

# OCCUPATIONAL HAZARDS IN THE CONSCIOUSNESS OF THE PARAMEDIC IN EMERGENCY MEDICAL SERVICE

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## ABSTRACT

**INTRODUCTION:** Due to their occupational responsibilities and volatile work environment, paramedics are in constant contact with harmful, dangerous factors, making them vulnerable to a number of occupational health risks. These include harmful biological, chemical, physical, as well as psychophysical factors (musculoskeletal system strain, stress, patient aggression, occupational burnout). The present study aims to evaluate occupational hazard prevalence among emergency medical service (EMS) paramedics, the possibility of occupational illness incidence, and related prophylaxis.

**MATERIAL AND METHODS:** The participant sample consisted of paramedics employed in five mobile EMS operational areas in the Masovian voivodship. The study involved 238 people, including 223 men and 15 women. The mean age was  $39.03 \pm 9.27$  years for males, and  $31.93 \pm 7.76$  years for females. The study took place between May and September 2019 using diagnostic survey methodology.

**RESULTS:** Participants ordered the following factors based on a scale of threat: biological factors (47%), psychophysical factors (41%), chemical factors (7%), and physical factors (5%). Health issues included musculoskeletal system discomfort (39%) and mental overload (33%). Participants indicated harmful biological factors to cause illnesses such as influenza (85%), tuberculosis (79%), and hepatitis B or C (70%). The study showed that 73% of the participants are occupationally exposed to patient aggression, while 15% experienced occupational burnout.

**CONCLUSIONS:** Paramedics are exposed to a number of occupational hazards daily. The ones most significant in terms of serious disease development are harmful biological factors, musculoskeletal risk factors, fatigue, mental overload related to occupational responsibilities.

**KEY WORDS:** paramedic; work environment; occupational exposure; harmful and dangerous agents; occupational illness

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## INTRODUCTION

The protection of employees against the risks caused by occupational factors detrimental to their health, assigning employees to job posts adequate to their psychophysical abilities, and adjusting the labor to the individual and the individual to the labor are all tasks that require a multifaceted approach and knowledge in different fields, as well as satisfying legal requirements in this domain [1].

The work of a paramedic involves saving human life and health. These premises are achieved through the undertaking of medical rescue measures with the aim of stabilizing basic life functions. A paramedic's work is challenging, it is complex and involved a number of different tasks. High physical fitness and dexterity are a necessity. The paramedic is also required to elevate professional competence, record documents, handle medical equipment and devices, collect information regarding patients' health, educate patients and their families about health issues, and promote health. Each of these tasks requires different abilities, predispositions, and skills [2–5].

Paramedics frequently work under the pressure of time. They often face unforeseen situations, such as the sudden deterioration of the patient's condition, or resuscitation, during which minutes can decide whether a patient will live. These kinds of situations lead to progressive fatigue, lower effectiveness of work, and the deterioration of psychological comfort. In numerous cases, they are witnesses of events and personal experiences related to sudden, life-threatening situations which can result in symptoms related to post-traumatic stress disorder (PTSD) [6]. Additional problems for paramedics arise from relations with colleagues, patients, and their families, which can sometimes take place in a situation of high emotional tensions. Due to the nature of their work, this occupational group suffers from circadian rhythm disorders, which consequentially leads to unfavorable emotional and health consequences [7]. The work of a paramedic may carry risks for their health, as they come in contact with various biological factors in their work, including potentially contagious material from the sick (blood, secretions, excretions) [8–11].

In the Polish context, the work of a paramedic is additionally difficult, as the occupation is characterized by low social prestige, low possibility of growth or advancement, and low material satisfaction. Under the current healthcare circumstances, it

is one of the occupational groups most vulnerable to stress. The stress sources of this occupational group include: poorly organized work; shift work that disrupts the natural biological rhythm of the organism; unrhythmic work, periodically causing high overload; lack of satisfactory remuneration; lack of recognition from supervisors; lack of growth prospects in their career.

