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EMERGENCY MEDICAL SERVICE

RATOWNICTWO MEDYCZNE



VENTILATOR-ASSOCIATED PNEUMONIA AMONG PATIENTS WITH COVID-19

BURNOUT SYNDROME PREVALENCE AMONG EMERGENCY MEDICINE WORKERS

**NEEDS AND CHALLENGES IN DISPATCHING EMERGENCY MEDICAL SERVICES
IN SITUATIONS OF POTENTIAL MILITARY DANGER**

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We regret to inform you that the article "Ataxia in children in the practice of a paramedic" by Dariusz Zawadzki, Mariusz Ciastkowski, Agnieszka Ciastkowska-Berlikowska published in EMS 2/2023 turned out to be hidden plagiarism. This text has been withdrawn from all databases including EMS and the website www.emergencymedicalservice.pl, and the publisher has taken actions in accordance with COPE guidelines.

We apologize to our readers for the situation.

MODERN APPROACHES TO PREVENTION AND OUTPATIENT TREATMENT OF DIABETIC FOOT SYNDROME

Oleh H. Krasnov¹, Vitalii I. Liakhovskiy¹, Serhii A. Sagaradze², Olexandr M. Liulka¹, Nataliia Liakhova¹, Oksana I. Krasnova¹

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ABSTRACT

Aim: Improving prevention and outpatient treatment for patients with complications of diabetic foot syndrome.

Material and methods: We have carried out a comprehensive examination and treatment of 1247 patients with diabetic foot syndrome with stage I-II, III B for Meggit-Wagner during 2012-2022. The main group (748 patients) consisted of patients who were regularly observed by a vascular surgeon. The control group (499 patients) consisted of patients who did not regularly see a doctor, more often only when it was necessary.

Results: Most patients with diabetic ulcers and foot wounds of both groups were treated on an outpatient basis. The average terms of wound healing were 21.3 ± 1.4 days in the main group and 36.5 ± 1.7 days in the control group. Complicated cases of DFS required hospitalization in 135 (18.1%) patients of the main group and in 209 (42.0%) patients in the control group. After hospitalization, amputations were performed at the level of the shin and thigh in 9 (6.7%) patients of the main group and in 29 (13.9%) patients of the control group.

Conclusions: In the development of complications of diabetic foot syndrome, the leading role is played by neuropathy, a mechanical factor, the progression of atherosclerosis against the background of decompensation of diabetes mellitus, a lack of compliance in patients and preventive measures. Systematic monitoring of patients, carrying out regular preventive and therapeutic measures can improve the quality of life of such patients; reduce the duration of treatment, the frequency of their hospitalization and the risk of high amputation.

KEY WORDS

diabetic foot syndrome, prevention, outpatient treatment

INTRODUCTION

The problem of diabetes mellitus (DM) and its complications is currently relevant in medical, social and economic aspects in most developed countries of the world. Nowadays more than 400 million people in the world suffer from DM [1]. In Europe, 1 in 11 adults are living with DM, and 1 in 3 of them are undiagnosed. In 2021, \$189 billion was spent on DM only in Europe [2]. An increase in the number of patients with DM leads to an increase in the number of complications of this disease [2, 3].

One of them is diabetic foot syndrome (DFS), which develops in more than 10% of patients and in almost 70% of them requires surgical treatment [3]. DFS is a specific complex of foot lesions in DM, which is based on diabetic angiopathy, peripheral neuropathy, and osteoarthropathy of the lower extremities, which are observed in parallel with the development of severe purulent-necrotic complications against the background of metabolic disorders and immunosuppression [4-6]. About a third of patients with DM are hospitalized precisely with

DFS complications. The main cause of amputations in DFS is an infectious-necrotic process on the foot, which develops against the background of wounds, cracks and ulcers [7, 8, 9]. Polyneuropathy and high pressure in some areas of the foot contribute to the development of ulcers [9, 10]. The severity of the course of the wound process in DM is due to the fact that the phase of wound cleansing is excessively prolonged and the phase of its regeneration does not begin [11]. Often, the occurrence of purulent-inflammatory and destructive lesions of the foot leads not only to the loss of the lower limb, but also to the death of the patient [6, 12].

Today, in developed countries, the concept of DM has been adopted, according to which it is not a disease, but a lifestyle [1, 5]. It is important not only to treat DFS, but also to prevent it. Quality care for patients with DFS significantly reduces the incidence of foot injury [6, 9, 10]. With timely identification of the problem and compliance with all recommendations for foot care, the patient can lead his usual life [12, 13]. This is especially important in the context of the COVID-19 epidemic and hostilities

in Ukraine. Therefore, the issues of prevention and care for patients with DFS in the outpatient setting are now particularly relevant.

AIM

Improving prevention and outpatient treatment for patients with complications of diabetic foot syndrome, reducing complications and improving the quality of life of such patients.

MATERIAL AND METHODS

We have carried out a comprehensive examination and treatment of 1247 patients with DFS with stage I-II, III B for Meggit-Wagner, who were treated in the outpatient department of the Second city hospital of Poltava and the medical center Medion during 2012-2022.

All patients underwent a comprehensive examination, which included a general clinical examination, radiography of the foot, ultrasound duplex angioscanning of the lower extremities, doplerometry, bacteriological examination of the wound, endocrinologist consultation and measurement of the area of wounds according to indications. Tactile sensitivity was determined using a monofilament in symmetrical areas of the fingers and foot. Temperature sensitivity was determined by touching the symmetrical areas of both feet with a cooled metal handle of the neurological malleus.

The first (main) group (748 patients) consisted of patients who were regularly observed by a vascular surgeon and underwent the necessary examination and treatment. The second (control) group (499 patients) consisted of patients who did not regularly see a doctor, more often only when it was necessary.

Patients with DFS from both groups were divided into 2 subgroups: I – neuropathic form, II – neuroischemic form. In terms of age and sex composition, both in the first and second groups, women aged 50 to 70 years prevailed. When determining the clinical form of DFS, the Meggit-Wagner classification was used.

RESULTS

The duration of diabetes up to 10 years was in 246 (32.9%) of patients in the main group and 289 (57.9%) in the control group. For more than 10 years, 502 (67.1%) of patients in the main group and 210 (42.1%) in the control group were ill. Insulin-dependent DM was in 127 (16.9%) patients of the main group and in 89 (13.6%) patients of the control group.

The diagnosis of neuroischemic form of DFS was established in 135 (18.1%) patients of the main group and 87 (17.4%) patients in the control group. Other patients had a neuropathic form of DFS. The average area of ulcerative defects was 2.3 ± 0.2 cm², they were localized in areas of the greatest pressure when walking.

The main blood flow in the femoral-popliteal segment was preserved in 702 (93.9%) patients of the main group, and in 462 (92.6%) of the control group. Among patients with violation of the main blood flow, stenosis-

occlusion of the arteries of the lower leg and Monckeberg's sclerosis were observed in 37 (80.4%) of patients in the main and 26 (70.3%) in the control group.

Tactile sensitivity was preserved in 493 (65.9%) of the patients in the main group. The ability to distinguish between temperature differences was preserved in 119 (15.9%) patients. Foot pain sensitivity was preserved in 472 (63.1%) patients studied. Thus, a clinical study of the state of peripheral somatic innervation showed that manifestations of neuropathy of varying degrees are characteristic of all patients with DFS. Of the 3 types of sensitivity (pain, temperature, tactile), the most characteristic and early was a violation of the temperature one.

Patients with superficial and deep ulcers, osteoarthritis, phlegmon and gangrene of the finger and foot were distinguished according to the depth of the foot lesion. A superficial ulcer was understood as a defect that does not extend beyond the dermis and does not pass to the surrounding tissues. A deep ulcer was a defect in the entire thickness of the dermis, accompanied by purulent discharge and necrotic lesions of the soft subcutaneous tissues: fascia, tendons, and muscles. Osteoarthritis was understood as an isolated destruction of the bones and joints of the foot (tarsus and phalanges), often combined with a deep ulcer.

Stage I according to Wagner was detected in 379(50.7%) patients of the main and in 212 (42.5%) patients of the control group. At the bottom of such an ulcer, granulation tissue covered with fibrinous plaque was observed.

Stage II according to Wagner was detected in 245(32.8%) patients of the main and in 204(40.9%) patients of the control group. Ulcerative defects and fistulas were external manifestations of tendon necrosis, fascial-aponeurotic formations, and osteomyelitis.

Superficial ulcerative defects and deep isolated injuries of the soft tissues of the foot were localized mainly on the plantar surfaces of the foot in areas of increased pressure.

Stage III B according to Wagner was detected in 124 (16.5%) patients of the main and in 83(16.6%) patients of the control group. Destructive bone changes without skin damage occurred in 26 (3.5%) patients of the main group and in 13(2.6%) patients of the control group. The combination of bone destruction with soft tissue defects was in 98 (13.1%) patients of the main group and in 70 (14.1%) patients of the control group, soft tissue defects were in the form of a fistula and deep foot ulcers. The bone tissue visually had the appearance of "melting sugar" and was rough on palpation.

The X-ray picture of bone destruction was expressed in rarefaction and disappearance of the bone contour, and with destructive changes in the joints of the foot, it was in the form of pitting of the contours of the joints, violation of congruence and an increase in the joint space. Destructive changes were not always detected radiographically, which occurred in 47 (37.9%) patients of the main group with bone destruction. The absence

of radiological signs of bone destruction is not proof of complete bone tissue. For the diagnosis of osteomyelitis in the absence of its signs on the radiograph in the presence of a clinical picture of bone destruction, we used magnetic resonance imaging [14].

According to the location of the lesion, the patients were distributed as follows: lesions of the distal foot (fingers, metatarsal bones) - 433(57.9%) of patients in the main and 369(73.9%) of the control group; damage to the proximal part of the foot (arch, calcaneal area) - 42.1 and 26.1% of patients, respectively. Among diabetic foot ulcers, neuropathic and neuroischemic (neuropathy in combination with ischemia) predominated.

Patients of both groups were prescribed basic drug therapy, which included compensation of carbohydrate metabolism; antibacterial therapy, taking into account the sensitivity of the microflora; elimination of manifestations of critical ischemia of the foot; in the neuropathic form of DFS, metabolic therapy was prescribed; symptomatic therapy. We aimed to start antibiotic therapy as soon as possible in patients with DFS. At the same time, the following factors were taken into account: severity, risk of complications, results of microbiological examination, preliminary use of antibiotics. The duration of the course was based on the clinical assessment of the course of the wound process and was a minimum of seven days for standard antibiotic therapy. In the presence of osteomyelitis, we prescribed antibiotics for up to six weeks, using oral forms of antibiotics.

To correct diabetic osteoarthropathy, unloading of the foot was used: bed rest, wearing orthopedic shoes that reduce the load on the foot when walking, immobilizing unloading bandages, and the use of crutches.

Local treatment included debridement and treatment of wound and ulcer surfaces with antiseptic preparations using enzyme preparations, hyaluronic acid preparations, and water-soluble ointments. Conducting local treatment depended on the phase of the wound process. So, in the first phase, we used hydrophilic preparations, dressings from aqueous solutions of antiseptics and antibiotics. In the cleansing stage, hydrophilic-based ointments were effective. In the regeneration stage, preparations aimed at epithelialization and acceleration of wound healing were used. Modern wound dressings were also used, taking into account the phase of the wound process, to maintain the principle of "wet wound healing".

