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PREPARATION OF AN ENTERPRISE FOR EMERGENCY SITUATIONS AND THEIR BETTER COMMUNICATION

PRZYGOTOWANIE PRZEDSIĘBIORSTWA PRODUKCYJNEGO NA SYTUACJE AWARYJNE I LEPSZA KOMUNIKACJA DOTYCZĄCA SYTUACJI AWARYJNYCH W PRZEDSIĘBIORSTWIE

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Summary: The article presents issues related to emergency situations, referring to legal and normative requirements (in particular ISO 45001 and ISO 14001). After defining what an emergency situation is and indicating the differences between it and a crisis situation, arguments in favour of preparing companies for such situations were presented. In order to identify those threats that may cause an emergency situation, the threats were identified and risk assessed using a matrix method used by the Government Security Centre, modified for the purposes of research. This was followed by detailed guidelines for the drafting of the procedures to ensure its completeness, and a general scheme for it was proposed. Finally, technological proposals to improve communication and facilitate access to emergency procedures were presented and conclusions drawn.

Keywords: emergency situation, accident, safety, risk assessment, communication.

Streszczenie: W artykule przedstawiono zagadnienia związane z sytuacjami awaryjnymi, nawiązując do wymagań prawnych oraz normatywnych (szczególnie ISO 45001 oraz ISO 14001). Po zdefiniowaniu, czym jest sytuacja awaryjna, oraz wskazaniu różnic między nią a sytuacją kryzysową przedstawiono argumenty przemawiające za przygotowaniem przedsiębiorstw na takie sytuacje. Aby wyodrębnić te zagrożenia, które mogą wywołać sytuację awaryjną, wykonano identyfikację zagrożeń oraz ocenę ryzyka przy wykorzystaniu metody matrycowej, stosowanej przez Rządowe Centrum Bezpieczeństwa, zmodyfikowanej na potrzeby badań. Następnie wyszczególniono wytyczne dotyczące sporządzania procedur, które zapewnią jej kompletność, oraz zaproponowano jej uniwersalny schemat. Na zakończenie

przedstawiono propozycje technologiczne ułatwiające komunikację i dostęp do procedur awaryjnych oraz sformułowano wnioski.

Słowa kluczowe: sytuacja awaryjna, awaria, bezpieczeństwo, ocena ryzyka, komunikacja.

1. Introduction

Regardless of size, in almost every mechanized company there is a possibility of an accident which can have a serious impact on machines, materials and equipment, but also on the population and the environment. This is not only about stoppages at work or costs associated with the removal of faults, but also about the safety of employees and the impact on the environment. In order to ensure a high level of safety, it is necessary to prevent the emergence of hazards through the preparation of emergency plans and continuous monitoring of the implemented actions. Properly prepared procedures with which employees have been familiarized and trained in advance, in the event of a hazard enable a proper response and may contribute to the elimination or reduction of losses resulting from an accident [Ewertowski 2018].

When dealing with the subject of an accident in the company, it is necessary to explain what is meant by an emergency situation. There are many definitions of an accident, such as unexpected (unplanned) or sudden event (event), which causes or is capable of causing injury to people or damage to buildings, plants, materials or the environment [<http://archiwum.ciop.pl/18383.html>]. Another point of view is the definition by the Organisation for Economic Cooperation and Development (OECD), which defines an emergency as a near miss, an unexpected (unplanned), sudden event which, without mitigating action by safety systems or procedures, could cause serious injury to humans or damage to buildings, facilities, materials or the environment, leading to serious adverse effects [<http://archiwum.ciop.pl/18383.html>]. When this situation worsens over time, it may turn into a crisis situation, i.e. a situation during and immediately after the event, which permanently prevents or drastically hinders the functioning of important business processes. Therefore, depending on the needs of the company, the Crisis Headquarters and Emergency Teams, whose activities are directly related to each other, are appointed to perform tasks related to such events. Actions at the level of emergency situation are so important that they can stop the further development of undesirable events. Developed, implemented and periodically updated emergency plans allow for a quick response to the existing situation, while preventing it from transforming into a crisis situation, the consequences of which are undoubtedly more difficult to eliminate. The authors of this paper pay special attention to the importance of safety procedures in the discussed emergency situations. Therefore, it is necessary to look at what exactly is meant by procedure. Standards such as PN-ISO 9000:2015 and ISO 45001:2018 define a procedure as an established way of carrying out an action

or process, but they may or may not be documented. In fact the focus here is on the documented ones.

