

PART III. OTHER

DZIAŁ III. RÓŻNE

FIREFIGHTERS' KNOWLEDGE ABOUT ADVANCED FIRST AID
IN THERMAL BURNS IN CHILDREN: SURVEY RESEARCH

WIEDZA STRAŻAKÓW NA TEMAT KWALIFIKOWANEJ PIERWSZEJ POMOCY
W URAZACH TERMICZNYCH W GRUPIE DZIECI:
BADANIE ANKIETOWE

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- B. Data collection/entry
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- C. Data analysis/statistics
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- D. Data interpretation
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- E. Preparation of manuscript
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Summary

Background. The aim of the study was the assessment of the level of firefighters' knowledge about the principles of helping injured minors (children of no specific age) with thermal burns.

Material and methods. An anonymous survey was conducted in the period 1st February 2023 - 30th April 2023 among firefighters in the three Polish voivodships: Lublin, Świętokrzyskie and Warmian-Masurian. The study included 346 people who agreed to participate in the study and completed the questionnaire. The original questionnaire included 17 questions regarding demographic and checking the knowledge of emergency medical services including the issue of thermal burns.

Results. In the study group, the average length of service was 11±7 years. People with longer work experience were statistically significantly more likely to provide aid to burn victims (45% vs. 58%, $p=0.022$), but there was no statistically significant impact of work experience on the level of knowledge about: the influence of the burn surface area on the risk of developing hypothermia in a child ($p=0.880$; $p=0.482$), the severe burn surface area in a child ($p=0.478$; $p=0.143$), and calculating the burn surface area in a child ($p=0.408$; $p=0.168$).

Conclusions. The level of firefighters' knowledge about helping minors injured due to thermal burns is insufficient. The frequency of helping burn victims did not have a significant impact on the level of knowledge about the burn surface area and the risk of shock. Child's reactions to stress and pain, as well as the emotions of parents were indicated as the most frequent difficulties while providing advanced first aid.

Keywords: advanced first aid, fire service, burn, knowledge, child

Streszczenie

Wprowadzenie. Celem badań była ocena poziomu wiedzy strażaków z zakresu zasad udzielania pomocy poszkodowanym małoletnim (dzieciom bez określenia konkretnego wieku) z oparzeniem termicznym.

Materiał i metody. Anonimową ankietę przeprowadzono w okresie od 01.02.2023 r. do 30.04.2023 r. wśród strażaków w trzech województwach: lubelskim, świętokrzyskim i warmińsko-mazurskim. Do badań włączono 346 osób, które zgodziły się na udział w nich i wypełniły kwestionariusz. Autorski kwestionariusz obejmował 17 pytań – w tym metryczkę – oraz pytania sprawdzające wiedzę z zakresu ratownictwa medycznego, w tym oparzeń termicznych.

Wyniki. Średni staż pracy w grupie badanej wynosił 11±7 lat. Osoby z dłuższym stażem pracy istotnie statystycznie częściej udzielały pomocy oparzonej (45% vs 58%, $p=0,022$), nie wykazano istotnego statystycznie wpływu stażu pracy strażaków na wiedzę dotyczącą: wpływu powierzchni oparzenia na wystąpienie hipotermii u dziecka ($p=0,880$; $p=0,482$), powierzchni oparzenia w stopniu ciężkim u dziecka ($p=0,478$; $p=0,143$), wyliczania powierzchni oparzenia u dziecka ($p=0,408$; $p=0,168$).

Wnioski. Stan wiedzy strażaków z zakresu zasad udzielania pomocy poszkodowanym małoletnim z powodu oparzenia termicznego jest niewystarczający. Częstość udzielania pomocy poszkodowanym nie wpłynęła istotnie na stan wiedzy badanych z zakresu znajomości powierzchni oparzenia oraz ryzyka wystąpienia wstrząsu. Reakcje dziecka na stres i ból oraz emocje rodziców strażacy wskazali jako najczęstsze trudności podczas udzielania kwalifikowanej pierwszej pomocy.

Słowa kluczowe: kwalifikowana pierwsza pomoc, straż pożarna, oparzenie, wiedza, dziecko

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Introduction

Firefighters are prepared to provide quick and professional help to people injured in various health and life-threatening situations. They operate in two types of events: fires (F) and local hazards (LH) [1].

