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THE POTENTIAL FOR THE USE OF TELEMEDICINE TOOLS IN THE NATIONAL EMERGENCY MEDICAL SERVICE – A FORECAST OF A NEW SYSTEM ORGANISATION MODEL USING THE EXAMPLE OF POMORSKIE PROVINCE

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Abstract

Purpuse: The National Emergency Medical Service (NEMS) is facing financial and human resources problems and according to the Supreme Audit Office (SAO), the shortage of doctors and the financial problems will increase. The purpose of the paper is to show that the introduction of live streaming to the Emergency Medical Teams (EMTs) will mitigate the problems resulting from the shortage of medical staff and will significantly reduce the cost of maintaining the operational readiness of the EMTs.
Methodology: The paper is based on applicable legislation and the Provincial Action Plan of the NEMS system for the Pomorskie Province. The forecast was prepared for the outlays and effects of the new organisation and operation of the NEMS system in Pomorskie Province.
Findings: The implementation of live streaming in Pomorskie Province would help reduce the cost of operation of the NEMS system in the province by PLN 10,190,800.00 per year. In addition, this tool would allow the system to operate with only 16 physicians employed, which corresponds to 10% of the current resources and about 90% of the physicians could be employed in other parts of the healthcare system.

Keywords: telemedicine, Emergency Medical Service, model of system

Klasyfikacja JEL: I 180; H 510;

Introduction

The NEMS is an important component of the healthcare system, as it is responsible for providing healthcare services in pre-hospital conditions and is one of the pathways that patients follow on their way to a hospital. Due to socio-economic development and a growing and aging population, the healthcare system requires reforms. In recent years, the healthcare system, including the NEMS, has been facing financial problems and a shortage of medical personnel, and the situation deteriorates year after year, as evidenced by statistics and reports from the SAO.

According to Statistics Poland [4], in 2020, the NEMS in Poland included 239 Hospital Emergency Departments, 21 Helicopter Emergency Medical Service (HEMS) teams, and 1581 Emergency Medical Teams (EMTs), of which 1238 were basic teams - without physicians on board (B) and 343 were specialised teams - with physicians on board (S). Although overall the number of units in the system has increased over the years, the number of specialised teams has decreased markedly, for as recently as in 2012 there were as many as 614 of them [5]. According to a report by the SAO [6], the NEMS system suffers from a number of problems, the vast majority of which are related specifically to the EMTs. Critical comments were noted regarding, among other things, exceeding the statutory median time to arrival of EMTs, and staff shortages – mainly a shortage of physicians in the system, which, according to the SAO, will increase in the future – and financial problems. Therefore, it is essential for the NEMS to ensure effective provision of aid with optimal use of the system's resources.

1. Purpose of the paper

The purpose of this paper is to identify the potential for the use of telemedicine tools in the NEMS system, and thus to indicate that the introduction of live streaming in EMTs will reduce the scale of the shortage of medical personnel, both within the NEMS and the healthcare system as a whole, and will significantly reduce the operational readiness costs of the EMTs. Based on the data and organisational structure of the NEMS system in Pomorskie Province in terms of the number of medical personnel employed, the number of units in the system, and the cost of operational readiness of the EMTs, the study made projections about the costs and benefits of a wider introduction of telemedicine tools in the NEMS. Moreover, the assumption of the paper is to provide a basis for discussion on solving the current problems of NEMS functioning.

2. Materials and methods

The basis for the operation of the NEMS is the Act on National Emergency Medical Service, which stipulates that it is the responsibility of the provincial governor to develop a plan for the operation and financing of the NEMS. The plan must specify, among other things [1]:

- the number and distribution of the system's units in the province,
- the areas of operation and the operational regions,
- the calculation of the costs of the operation of EMTs.

The plan of operation of the NEMS in Pomorskie Province was used as the basis for the study. A projection of the costs and benefits of a wider introduction of telemedicine tools in the NEMS was carried out based on a case study of the NEMS system in Pomorskie Province, specifically of the EMTs operational and medical personnel working there. Organisational conditions, cost levels, and prices in effect in 2021 were utilised when carrying out the projection. Reports, statistics, applicable legislation, and the Provincial Plan of Operation for the NEMS System in Pomorskie Province, prepared by the organiser of the NEMS system – the provincial governor – were used to achieve the objective. In addition, official product information made available by the manufacturer of a monitor/defibrillator was also used, as well as information on

the results of bidding procedures carried out in 2021, allowing further projection of the cost of implementation of the system in question.