All kinds of aspects of preparing the company for random situations, which may have a negative impact on both the production process and employee safety, are usually based on legal requirements (e.g. periodical evacuation exercises) and conclusions drawn from the assessment of professional and process risk, reports on potential accidents and accidents at work. In the above cases, prevention consists in drawing conclusions from events and implementing actions aimed at preventing their occurrence in the future. However, the broadly understood safety of an organization is not only based on the analysis of accidents and safety within the organization, but also takes into account random factors and the environment of the enterprise. Only a comprehensive look at the plant and its surroundings will allow for its proper preparation in case of emergency situations.

Speaking of emergency situations, it is worth referring to the three levels of human reliability according to J. Reason. According to this concept, the level of human reliability depends on the cognitive level, which is related to the level of complexity. One can distinguish three levels: skills, procedures and knowledge. The level of knowledge is the most unreliable, because the operator is confronted with situations unknown before and has to use his/her imagination and experience to make a decision. Human reliability can be increased by lowering the cognitive level of action, e.g. from the level of knowledge to the level of procedures [Szopa 2009]. The majority of enterprises, especially small and medium enterprises in safety matters, are limited to meeting legal requirements, and thus providing employees with only the required minimum in terms of safety. Then one can talk about the third level – the level of knowledge at which there is a good chance for employees to make mistakes. The application of emergency procedures in the company allows it to move to the second level (the level of procedures), and the combination of them with training and periodical exercises allows to reach the level of skills and improve reliability. This results in a reduction in material and financial losses, as well as a smaller number of accidents and situations that initiate hazards. In this way, both the employees, due to greater safety, and the company itself, which has smaller financial losses resulting from accidents and emergency situations, benefit.

By fulfilling the legal requirements through periodical evacuation exercises, the company provides employees with information on the evacuation scheme from the plant to the safe zone. It is worth noting, however, that not every emergency event will be based on the implementation of evacuation activities and not in every case will general emergency alarm systems work. Clearly defined procedures, which are identified for each possible event and disseminated among employees, cyclically repeated and updated, will allow not only to shorten the response time to the event or determine responsibility during rescue operations, but also to reduce chaotic behavior and acts of panic. Identifying and indicating potential threats is only the

first step in preparing the company for emergency situations. The next step is to assess the risk of an accident using the available methods and tools [Wróblewski 2015]. The matrix method prepared by the Governmental Centre for Safety (RCB) was used in the risk assessment, with the scale of probability and consequences modified for the purpose of adjusting the scale to the presented definition of an emergency situation in an average enterprise [<https://rcb.gov.pl/wp-content/uploads/ocenaryzyka.pdf>]. For medium and high risk threats, actions aimed at reducing the risk to an acceptable level should be proposed. Then a scheme of proceeding in the event of an accident should be created in the form of a procedure, which is an internal document in the company and whose structure is defined and unified (the structure is described in Chapter 4 of the article).

2. Legal requirements

As already mentioned, the development of emergency procedures is not mandatory. Most legal requirements in this aspect apply to plants with increased and high risk of serious industrial accident (ZZR and ZDR) and does not impose similar requirements on plants not classified into the above categories. The most important legal regulations concerning the prevention of serious accidents of an international character include the SEVESO III Directive [Directive 2012/18/EU]. This Directive aims to protect the population and the natural environment of the Member States. The main focus is on the threats caused by hazardous substances and the responsibilities of the plants operators regarding the risk of a serious industrial accident. The responsibilities include the principles of the landscaping and operational and rescue plans. In Poland, the most important legal act in this area is the Act of 27 April 2008. Environmental Protection Law (Dz. U. 2001, nr 62, poz. 627), which also implements the provisions of the Seveso III Directive and aims to prevent events that may cause accidents and limit their possible consequences for people and the environment.

On the basis of the events data with the scale of serious accidents which occurred in 2013, the largest number of these events was recorded in the Mazowsze voivodeship (22) and the Lower Silesia voivodeship (16). The number of accidents in a given area is determined by the number of industrial plants, the nature of production and the type of chemical substances used.