## Identification of hazards and their sources

A paramedic is a healthcare professional possessing the required qualifications with appropriate documents as confirmation. An EMS paramedic works in medical entities which are part of the national emergency medical services. They fulfill occupational duties to the local community, in the residential environment, in case of health, illness, or handicap they undertake rescue medical measures in a non-hospital environment in order to save a person in a sudden life-threatening condition. During their occupational duties, they are required to undertake rescue medical measures in accordance with the possessed qualifications and regulations defining good medical care, while cooperating with other members of the team or other services taking part in the rescue operation. In accordance with the nature of their work, they undertake measures related to the promotion of health, disease prophylaxis, nursing, medicating, diagnosis, health improvement, and rehabilitation. Fulfilling the high standards related to their occupation requires the paramedic to constantly educate themselves, and to maintain a constant high physical fitness [5, 12, 13].

The occupation of the paramedic involves exposure to a multitude of factors, which can negatively influence their health. Therefore, the identification of hazards and estimation of occupational risk should be carried out with an accepted methodology [14, 15].

## Biological hazards

Biological factors in the work environment are defined as cellular microorganisms capable of replicating or transferring genetic material, including genetically modified cell cultures or internal parasites which can be the cause of infection, allergy, or poisoning. Thus, harmful biological factors in the work environments include not only microorganisms causing contagious diseases, but also micro- and macro-organisms, as well as structures and substances produced by these organisms, whose

existence in the workplace has a negative impact on human health and can be the cause of allergic, toxic, or cancerous occupational diseases, while also functioning as vectors of pathological germs. They cause a heightened risk of contagious and invasive disease contraction due to the direct contact with patients and their contagious material. Very frequently, those are highly virulent and pathogenic microorganisms. Furthermore, they have transmittance pathways that are specific to paramedics [1, 8–13, 16].

The highest risk is posed by biological factors causing negative health effects such as: hepatitis B and C, acquired immunodeficiency syndrome (AIDS), severe acute respiratory syndrome (SARS), methicillin-resistant *Staphylococcus aureus* (MRSA) infection, and contemporarily COVID-19, which are transmitted through the air or droplets, or from human to human [1, 8–11, 16].

### Chemical and physical hazards

Chemical substances in the work environment exist in gas, vapor, liquid, or solid form. In occupational exposure conditions, the intake of chemical substances into the organism takes place in the respiratory and digestive systems, as well as the skin and mucous membranes. The organism's reaction to exposure depends on the physico-chemical properties of the substance, the intake route, dose size, period of exposure, temperature and humidity or the air in the work environment, as well as individual qualities of the employee, such as gender, age, general health, eating habits and the endocrine, immune, genital systems' condition. Such reactions may include exposure effects that are local (irritation and allergic reaction of the skin or mucous membranes) or systemic (affecting the human internal organs), and their intensity may be acute or chronic in nature. The work of a paramedic involves exposure to a number of chemical substances which are harmful to the organism (xenobiotics). Examples with significant impact include agents used in aseptic treatments, meaning cleaning, disinfecting, and sterilizing agents, which contain harmful substances that harm the skin, mucous membranes, and respiratory systems, as well as medical drugs, rubber components, or some metals. Chemical factors can be the cause of incidental or chronic acute poisoning if long-term exposure to small doses takes place (e.g., rescue operations during a fire). Furthermore, long-term consequences may take place due to the

effect of chemicals on the genetic material, such as a mutagenic, teratogenic, embryotoxic, cancerogenic or allergenic activity). A paramedic's work is related to the exposure to a number of highly allergizing factors, the most significant of which being natural rubber latex. Outcomes of medical personnel's exposure to chemical factors in the workplace include health consequences such as cancers, allergies, tissue or even organ degeneration, toxic outcomes understood as disruptions of biochemical reactions, immunity and reproduction disorders, including the broad array of teratogenic outcomes, including fetal development disorders, embryonic effects involving specific developmental disorders in the fetal period, and infertility, which is the inability to carry out conception or become pregnant [1, 9, 10, 17–23].

Harmful physical factors that paramedics are exposed to include volatile, adverse microclimate during departures to the patient, noise, light, musculoskeletal overload, limited work area, forced posture, mechanical vibration, or monotone movement at work [1, 9, 10, 24–26].

### Psychophysical hazards

In the most general sense, psychophysical factors in the workplace are understood as cumbersome factors capable of deteriorating the worker's physical and mental abilities [1, 13–15].

Employee health in virtually every profession largely depends on their ability to cope with stress. In turn, the quality of the strategies used in stressful situations largely depends on their self-perception and self-appraisal, as well as individual potential abilities in the context of a particularly stressful situation.