According to the plan of operation of the NEMS for Pomorskie Province dated July 15, 2021 [2], prepared by the Pomorskie Province Governor's Office in Gdańsk, the structure of the NEMS system was as follows (Table 1).

Table 1. Structure of the NEMS system in the Pomorskie Province in 2021

	EMT		HEMS	Emergency Dept.	Medical Dispatch Centres
	S	B			
Number of units	20	76	1	13	2
Physicians	160		7	344	0
Nurses	28		0	299	80
Paramedics	941		9	331	
TOTAL	**1,129**		**16**	**974**	**80**

EMS - Emergency Medical Teams, S - Specialised; B - Basic; HEMS - Helicopter Emergency Medical Service

Sourse: Plan działania systemu Państwowe Ratownictwo Medyczne dla Województwa Pomorskiego z dnia 15 lipca 2021 roku, Pomorski Urząd Wojewódzki w Gdańsku, https://uwgdansk.bip.gov.pl/ratownictwo-medyczne-wbizk/wojewodzki-plan-dzialania-systemu-panstwowego-ratownictwa-medycznego.html (dostęp: 21.12.2022).

In its financial aspects (by March 15 of the year preceding the financial year), the plan is submitted to the Minister of Health, and the allocation of funds is made through the relevant branch of the National Health Fund (NHF), which receives funds from the province governor in the form of an earmarked grant and enters into a contract with the dispatcher of EMTs to carry out Emergency Medical Activities (EMA). The dispatchers are paid a daily lump sum, which in turn depends on whether the team is specialised or basic. From October 1, 2021, the fee rate for the services provided by basic and specialised EMTs – the so-called day-ambulance rate – stood at PLN 5,583 for an S team and PLN 4,187 for a B team [1, 3].

Another basis for the study was the legal conditions for Emergency Medical Activities (EMAs), according to which some EMAs can be performed by paramedics and nurses working in the system independently, without a physician's order. The Regulation on emergency medical activities and health services other than emergency medical activities that may be provided by a paramedic [7] distinguishes thirty such activities, including manual defibrillation based on an ECG or cardiac monitor recordings, preparation and evaluation of ECG recordings, determination of critical parameters, and administration of 47 medications. However, according to these regulations, the application of certain medications must be preceded by a streaming of the ECG examination. The physician receiving the streaming evaluates the ECG remotely before issuing an order, which explicitly indicates the need for telemedicine solutions. The Regulation also lists the EMAs that can be performed by a paramedic based on a physician's order and does not exclude the possibility of issuing such an order remotely.

The devices that are obligatorily required to be included in the equipment of each EMT, including devices for assessing vital signs, performing ECGs, and streaming vital signs, are specified in Annex 3 to the Order of the President of the National Health Fund [8]. Although a defibrillator and a monitor are required as mandatory equipment of each ambulance of the NEMS system, they can be one integrated device. The monitors/defibrillators on the market today are not only a combination of devices that allow the analysis of a patient's heart rate and the performance of electrotherapy, but also offer the possibility of collecting a much broader

spectrum of vital signs. In addition, the latest devices of this type allow to perform live streaming of the patient's vital signs (ECG curves, body temperature, heart rate, saturation [SpO2], end-tidal carbon dioxide [EtCO2], and number of breaths per minute). In addition to these, the physician can also view ECG recordings made with the monitor/defibrillator, and non-invasive blood pressure [NIBP] measurements as well as alarms and a trends report. Thus, this device brings unprecedented possibilities for the physician to remotely assess the patient's vital signs in real time [9].

When analysing three sample tenders for the supply of defibrillators for EMTs (which also have an advanced monitor function), published in 2021 [10, 11, 12], one can assume the following average price of these devices and the cost of their implementation with a live streaming system for all EMTs in Pomorskie Province (Table 2).