Analysing the data in Figure 1 it can be stated that 40% of the events with potential for serious accident took place in plants not belonging to the categories ZDR and ZZR. It can therefore be concluded that it is equally important to prepare the requirements for plants not belonging to the two above categories, because the possibility of occurrence with the characteristics of a major accident is independent of the category of enterprise. It should be mentioned, however, that the ZDR and ZZR plants have, in accordance with the requirements, a system in place to prevent such accidents and the scenarios for dealing with them.

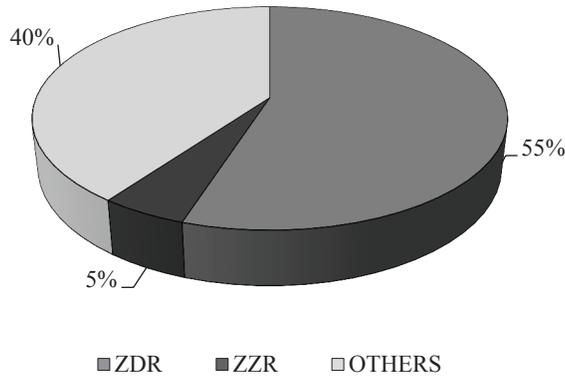


Fig. 1. Percentage of accidents in Poland in 2013

Source: own elaboration based on [Bronisz, Dadasiewicz 2014, p. 7].

Nowadays more companies decide to implement a management system. A well-built system allows them to systemize the functioning of the organization and improves the management process and also helps to meet customer expectations, improve the quality of goods and services offered and the position of the company among the competition. This system also allows for the improvement of internal communication within the organization and the acquisition of new contractors. The most popular organization management systems include:

- Quality Management Systems (ISO 9001),
- Environmental Management Systems (ISO 14001),
- Occupational Health and Safety Management Systems (ISO 45001).

When analysing the requirements of the ISO standards, it should be noted that environmental and safety management systems draw attention to the need to ensure preparedness for response to emergency situations in the organization. In the case of the environmental management system, point 8.2 of standard 14001 (Emergency preparedness and response) focuses on the preparation of emergency response plans and actions by the organisation, focusing on preventing or mitigating the negative impact of such situations on the environment. When developing emergency action plans, consideration should be given, among other things, to the method of responding to an emergency and removing the negative effects of an existing situation, internal and external communication, periodical exercises on how to react to an emergency situation, or training of those responsible for action following an emergency event. These plans take into account not only a given organizational unit, but also its surroundings. With regard to the health and safety management system, the requirements of which are laid down in the 45001 standard, Section 8.2 (Emergency preparedness and response) deals with situations posing a safety risk, focusing mainly on those situations that may turn into accidents. In addition to the development

of a response plan, the requirements also include the need to conduct training, periodic testing (and, if necessary, improvement), and to conduct exercises to implement such a plan. Adequate communication and exchange of information within the organization also plays an important role here.

Despite the fact that the discussed standards concern various areas, their common part is to draw attention to emergency situations in an enterprise resulting in a threat to the environment or safety. In both cases, a frequent element of the procedure in the event of an accident is the evacuation process, which allows to ensure the safety of people passing through the danger zone. The standards require that such action/response plans should be documented.

In addition to the legal regulations and requirements of standards, companies taking care of safety also create their own forms of enforcement of compliance with the guidelines from cooperating companies – these include codes and procedures imposed by the cooperating organizations. An example of such a document is the IWAY Standard for cooperating companies and suppliers of the IKEA Group. It promotes basic standards for employee rights and environmental protection among business partners. In section 7 of the Standard “Emergency situations and fire protection”, point 7.1 “Emergency plans” clearly defines the obligation to develop and implement emergency plans in order to eliminate, minimize and control risk. In addition, it defines the scope of the plans (this covers at least potential hazards and contingency scenarios and responsibility after the occurrence of emergency situations).