The occurrence of violence and aggression are all the more common in the workplace, including that of a paramedic. Lists of aggressive behaviors include various acts of psychological violence: threatening, intimidation, insults, mockery, antagonistic behavior (screaming, yelling, threatening with a fist, spitting), and physical aggression. Paramedics often encounter verbal, or even physical aggression from their patients. Another problem encountered in the work, which involves constant mental and physical strain, is chronic fatigue syndrome, PTSD, and occupational burnout, which are results of their work's nature. The work of a paramedic requires heightened mental effort related to observing the patients' suffering; high engagement in others' affairs, hurting people; high empathy, and understanding for the patient; self-identification with the patient's problems; in-

creased responsibility for the results of their work. All of these factors can in a simple way contribute to the occurrence of serious disorders, at first emotional, and later occupational burnout syndrome [1, 6, 7, 12, 13, 24].

A significant health concern related to the work activities in this occupational group is the strain and its resulting issues with the musculoskeletal system. In this case alike, accidents at work occur frequently, including injuries related to improper posture at work and excessive physical activity during the moving and hoisting of patients. The cause of such incidents is the lack of sufficient knowledge regarding the techniques of safe lifting and moving of patients and not posturing the body correctly during work activities [13, 17, 25–27].

## MATERIAL AND METHODS

In 2019, the National Medical Emergency Service System in Poland offered 1577 (100%) mobile EMS, 369 (100%) of which were specialized and 1208 (100%) of which were basic level. In the Masovian voivodship, there were 200 mobile EMS, which constituted 12.7% of all teams [46 specialized (12.5%) and 154 basics (12.7%)] [28].

The sample selection was deliberate, as the Mazovian voivodship has the highest number of EMS on a national scale.

The study was carried out in the period between May and September 2019 amongst occupationally active paramedics in EMS from five operational regions in the Mazovian voivodship: Warsaw, Płock, Ostrołęka, Siedlce, and Radom. Paramedics' participation was voluntary. The research was carried out in accordance with the Helsinki Declaration, meaning it was anonymous and voluntary in nature. Every participant was granted informed consent and was informed of its aims and the ability to withdraw participation at any stage of the study.

The research adopted the diagnostic survey method, using a questionnaire developed for the purpose of the present study, which included a fiche including areas indicated on the occupational exposure evaluation form in relation to occupational disease suspicion [29], and comprised four sections including 23 questions regarding the basic groups of hazards related to the daily work of an EMS paramedic. A majority of the questions were closed, and if another option such as "other" could be marked, participants were asked to specify their answer and

give an example. The first part of the questionnaire (questions 1–11) was related to biological hazards encountered at work and focused on assessing the level of knowledge regarding their types, potential exposure routes, the illnesses they may cause, and the knowledge regarding the means of self-protection and behaviors in a so-called emergency situation involving a harmful biological factor. Questions 12–16 were related to musculoskeletal system threats and consequential pain, their frequency of incidence and duration, as well as the evaluation of the consciousness of their existence. The following questions (17–21) dealt with mental strain. These questions raised the issue of aggression from patients, their families, or cohabitants, towards the participants, as well as stress and fear for their own safety. The issue of burnout was also addressed, and respondents were asked if they are aware of what the term entails and whether they experienced it. Finally, questions 22 and 23 asked paramedics which hazards, *i.e.*, biological factors, musculoskeletal pain, mental strain, chronic fatigue, occupational burnout, allergies, or others, do they consider to be the most significant in their work (participants were asked to assign numbers from 1–7 to particular hazards, with 1 — most significant, 7 — least significant). Participants were also asked if they are aware of what occupational diseases they are exposed to in their work. The results were presented in descriptive form.

The study involved 238 participants, including 223 men and 15 women. The mean age of the participants was  $39.03 \pm 9.27$  years for males, and  $31.93 \pm 7.76$  years for females (Tab. 1).

The mean work experience of the participating paramedics showed significant gender differences ( $p = 0.000$ ). It was  $12.62 \pm 9.41$  years for males, and  $5.36 \pm 7.04$  years for females. In both groups, the shortest work experience was approximately half a year (Tab. 2). Participants had further secondary education, or professional/master's degree in higher education (Tab. 3).