During the intervention, firefighters have contact with people with bodily injuries, including thermal burns. Burned children are a particularly difficult group of victims. The first goal of the help provided by firefighters is to stop exposure to an unfavorable factor, then to evacuate victims from the danger zone and implement the procedures of advanced first aid. The scope of firefighters' activities is limited by their knowledge, experience and equipment of rescue kits at the disposal of the National Rescue and Firefighting System (NRFS) [2-4].

The NRFS includes the State Fire Service and the Voluntary Fire Service. Both among professional and volunteer firefighters, there are a number of people with paramedic qualifications, including rescuers with clinical experience in the units of the State Emergency Medical Services. Firefighters with medical education and experience are the pillars of medical assistance during real operations [5].

Firefighters without paramedic qualifications are qualified to provide advanced first aid. In accordance with the regulations, they obtain re-certification within a 3-year period. Fire Protection Units provide advanced first aid. The equipment and procedures allow them to carry out medical activities in many types of health and life-threatening situations that firefighters may encounter during rescue and firefighting operations. The level of advanced first aid exceeds the scope of the first aid that can be provided by a witness of the incident or a vehicle driver after a driving license course. However, these activities are less advanced than medical rescue activities performed by the State Emergency Medical Services [6,7].

Firefighters' medical kits contain hydrogel dressings of various sizes and for various purposes (dressings for the chest and those dedicated to head burns with holes for the eyes and respiratory tract). By effectively and quickly cooling the burn wound, hydrogels reduce tissue destruction by transferring heat from deeper tissue layers to the outside, while protecting against secondary injuries [8-10].

The aim of this study was the assessment of the level of firefighters' knowledge about the principles of helping injured minors (children of no specific age) with thermal burns.

Material and methods

An anonymous survey was conducted in the period 1st February 2023 - 30th April 2023 among firefighters in the three Polish voivodships: Lublin, Świętokrzyskie and Warmian-Masurian. Although 360 firefighters participated in the study, only 346 surveys were entirely completed and subjected to the analysis. 14 incomplete questionnaires were rejected.

The original questionnaire included 17 questions regarding demographics and checking the knowledge of emergency medical services as well as firefighters' experience in rescue and firefighting operations related to thermal burns in children. There were also questions about the age of victims, difficulties in providing first aid, the extent of burns, the risk of developing shock and hypothermia, the term severe burn and estimating the burn surface area.

The questionnaire contained single-choice questions. It gave an opportunity to select the value appropriate in the opinion of the respondent as well as to enter the length of service and age; it also had open questions. The questions covered the knowledge of advanced first aid procedures related to thermal burns and the differences between an injured adult and a child.

In addition, the respondents were asked to express their opinion whether the rescue kits available at the disposal of the NRFS are sufficient to help children after thermal burns. In January 2023, the consent was obtained from the Provincial Commanders of the State Fire Service in all studied voivodships. The survey

in a paper (printed) version is fully anonymous and in line with the principles of the *Declaration of Helsinki*. The participation in the research was voluntary, of which the respondents were informed before the study.

Statistical analysis

Qualitative variables (age, gender) for the entire group were presented as quantitative values (n) and percentages (%), while proportions within the groups were assessed using the Chi-square test. Statistica 13 software (StatSoft Inc., Tulsa, OK) was used for statistical analysis. The level of significance was $p < 0.05$.

Study limitation

Over 31,000 people serve in the State Fire Service; there are approximately 4,500 firefighters in the studied voivodships [11]. The study results come from a group not exceeding 8% of the population of firefighters serving in shifts.

Results

The study was based on the questionnaires completed by 346 firefighters. Table 1 presents demographics and the answers to the questions checking the respondents' clinical knowledge.