In the case of the destructive process of foot tissues, various types of necrectomy were performed [15]. Necrectomy was carried out by a mechanical, chemical method, with the help of applying a wound dressing. Local treatment of wounds also included removal of areas of hyperkeratosis and primary treatment of the ulcer.

Most patients with diabetic ulcers and foot wounds of both groups were treated on an outpatient basis. The average terms of wound healing were 21.3 ± 1.4 days in the main group and 36.5 ± 1.7 days in the control group. Complicated cases of DFS required hospitalization in 135

(18.1%) patients of the main group and in 209 (42.0%) patients in the control group. After hospitalization, amputations were performed at the level of the shin and thigh in 9 (6.7%) patients of the main group, and in 29 (13.9%) patients of the control group.

DISCUSSION

The main risk factor for diabetic foot ulcers is neuropathy, which is manifested by damage to sensory, motor and autonomic nerve fibers [1, 9, 10]. D. Armstrong and co-authors identify ten risk factors for DFS, and five of them (lack of sensory protection; foot deformity caused by inadequate pressure; cracks and increased bone blood flow; poor gait; history of foot amputations and ulcers) are somehow caused by neuropathy [12].

Observations of patients with diabetes show that neurological disorders are an extremely early sign of the disease. Patients with DFS are characterized by uneven manifestations of neuropathy, varying degrees of severity of clinical signs of sensory disturbances. According to our data a clinical study of the state of peripheral somatic innervation showed that manifestations of neuropathy are typical for all patients.

Neuropathy, according to our data, is permanent, and in 56.1% of patients it is the only manifestation of DFS. In this regard, we agree with the statement [1, 7, 10] that damage to the nervous system is the main pathogenetic factor in the development of destruction of soft tissues and bones in DM. The main subjective manifestations of neuropathy are pain in the feet like paresthesia and a feeling of numbness of the feet, which brilliantly illustrates the statement that "a patient with DM lives separately from his feet" [1, 3, 9]. Thus, trophic changes in the skin and metabolic disorders in the soft tissues of the lower extremities create favorable conditions for the attachment and development of infection with the occurrence of purulent-necrotic processes on the foot. In addition, these factors significantly inhibit regenerative and reparative processes in tissues, which have a decisive influence on the results of treatment [3, 5, 7].

The mechanical factor also played an important role in the etiology of most diabetic foot ulcers. Foot deformity in combination with neuropathy led to increased plantar pressure in certain areas of the foot during walking, which caused tissue damage [1, 9, 12].

Therefore, the treatment of DFS should be based on a sparing principle, the purpose of which is to preserve the supporting function of the limb and the anatomical and functional suitability of the foot [4, 8, 13].

One of the unfavorable factors in the course of a diabetic wound is a long period of its cleansing, which is a harbinger of a belated onset of the second and third periods of the wound process - proliferation of connective tissue and epithelization [5]. The long first period of the wound process (cleansing of the wound), with the appearance of new foci of necrosis, despite the ongoing treatment, leads to the fact that subsequent periods of the wound process in this patient do not occur at all [3, 6].

The first phase of the wound process, i.e., the cleansing phase, can be considered as a link, by acting on which it is possible to improve the results of treatment of patients with DM. The impossibility of the onset of the second phase of the wound process - proliferation - ultimately leads to the inevitability of amputation of the limb [4, 7, 9].

All this requires constant active dynamic monitoring of patients with DFS, including at the outpatient stage to correct not only general and local treatment, but also to actively change treatment tactics if necessary [3, 12].

Patients at the outpatient stage were assessed the risk of developing DFS. When examining the patient, both feet were examined for the presence of risk factors such as neuropathy, ischemia of the lower extremities, ulcers, calluses, inflammation, deformities, gangrene, and Charcot's arthropathy. Annually, patients underwent determination of the ankle-brachial index to determine the state of peripheral arteries.

At low risk of developing DFS, all risk factors are absent, except for callus, at moderate risk there is foot deformity, neuropathy, at high risk there is an ulcer or amputation in history, a combination of neuropathy and non-critical limb ischemia, in combination with callus or foot deformity, infection, critical limb ischemia, gangrene, Charcot's arthropathy [1, 5, 12].

We have developed a treatment and diagnostic algorithm to provide assistance to patients at the outpatient stage. Initially, an examination, laboratory and instrumental examination of the patient, radiography of the foot, dopplerometry, and ultrasonic angioscanning were performed. In the presence of non-destructive changes, the patient was referred for a consultation with an endocrinologist to resolve the issue of confirming the diagnosis of diabetes mellitus. In the presence of destructive changes, in the presence of ischemia, the question of the need and possibility of vascular reconstruction was de-

cidated. In these cases, the patient was sent to the vascular department for arteriography and further treatment. In the absence of critical ischemia of the limb, the patient was treated on an outpatient basis at stages I, II, III B according to Wagner, in the case of an active purulent-necrotic process, the patient was referred to the second level of medical care in the hospital.

In the absence of risk factors for the development of DFS, screening of such patients by a vascular surgeon once a year is necessary. In the presence of low and moderate risk factors, the patient should be examined every 3-6 months, respectively, and at high risk should be constantly under the supervision of a doctor, possibly in a hospital [1, 5, 12].

To prevent the development and progression of DFS, it is necessary to maintain long-term stable compensation of carbohydrate metabolism, educating patients on the rules of foot care, early detection of patients at risk of DFS, timely treatment of hyperkeratosis, corns, wearing orthopedic shoes, insoles, immobilizing unloading dressings, drug syndrome therapy, the use of antiplatelet agents and prevention of the development of atherosclerosis.

CONCLUSIONS

In the development of complications of DFS in patients at the outpatient stage, the leading role is played by such determinants as neuropathy, a mechanical factor, the progression of atherosclerosis against the background of decompensation of DM, a lack of compliance in patients and preventive measures.

Systematic monitoring of patients with diabetes, carrying out regular preventive and therapeutic measures can not only improve the quality of life of such patients, but also reduce the duration of treatment, the frequency of their hospitalization in a surgical hospital and the risk of high amputation of the lower limb.

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VENTILATOR-ASSOCIATED PNEUMONIA AMONG PATIENTS WITH COVID-19: A RETROSPECTIVE COHORT STUDY

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ABSTRACT

Aim: Mechanical ventilation (MV) is common in severe cases of coronavirus disease 2019 (COVID-19), but can lead to complications, such as ventilator-associated pneumonia (VAP). This retrospective cohort study aimed to investigate the VAP characteristics in patients with COVID-19.

Material and methods: We assessed the prevalence of VAP and its effects on mortality, length of stay in the intensive care unit (ICU), and MV time. We also identified the most common bacteria causing VAP and their resistance patterns.

Results: Medical records of 235 patients with COVID-19 were analysed. After excluding 55 patients, a total of 180 patients were included in the study. Of the 180 patients included in this study, 67 (37%) developed VAP, and the mortality rate was 70.1%. Patients with VAP had a longer duration of stay in the ICU and required MV for longer durations than those without VAP. *Klebsiella pneumoniae*, *Staphylococcus aureus*, and *Enterococcus faecalis* were the most prevalent bacterial species. Multi-drug resistant pathogens were found in 57% of cases. Although patients with VAP exhibited a higher mortality rate compared to those without VAP, the difference was not statistically significant.

Conclusions: Our findings suggest that VAP is a common complication in patients with COVID-19 receiving MV and that multidrug-resistant bacteria are a significant concern. This highlights the need for effective prevention and management strategies for VAP in this population.

KEY WORDS

ventilator-associated pneumonia; COVID-19, intensive care unit

INTRODUCTION

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the causative agent for coronavirus disease 2019 (COVID-19), was first identified in China's Hubei region in December 2019 and has since spread worldwide [1]. Although most clinically detectable SARS-CoV-2 infections are asymptomatic and mild [2], patients with pre-existing cardiovascular risk factors, such as men over 50 years of age with hypertension, obesity, diabetes, heart failure, chronic bronchitis, and asthma, are at significant risk of developing severe conditions [3]. In addition, SARS-CoV-2 infection can cause acute respiratory failure, necessitating mechanical ventilation (MV) [4]. Coinfections are independent factors that worsen the prognosis of surviving patients in the intensive care unit (ICU), with rates ranging from 0% to 55% [5].

Studies have shown that more than 69% of patients admitted to the ICU because of COVID-19 may require MV [6]. During admission to the ICU, the patient's natural immunity is weakened owing to the use of MV, corticosteroids, analgosedation, and the impairment of coughing and mucociliary function, making them more susceptible to ventilator-associated pneumonia (VAP). Several studies

have reported that VAP can occur in up to 100% of these patients [7-9], with a mortality rate of 42.7% [10]. Apart from a high mortality rate, VAP is associated with long-term MV and ICU admission and a high incidence of acute respiratory distress syndrome (ARDS) [6].

VAP usually develops after a patient has been on invasive MV for more than 48 hours. Features that can help healthcare providers identify VAP include new changes on chest radiographs, microbiological verification, and the manifestation of clinical signs. In this study, we aimed to determine the characteristics of VAP among patients with COVID-19.

MATERIALS AND METHODS

STUDY DESIGN AND POPULATION

We conducted a single-centre retrospective cohort study in accordance with the STROBE guidelines to investigate the effects of COVID-19 on VAP development. A total of 235 adult patients with COVID-19 were admitted to the University Clinical Hospital ICU in Białystok, Poland, between March 3, 2020, and July 1, 2021. The inclusion criteria for this study were individuals older than 18 years of age with an acute infection caused by COVID-19,

confirmed by reverse transcription-polymerase chain reaction of nasal and pharyngeal swab specimens or lower respiratory tract secretions. Pregnant women, and those admitted to the ICU for reasons other than COVID-19, such as elective operations or emergency issues, were excluded from the study. Therefore, 180 individuals who met the inclusion criteria were included in this study, of whom 67 were classified into the VAP group. All information regarding the selection criteria is shown in the flowchart in Figure 1. Regarding the VAP criteria, we based our assessment on the European Centre for Disease Prevention and Control guidelines [11]. Samples of the lower respiratory tract secretions were obtained before antibiotic administration. The day on which these samples were positive for all suspected VAP pathogens was considered the start of VAP.

STATISTICAL ANALYSIS

The patients' data were entered into a predefined, institutional database. A t-test or chi-square test was used to assess the relationship between the variables, and corresponding p-values were reported. In addition, two-state logistic regression was used to investigate the factors that significantly affected patients. A p-value of less than 0.05 was considered statistically significant. All the analyses were performed using R software v.4.1.1 [12].

RESULTS

Table 1 presents the demographic and clinical characteristics of the patients at ICU admission, as well as the risk factors for developing VAP. Notably, bacterial co-infection occurred in only 33% of the participants in our study. Interestingly, the mean age of patients in the group who developed VAP (63.4) was statistically significantly lower than that of the other group (67.6, p-value=0.029). Additionally, the number of female patients who developed VAP (n=20) was statistically significantly lower than that of male patients (n=47). Comorbidities were common in the study population, with diabetes mellitus, atrial fibrillation, hypertension, and chronic heart failure being the most prevalent comorbidities. The mean score for the acute physiology and chronic health evaluation (APACHE II) was 30 at the time of the patients' admission to the ICU. Moreover, there was a statistically significant difference between the two groups in the mean ratio of the partial pressure of oxygen in the arterial blood to the fraction of inspiratory oxygen concentration (measured in mmHg), international normalized ratio, and neutrophil count. The C-reactive protein, procalcitonin, and neutrophil counts were not statistically significantly different between the two groups.