Table 2. Simulation of the implementation of live streaming in Pomorskie Province

Monitor/Defibrillator					
Contracting Authority in 2021	**Quantity (pcs.)**	**Total value in PLN**	**Unit price in PLN**	**Average unit price in PLN**	**Cost for 96 EMTs in PLN**
Pleszewskie Centrum Medyczne	1	89,763.23	89,763.23	95,329.84	9,151,664.32
Szpitale Pomorskie	2	182,952.00	91,476.00		
WPR SPZOZ in Lublin	3	314,250.84	104,750.28		
Cost of annual license in PLN (10% of device value)				9,532.98	915,166.43
			TOTAL:	**104,862.82**	**10,066,830.75**

Sourse: *Pleszewskie Centrum Medyczne w Pleszewie Sp. z o.o., Znak sprawy Te 2300-28/2021 z 22.12.2021 r.,* Pozyskano z: http://www.szpitalpleszew.pl/przetargi.php?nrz=885 (21.12.2022);
Szpitale Pomorskie Sp. z o.o., Znak sprawy D25C/252/N/8-20rj/21 z 27.05.2021 r., Pozyskano z: https://www.platformazakupowa.pl/transakcja/463612 (dostęp: 21.12.2022);
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As live streaming is an innovative technology not yet implemented in the country, for the purposes of the study, the annual cost of the transmission license was assumed to be 10% of the average value of a monitor/defibrillator, i.e., PLN 9,532.98. The total cost of the device together with a one-year license for live streaming is therefore PLN 104,862.82 for one EMT, which translates into PLN 10,066,830.75 for all teams operating in Pomorskie Province.

3. Results

Based on the assumptions outlined above, a projection has been made for the conversion of Specialised Emergency Medical Teams into Basic Teams and for the implementation of telemedicine solutions for these teams in the form of live streaming of vital signs. The conversion into basic teams of the twenty specialised teams operating in Pomorskie Province will result in significant personnel changes in the entire NEMS system in Pomorskie Province (Table 3).

Table 3. Change in the personnel structure of the NEMS system

	EMT		HEMS	Emergency Dept.	Medical Dispatch Centres
	S	B			
BEFORE THE CONVERSION					
Number of units	20	76	1	13	2
Physicians	160		7	344	0
Nurses	28		0	299	80
Paramedics	941		9	331	
TOTAL	**1,129**		**16**	**974**	**80**
AFTER THE CONVERSION					
Number of units	0	96	1	13	2
Physicians	0		7	488	16
Nurses	28		0	299	80
Paramedics	941		9	331	
TOTAL	**969**		**16**	**1,118**	**96**

EMS - Emergency Medical Teams, S - Specialised; B - Basic; HEMS - Helicopter Emergency Medical Service
Sourse: Own study.

Conversion of an S EMT into a B EMT would reduce the number of team personnel from 1,129 to 969, while maintaining the same number of ambulances. Of the 160 physicians working in the EMTs in Pomorskie Province at present, 144 (90%) could support Hospital Emergency Departments (HEDs) and/or other hospital departments facing a shortage of physicians, thus strengthening the region's healthcare system. HEDs would thus become the units of the NEMS system employing the largest number of medical personnel. The remaining 16 physicians (10%) would continue to support the EMTs with their knowledge and experience by remotely consulting patients' vital signs information provided by live streaming and making recommendations to the paramedics and nurses working in the system, from a telemedicine centre operating, for example, within the Medical Dispatch Centre.

Involving 16 physicians to work with live streaming at the telemedicine centre would require the creation of three new stations. As a general rule, each physician would work in a 12-hour shift system: a day shift followed by night shift on the following day, with a minimum of 48 hours off afterward. Given the standard working time (up to 37 hours and 55 minuts per week), each station would be manned by at least five rotating physicians (5 FTEs) to prevent overtime, making a total of 15 employees at three stations, plus one additional employee in case of the absence any of the other employees. It is assumed that these stations would be designed to handle only telemedicine live streaming from EMTs. With live streaming from a monitor/defibrillator, each station would have the ability to handle at least several incidents per hour, which, with three stations available, provides an unprecedented ability to provide medical consultations within EMTs in the entire province. Assuming an average remote consultation time of 10 minutes (6 cases per hour), the daily capacity of the three telemedicine stations could be as high as 432 consultations (432 patients), which, compared with the capacity of the 20 existing Specialised Teams, is a significant increase in the capacity of the NEMS system in the province.

In addition to personnel changes in the NEMS system, the conversion of the EMTs would also involve a change in the cost of their operation resulting from the daily flat rate (Table 4).

