareness of the issue. In the second phase, other AEDs were placed, but above all private entities were approached in the form of a public call, some of which acquired their own AEDs and subsequently joined the already functioning system. In the third and fourth phases, the program was extended to the entire region and the Czech Republic was involved. Gradually, an AED network was created in the whole region, which currently provides widespread availability of AEDs approaching the 5-minute limit. [8]

From the experience of Prague and Brno, it can be concluded that mobile AEDs have a greater use. In Příbram, it is thus possible to evaluate the equipment of the Police of the Czech Republic and the Municipal Police of the AED positively, because practice shows that their use is probable.

Although the majority of applications are mobile AEDs, a network of stationary AEDs is developed in Prague and Brno. It can be stated that their deployment also makes sense and this approach should be followed in Příbram, especially in the case of emergencies, when the forces and resources of the IRS units would be currently exhausted. However, care must be taken to strike a balance between stationary and mobile AEDs so that their range does not unnecessarily overlap and so that funds are not wasted.

Experience from Prague and Brno also suggests that stationary AEDs can only be used if they are close to the places where the SCA occurred. This fact confirms the need to place a stationary AED based on a detailed assessment of the site in relation to local conditions. Such an approach was chosen in the solution of this work.

Based on a comparison of the number of AEDs in municipalities of similar size, it can be assumed that the current equipment of Příbram AED is at a good level. By

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recalculating the AED per thousand inhabitants, it was found that Jihlava is best equipped with 0.43 AEDs per 1,000 inhabitants. Příbram, with a conversion of 0.37 AED per 1,000 inhabitants, is in second place. There are 0.28 per 1,000 inhabitants of mobile AEDs in Příbram, which ranks it first among the compared municipalities, while on average there are 0.05 mobile AEDs per 1,000 inhabitants in these municipalities. By comparing the recalculation of mobile AEDs, Příbram can be evaluated as above-standard equipped in the conditions of the Czech Republic in comparison with similarly large cities.

An example of a necessary evaluation of the effectiveness of AED placement is the Příbram polyclinic. Placement of the AED in non-inpatient medical facilities, such as clinics or GP surgeries, is generally recommended. According to the claims of Šín et. al. (2014) 1.6% of sudden circulatory arrests occur in these facilities. However, these facilities are usually not equipped to provide adequate care in the case of SCA and the emergency services will intervene here as well. The Příbram polyclinic is located in close proximity to the emergency medical base. Theoretically, the emergency medical service would get to this place on foot as quickly as in a vehicle. It can also be expected that the medical staff present are sufficiently prepared to provide first aid until the arrival of the emergency medical service. This fact confirms that the blind placement of AEDs according to models from other cities or only on the basis of the Guidelines for Resuscitation 2015 is not a reasonable approach, but each site needs to be approached individually with an evaluation of specific local conditions. [10]

Also, according to Truhlář (2010), the placement of AEDs in places within easy reach of emergency medical services is irrelevant. One of the common causes of failure of publicly available AED programs is the inability to provide fast enough help to lay rescuers, and the time to automated defibrillation is comparable to emergency medical intervention. Specifically in the case of a polyclinic, although we can assume a relatively fast and correct use by medical staff, the polyclinic is still so close that the emergency medical service would be in place almost immediately. Other common causes of AED programmer failure include the low frequency of AED usage and cost inefficiencies, which can be accepted, and this approach has been used. [11]

To expand the network of mobile and stationary AEDs, there are possibilities to use programs for the placement of AEDs and contributions from higher administrative units (mainly regions). Hes (2018) states that in 2017, the Karlovy Vary Region managed to place 20 AEDs among the intervention groups of the Police of the Czech Republic, the Municipal Police and the Fire and Rescue Service. The EMS also provides them with regular training in emergency resuscitation and the use of AEDs. Another possibility may be, as stated by Krejčí (2020) in the AED Deployment project in Brno and the South Moravian Region, the distribution of costs between public institutions and private entities. In Brno, we also managed to acquire major companies as sponsors supporting the AED placement program. [8, 12]

Conclusion

It is necessary to ensure a balance in investments between stationary and mobile AEDs so that their range does not overlap and thus funds are not wasted unnecessarily. The AED network must be equivalent to the calculation of population density with a variable factor of the age of the population, terrain fragmentation and the availability of emergency services. The availability of the AED must be practically immediate as

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part of the provision of first aid, otherwise, according to the curve, the probability of survival or survival without serious consequences decreases by 10% with each minute.

The overall coverage of the AED in Příbram was shown to be at a good level within the monitored group. The AED program in Příbram was created without connection to the technical possibilities of the emergency medical service and thus increases the financial sustainability of the project. The financial costs of sustainability are also not kept in a separate chapter and there is a lack of further development of the AED program, incl. incentives for private entities.

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