3. Identification of hazards and assessment of risks associated with emergency situations

Before creating procedures it is worth considering what threats occurring on the area of a plant may contribute to the occurrence of an emergency situation and are so important that it is necessary to develop such a procedure for them. It is not possible to develop a universal list of procedures that will apply in every company or organization. Each company is different, and potential hazards are influenced by many factors, such as the size of the plant, the number of employees, the nature of the business, the materials or equipment used, etc. Due to this diversity among enterprises, it is so important to adapt the existing procedures to the specificity of the company [Kępka 2015]. In order to determine the list of emergency situations for which it will be necessary to prepare procedures, it is necessary to identify hazards. At the same time, it should take into account both the events that may occur inside the plant and those that may occur outside. In the second case, it is necessary to take into account the environment of the plant and factors and situations that may not be influenced by the company. A checklist is a useful tool for identifying those hazards. A properly formulated list of questions allows to find quickly nonconformities and shortcomings in the functioning safety system and identify any hazards occurring inside the plant

and from outside. When creating and using the checklist, it is worthwhile to save any comments and additional information. Closed questions may not be enough. Additionally, when conducting a risk identification process, it is worth consulting other employees. It may turn out that the OHS service will not have as much knowledge

Table 1. Classification of probability and their characteristics

Scale	Probability	Description
1	very rare	The event is either impossible or unlikely to occur. It can only occur in exceptional circumstances. Occurrence does not occur or occurs less than once in every 15 years.
2	rare	A possible occurrence, but less frequently than once every 10 years but more frequently than once every 15 years.
3	possible	It can happen in certain conditions and at certain times. It occurs less than once every 5 years but more than once every 10 years.
4	probable	The occurrence of an event is possible, it may occur once every 5 years, but not more than once a year.
5	highly probable	The event is very possible or certain, or the event is notorious. The frequency of the event is at least once a year.

Source: own elaboration based on [<https://rcb.gov.pl/wp-content/uploads/ocenarzyka.pdf>].

Table 2. Classification of effects and their characteristics

Scale	Effects	Category	Description
A	irrelevant	Z	None or negligible injuries to workers
		M	Lack or insignificant financial losses
		S	Lack or non-measurable impact on the environment
B	minor	Z	Minor injuries/injuries requiring first aid to an employee
		M	Minor damage, minor financial losses
		S	Low environmental impact with non-measurable effect
C	medium	Z	Severe body injury/injury resulting in absence of the worker
		M	Significant damages, significant financial losses. Standstill of the plant for a short period of time, small production delays
		S	Certain effects in the environment but short-term or small effects with long-term effect
D	large	Z	Numerous injured and/or fatal casualties
		M	Serious damage on the premises of the plant, high financial losses. Ceasing the operation of the plant for a longer period of time, considerable delays in production
		S	High environmental impact
E	catastrophic	Z	Numerous deaths and casualties
		M	Very serious damage, also outside the factory premises. Losses preventing further operation of the facility
		S	Long-term effects leading to degradation of the natural environment

Where: Z – life and health; M – property; S – environment.

Source: own elaboration based on [<https://rcb.gov.pl/wp-content/uploads/ocenarzyka.pdf>].

about hazards in particular areas as the employees of specific positions or the management. Once the list of hazards has been prepared, it should carry out a risk assessment that will help to identify the most important hazards for which procedures will be drawn up. Examples of risk estimation/assessment methods include the Risk Score method used to assess professional risk, or the qualitative FMEA method. In the risk assessment, however, the authors proposed a matrix method used by the RCB with a modified scale of probability and impact for the purposes of the article. The matrix method allows to take into account a whole range of risks that may cause an emergency situation. The following is an classification example of the probability and hazards effects, based on the RCB method and applied by the authors to the scale of hazards likely to occur in a medium-sized manufacturing company:

In order to facilitate risk assessment, the following colours have been introduced in the matrix corresponding to the individual risk values:

- minimal (blue),
- small (green),
- medium (yellow),
- large (red),
- extreme (brown).

probability	5	yellow	yellow	red	red	brown
	4	yellow	yellow	yellow	red	red
	3	green	yellow	yellow	yellow	red
	2	green	green	yellow	yellow	yellow
	1	blue	green	green	yellow	yellow
			A	B	C	D
		severity				

Fig. 2. The risk matrix

Source: [<https://rcb.gov.pl/wp-content/uploads/ocenarzyka.pdf>].

The next step in the risk assessment is to determine the acceptability of the risk. There are three categories: acceptable risk, tolerable risk and non-acceptable risk. Threats on a tolerable and non-acceptable level indicate the need to take (additional)

measures to improve safety and to monitor them. It is precisely these hazards that can contribute to the occurrence of emergency situations in the plant requiring preparation and practice of procedures.