Considering the hospitalization period, the mean hospital stay was 16.8 days in the patients with VAP,

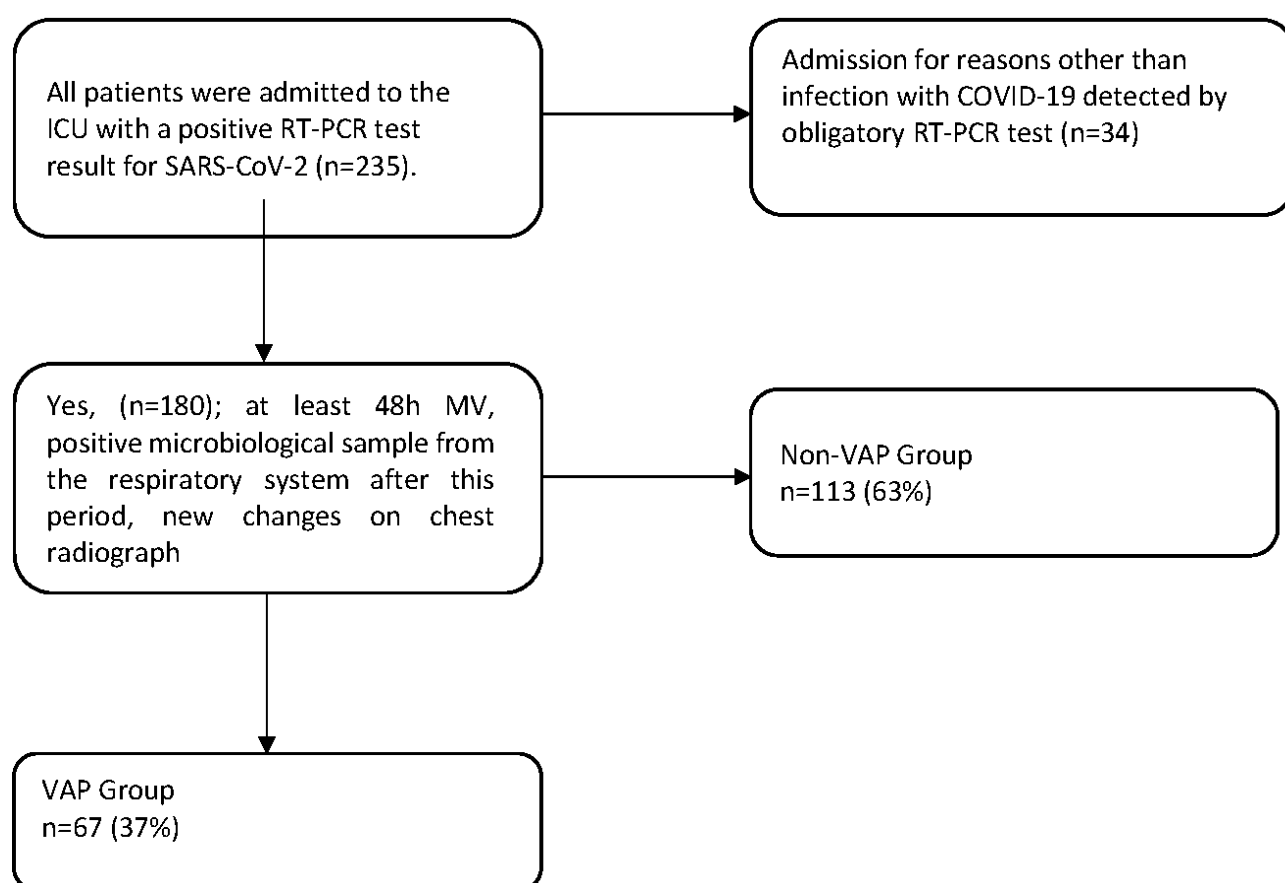


Fig. 1. Flowchart of patient screening and inclusion. ICU: intensive care unit; MV: mechanical ventilation; VAP: ventilator-associated pneumonia; SARS-CoV-2: severe acute respiratory syndrome coronavirus 2; COVID-19: coronavirus disease 2019; RT-PCR: reverse transcription-polymerase chain reaction.

Table 1. Characteristics of patients with COVID-19 at ICU admission, risk factors for developing ventilator-associated pneumonia, disease course, treatment, and outcomes.

Headcount	Non-VAP n= 113 (63%)	VAP n=67 (37%)	All n=180	p-value
Baseline and demographic				
Mean age (\pm SD) - years	67.6 (12.4)	63.4 (12.0)	66.0 (12.4)	0.029
Female; n (%)	59 (52.2)	20 (29.9)	79 (43.9)	0.006
Average BMI (\pm SD)	32.2 (7.3)	35.1 (27.8)	33.3 (17.9)	0.282
DM; n (%)	32 (27.6)	24 (35.8)	56 (30.6)	0.25
AF; n (%)	15 (12.9)	10 (14.9)	25 (13.7)	0.824
HT; n (%)	67 (57.8)	44 (66.7)	111 (61)	0.270
Obesity; n (%)	24 (20.7)	15 (23.1)	39 (21.5)	0.710
CHF; n (%)	27 (23.3)	14 (21.2)	41 (22.5)	0.854
On arrival in the ICU				
Mean APACHE II (\pm SD)	31 (8)	29.0 (7)	30 (7)	0.150
Mean PaO ₂ /FiO ₂ (\pm SD) [mmHg]	134.1 (86.6)	115.6 (54.7)	127.2 (76.6)	0.118
INR (\pm SD)	1.4 (0.3)	1.3 (0.2)	1.4 (0.3)	0.034
CRP (\pm SD) [mg/L]	81.2 (90.1)	90.8 (94.6)	84.8 (91.6)	0.501
Interleukin 6 (\pm SD) [pg/mL]	378.4 (778.6)	622.8 (1053.8)	481.4 (908.8)	0.145
White Blood Cells (\pm SD) [$\times 10^3/\mu$ L]	14.1(10.3)	12.5(8.7)	13.5(9.7)	0.273
Absolute neutrophils (\pm SD) [$\times 10^3/\mu$ L]	10.7 (6.6)	11.4 (7.3)	11.0 (6.9)	0.628
Neutrophils Percent (\pm SD)	69.1 (32.6)	82.8 (14.1)	75.0 (27.0)	0.017
Procalcitonin (\pm SD) [ng/mL]	3.0 (10.6)	1.4 (4.8)	2.4 (8.9)	0.230
During hospitalization				
Mean LOS at ICU (\pm SD) [days]	11.6 (9.8)	16.8 (10.6)	13.6 (10.3)	0.001
The average MV duration (\pm SD) [days]	10.9 (8.4)	14.8 (8.6)	12.4 (8.7)	0.004
Corticosteroids; n (%)	97 (85.8)	60 (89.6)	157 (87.2)	0.624
Prone Position; n (%)	42 (37.2)	30 (44.8)	72 (40.0)	0.395
Infusion of NMBAs at least 1 day; n (%)	74 (65.5)	58 (86.6)	132 (73.3)	0.004
INR; n (\pm SD)	1.3 (0.2)	1.2 (0.2)	1.2 (0.2)	0.288
CRP; n (\pm SD)	107.0 (73.7)	99.8 (85.9)	104.3 (78.3)	0.556
Interleukin 6; n (\pm SD)	532.4 (866.6)	655.0 (888.1)	583.3 (874.7)	0.396
Absolute neutrophils; n (\pm SD); [$\times 10^3/\mu$ L]	13.0 (7.2)	11.2 (5.4)	12.3 (6.6)	0.125
Neutrophils Percent; n (\pm SD)	82.2 (10.5)	81.0 (10.9)	81.7 (10.6)	0.521
Procalcitonin; n (\pm SD)	4.1 (10.1)	2.7 (5.3)	3.6 (8.6)	0.282
After 24 hours of ICU hospitalization				
CRP; n (\pm SD) [mg/L]	70.3 (79.4)	71.2 (68.4)	70.6 (75.1)	0.946
INR; n (\pm SD)	1.3 (0.3)	1.4 (0.3)	1.4 (0.3)	0.087
Interleukin 6; n (\pm SD) [pg/mL]	207.6 (252.8)	395.5 (520.1)	273.6 (373.2)	0.146
Absolute neutrophils; n (\pm SD) [$\times 10^3/\mu$ L]	11.9 (5.3)	8.2 (4.9)	10.6 (5.4)	0.079
Neutrophils Percent; n (\pm SD)	69.1 (33.0)	84.6 (6.8)	74.6 (27.5)	0.156
Procalcitonin (\pm SD) [ng/mL]	2.4 (7.2)	1.2 (3.8)	1.9 (6.2)	0.326

White Blood Cells; n (±SD) [$\times 10^3/\mu\text{L}$]	14.9 (11.4)	11.6 (7.5)	13.7 (10.3)	0.088
After 48 hours of ICU hospitalization				
CRP; n (± SD) [mg/L]	57.2 (74.5)	50.8 (59.8)	54.6 (68.8)	0.610
Procalcitonin; n (± SD) [ng/mL]	1.8 (5.1)	0.9 (2.3)	1.4 (4.1)	0.283
White Blood Cells; n (±SD) [$\times 10^3/\mu\text{L}$]	16.0 (12.9)	11.5 (6.5)	14.2 (11.1)	0.027
Interleukin 6; n (± SD) [pg/mL]	256.8 (370.7)	135.8 (143.3)	187.6 (267.8)	0.190
Absolute neutrophils; n (±SD) [$\times 10^3/\mu\text{L}$]	11.7 (6.7)	7.8 (4.7)	9.8 (6.0)	0.074
Neutrophils Percent; n (± SD)	68.4 (30.6)	78.7 (7.8)	73.4 (22.9)	0.216
INR; n (± SD)	1.3 (0.2)	1.2 (0.2)	1.3 (0.2)	0.043
After 72 hours of ICU hospitalization				
CRP; n (± SD) [mg/L]	54.5 (58.5)	38.4 (41.9)	48.4 (53.2)	0.118
Interleukin 6; n (± SD) [pg/mL]	843.0 (1516.6)	313.9 (556.6)	637.2 (1250.4)	0.221
White Blood Cells; n (±SD) [$\times 10^3/\mu\text{L}$]	17.3 (12.5)	12.5 (6.8)	15.6 (11.0)	0.030
Absolute neutrophils; n (±SD) [$\times 10^3/\mu\text{L}$]	14.3 (5.4)	11.3 (5.9)	12.6 (5.8)	0.180
Neutrophils Percent; n (± SD)	76.6 (23.3)	57.8 (32.9)	66.2 (30.0)	0.107
Procalcitonin; n (± SD) [ng/mL]	1.1 (2.0)	0.7 (1.5)	1.0 (1.9)	0.231
Outcome				
Death; n (%)	63 (55.8)	47 (70.1)	110 (61.1)	0.079

The results are reported as a number (percentage) for categorical variables and median [IQR] and SD for continuous variables. DM - Diabetes Mellitus; AF - Atrial Fibrillation; HT - Hypertension; CHF - Chronic Heart Failure; APACHE II - Acute Physiology and Chronic Health Evaluation II; NMBAs - neuromuscular blocking agents; LOS - length of stay; ICU - Intensive Care Unit.

which was longer than that in the non-VAP group (10.9 days). The same trend was observed for the average MV duration. Among the other interventions, only the infusion of muscle relaxants showed statistically significant differences. The results also suggested that patients with VAP had higher mortality rates (70.1%) than those without VAP (55.8%). However, this difference was not statistically significant (p -value=0.079).