Table 1. General characteristics of the group of respondents

Answers	Work experience		p	Paramedic qualifications		p	Total
	≤11 years	>11 years		Yes	No		
Have you ever helped people with burns? n (%)							
Yes	96 (45)	76 (58)	0.022	78 (59)	94 (44)	0.006	172
No	118 (55)	56 (42)		54 (41)	120 (56)		174
How many times have you helped burn victims? n (%)							
1-2 times	186 (88)	110 (83)	0.288	107 (81)	189 (89)	0.086	296
3-5 times	11 (5)	11 (8)		8 (6)	14 (7)		22
5-10 times	11 (5)	5 (4)		10 (8)	6 (3)		16
>10	4 (2)	6 (5)		6 (5)	4 (2)		10
Have you helped a child with thermal burns during rescue and firefighting activities? n (%)							
Yes	16 (8)	3 (2)	0.039	14 (11)	5 (2)	0.001	19
No	198 (93)	129 (98)		118 (89)	209 (98)		327
What burn surface area (in %) predisposes the child to shock? n (%)							
1-2	10 (5)	7 (5)	0.148	4 (3)	13 (6)	0.240	17
3-4	16 (8)	7 (5)		12 (9)	11 (5)		23
5-6	24 (11)	10 (8)		12 (9)	22 (10)		34
7-8	28 (13)	10 (8)		19 (14)	19 (9)		38
Over 9	88 (41)	53 (40)		54 (41)	87 (41)		141
I don't know	48 (22)	45 (34)	31 (24)	62 (29)	93		
What burn surface area (in %) predisposes the child to hypothermia? n (%)							
1-3	13 (6)	8 (6)	0.028	7 (5)	14 (7)	0.322	21
4-6	30 (14)	12 (9)		19 (14)	23 (11)		42
7-9	35 (16)	33 (25)		30 (23)	38 (18)		68
Over 10	77 (36)	31 (24)		43 (32)	65 (30)		108
I don't know	59 (28)	48 (36)		33 (25)	74 (35)		107

How many minutes should a burn covering more than 10% of the child's body be cooled? n (%)							
1-2	38 (18)	22 (17)	0.880	25 (19)	35 (16)	0.482	60
5	16 (8)	13 (10)		9 (7)	20 (9)		29
10	109 (51)	68 (52)		62 (47)	115 (54)		177
12	35 (16)	18 (14)		22 (17)	31 (15)		53
I don't know	15 (7)	11 (8)		13 (10)	13 (6)		26
Choose severe burns in a child from the options given below n (%)							
II° 2% of both hands	15 (7)	7 (5)	0.478	9 (7)	13 (6)	0.143	22
II° 5% of the foot	11 (5)	7 (5)		9 (7)	9 (4)		18
II° 10% of the chest	128 (60)	71 (54)		67 (51)	132 (62)		199
II° 21% of the frontal body surface	45 (21)	31 (24)		37 (28)	39 (18)		76
I don't know	15 (7)	16 (12)		10 (8)	21 (10)		31
What body surface area (in %) in a child aged 12 months is a II° thermal burn of the face, anterior part of the neck, clavicular, subclavicular, medial arm, sternal, mammary, axillary and thoracic area? A burn visible in the graphic (burn surface area marked in red) n (%)							
18	32 (15)	25 (19)	0.011	23 (17)	34 (16)	0.838	57
21	42 (20)	22 (17)		25 (19)	39 (18)		64
24	51 (24)	19 (14)		28 (21)	42 (20)		70
27	73 (34)	42 (32)		39 (30)	76 (36)		115
I don't know	16 (8)	24 (18)		17 (13)	23 (11)		40
What is the body surface area (in %) of a facial burn in a 4-year-old child? n (%)							
5-6	31 (15)	16 (12)	0.408	11 (8)	36 (17)	0.168	47
8-9	84 (39)	60 (46)		54 (41)	90 (42)		144
11-12	34 (16)	23 (17)		24 (18)	33 (15)		57
14-15	45 (21)	18 (14)		29 (22)	34 (16)		63
I don't know	20 (9)	15 (11)		14 (11)	21 (10)		35
Were there any difficulties in providing aid in this case? n (%)							
Yes	44 (21)	32 (24)	0.422	31 (24)	45 (21)	0.592	76
No	170 (79)	100 (76)		101 (77)	169 (79)		270
Do you consider the resources (materials) available in the NRFS to help children injured due to burns to be sufficient? n (%)							
Yes	148 (69)	103 (78)	0.055	99 (75)	152 (71)	0.461	251
No	66 (31)	28 (21)		33 (25)	61 (29)		94
Do you consider the advanced first aid procedures of treating thermal burns to be sufficient? n (%)							
Yes	174 (82)	111 (85)	0.467	108 (82)	177 (84)	0.689	285
No	39 (18)	20 (15)		24 (18)	35 (17)		59