## RESULTS

According to the gravity of the threat perceived by the participating paramedics, the most dangerous hazards include biological factors (47%), psychophysical factors (41%), chemical factors (7%), and physical factors (5%). Reported health problems included musculoskeletal pain (39%) or mental strain

**Table 1. Participant age in years between genders**

Gender	n	M	SD	Min	Max	p-value
Male	223	39.03	9.27	23.00	65.00	0.003*
Female	15	31.93	7.76	23.00	50.00	

\*Mann-Whitney U Test;  $p < \alpha$ ;  $\alpha = 0.05$ ; SD — standard deviation

**Table 2. Years of participant work experience between genders**

Gender	n	M	SD	Min	Max	p-value
Male	223	12.62	9.41	0.50	41.00	0.000*
Female	15	5.36	7.04	0.50	28.00	

\*Mann-Whitney U Test;  $p < \alpha$ ,  $\alpha = 0.05$ ; SD — standard deviation

**Table 3. Level of education between genders**

Level of Education	n [%]	Secondary/Further secondary education	Professional higher education	Masters higher education	p-value
Male	223 (100.00)	48 (21.52)	132 (59.19)	43 (19.28)	0.109*
Female	15 (100.00)	1 (6.67)	8 (53.33)	6 (40.00)	

\* $\chi^2$  Test;  $p > \alpha$ ;  $\alpha = 0.05$

**Table 4. Percentage exposure to biological factors during work according to participants**

Harmful biological factor	Frequency and distribution
Viruses	97% (231)
Bacteria	94% (224)
Pathogenic fungi	67% (159)
Parasites	48% (114)
Prions	15% (36)

\*Results do not add up to 100%, because participants could identify more than one factor

(33%). Among illnesses caused by harmful biological factors, participants pointed toward the possibility of influenza (85%) or tuberculosis (79%) contraction, followed by hepatitis B or C (70%).

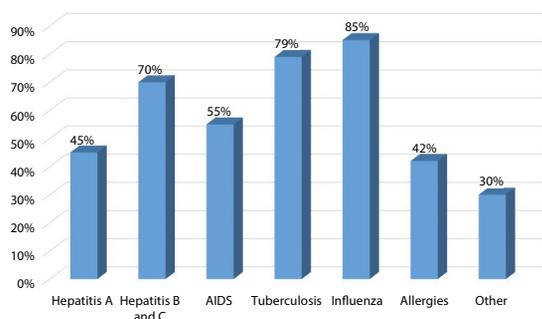
The study only references the indicated threats posed by biological and psychophysical factors, due to the fact that participants believe them to be the most important source of their health problems.

A vast majority of the participating paramedics (97%) indicated that their work involves daily exposure to harmful biological factors (Tab. 4), the ones most commonly reported being: viruses, bacteria, and pathogenic fungi.

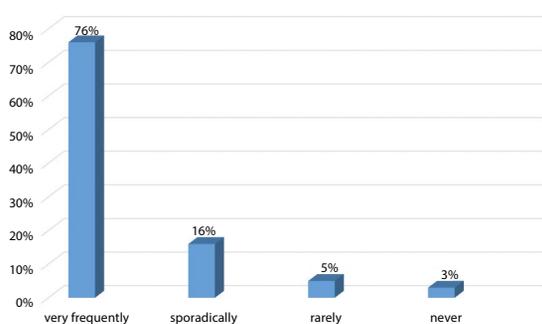
When asked about their perceived pathways of contracting harmful biological factors at work, par-

ticipants more or less universally reported four main methods of contagion, such as: inhaling air, *i.e.*, air pathway (81%), contact with items previously touched by sick people (81%), contact with human blood (81%), contact with human secretions and excretions (85%). Meanwhile, 70% of the participating paramedics considered exposure to harmful biological factors to be related to a majority of the activities which are part of their daily work, 36% stated that it was related only to some activities, while 33% additionally reported touching lips and food with unwashed hands to be another pathway of contracting pathogenic microorganisms. Only 6% reported that they are only exposed to them in emergency situations, meaning situations where direct contact is made with infected biological material through a cut or through mucous membranes or the skin.