In the multivariate analysis, several factors were independently associated with VAP occurrence, including age (Odds Ratio (OR): 0.98, 95% confidence interval (CI): 0.95–1.01, $p=0.153$), sex (OR: 2.60, 95% CI: 1.33–5.23, $p=0.010$), MV duration (OR: 1.06, 95% CI: 1.02–1.10, $p=0.004$), and infusion of muscle relaxants for at least one day (OR: 3.74, 95% CI: 1.66–9.06, $p=0.002$). The results of the univariate analysis of factors associated with VAP are shown in Table 2.

A total of 67 individuals had positive microbiological results for co-infection. The most common pulmonary pathogens were *Klebsiella pneumoniae*, *Staphylococcus aureus*, and *Enterococcus faecalis* (Table 3). The mean time to VAP onset was 6 days from admission to the ICU, with a range of 0 to 12 days. Bacterial pathogens responsible for VAP were classified as sensitive, multidrug-resistant (MDR), or extensively-drug-resistant based on the European Centre for Disease Prevention and Control definition [11]. Interestingly, MDR was the predominant type of antimicrobial resistance, accounting for 57% of

the cases, while sensitive pathogens represented 43% of the cases. Furthermore, 91% of the individuals were infected with MDR pathogens, whereas only 8% of them were infected with sensitive pathogens.

DISCUSSION

Our findings suggest that patients with COVID-19 who develop VAP have a higher mortality rate than those who do not. This is consistent with other research results indicating that VAP is more frequent and more likely to result in death in patients with COVID-19 than in those without COVID-19 [10, 11]. Additionally, prolonged MV and length of stay in the ICU are common features of VAP [11, 13]. Conversely, a longer MV duration increases the risk of VAP [11], which is consistent with our findings.

In our study, we observed a lower occurrence rate of VAP compared to other European countries [14], while the mortality rate associated with VAP was higher. In contrast, an Egyptian study reported 100% mortality among patients with COVID-19 and VAP [7], whereas a study conducted in Italy revealed that only 25.6% of patients with COVID-19 who were admitted to the ICU developed VAP [15]. These differences could be related to the healthcare systems in different regions of the world, the severity of COVID-19 in late-stage patients, and overwhelming ICU capacities.

Infection-induced immune impairment, prolonged MV duration, prolonged use of sedation, frequent prone

Table 2. Logistic regression of factors associated with VAP occurrence.

Independent variables	Univariate Analysis	Multivariate Analysis
	OR (95%CI), p-value	OR (95%CI), p-value
Muscle relaxants	4.77 (2.28–11.03), p<0.001	3.74 (1.66–9.06), p=0.002
MV duration	1.07 (1.04–1.11), p<0.001	1.06(1.02–1.10), p=0.004
APACHE III	1.00 (0.96–1.04), p=0.970	
ICU LOS	1.06 (1.03–1.10), p<0.001	
Chronic organ insufficiency or immunocompromised	1.03 (0.56–1.92), p=0.917	
Sex	2.43 (1.25–4.87), p=0.010	2.60 (1.33–5.23), p=0.010
Age	0.97 (0.95–1.00), p=0.027	0.98 (0.95–1.01), p=0.153
Prone position	1.41 (0.77–2.56), p=0.262	
Use of corticosteroids	1.25 (0.51–3.37), p=0.645	

ICU - Intensive Care Unit; LOS - length of stay; MV - mechanical ventilation; APACHE II - Acute Physiology and Chronic Health Evaluation II; ARDS - Acute Respiratory Distress Syndrome; OR - Odds Ratio.

Table 3. Pathogens causing ventilator-associated pneumonia.

Ventilator-associated Pneumonia Pathogens	Frequency in patients' samples
<i>Klebsiella pneumoniae</i>	33
<i>Staphylococcus aureus</i>	22
<i>Enterococcus faecalis</i>	14
<i>Acinetobacter baumannii</i>	8
<i>Escherichia coli</i>	7
<i>Corynebacterium species</i>	5
<i>Enterobacter cloacae</i>	5
<i>Proteus mirabilis</i>	4
<i>Citrobacter freundii</i>	2
<i>Haemophilus influenzae</i>	2
<i>Staphylococcus haemolyticus</i>	2
<i>Stenotrophomonas maltophilia</i>	2
<i>Burkholderia gladioli</i>	1
<i>Corynebacterium striatum</i>	1
<i>Delftia acidovorans</i>	1
<i>Hafnia alvei</i>	1
<i>Klebsiella oxytoca</i>	1
<i>Pseudomonas aeruginosa</i>	1
<i>Staphylococcus cohnii</i>	1

ventilation, and a higher risk of pulmonary infection are other factors that may have contributed to the increased risk of VAP in COVID-19 infections compared to other ARDSs [16-18]. Our study identified sex and the use of neuromuscular blocking agents as independent factors influencing the occurrence of VAP, which is consistent with another study [19]. Additionally, obesity and other comorbidities are important factors that cannot be ignored [13], as they are linked to a higher risk of severe COVID-19 rather than the development of VAP [13]. In our study, 59% of patients had a BMI over 30 kg/m², which is a notable number given the prevalence of obesity in the Polish population (19%) [20]. Obesity may also indicate poorer baseline health owing to its association with lower socioeconomic status [21]. Similar to a previous study [22] prone positioning did not affect the occurrence of VAP in our study. Corticosteroids, which are commonly used to control ARDS development in severe COVID-19 cases, may decrease the immune system response [23] and indirectly increase the risk of co-infection [24]. However, this dependence was not observed in our study.

The main pathogens identified in our study were *Klebsiella pneumoniae*, *Staphylococcus aureus*, and *Enterococcus faecalis*, which is consistent with previous reports on non-pandemic cases [11], as well as other pandemic-related studies [13]. The emergence of MDR strains in our study was found to be associated with several factors including ARDS and other reasons that contribute to the development of MDR. Our findings are in agreement with similar reports that the overuse of antibiotics is related to an increase in MDR rates [25]. Therefore, we suggest that patients with COVID-19 should receive empirical treatment based on clinical evidence and appropriate antimicrobial medications following regional guidelines [26]. Our findings highlight the importance of promptly modifying empirical therapy based on the availability of microbiological test results. Therefore, we recommend that healthcare providers closely moni-

tor the progress of their patients and adjust their treatment plans accordingly once the results of the microbiological tests are ready. MDR organisms and inadequate early antibiotic therapy are well-known risk factors for mortality in patients with VAP [27, 28]. However, Blonz et al. [29] found that the first empirical therapy appeared to reduce the prevalence of polymicrobial VAP, although prior antibiotic treatment may predispose the organisms to resistance.

LIMITATIONS

The layout and structure of our study were strong, with clearly defined variables used in the analysis. The VAP specifications also adhered to the European Centre for Disease Prevention and Control guidelines. Furthermore, our

study identified a possible risk factor for mortality in critically ill patients. However, our study had some limitations. Firstly, our results may not be applicable to other hospitals owing to the monocentric study design. Secondly, the retrospective design of this study prevented the elimination of several covariates. Additionally, it can be difficult to distinguish between bacterial VAP and upper respiratory colonisation in patients with severe COVID-19 [30].

CONCLUSIONS

Our findings suggest that VAP is a common complication in patients with COVID-19 receiving MV and that multidrug-resistant bacteria are a significant concern. This highlights the need for effective prevention and management strategies for VAP in this population.

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ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of Medical University of Białystok, Poland (protocol code: APK.002.242.2021, date of approval: 29.04.2021). Patient consent was waived due to the retrospective nature of the study.

CONFLICT OF INTEREST

The Authors declare no conflict of interest.

ADDRESS FOR CORRESPONDENCE

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BURNOUT SYNDROME PREVALENCE AMONG EMERGENCY MEDICINE WORKERS: A SURVEY STUDY

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ABSTRACT

Aim: To measure the level of burnout among medical professionals.

Material and methods: The study was conducted on during the 15th University Conference of Emergency Medicine in Łódź (Nov 2022, Łódź, Poland). In order to conduct the study, a survey consisting of 24 questions was used. The measurement of burnout was measured using the satisfaction with life scale and Maslach Burnout Inventory. Out of 288 conference participants, 86 participated in the study (29,9%). Statistica 64 was used for statistical analysis.

Results: It turns out that 10,5% (n=9) feels burned out constantly, whereas 45,3% (n=39) feel it occasionally. Almost half (44,2%, n=38) never gets the feelings of exhaustion or it happens to them very rarely. The tests show that there is significant correlation stating that medical professionals with higher levels of burnout tend to reach for stimulants such more often. Those that drink more alcohol and/or take psychiatric drugs claim that using those substances provides them with feelings of relief and helps them cope with the stress surrounding labour. A lower level of burnout among medics goes in pair with the love of what they are doing.

Conclusions: Medical professionals with higher levels of burnout tend to reach for stimulants such as psychiatric drugs more often – those medics claim that substance use helps them cope with the workplace related stress. Being satisfied with the choice of profession is connected to lower levels of burnout prevalence.

KEY WORDS

stress, burnout syndrome, emergency medicine, psychotropics, substance abuse, occupational satisfaction

INTRODUCTION

Burnout syndrome is one of the major worldwide problems pertaining to a constantly increasing percentage of our society [1]. Thus far burnout has been defined as a psychological syndrome emerging as a response to chronic interpersonal stressors at work [2, 3]. According to the World Health Organizations' standpoint from 2019 burnout has been included in the 11th Revision of the International Classification of Diseases (ICD-11) as an occupational phenomenon. The three main dimensions of this syndrome are feelings of exhaustion, increased distance from one's job, or negative, cynical feelings related to it and reduced efficacy at work [3].

This psychological syndrome could be in particular associated with careers based on interpersonal relations such as education, human services and health care. These vocations are related to occupational stressors as much as to emotional factors affecting the level of burnout [2]. Health care professions not only demand a lot of empathy, selflessness and putting others' needs above your own, but they also face a lot of problems like aggressive and demanding patients, lack of respect (as well from co-workers), understaffing, excessive workload, or funding cutbacks [2]. It is vitally important to explore the

mechanisms of burnout, continuously trace the levels of it and search for methods to decline it, since this occupational phenomenon can affect the ability to make important and sudden decisions increasing at the same time the risk of medical errors and result in poor patients' safety [4].

Even though psychiatric medicaments, are necessary in some cases to lead a normal life, they can also be used in a wrong way. Research from Spain revealed that the medical personnel that experiences heavy stress at workplace is more likely to reach for drugs, as a coping mechanism [5]. Not only the healthcare labor force is affected by this problem. In Denmark research on human service workers showed that work-related burnout is an important risk factor for antidepressant treatment [6].

Our research group decided to carry out a survey study during a medical academic Conference to analyse the levels of burnout among a group of health care workers from different regions of Poland. This study was also based on the other crucial factors relevant to burnout syndrome such as stress level [2, 3], job satisfaction [7], consumption of alcohol and other substances [8], as well as psychiatric medication use [9].