For the purposes of statistical analysis, the division was made based on the average length of service, which in the study group was 11±7 years. The statistical analysis showed that people with longer work experience were statistically significantly more likely to provide help to burned patients (45% vs. 58%, $p=0.022$). The correlation also applies to people with paramedic qualifications (44% vs. 59%, $p=0.006$). The answers to the question regarding the burn surface area predisposing to hypothermia in a child revealed a statistically significant impact of work experience on giving the correct answer ($p=0.028$). It has been demonstrated that work experience has an impact on the ability to estimate the thermal burn surface area ($p=0.011$). There was no statistically significant impact of work experience on the ability to define severe burn in a child depending on the location and burn surface area ($p=0.478$; $p=0.143$). In the opinion of the study group, the resources available in the NRFS and the procedures for treating thermal burns are sufficient (73% and 83%).

In addition, 51 people provided answers to the open question: What were the difficulties in helping a child with burns? There were 60 answers, several firefighters entered 2 difficulties (Figure 1).

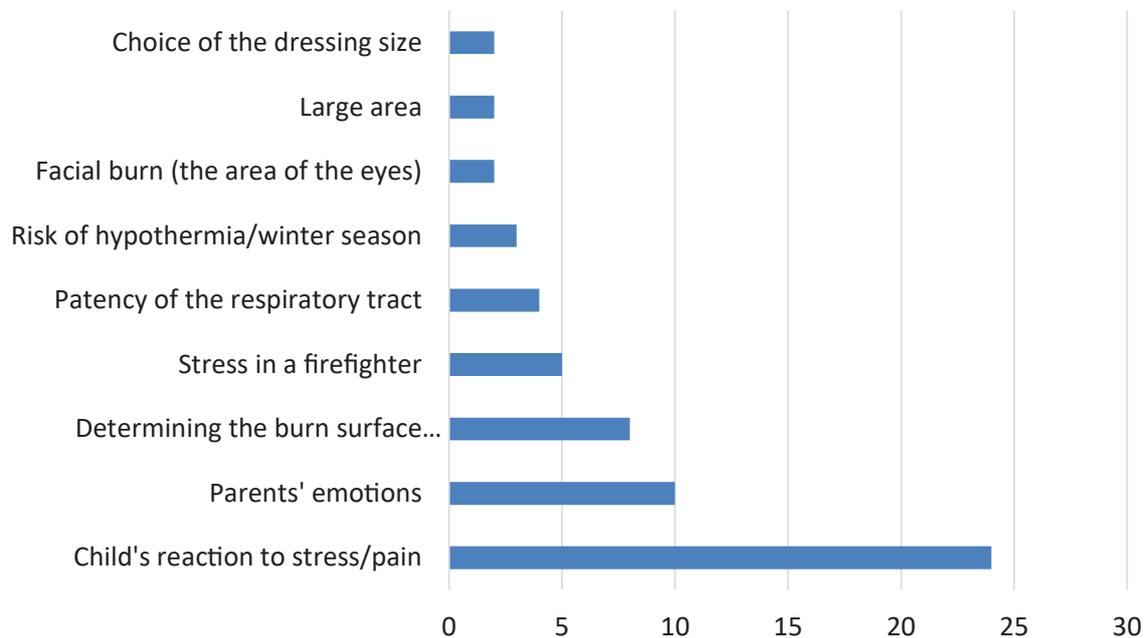


Figure 1. The answers to the open question 15 – difficulties in helping a burned child

In question 12, which tested the ability to estimate the burn surface area for the descriptive part (Table 1), the authors used a graphic (Figure 2) presenting the burned area.