The risk matrix, which makes probability dependent on the effects of hazards, allows to determine the value of risk.

4. Emergency procedure for dealing with emergencies

Once the list of emergency situations relevant to the company has been established, procedures can be developed to deal with their occurrence. As far as possible, the procedures should follow a similar structure and be developed according to one predefined template. For this purpose, it is worth starting with a universal template on the basis of which a documentation will be prepared. None of the previously presented legal acts or standards contains strict rules for preparing the required products or response plans. The authors used as an example the model of a company's emergency response plan constituting Annex No. 1 to the Regulation of the Council of Ministers of 18 January 2005 on emergency plans conduct in the event of radiation events, which was repealed by the Act of 13 June 2019 amending the Act – Nuclear Law, but constitutes a good basis for preparing such a document [<http://prawo.sejm.gov.pl/isap.nsf/download.xsp/WDU20050200169/O/D20050169.pdf>]. Moreover, one of the American OSHA (Occupational Safety and Health Administration) standards concerning emergency action plans [<https://www.osha.gov/SLTC/etools/evacuation/eap.html>] was used to develop a universal emergency procedure. On the basis of these two sources, a list of determinants for response procedures and plans was created. In order to fulfil its function the emergency response procedure should meet the following criteria:

- The instructions in the manual should be as short as possible and contain only the necessary information.
- Messages should be written in a way that is factual and understandable to everyone (in the native language, without complicated phrases).
- It is advisable to consult the procedures with experts in the field (e.g. the Fire Department Commander).
- The arrangement of the procedure and access has to be easy for employees to use the document.
- Once the procedures have implemented, one should be familiarised with them.

In accordance with the above requirements, a sample procedure template has been created, which is as follows:

1. The purpose of the procedure

The purpose of this procedure is to define the rules of conduct in the event of a hazard at a tolerated and unacceptable level that may generate an emergency situation and to define the obligations of the employer and employees managing

specific organisational units, responsible for ensuring the safety of lower-level employees in the situation. This procedure contains systematized information on a given issue.

2. The subject and scope of the procedure

The procedure defines the method and the competences and responsibilities of persons implementing actions related to reacting to an emergency situation, taking actions to reduce the risk, the conditions for taking a decision on evacuation (specifying the person authorized / responsible for making this decision), the ways of announcing the alarm and the rules of conduct during an emergency situation.

3. The basis for initiating the procedure

The procedure shall be initiated in the event of a hazard (description of the hazard, conditions for alarm, determination of the scale of the hazard and adjustment of actions to the magnitude of the hazard) or in the event of other sudden events of a similar nature which may pose a threat to human life and health.

4. Ways of announcing the alarm

Determining how to announce the alarm (oral, audible, gongs, sirens, signal in the computer or phone application, etc.). If a specific situation poses a threat to the environment or neighbouring objects, the alarm information should also be forwarded to them. The person responsible for announcing the alarm and forwarding the message should be designated.

5. Assignment of responsibilities

The persons responsible for the tasks during the emergency response shall be identified, to whom decisions and instructions (e.g. to carry out an evacuation) shall be communicated.

Contact details:

Post	Name and surname	Telephone number

Responsibilities of the President of the Management Board/Vice President/ Director:

-

Responsibilities of the Department managers:

-

6. Emergency response rules

A step-by-step procedure is defined from the time a hazard is detected to the completion of a procedure or the transfer of responsibilities to qualified services outside the facility.

7. Post-cancellation proceedings

Defines the actions to be taken by employees after the alarm is cancelled.

8. Periodic exercises

Periodic exercises (including test evacuation) are conducted to update the procedure, remind employees of the rules of conduct during evacuation, consolidate their knowledge and test their skills. These exercises take place at least once every two years.

Number	Date of exercise	Signature of the person conducting the exercises	Deadline for further periodic exercises
1.			

9. Updating of procedure

Number	Scope of the update procedure	Date
1.		

10. Related documents

Examples of documents to which the procedure may be linked:

- fire safety manual,
- evacuation plans,
- procedures to be followed.