THE AIM

The main goal of the research was to measure the level of burnout and satisfaction of work among medical professionals. The additional aim was to measure their life satisfaction and eventual psychotropic substance use regarding them to the burnout level.

MATERIAL AND METHODS

In order to conduct the study, a survey consisting of 24 questions was used. 19 of them were single-choice questions. The remaining 5 questions assessed opinions, attitudes or views using a 7-point Likert scale: 1-I completely disagree 2-I disagree 3-I somewhat disagree 4-I neither agree nor disagree 5-I somewhat agree 6-I agree 7-I completely agree.

The satisfaction with life scale (SWLS) and Maslach Burnout Inventory (MBI) have been a source of inspiration to the construction of the survey. Their overall aim and construction has been used in the questions created, however in order to gather more respondents, the number of questions has been reduced. These tools enable to assess global life satisfaction with particular focus on exhaustion, cynicism and professional efficacy [10, 11]

The study was conducted on November 19th and 20th, 2022 during the 15th University Conference of Emergency Medicine in Łódź, organized at the Clinical and Didactic Center of the Medical University of Łódź. Out of 288 Conference participants, 86 participated in the study (29.9%). The target group of the study were

doctors specializing in emergency medicine (32.5%, n=28), doctors of other specializations (18.6%, n=16) and paramedics (18.6%, n=16). The remaining groups of respondents were medical trainees (10.5%, n=9) and nurses (4.7%, n=4). Other working groups constitute of 13 people (15.1%). Slightly more than half of the respondents were men (55.8%, n=48). Most of the respondents were residents of larger cities - inhabited by over 500,000 people (40.7%, n=35) and inhabited by 250-500.000 inhabitants (19.8%, n=17).

In order to process the data descriptive methods and statistical inference methods were used. In order to establish a specific method, the conformity of the distributions of analysed measurable variables with the standard deviation was checked. This was performed using the Shapiro-Wilk test. Due to the fact that the distributions of analysed measured variables differed significantly from normal distribution, nonparametric tests were used instead of parametric tests.

The Mann Whitney U test is the strongest nonparametric alternative to the Student's t-test for independent samples. The results with an appropriate number of degrees of freedom and probability of error $p < 0.05$ were considered statistically significant. The Mann Whitney U test was used for all nominal variables obtained in the study – comparing gender, whether the respondent has taken psychiatric drugs before and whether the respondent would choose the same specialisation if they could do it again. It was performed using the Statistica

Table 1. Characteristics of the respondents.

Variable	Subgroup	n	[%]
Gender	Male	48	55.8
	Female	38	44.2
Age	Below 40	47	54.7
	40 and over	39	45.3
Domicile	A town with less than 25,000 inhabitants	14	16.3
	A city of 25-50 thousand inhabitants	9	10.5
	A city of 50-250 thousand inhabitants	11	12.8
	A city of 250-500 thousand inhabitants	17	19.8
	A city with over 500,000 inhabitants	35	40.7
Occupation	Physician/Resident specializing in emergency medicine	28	32.5
	Physician/Resident with a specialization other than emergency medicine	16	18.6
	Trainee doctor	9	10.5
	Paramedic	16	18.6
	Nurse	4	4.7
	Other	13	15.1
Labor sector	Public	53	61.6
	Private	5	5.8
	Public and Private	28	32.6

64 software. The Spearman rank-order correlation coefficient (Spearman's correlation, for short) is a nonparametric measure of the strength and direction of association that exists between two variables measured on at least an ordinal scale. The correlations with probability of error $p < 0.05$ were considered statistically significant. The Spearman's correlation was used for all possible variables obtained in the study, except for those covered by Mann Whitney U test. It was performed using the Statistica 64 software.

RESULTS

The main characteristics of the respondent group is shown in Table 1. As it turns out, when asked directly, 10.5% ($n=9$) feels burned out constantly, whereas 45.3% ($n=39$) feel it occasionally – those two groups will be re-

garded as affected by burnout syndrome later on in the research article. Almost half (44.2%, $n=38$) never gets the feelings of exhaustion or it happens to them very rarely. 64 people (74.4%) claim, that they have never taken psychiatric drugs before.

The tests show that there is significant correlation stating that surveyed medical professionals with higher levels of burnout tend to reach for stimulants such as psychiatric drugs more often. There is no statistical significance pointing towards alcohol intake and burnout correlation. However, those that drink more alcohol and/or take psychiatric drugs claim that using those substances provides them with feelings of relief and helps them cope with the stress surrounding labour. At the same time there is a significant correlation between psychiatric drugs use and the overall feelings of dissat-

Table 2. The existence of a difference between groups by variable whether the respondent had taken psychiatric drugs before.

Variable	Mann-Whitney U Test (w/ continuity correction) By variable whether the respondent had taken psychiatric drugs before	
	Z	p-value
How old are you?	0.79676	0.425593
What is the size of the city you live in?	-1.41536	0.156965
What is your profession?	0.96007	0.337022
How many years have you worked in your profession?	0.77696	0.437182
In which sector of healthcare do you work in? (Public/Private/Both)	-0.00495	0.996051
How many jobs are you currently working in?	-0.47014	0.638258
How many shifts per week do you have?	-1.06399	0.287333
How do you like your job?	1.34607	0.178280
How often do you consume alcohol?	-0.62355	0.532925
Do you use stimulants (alcohol, drugs) as a method of relieving stress?	-2.46945*	0.013533*
Do you feel that using stimulants helps in combatting stress?	2.11314*	0.034590*
Would you encourage your child to pursue a career of a medical doctor?	-0.77696	0.437182
If the previous question says "Yes", would you encourage your child to choose the same specialisation as you did?	-0.04949	0.960530
How do you rate your salary?	-0.09898	0.921157
In a scale of 1-10 how do you rate the stress at your workplace?	0.66314	0.507242
Does your profession give you satisfaction?	1.44505	0.148445
Does your profession influence your personal life negatively?	-0.56911	0.569281
Is most of the problems in your life caused by your profession?	-0.31672	0.751454
Do you feel burned out?	-2.73174*	0.006301*
On a scale of 1-7 how do you agree with a following sentence:		
My life is close to ideal.	2.12798*	0.033339*
On a scale of 1-7 how do you agree with a following sentence:		
The conditions that I'm living in are perfect.	1.68259	0.092455
On a scale of 1-7 how do you agree with a following sentence:		
I am content with my life.	1.21246	0.225339
On a scale of 1-7 how do you agree with a following sentence:		
I achieved what I wanted in my life.	0.92543	0.354746
On a scale of 1-7 how do you agree with a following sentence:		
If I could live my life again I wouldn't want to change anything.	2.41006*	0.015950*

* $p < 0.05$

isfaction, manifested in a number of different questions measuring satisfaction (Table 2).

As one can see pursuant to Table 3, in most cases no association between a burnout level and another factor can be demonstrated. A lower level of burnout among medics goes in pair with job satisfaction : there is statistical significance showing a strong link between not feeling burned out and liking their job, already having worked many years in their field, as well as with choosing the same profession if they had to progress in their carriers again – this last in regard to a separate Mann Whitney U test. Higher levels of burnout are correlated with a person having more jobs, not feeling fulfilled, as well as with the work disrupting their personal life.

DISCUSSION

Occupational burnout and its consequences - even though not classified as a medical condition - are a worldwide occurring phenomenon defined officially by the WHO as a „syndrome conceptualized as resulting from chronic workplace stress that has not been successfully managed” [3]. The appellation „occupational burnout” is especially common within professions whose characteristics are largely structured around interpersonal contacts - such as medical field. In our research, we aimed to determine the levels of stress and the occurrence of burnout within the medical profession.

We have found that the occupational burnout prevalence rate matched the stress levels in the medical field

Table 3. Correlation between feeling burned out and other factors measured.

Variable	Spearman Rank Order Correlations	
	MD pairwise deleted Marked correlations are significant at p < .05000	Do You feel burned out? Scale 1-5
What is the size of the city you live in?		0.083316
How many years have you worked in your profession?		0.240313*
In which sector of healthcare do you work in? (Public/Private/Both)		0.086024
How many jobs are you currently working in?		0.293993*
How many shifts per week do you have?		0.104132
How do you like your job?		-0.335500*
How often do you consume alcohol?		0.054461
Do you use stimulants (alcohol, drugs) as a method of relieving stress?		0.044943
Do you feel that using stimulants helps in combatting stress?		0.033979
Would you encourage your child to pursue a career of a medical doctor?		0.060405
If the previous question says “Yes”, would you encourage your child to choose the same specialisation as you did?		0.020467
How do you rate your salary?		0.051943
In a scale of 1-10 how do you rate the stress at your workplace?		0.093462
Does your profession give you satisfaction?		-0.237251*
Does your profession influence your personal life negatively?		0.287929*
Is most of the problems in your life caused by your profession?		0.271866*
On a scale of 1-7 how do you agree with a following sentence:		
My life is close to ideal.		-0.116910
On a scale of 1-7 how do you agree with a following sentence:		
The conditions that I’m living in are perfect.		-0.068320
On a scale of 1-7 how do you agree with a following sentence:		
I am content with my life.		-0.130975
On a scale of 1-7 how do you agree with a following sentence:		
I achieved what I wanted in my life.		-0.049481
On a scale of 1-7 how do you agree with a following sentence:		
If I could live my life again, I wouldn’t want to change anything.		-0.040409

p* < 0.05

and affected more than half of the study group (54.6%, n=48). Responders who suffer from burnout syndrome were more likely to abuse the use of psychiatric drugs and claimed that substances of such help them with stress levels management. The majority of our responders claimed feelings of high job fulfillment and job satisfaction (63.9%, n=55) [high being 4 and above on a 1-5 scale].

A high burnout prevalence rate among medics and healthcare workers is a threat not only to their own individual health, but also to the health of their patients as burnout levels correlate with the risk of medical errors [12]. That should be of interest not only to individuals working in the medical field but also to institutions like hospitals, clinics and other workplaces functioning in healthcare - especially since according to recent data systemic factors such as excessive workload, workflow, and administrative burden [13] play a huge role in burnout development. Our study showed a correlation between burnout levels and the number of places an individual is employed in. It is probable to state that the more jobs one individual has the bigger the workload they have to face. Other research has shown that the amount of workload increases the burnout risk among medical staff [14]. The question of why healthcare workers need to work at more than one place at once should be especially valid in Poland (the country of residence and work of participants of our survey) where according to other research data [13] almost half of the physicians surveyed, have more than one place of employment.

Job conditions appear to be pivotal as our study shows that those who like their job are less likely to suffer from burnout syndrome. The recipients who claim that they would make the same choice career-wise and pick the same medical specialty as they did before if offered a chance, tend to like their job and feel high levels of job satisfaction. It is worth mentioning that liking a job is not the same as being interested in it. People can probably be uninterested in the scientific part of medicine and at the same time like their job for different reasons (like good pay, a friendly atmosphere, the feeling of fulfillment).

High levels of stress are important not only when analyzing different burnout factors and origins, but also because they can be one of the leading factors adding up to developing depression. Doctors are a high-risk group since they suffer from higher levels of stress than the general population [15]. Some of those doctors who develop depression or have had depression in the past - if properly diagnosed and treated - surely were prescribed psychiatric drugs at one point throughout the course of their lives. That seems to be important considering that our research showed that individuals who exhibit symptoms of occupational burnout are more likely to abuse psychiatric drugs.