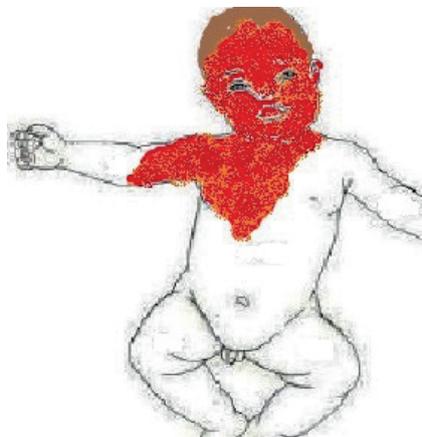


Figure 2. The graphic used in question 12, supplement to Table 1

Discussion

The analysis was conducted as a part of our research into firefighters' interventions in which a burned child was involved. The results of the analysis confirm that this is a rare case ($n=49$ in the years 2019-2020 in Poland). Therefore, firefighters do not have much practice in providing aid to such patients. They can maintain their knowledge at a high initial level thanks to trainings and exercises during service. The participation in our study is also a way of improving knowledge about burns [12].

In Poland, the number of paramedics among firefighters is increasing. In 2017, there were 1,728 firefighters with paramedic qualifications, and in 2021 the number exceeded 2,200. This number is constantly growing, because medical qualifications are desired in the process of recruitment for the State Fire Service. An opportunity to gain additional clinical experience in the units of State Emergency Medical Services, especially in pharmacotherapy and the use of advanced medical equipment, may have a positive impact on the treatment of burn victims by NRFS. This also increases the level of knowledge among other firefighters who deal a firefighter having experience in emergency medical services during exercises and real activities [13,14].

Nadolny et al. [15] analyzed interventions of the Emergency Medical Services in burn victims in 2018. Of the 547 cases included in the observation based on ICD-10 medical diagnoses with codes related to burns (T20-T32), as many as 193 involved people under 18 years of age, which meets the criteria of our analysis. There is a large difference between the number of burned children encountered in the practice of the State Emergency Medical Services and State Fire Service, which may be due to the causes of burns. The most common cause (85%) of burns in children are hot liquids, e.g. coffee or tea, carelessly left within the child's reach by adults. The State Emergency Medical Services intervene in such events, while the NRFS is involved in the event of fire incidents resulting in children being burned, which is not very common. Because units of the State Emergency Medical Services are the leading medical rescue service, during fire incidents firefighters evacuate the injured to a safe zone and transfer them to medical services. The implementation of advanced first aid procedures regarding burns is not frequent and applied in the initial phase when units of the State Emergency Medical Services are absent at the site of the incident [15,16]. This tendency is confirmed by the results of the questionnaire, in which only 10% of the respondents indicated that they provided advanced first aid to a burned child during rescue and fire-fighting operations.

According to the statistics of the Headquarters of the State Fire Service, in 2020 in Poland out of 49,603 fire victims there were 162 children, and in 2021 there were 149 children among 53,015 injured. The data does not specify whether the children injured in the fires had burns or other injuries. The total number of fire victims does not result from extensive or severe burns with the risk of developing shock, but from being poisoned by inhalation of fire gases, mainly carbon monoxide (CO) and hydrogen cyanide (HCN). In firefighting nomenclature, the risk of exposure and poisoning by these two compounds is known and called "toxic twins" [17].

Because the skin of a child is more sensitive than the skin of an adult, injuries to this organ have more serious consequences. Hypovolemic shock usually occurs with burns of more than 10% of the child's body surface. In our study, approximately 40% of the firefighters correctly indicated the size of the burn surface area predisposing to shock [18].