Table 4. Change in the cost of operation of EMTs

Alternative	EMT		Number of EMTs	Costs in PLN		
		Day-ambulance rate		Daily	Annually	5 years
A	S	PLN 5,583.00	20	111,660.00	40,755,900.00	203,779,500.00
	B	PLN 4,187.00	76	305,651.00	105,531,241.50	527,656,207.50
	TOTAL:		**96**	**417,311.00**	**146,287,141.50**	**731,435,707.50**
B	S	PLN 5,583.00	0	0.00	0.00	0.00
	B	PLN 4,187.00	96	389,391.00	136,096,342.00	680,481,708.00
	TOTAL:		**96**	**389,391.00**	**136,096,341.50**	**680,481,707.50**
A - B			**TOTAL:**	**27,920.00**	**10,190,800.00**	**50,954,000.00**

A - current cost of operation of EMTs; B - cost of operation of EMTs after the conversion
Sourse: Own study.

The alternatives presented in Table 4, namely A – the current cost of operation of EMTs, and B – the cost after the conversion of S EMTs into B EMTs –differ by the value of the daily lump sum rate for the 20 converted teams. This change would result in a savings of PLN 1,396.00 per team, which means that by converting 5 Specialised Teams, the system would save the amount of PLN 6,980.00 per day, which would be more than sufficient to finance the operation of an additional, sixth B EMT. Also included in both alternatives are the costs of operational readiness of Basic Teams operating only seasonally in the province. The conversion of 20 S EMTs into B EMTs would result in savings for the province of PLN 27,920.00 per day, which translates into PLN 10,190,800.00 per year. Over a period of five years, the total savings could be as high as PLN 50,954,000.00.

In order for the above changes to be implemented and, thus, the live streaming telemedicine tool to be available to the same extent in all EMTs in Pomorskie Province, it may be necessary to replace the fleet of defibrillators/monitors with new ones. This would involve the purchase of technologically adapted defibrillators/monitors and a transmission license. The one-time cost of implementation of these elements for the 96 EMTs would be PLN 10,066,830.75. In subsequent years, the use of the system would involve only renewing the subscription (license), the annual cost of which is PLN 915,166.43, with no additional purchases required. The conversion of Specialised Teams into Basic Teams, on the other hand, would bring annual savings of PLN 10,190,800.00 in the cost of operation of the NEMS system in Pomorskie Province (Table 5).

Table 5. The cost of implementation of a live streaming system

		Costs before the conversion	5-year simulation	Conversion	After the conversion	5-year simulation
EMT	**S**	40,755,900.00	203,779,500.00	0.00	0.00	0.00
	B	105,531,241.50	527,656,207.50	136,096,341.50	136,096,341.50	680,481,707.50
TOTAL:		**146,287,141.50**	**731,435,707.50**	**136,096,341.50**	**136,096,341.50**	**680,481,707.50**
Cost of equipment		0.00	0.00	9,151,664.32	0.00	0.00
Licenses		0.00	0.00	915,166.43	915,166.43	4,575,832.15
TOTAL:		**0.00**	**0.00**	**10,066,830.75**	**915,166.43**	**4,575,832.15**
TOTAL:		**146,287,141.50**	**731,435,707.50**	**146,163,172.25**	**137,011,507.93**	**685,057,539.65**

Sourse: Own study.

The cost of implementation of a live streaming system can be more than returned, as it will result in a one-time savings of PLN 123,969.25 in the year of the conversion. These funds could cover the cost of setting up 3 new telemedicine centre stations and the purchase of at least the necessary ICT and computer equipment and office supplies as well as cover other costs not included in the calculations presented herein.

4. Discussion

The introduction of live streaming within the structures of the NEMS system in Pomorskie Province requires formal changes and replacement of all monitors/defibrillators that are currently used by EMTs. To this end, it will be necessary to carry out a market analysis and, on its basis, to secure appropriate funds to make this purchase as well as to estimate the time necessary for the transformation of the system.

The process of replacement of the equipment will need to be extended over time due both to formal reasons relating to the need to, at a minimum, prepare and carry out tender procedures, and to the difficulty for potential suppliers to deliver such a sizable number of devices. To streamline the system transformation process, it may be necessary to gradually replace the equipment and systematically train the personnel, establish a streaming reception centre, and finally gradually convert S teams into B teams and carry out a migration of the human resources.