The results of previous research on the matter of occupational burnout showed data similar to results obtained by us [16], especially results registered within the emergency department staff [17] whose representatives

were the main participants of our survey. Most scientific sources claim high levels of burnout among medical staff. [18].

Our results on job fulfillment and job satisfaction align with other data collected from countries of the EU [19] (~59% of physicians working in European hospitals are overall satisfied). It is important to pinpoint that our research was carried out in a democratic European high-income country.

Results from countries of other - especially income and sociopolitical - characteristics may differ from those obtained by us. For example, according to data collected in China an even bigger part of responders (~84%) experience symptoms of burnout [20], and over 46% report career choice regret.

Our data show that high levels of stress were reported by most (67.4%, n=58) of our responders [high being 7 and above on a 1-10 scale]. In comparison, a study on a similar matter analyzing the Danish population of doctors who were already specialists determined that 55% of those examined acknowledged high levels of stress in their lives [21]. A cross-sectional study of medical residents (of various specialties) from Germany showed a significantly lower (than the previously mentioned here numbers) percentage of responders reporting high levels of occupational stress (only 17%) [22].

Our research showed that individuals who exhibit symptoms of occupational burnout are more likely to abuse psychiatric drugs. Previous studies have shown that those who have a history of taking medications for sleep disorders are at a higher risk for burnout [23]. That same group of responders who admitted to psychiatric drug intake declared that substances of such tend to help them soothe their nerves and bring them ease. Doctors tend to manage their emotions inadequately and have problems with recognizing emotional reactions [24] thus they might find it troublesome to differentiate between stress and emotions like sadness, anger, or anxiety.

According to our study there is no statistically significant correlation between alcohol drinking and burnout contrary to most other studies analyzing the same matter [25]. However, the matter of the association between alcohol and burnout seems to be unclear. According to other scientific sources it was only alcohol dependence that was statistically valid in its correlation to burnout, whereas the association between alcohol consumption and burnout was found to be statistically insignificant [26].

A comparably performed study on participants of a medical conference in Ghana showed low levels of burnout [27]. That stands in contrary to what we've discovered in our research. Therefore, more studies should be performed on various groups of health professionals attending science conferences.

CONCLUSIONS

Our study demonstrated that among the surveyed medical professionals that took part in the Conference, the levels of burnout were elevated. As the results

showed job satisfaction plays a significant role in the perceived levels of burnout. Healthcare workers who enjoy their work don't regret their career choices and would encourage family members to follow their steps. Higher levels of burnout are associated with job dis-

satisfaction, workload and the impact of ones' work on the personal life. Burnout syndrome also seems to have a relevant impact on the intake of psychiatric drugs or other stimulants, meanwhile there is no crucial correlation with the alcohol consumption.

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CONFLICT OF INTEREST

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COMPARISON OF THE EFFICACY OF INSERTING MIDLINE CATHETERS BY EXPERIENCED AND INEXPERIENCED NURSES: A RETROSPECTIVE OBSERVATIONAL STUDY

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ABSTRACT

Aim: The purpose of this retrospective observational study was to compare peripheral venous cannulation performed under ultrasound guidance by experienced and inexperienced nurses.

Material and Methods: The observational study was retrospective. Analysis was done of eighty-seven charts of successful ultrasound-guided cannulations performed by experienced and inexperienced operators over a 5-month period.

Results: In the experienced group, an average of 1.31 puncture attempts were performed (median=1), and in the inexperienced group that number was 1.42 (median=1). One attempt was enough for 76.6% (n=36) and 72.5% (n=29) of cannulations, respectively. Experienced nurses needed statistically significantly less time to successfully puncture a vessel (p=0.003).

Conclusions: Implementing the procedure of inserting midline catheters under ultrasound guidance should be based on properly conducted training and supervised clinical experience. Performing an adequate number of cannulations during training reduced the time required for the procedure and decreased the number of failures. Completing 20 to 50 cannulations during the course makes it possible to achieve a high success rate of vascular access insertion with a minimum number of attempts.

KEY WORDS

nurses, ultrasound-guided, cannulation, midline, catheters

INTRODUCTION

Difficult Intravenous Access (DIVA) is one of the clinical challenges of health care. It can lead to patient discomfort, medical staff time spent on attempts doomed to failure, delayed intravenous therapy and increased cost of care [1, 2]. To improve efficiency and minimize complications in DIVA, ultrasound-guided cannulation is recommended [3-5]. Ultrasound increases the effectiveness of inserting vascular access, but the procedure is a skill that requires training and experience. Current studies show that the number of cannulations performed to ensure proficiency vary, therefore it is important to prepare clinicians adequately and include the teaching of theory, simulation techniques, and then clinical practice with the support of a supervisor [6-9].

THE AIM

The purpose of this study was to compare peripheral vein cannulations performed under ultrasound guidance by experienced and inexperienced nurses based on a prospective analysis of records.

MATERIAL AND METHODS

Study No. AKBE/103/2023 was acknowledged by the Bioethics Committee. The observational study was retro-

spective in nature. We analyzed cannulation cards that were performed from March to July 2023 by the Vascular Access and Infusion Team.

LIMITATIONS

The material collected included 88 cannulation cards. One cannulation was unsuccessful and was excluded from further analysis, but included under cannulation efficiency (40/41). Finally, 87 patient cards were analyzed. In the group of inexperienced operators, 8 cards were not completely filled out. In this group, 40 out of 47 cannulation cards were included in the analysis.

PATIENT ELIGIBILITY

The Vascular Access and Infusion Team performed cannulation on patients pre-enrolled by physicians and nurses of hospital departments based on two criteria: a prognosis of difficult intravenous access assessed by the A-DIVA scale and/or two unsuccessful attempts to insert a peripheral cannula [1]. The decision to insert the type of cannula was made by the Vascular Access and Infusion Team. A midline or mini-midline catheter was inserted in difficult intravenous access when the anticipated duration of intravenous therapy was >5 days and/or it was not technically possible to insert a peripheral

intravenous cannula (the vessel identified was located deeper than 12-16 mm under the skin) [10-12].

PERFORMANCE OF THE PROCEDURE

After obtaining the patient's informed verbal consent for cannulation, an ultrasound examination of the veins of the forearm and upper arm was performed using a Dрамиński Blue device with a 10 MHz 4.0 cm linear probe. After selecting the optimal vessel puncture site using the Aseptic Non-Touch Technique (ANTT), the ultrasound-guided cannulation procedure was performed using Smartmidline Vygon, Arrow Midline Teleflex and Leaderflex Vygon sets. The test procedure consisted of observing the insertion technique and the cannulation time by the assistants.

PERSONS WITHOUT EXPERIENCE

The training of those performing the procedure consisted of participating in training under medical simulation conditions and observing the procedure under real conditions. After completing training in ultrasound-guided needle guidance and the Seldinger cannula insertion technique, operators performed 20 cannulations under the guidance of a procedure supervisor, who pro-

vided additional instructions or continued the procedure if difficulties arose. Subsequent cannulations were carried out independently with the possibility of obtaining support. The study involved separating two groups. The inexperienced group included 5 nurses who performed <50 cannulations (including 20 under supervision), and the experienced group included 3 nurses who performed >50 independent cannulations (excluding 20 supervised ones).

DATA COLLECTION

After the procedure, the operator filled out: a register of cannulas inserted, a cannulation card and an observation card. After collecting data from the records, the following variables were assessed: patient age, indication for the insertion of a midline catheter as determined by the person performing the cannulation, the number of cannulation attempts (one puncture of the patient's skin was considered to have been one attempt), diameter of the vein, length of the catheter inserted and diameter of the catheter inserted. Complications in the form of iatrogenic puncture of an artery or nerve were assessed. In addition, the assistant measured the time from skin puncture to free blood reflux.

Table 1. Gender, limb, catheter parameters, department.

	Group 1	Group 2
Gender	Women n=27 (57,4%)	Women n=21 (52,5%)
	Men n=20 (42,6%)	Men n=19 (47,5%)
Limb	Left n=19 (40,4%)	Left n=11 (23,4%)
	Right n=28 (59,6%)	Right n=29 (61,7%)
Length of catheter	8 cm n=2 (4,3%)	8 cm n=0 (0,0%)
	10 cm n=5 (10,6%)	10 cm n=0 (0,0%)
	12 cm n=7 (14,9%)	12 cm n=9 (22,5%)
	15 cm n=19 (40,4%)	15 cm n=26 (65,0%)
	20 cm n=13 (29,8%)	20 cm n=5 (12,5%)
Diameter of catheter	2 Fr n=2 (4,3%)	2 Fr n=0 (0,0%)
	3 Fr n=28 (59,6%)	3 Fr n=32 (80,0%)
	4 Fr n=17 (36,2%)	4 Fr n=8 (20,0%)
Department	Internal medicine n=36 (76,6%)	Internal medicine n=25 (62,5%)
	Surgical n=8 (17,0%)	Surgical n=11 (27,5%)

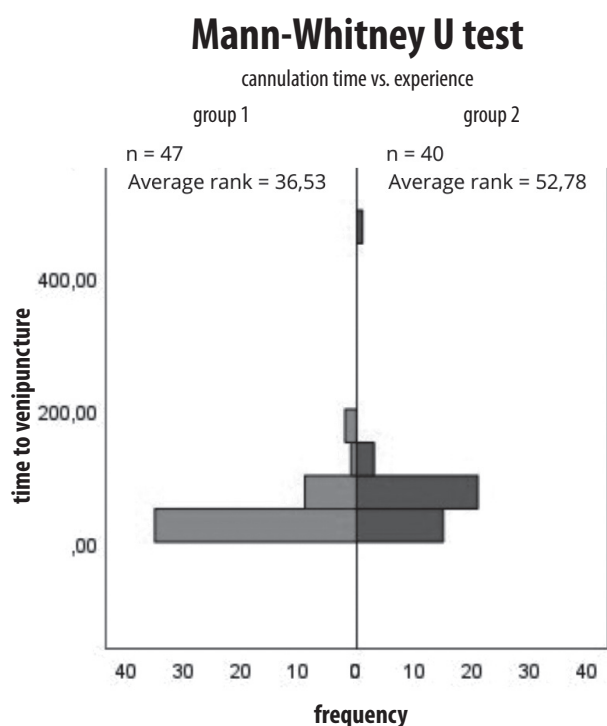


Fig. 1. Cannulation time vs. experience.

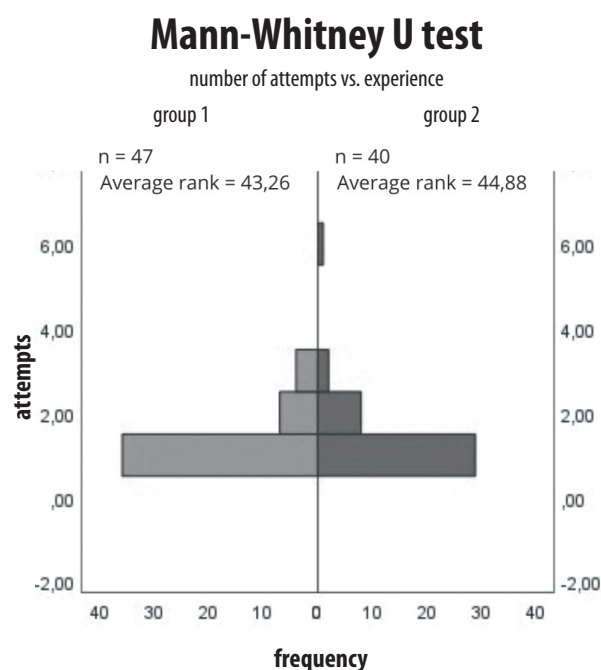


Fig. 2. Number of attempts vs. experience.