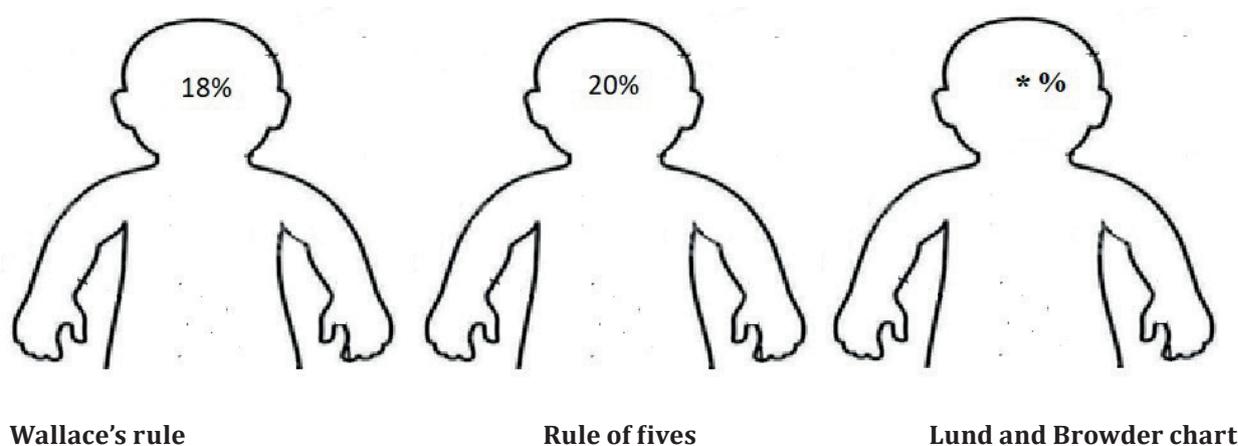
When cooling extensive burns, the risk of developing hypothermia should be taken into account because it worsens the prognosis. Therefore, firefighters have hydrogel dressings in their rescue kits. The recommendations for treatment of burns indicate the need to use them as a safe method of cooling the burn wound, which is also a non-pharmacological method of pain relief. Compared to cooling with running water, hydrogel dressings reduce the risk of developing hypothermia and provide more sterile conditions for burned tissue than water [19].

The Wallace's rule is used to estimate the extent of a burn expressed as a percentage. The body surface was symbolically divided into areas constituting percentage or a multiple of this value; the rule of nines is the synonym of Wallace's rule. For physiological reasons, this method is modified to estimate burns in children. The physiological differences between an adult and a child involve proportions, for instance, the bigger head in relation to the rest of the body. In their review, Osmatek et al. [20] present other methods of estimating the burned body surface area in children depending on age:

- rule of fives - for infants,

– *Lund and Browder chart* – for victims under 15 years of age.

These methods are illustrated in Figure 3.



**depending on age*

Figure 3. The comparison of methods for estimating burn surface area using the head as an example

Source: original image based on the study by Osmałek et al. [20].

In the authors' opinion, the question regarding difficulties in helping the injured was of great cognitive value, because the respondents had an opportunity to give an open answer based on their experience. In this respect, the firefighters indicated the lack of cooperation in a child under the influence of a strong pain stimulus, inability to fight pain, and negative emotions of parents and guardians (reaction to stress) which are transferred to children. The only methods for firefighters to combat pain are non-pharmacological, i.e. advanced first aid procedures for cooling the burn and psychological support. Other researchers also indicate parental stress as a difficulty in providing medical help to children [21,22].

In the authors' opinion, the level of firefighters' knowledge about burns in children can be improved with a new database of questions published by the Medical Examination Centre before re-certification of qualifications and relating to thermal burns in adults and children, taking into account current international guidelines.

When examining the firefighters' knowledge about burns in children, we referred to the knowledge of other professional groups helping burn victims. Zysiak-Christ et al [23]. assessed the knowledge of people not professionally connected with the health service. In the study group, 60% had witnessed a burn and 83% considered a burn as a frequent injury requiring first aid training, all the more so that the obligation to provide first aid is imposed by law on every Polish citizen; separate regulations oblige to provide first aid to drivers in accordance with the Art. 44 of the Road Traffic Act [24].

Based on the results of the online survey, Cierzniakowska et al. [25] concluded that the level of knowledge about treating burns is influenced by education (some people with medical education participated in the survey) and own experience of burns. The authors added that, apart from education and experience in providing first aid, the willingness, i.e. readiness to help, is relevant [25].

Conclusions

The firefighters' knowledge about the principles of helping minors injured due to thermal burns is insufficient. The frequency of providing aid to burned children did not have a significant impact on the respondents' knowledge about the burn surface area and the risk of developing shock. The training program

for NRFS rescuers should include the information on the recommended cooling time, the assessment of the extent of burns and the risk of developing shock and hypothermia in children. Firefighters find their rescue kits sufficient to treat thermal burns in children. In the opinion of firefighters, the child's reaction to stress and pain as well as parents' emotions are the most common difficulties in providing advanced first aid.

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