The answers given to the question regarding the knowledge of diseases that can be caused by harmful biological factors that participants come in contact with during their daily work were rather varied as shown in Figure 1. A majority identified influenza (as much as 85%) and tuberculosis (79%) as diseases with the highest risk of contagion. Hepatitis B and C were also reported (70%). "Other" diseases listed by participants were mostly pediculosis and tetanus.



**FIGURE 1.** Illnesses caused by harmful biological factors at work according to participants

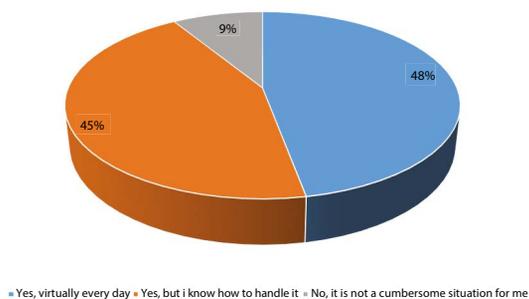


**FIGURE 2.** Frequency of musculoskeletal pain incidence according to participants

**Table 5. Cause of musculoskeletal pain according to participants**

Cause of musculoskeletal pain	Frequency and distribution
Forced body posture	64% (152)
Excessive physical activity	58% (139)
Overloading the musculoskeletal system	42% (101)
I do not associate it with work	3% (8)

\*Results do not add up to 100%, because participants could identify more than one factor



**FIGURE 3.** Frequency of mental stress according to participants

Musculoskeletal system pain is the second and almost equally significant and important group of threats reported by the participants. Musculoskeletal pain related to the work of the participants was indicated by a majority of the respondents (97%).

Figure 2 shows how serious of a problem this is for paramedics, as it is visible that 76% of the participants report that such difficulties occur very often for them.

As far as the location of the pain is concerned, a vast majority of the participants indicated the sacro-lumbar area (97%), the cervical spine area (52%), shoulder area (31%), knee area (27%), and arms (24%).

As shown in Table 5, it is worth noting that a majority of the participating paramedics primarily relate their musculoskeletal system pains to improper and forced posture at work and excessive physical activity.

When a paramedic works with people in need of help, it may involve a significant mental strain, the threat of which was reported by 33% of the participants. When asked whether participants encounter aggression from patients in their professional work through verbal aggression, threats, or blackmail, 73% responded that they do. 52% also indicated that they encounter aggression from the families or cohabitants of their patients. The fact that 32% of the participants often face aggressive behavior at work, while 24% do, too, albeit less frequently, is concerning.

Figure 3 shows that high stress and mental strain related to medical rescue services in non-hospital conditions with the aim of saving the life of a person in a sudden life-threatening situation, was reported by 48% of the participating paramedics, and only 9% stated unambiguously that it is not a cumbersome situation for them.

Another serious problem related to the work of providing medical rescue services is occupational burnout syndrome, which affects a relatively large number of mobile ERT personnel. When asked whether they understand what this term means, 82% of the paramedics answered affirmatively, 15% of which admitted that they have experienced this condition. It is quite a large percentage, given that returning to work and one's responsibilities after such an experience can be extremely difficult and requires a significant effort and persistence from the affected individual. The work of a paramedic involves everyday commutes to patients. The stress

related to the fear for one's own safety is also a factor influencing the heightened mental strain among participants. Oftentimes patients themselves, their neighbors, or even cohabitants of the patient do not shy away from alcohol or other addictive substances which make them more aggressive towards their surroundings.

## DISCUSSION

The results of the present study indicate that the work of paramedics is tied to the high everyday risk of exposure to harmful biological factors which finds confirmation by other research in the literature [8–11, 16].

Szarpak [9] showed that as much as 80% of the studied paramedics declared coming in contact with patients' blood a couple of times a day, and 16% — a couple of times a week. These results are congruent with the findings of the present study.

Thomas et al. [10] study identified eight significant contagious diseases and transmission pathways. Firstly, those which are transmitted through blood and other body fluids: the human immunodeficiency virus (HIV), hepatitis B, and hepatitis C. Diseases transmitted through air include meningococcal meningitis, and severe acute respiratory syndrome (SARS), influenza, and tuberculosis. The last identified illness was methicillin-resistant *Staphylococcus aureus* (MRSA) infection, which spreads through direct contact. These findings are consistent with the present results regarding the knowledge of transmission pathways of biological factors during work and the possibility of negative health consequences such as diseases occurring.