Table 2. Number of attempts.

	Group 1	Group 2
1 attempt	n=36 (76,6%)	n=29 (72,5%)
2 attempts	n=7 (14,9%)	n= 8 (20,0%)
3 attempts	n=4 (8,5%)	n=2 (5,0%)
>4 attempts	n=0 (0,0%)	n=1 (2,5%)

STATISTICAL ANALYSIS

In order to select appropriate statistical tests to examine the relationship between variables, the fulfillment of the assumptions that allow the use of each test, i.e.: the type of variables, normality of distribution and appropriate sample size, was verified. The following statistical tests and methods were used for statistical analysis: the Mann-Whitney U test, the Kruskal-Wallis test and the Pearson correlation. During the statistical verification of the material collected, $p < 0.05$ was taken as the level of significance for the results obtained. The IBM SPSS Statistics 28 software was used to perform the calculations.

RESULTS

Analysis was made of eighty-seven charts of successful cannulations performed under ultrasound guidance by experienced (group 1, $n=47$) and inexperienced (group 2, $n=40$) operators over a 5-month period. In group 1, the cannula was successfully inserted 100% of the times, and in group 2 in 96% of the attempts were successful. Data on gender, the limb in which the catheter was placed, the length and diameter of the catheter, and the ward in

which the patient stayed are included in table 1. In Group 1, cannulas were inserted into the basilic vein 68.1% ($n=32$) of the times, into the brachial vein 27.7% ($n=13$) of the times and into the cephalic vein in 4.3% ($n=2$) of the patients. In group 2 these numbers were: 82.1% ($n=32$), 12.8% ($n=5$) and 5.1% ($n=2$), respectively. On the A-DIVA scale, patients in group 1 obtained an average score of 4.5 (min.3; max. 5; SD 0.69), and in group 2 they got 3.82 points. (min. 1; max. 5; SD 0.98). Group 1 made an average of 1.31 puncture attempts (min 1; median: 1; max. 3; SD 0.63), and group 2 performed 1.42 attempts (min 1; median 1; max. 6; SD 0.93). One attempt sufficed in 76.6% ($n=36$) of the cases in group 1 and in group 2 in 72.5% ($n=29$) of the cases, while two attempts were required for 14.9% ($n=7$) of the patients in group 1 vs. 10% ($n=8$) in group 2 (Table 2). The average time required to puncture a vessel and obtain blood flow was 37.25 seconds in group 1 ($n=40$; min 4 s; max. 180 s; SD 36.75) and 58.47 seconds in group 2 ($n=47$; min. 7 s; max. 480 s; SD 72.55). Nurses in group 1 needed statistically significantly less time to successfully puncture a vessel than in group 2 ($p=0.003$) (Fig. 1). In both groups, cannulation time was not dependent

on the vein chosen ($p=0.696$ and $p=0.647$), moreover the diameter of the vein being cannulated had no effect on the number of cannulation attempts required (group 1: $p=0.165$; group 2: $p=0.649$). Moreover, the number of attempts was independent of the group performing the procedure ($p=0.392$) (Fig. 2). There were no complications. One cannulation was unsuccessful, due to the operator's inability to puncture the vessel.

DISCUSSION

In an era of the increasing use of ultrasound during peripheral intravenous cannulation and recommendations for its use, nurses should be trained in applying this technique and allowed to gain experience [3, 4, 6]. Competence in ultrasound-guided intravenous cannulation can be obtained after completing an approved educational program. Such an approach results in an increase in the success of the first cannulation attempt in proportion to the number of procedures performed and is a skill that nurses master successfully [6, 13]. Nevertheless, there is no consensus on how to design the curriculum to achieve this competency [2]. Simple didactic measures can lead to the competent insertion of ultrasound-guided peripheral intravenous cannulas by novices, resulting in numerous positive outcomes for patients and health systems [2]. Training courses should consist of a theoretical and practical component. Lectures usually focus on the basics of ultrasonography and vascular anatomy. Practical training includes vein identification on a live model without cannulation, followed by vein cannulation using a non-human tissue model (usually gel phantoms) [14]. In subsequent stages, supervised cannulation of veins on the upper limb using the ultrasound-guided technique is performed on live patients to demonstrate competency. The following step involves supervised and supported clinical practice. A significant problem with this model may be the lack of available supervisors, which may be a barrier that delays staff from completing training [9]. Therefore, consideration may be given to incorporating an online form as an alternative method of supervision, especially when the availability of supervising staff is limited [9]. The studies included in the Hoskins et al. review described improved peripheral cannulation efficacy outcomes, including significantly reduced number of cases that involve inserting central venous catheter and associated infectious complications, fewer patient complaints concerning cannulation, reduced specialist involvement, and less frequent delays in therapy [2]. The authors also point out improved confidence, knowledge and competence in the procedures performed [2]. Nurses can insert peripheral intravenous cannulas under ultrasound guidance with a high success rate after an initial training period [8]. In a study by Blick et al., a total of 87% of ultrasound-guided intravenous cannulas inserted after the training program were successful on the first attempt. The probability of successful insertion increased with the nurses' experience and was 83% after 10 sessions [8]. In the report of the analysis, nurses described as in-

experienced (group 2) achieved a 96% success rate and this increased to 100% in the experienced group (group 1), with no cannulation complications. A number of studies have evaluated specifying the number of procedures that need to be performed before achieving competence in ultrasound-guided peripheral intravenous cannulation. Loon et al. describe an overall success rate of 93% on the first attempt, with an average of 34 procedures required to achieve competence [6]. By the fortieth procedure performance time was reduced. This phenomenon has also been confirmed by the analysis conducted at our center, in which the time required to puncture a vessel was statistically significantly reduced with practice ($p=0.003$). Peters et al. report an average first-attempt success rate at 71% ($n = 72$) in 102 recruited patients who had ≥ 2 DIVA risk factors [9]. In their study, one attempt was sufficient in 76.6% ($n = 36$) of the cases for experienced nurses and 72.5% ($n = 29$) of inexperienced ones, but all the patients were identified with ≥ 4 A-DIVA factors. Similar results are presented by other authors [2], where the overview presented the mean of the reported insertion attempts as 1.7 (1.31 and 1.42 in our study), while the success rate was 82.5% (100% and 96% in our study for group 1 and 2, respectively), and the first-time success rate was 75.5%. It would be worth considering a study that would identify potential additional factors that may affect the success of cannulation in difficult access, regardless of the technical skill of guiding the needle under ultrasound. With reference to the studies cited, this may be clinically relevant, in that once a certain level is reached, the procedure with only one attempt to puncture the vessel is not always successful. On the other hand, the studies available adopt different criteria for success at the next attempt, and, most importantly, the reasons for the need to perform it, which in statistical analysis does not always truly reflect the clinical problem (e.g., situations in which a vessel is successfully punctured during the first attempt - which confirms the skill of those performing the procedure - but for various reasons the insertion of a short peripheral cannula or midline catheter fails and a second puncture must be performed).

CONCLUSIONS

1. Starting to perform insertions of midline catheters under ultrasound guidance should be based on properly conducted training and supervised clinical experience.
2. Performing an adequate number of cannulations has reduced the time required for cannulation and decreased the number of failures.
3. Performing 20 to 50 cannulations makes it possible to achieve a high success rate of vascular access insertion with a minimum number of attempts.
4. Training in cannulation under ultrasound guidance should include not only the technical aspects of performing the procedure, but should also consider the role of proper medical record keeping for content and research purposes.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest.

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THE RELATIONSHIP BETWEEN EMOTIONAL INTELLIGENCE AND COPING WITH STRESS AMONG OF STUDENTS OF SELECTED MEDICAL FACULTIES – A CROSS SECTIONAL STUDY

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ABSTRACT

Aim: Assessment of the relationship between emotional intelligence and coping with stress among students of selected medical faculties.

Material and methods: The study was conducted among 730 people who were students of the Medical University of Bialystok. The research tool was an anonymous questionnaire, the Emotional Intelligence Questionnaire (INTE) and The Coping Inventory for Stressful Situations (CISS).

Results: In stressful situations, future nurses present the least of the task-oriented coping style, students of emergency medicine react least emotionally to stressful situations, and future doctors have the lowest rating for the avoidance-oriented coping style.

Conclusions: Half of the surveyed students are characterized by a high level of emotional intelligence, slightly fewer subjects have an average level. Women are characterized by higher emotional intelligence; the highest level of emotional intelligence is found in students of emergency medicine and medical analytics. In stressful situations, women present mainly an emotional attitude, while men present a task-oriented coping style. Stress management training is recommended, especially in the female population.

KEY WORDS

emotional intelligence, students, stress, empathy

INTRODUCTION

Emotional intelligence (EI), understood as a set of features, is strongly rooted in the personality structure and manifests itself in specific properties or behaviors, such as empathy, assertiveness, optimism, and independence. Emotional intelligence is also the human ability to stop negative emotions such as fear, anxiety, low self-esteem and replace them with positive emotions such as self-confidence, empathy or friendship [1-3].

EI has to do with how we learn and what abilities we acquire, how we can use them, and how we interact with other people. This is quite important in the medical professions, where we deal with both the patient in need of our care, but also with colleagues. Each of us has different abilities, competences, characteristics, and all interact with each other. Our education and contact with other people, and therefore, the quality of medical care pro-

vided, may depend on our emotional intelligence. Empathy is the concept that seems to be an interface between emotional intelligence, social intelligence and personality. It has been exceedingly popular among researchers for a long time, which results in a growing body of publications devoted to this term [3-5]. Most researchers of emotional intelligence refer to empathy understood in this way. Bar-On and Goleman list empathy as one of the components of EI. In turn, Salovey and Mayer indirectly include this construct primarily in the group of abilities related to the perception and understanding of emotions [6]. Salovey et al. developed a hierarchy of emotional abilities that participate in the coping process. It starts with the ability to recognize emotions, through the ability to understand and analyze emotions, and finally, at the top of the hierarchy they placed the ability to control emotions. According to the authors, in order to be able

to deal with stress effectively, all these skills must be at a high level. The authors believe that a low level of the more basic ability prevents the full use of the ability, which is higher in the hierarchy, and thus, it hinders the effective coping in a stressful situation [7]. There is a connection between emotional intelligence and stress. People with high emotional intelligence are better able to regulate their emotions and respond to stress in a healthier way. They are also better able to recognize the signs of stress in themselves and in others, and address it more effectively [8, 9]. During medical education, focusing on approaches that increase the student's confidence in the face of the stresses they will face throughout their professional life, will undoubtedly increase the level of empathy. Research has shown that women tend to have higher emotional intelligence than men, scoring higher on tests of empathy, understanding emotions, and managing emotions. Men, on the other hand, tend to have higher cognitive intelligence than women [10]. Men and women with higher emotional intelligence are better able to cope with stress. However, there are some differences in how men and women respond to stress. Women tend to be more emotionally aware and are better able to recognize and manage their emotions, which can help them cope more effectively with stress. Men, on the other hand, are more likely to repress their emotions and are more likely to use maladaptive coping strategies [11]. Nursing students tend to have higher emotional intelligence than and paramedic students, as well as higher levels of emotional resilience, which can help them better manage and cope with stress [12, 13]. Emotional intelligence can protect medical students from the stress of risky behavior and influence better clinical decision making in the future [14]. The aim of our research is to determine the relationship between emotional intelligence and coping with stress and what are the styles of coping with stress among students of nursing, emergency emergency medicine, medicine and medical analytics.