Both during the implementation of the system and once it is fully operational, it may be necessary to obtain simultaneously more consultations than the capacity of the telemedicine center allows. The on-site EMTs should reassess the availability of another center or follow the procedures as before (without live streaming system availability). In this case, based on the experience gained and separate research, setting up additional live streaming service stations should be considered.

Although the current legislation allows for the implementation of a live streaming system in the NEMS, an amendment of the applicable law would make it possible to further expand the scope of emergency medical activities carried out by paramedics and nurses working in the system. This would enable the performance by the above professional groups of such procedures as endotracheal intubation, on a much broader scale than is currently the case (in the 20 S-type EMTs), and expand the list of available medications. At the same time, this would not reduce the level of the services performed by the EMTs despite the shortage of medical staff.

5. Conclusions

The implementation of live streaming within the Pomorskie Province would make it possible to convert all 20 Specialised Teams into Basic Teams, which would directly contribute to a reduction of the cost of operation of emergency medical teams. By eliminating the S-type teams, which are much more expensive to operate, an annual savings of PLN 10,190,800.00 can be achieved. In addition, the changes would allow for the allocation of the physicians working in EMTs in Pomorskie Province. With the ability to transmit vital signs in real time, 144 physicians could be employed, for example, in Hospital Emergency Departments, thus strengthening the health care system. The 16 doctors working at the telemedicine centre's 3 stations would also have the ability to remotely support EMTs when assisting up to 432 patients per day. This would eliminate both the shortage of medical staff in the NEMS and in the healthcare system as a whole, since the live streaming of the patient's vital signs would be received by a physician employed in the telemedicine centre, who would assess the patient's clinical condition based on this information and order the appropriate treatment, including the transport destination and the administration of medicines. In addition, by expanding the scope of the Emergency Medical Activities, the healthcare services provided by the EMTs would compensate for the shortage of medical personnel by even raising the current level of the services provided. Thus, this solution makes it possible to provide effective assistance with optimal use of the system's resources. Live streaming provides therapeutic, logistical, staffing, and economic benefits alike. Its nationwide implementation would thus be a kind of remedy for the problems afflicting the NEMS system that have been outlined in the SAO report.

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POTENCJAŁ WYKORZYSTANIA NARZĘDZI TELEMEDYCZNYCH W PAŃSTWOWYM RATOWNICTWIE MEDYCZNYM - PROGNOZA NOWEGO MODELU ORGANIZACJI SYSTEMU NA PRZYKŁADZIE WOJEWÓDZTWA POMORSKIEGO

Streszczenie

Cel: Państwowe Ratownictwo Medyczne, boryka się z problemami natury finansowej oraz niedoborem kadry lekarskiej, które corocznie narastają, czego dowodzą dane statystyczne i raporty Najwyższej Izby Kontroli (NIK). Celem pracy jest wskazanie, iż wprowadzenie do Zespołów Ratownictwa Medycznego (ZRM) rozwiązania w postaci streamingu live pozwoli na zmniejszenie skali niedoboru kadry lekarskiej oraz na istotne zmniejszenie kosztów utrzymania gotowości operacyjnej Zespołów Ratownictwa Medycznego.
Materiał i metody: Praca powstała w oparciu o studium przypadku systemu Państwowego Ratownictwa Medycznego w województwie pomorskim. Bazując na aktach prawnych oraz Wojewódzkim Planie Działania systemu PRM dla województwa pomorskiego dokonano projekcji nakładów i efektów nowej organizacji i funkcjonowania systemu Państwowego Ratownictwa Medycznego w województwie pomorskim.
Wyniki: Wdrożenie streamingu live na obszarze województwa pomorskiego przyczyniłoby się do obniżenia kosztów działalności systemu PRM w województwie o 10 190 800,00 zł w skali roku. Ponadto narzędzie to pozwala na funkcjonowanie systemu w oparciu o zatrudnienie jedynie 16 lekarzy, tj. 10% względem obecnych zasobów oraz konwersję Zespołów Specjalistycznych w Zespoły Podstawowe, co przyczynia się bezpośrednio do obniżenia kosztów funkcjonowania systemu. Dzięki transmisji parametrów życiowych w czasie rzeczywistym, ok 90% lekarzy mogłoby znaleźć zatrudnienie w innych obszrach systemu ochrony zdrowia.

Słowa kluczowe: telemedycyna, Państwowe Ratownictwo Medyczne, model systemu

JEL classification: **I 180; H 510;**

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