The health issue related to the overloading and consequent pain of the musculoskeletal system identified in the present research was also found in other studies [17, 25–27].

Reichard et al. [17] showed that the musculoskeletal disorders experienced by paramedics constituted 40% of all injuries in this group. The injuries related to body movement were most commonly an outcome of lifting, moving, or transporting patients and/or equipment. These findings correlate with the present study.

Friedenberg et al. [27] found that the frequency of back pain ranges between 30% and 66%, while for back injuries and bruising the frequency ranges from 4% to 43%. The frequency of back pain from falling, slipping, tripping, and overloading during

lifting and moving patients or equipment ranges from 10% to 56%, with the most frequent injury being overloading. Risk factors included lifting, work in an uncomfortable position, loading patients in the ambulance, and cardio-respiratory resuscitation procedures. The causes of musculoskeletal pain identified in the study are comparable to Friedenberget al's findings.

Prairie et al. [25] showed that loading stretchers into the ambulance is an activity putting paramedics at high risk of back injury. During interviews, paramedics described a multitude of problems related to the weight of the patients and stretchers. The procedure of loading stretchers into the ambulance requires additional activities (such as raising your hands and extra lifting), which cause additional activity and strain for the musculoskeletal system. The aforementioned finding is consistent with the results of the present study.

Prairie et al. [26] have also found that during work involving medical care and moving patients, paramedics moved their torsos in ways that can significantly increase the prevalence of lower back disorders. The study showed that the professional activities carried out in the transport of the patients in the ambulance were characterized by a significantly bent posture, and during transport, paramedics adopted very twisted postures. According to the authors of the study, the vibrations during the ambulance ride and the uncomfortable back posture adopted during paramedic activities may increase the risk of musculoskeletal disorders. The presented results are comparable to the findings of the present study in terms of the identification of the musculoskeletal pain of the respondents.

The present study identified psychophysical hazards related to professional work leading to negative mental consequences such as stress, PTSD, aggressive behavior, occupational burnout, or depression, which find confirmation in other studies of this occupational group [6, 7, 24, 30].

Roberts et al. [24] research confirmed that the risk of mental injury among medical personnel was the highest for paramedics and was 13 times greater than that of nurses. Their results correlate with the present study, where 33% of the respondents indicated significant mental strain in their work.

In the present study, respondents were asked whether they encounter aggression from patients in their professional work, in the form of verbal aggression, threats, or blackmails, and as much as 73%

answered that it was the case. 52% encountered aggression from families or cohabitants of their patients, meanwhile, 32% of the respondents frequently encounter acts of aggression in their work. These results are similar to the ones obtained in Pękala et al.'s [30]. They showed that 98.1% of the participants experienced aggression in relation to their work. Only 1.9% of the respondents have never experienced workplace aggression. As much as 75% of the participants said that the issue of aggression towards paramedics is frequent.

## CONCLUSIONS

As part of the broad category of healthcare medical personnel, paramedics are exposed to a number of occupational hazards in their daily work.

The most significant hazards leading to the development of serious disorders or illnesses primarily include biological factors, threats to the musculo-skeletal system, fatigue, and the mental strain related to professional activities.

The identification of occupational hazards is incredibly important for the efficient functioning of EMS, because it enables the incorporation of preventative measures, and employers making competent use of them encourage work safety and protect the health of paramedics. Various protective and prophylactic measures ought to be employed in the work process in order to protect the health and life of paramedics.

The ability to access specialistic help from a psychologist or a psychiatrist in a crisis situation (such as a traumatic event, or an act of aggression) should be regarded as a standard procedure among EMS employers.

## Author input

(A) concept; (B) data collection; (C) literature review; (D) study writeup; (E) supervision

Agnieszka Gonczaryk — A, B, C, D; Jarosław Chmielewski — A, B, C, D; Agnieszka Strzelecka — C, D; Jarosław Fiks — C,D; Grzegorz Witkowski — C, D; Magdalena Florek-Łuszczki — A, D, E.

## Authors' contribution

All authors passed the four criteria for authorship contribution based on the International Committee of Medical Journal Editors (ICMJE) recommendations.

## Conflict of interests

None.

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