5. Information technologies facilitating communication and access to emergency procedures in the enterprise

Communication plays an important role in emergency and crisis situations. The mentioned standards of management systems also emphasize the proper flow of information in the organization in internal and external communication. The standard ISO 45001:2018 emphasizes the role of internal communication in terms of prevention, preparedness and response to emergencies (paragraph 8.2). Therefore, it is worth noting the possibilities of improving communication provided by today’s technological solutions. In the case of internal communication, the most convenient way of transmitting information is by intranet where employees can read information and share documentation. The hardcopy procedures in the workplace area may be impractical. By placing such procedures in the system, employees using computers have the opportunity to quickly find a specific scheme of action (e.g. after entering a short password related to the hazard, the search engine indicates the appropriate procedure), which will significantly accelerate their response time to the threat. Such a form is also much more convenient in the case of updating the documentation and learning it.

Another solution is to use a short text message (SMS) notification system similar to the “SMS Alert RCB” warning system. This idea is based on RCB solutions which send out information about weather alerts to people living in endangered areas. In order to receive RCB Alert people do not need to install any applications. It will be received by anyone who has a mobile phone, regardless of which operator it is registered with. It is also irrelevant whether it is the latest generation smartphone or a regular, old mobile phone. If a person is in an area where life or health hazards may occur and their phone is switched on, they will receive SMS with information about the type of hazard and the location, as well as advice on what to do [<https://rcb.gov.pl/alert-rcb-w-nowej-odslonie/>]. This may have a special role to play in events that affect the outdoor environment of the facility.

Another proposal facilitating the process of communication within the organization, is a mobile app for a mobile phone compatible with the alarm system in the plant. If a threat is detected, the app sends an alert to the employees’ phones with information about the threat and a short description of the procedure. The app interface should contain only the most important information, making the message legible. An example of the solution is the Staying Alive mobile phone app, and especially its “Citizen Responder” function, which allows to notify people in a specific location of the fact that there are people in the vicinity who require immediate rescue action. In general, Staying Alive includes a list of defibrillators worldwide and allows to easily report new locations [<https://www.stayingalive.org/index.php?lang=pl>]. The project of functioning of the application using this type of solutions for the needs of emergency procedures in the plant looks as follows:

- When a threat is detected, the alarm system sends out a message.
- A message appears on the device screen: “CAUTION: DANGER EXAMPLE” along with an acoustic signal or vibrations.
- After clicking (touching) the message on the screen, the employee receives a short procedure for dealing with the situation.

Such a technological solution would make it possible to improve the flow of information within the organization, as well as to inform about the threat to persons who, for some reason, at the time of an emergency, were outside the hazard area. This is particularly important in the event that the plant is fully evacuated and the employees are temporarily outside the building (e.g. smoking rooms, parking lot, plant area). The announcement will allow them to evacuate to the assembly point, even if they have not heard the alarm. Additionally, the person in charge of the evacuation could verify more easily workers’ presence at the collection point.

6. Conclusion

Conducting analyses indicating hazards and preparing procedures will not ensure the proper preparation of a plant for emergencies. In order to do this, it is necessary to provide training for employees and periodical practical exercises to react to these

situations. Thanks to periodical exercises, the reaction time of employees in emergency situations is shortened and their actions in the event of an emergency are more systematic. Based solely on the legal requirements, one cannot provide comprehensive protection of the organization against adverse events. Going beyond the established schemes will result in the company improving its safety culture [Gabryelewicz, Krupa, Sadłowska-Wrzesińska 2015, pp. 77-83]. All activities going beyond the legal requirements are aimed at ensuring the highest possible level of safety not only of the plant and its surroundings, but also of the employees. The article presents a modified, comprehensive method of hazard identification and risk assessment based on the RCB methodology and an original template of the procedure to be followed in the event of an emergency. These tools have been adapted to the needs of medium-sized companies, so that they can provide support for the development of the procedures in question, taking into account the specific requirements of the performer of the analysis. In order to improve communication about emergency situations and access to procedures related to them, examples of IT technology improving the above mentioned processes are presented. Empirical evidence that it is worth developing procedures (e.g. evacuation) and conducting cyclical exercises is the example of the evacuation of people during the attack on the World Trade Center conducted by Rick Rescorla, Head of Security at Morgan Stanley, whose headquarters was in the WTC building during the attack on 11 September 2001. The efficient evacuation, based on good communication and cyclical training, under his leadership saved 2,687 lives.

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