MATERIAL AND METHODS

The research was conducted among 730 people who are students of the Medical University of Białystok, Poland. The research tool is an original anonymous questionnaire regarding sociodemographic data, such as gender, age, field of study, year of study, place of residence and the reason for choosing the given field of study. Two standardized questionnaires evaluating psychometric measures were also used: the Emotional Intelligence Questionnaire (INTE) and the Stress Coping Questionnaire (CISS). The selection of study participants from different fields and years of study was random and increased the possibility of obtaining data from various perspectives. The participants included 217 (29.7%) nursing students, 75 (10.3%) emergency medicine students, 302 (41.4%) medical students, 136 (18.6%) medical analysis students selected by random sampling from both genders. In the study group were 554 (75.9%) women and 176 (24.1%) men.

RESEARCH TOOLS

Emotional intelligence questionnaire (INTE) is used to measure emotional intelligence, understood as the ability to recognize, understand, and control one's own and other people's emotions, as well as the ability to effectively use emotions in managing one's own and other people's actions. The internal consistency by Cronbach's alpha for the scale is between 0.83-0.87. It consists of 13 statements, which should be answered on a 5-point scale, corresponding to the degree of agreeing with a given statement. Based on the INTE questionnaire, a numerical measure of emotional intelligence is determined. The minimum score is 33 and the maximum is 165 points. The higher the score, the higher the level of emotional intelligence of the tested person. The obtained numerical results are also categorized into a 3-point adjective scale, based on the following classification: low results - up to 77 points; average results - up to 121 points; high scores - over 121 points [15].

The Coping inventory for stressful situations Scale CISS is used to examine styles of coping with stress. It consists of 48 detailed questions, the answers to which are scored on a scale of 1 to 5. The value of 1 point corresponds to the absence of certain behaviors, and the value of 5 points to very frequent behavior of a certain type. The internal consistency by Cronbach's alpha for the scale is between 0.78 and 0.90. On the basis of detailed answers, three styles of coping with stress are assessed: task-oriented style (TOS); emotion-oriented style (EOS); avoidant-oriented style (AOS). The latter style can take two forms: engaging in distraction seeking (DS) activities; social diversion (SD). Each way of coping with stress is determined on the basis of answers to 16 sub-questions, so the tested persons can score from 16 to 80 points in each of them. The higher the point value, the more the respondent uses a given style of coping with stress in his/her life. The point range for DS is from 8 to 40 points, and for SD from 5 to 25 points [16].

STATISTICAL ANALYSIS

The SPSS version 2022 package was used for the statistical analysis, and several statistical tools were used to calculate individual results: the t-test for independent samples is a statistical test that compares the average values of a numerical feature in two populations. The chi-square test of independence was used to test the relationship between two features measured on a nominal scale. Analysis of variance (ANOVA) is a statistical technique for comparing the average level of a numerical characteristic in several populations. The analysis of variance test requires the fulfillment of two assumptions: about the normality of the distribution of the numerical feature in each of the considered groups and the same level of variability (so-called homogeneity of variance) of the numerical feature in the individual groups. The Power Analysis module was used to analyze the sample size. Spearman's rank correlation coefficient is used to study the relationship between two numerical features.

RESULTS

The average rating of emotional intelligence in the surveyed population is on the border of the average and high category, which is also reflected in the results of the classification into the category of intelligence - half of the surveyed people received average (49.2%) or high (50.0%) ratings. Emotional intelligence at a low level is characterized by less than 1% of the surveyed people. Detailed data are presented in table 1. The task-oriented style (TOS) of coping with stress consists in undertaking tasks aimed at solving the problem through cognitive transformation or attempts to change difficult situations. The emotion-oriented coping style (EOS) is characteristic for people who, in stressful situations, focus on themselves and their own emotions. These people often get angry, feel guilty and depressed.

The avoidance-oriented style of coping with stress (AOS) consists in avoiding thinking about difficult situations that cause anxiety. The avoidant style can additionally take two forms: engaging in substitute activities (DS), e.g. watching TV, overeating or seeking social contacts (SD). Data in table 1. The avoidance strategy was most often used (44.9%), and in particular, its strategy of seeking social contacts (37.5%).

GENDER OF STUDENTS AND THE VALUES OF PSYCHOMETRIC MEASURES

This part analyzes the influence of gender on the mental condition of the surveyed students of medical faculties. The analysis consisted of the compilation of in-

formation on the average level of each measure and the variability of results for students of both genders and the assessment of the significance of differences in average values using the t test for independent samples.

When describing the results of the statistical tests used in the work, the usual rules of description and interpretation of the test probability value p were used. Additionally, the results of categorization of psychometric measures were compared to adjective scales, but the results obtained for numerical measures should be treated as the leading ones. The categorization of numerical values into the adjectival scale leads to a significant loss of information.

There are statistically significant differences in the average value of psychometric measures between male and female students for most of the considered measures. Women are characterized by higher emotional intelligence, in a stressful situation they are less focused on task-oriented coping, and have more an emotional or avoidant style. Men have a slightly higher self-efficacy rating, but here the differences are relatively small (the value of test probability p is close to 0.05). Data are presented in table 2.

In the case of emotional intelligence assessments, there is a difference between the two genders on the border of a statistically significant result (test probability value p minimally above 0.05). Among men, there are more people with a high level of using the task-oriented coping style in stressful situations. The difference between the two genders is statistically significant

Table 1. Average result of the INTE questionnaire and Scale CISS score by coping styles.

	\bar{x}	Me	SD	c25	c75	Min	Max
INTE	120.5	121.5	14.7	112	130	64	161
CISS-TOS	56.4	57	9.7	50	62	26	80
CISS-EOS	48.9	48	11.0	41	57	16	78
CISS-AOS	45.9	46	10.3	40	53	16	76
CISS-DS	17.8	18	5.5	14	22	7	34
CISS-SD	16.7	17	4.8	13	20	5	25

Task-oriented style (TOS); emotion-oriented style (EOS); avoidant-oriented style (AOS); engaging in distraction seeking (DS) activities; social diversion (SD)

Table 2. Values of psychometric measures broken down by gender.

Psychometric measure	Gender						p
	Man (N = 176)			Woman (N = 554)			
	\bar{x}	95% CI	SD	\bar{x}	95% CI	SD	
INTE	117.8	115.3-120.3	16.9	121.3	120.1-122.5	13.8	0.0056
CISS-TOS	57.8	56.2-59.3	10.3	55.9	55.2-56.7	9.5	0.0318
CISS-EOS	45.9	44.3-47.5	10.6	49.8	48.9-50.7	11.0	0.0000
CISS-AOS	42.2	40.6-43.7	10.3	47.1	46.2-47.9	10.0	0.0000
CISS-DS	16.3	15.5-17.1	5.4	18.3	17.9-18.8	5.4	0.0000
CISS-SD	14.8	14.1-15.5	4.7	17.3	16.9-17.6	4.6	0.0000

Task-oriented style (TOS); emotion-oriented style (EOS); avoidant-oriented style (AOS); engaging in distraction seeking (DS) activities; social diversion (SD), p – test probability value calculated using the t-test for independent samples

($p=0.0176$). On the other hand, women use the emotional style ($p=0.005$) and the avoidance style ($p=0.0000$) significantly more often.

PLACE OF RESIDENCE AND THE VALUES OF PSYCHOMETRIC MEASURES

The analysis of the impact of the place of residence on the psychometric assessment of medical students was broken down into rural areas, small towns and large towns. The significance of differences in the average level of psychometric measures between the students and the place of residence was assessed using the analysis of variance test. The level of most CISS and INTE measures does not differ in a statistically significant way between the compared groups. People from cities are more focused on the task style ($p=0.0001$). Data are presented in table 3.

FIELD OF STUDY AND THE VALUES OF PSYCHOMETRIC MEASURES

There are statistically significant differences in the psychometric assessment of candidates from various medical fields, with the exception of two measures: EOS

and DS as regards for the assessment of emotional intelligence, the “worst” are people from the medical field, which differ from the other three groups. In stressful situations, the smallest tendency towards the task-oriented coping style is shown by future nurses, students of emergency medicine react least emotionally to stressful situations, and future doctors have the lowest score for the avoidance-oriented coping style – which, however, is relatively most often used by future nurses. People who are to become doctors in the future can expect a higher level of task-oriented coping style in stressful situations, less frequent use of the avoidance style, slightly higher satisfaction with life and lower emotional intelligence. People from other faculties can be characterized in a similar way - for example, paramedics are distinguished by the lowest score for the EOS measure, i.e. a low level of emotions in stressful situations. Of course, these results may partly be the result of the dominance of men among students of emergency medicine and their relatively large presence (compared to other fields of studies) among medical students. However, this does not change the fact that a “statistical” person studying a given field is distinguished by certain specific mental

Table 3. Values of psychometric measures broken down by place of residence.

Psychometric measures	Place of residence									P
	Rural area (N = 218)			Small town (N = 253)			Large town (N = 259)			
	\bar{x}	95% CI	SD	\bar{x}	95% CI	SD	\bar{x}	95% CI	SD	
INTE	120.2	118.2-122.2	15.0	119.2	117.3-121.1	15.6	121.9	120.2-123.5	13.4	0,1148
CISS-TOS	54.8	53.5-56.2	10.3	55.6	54.4-56.7	9.2	58.5	57.3-59.6	9.4	0.0001
CISS-EOS	48.8	47.3-50.3	11.3	49.3	47.9-50.6	11.0	48.5	47.1-49.8	10.8	0.7112
CISS-AOS	46.3	45.0-47.7	10.1	46.4	45.2-47.7	10.2	45.0	43.7-46.2	10.4	0.2059
CISS-DS.	18.2	17.5-18.9	5.4	18.0	17.4-18.7	5.5	17.3	16.6-1.9	5.5	0.1166
CISS-SD	16.6	16.0-17.2	4.5	16.8	16.2-17.4	4.8	16.5	15.9-17.1	4.9	0.7258

p – test probability value calculated using the ANOVA test; Task-oriented style (TOS); emotion-oriented style (EOS); avoidant-oriented style (AOS); engaging in distraction seeking (DS) activities; social diversion (SD)

Table 4. Values of psychometric measures by field of study.

Psychometric measures	Place of residence												P
	Nursing (N = 217)			Emergency medicine (N = 75)			Medicine (N = 302)			Mediacal analytics (N = 136)			
	\bar{x}	95% CI	SD	\bar{x}	95% CI	SD	\bar{x}	95% CI	SD	\bar{x}	95% CI	SD	
INTE	121.5	119.5-123.5	14.7	122.1	118.5-125.8	15.8	118.5	116.8-120.2	15.0	122.1	119.9-124.3	12.8	0.0288
CISS-TOS	54.7	53.4-56.0	9.5	57.1	54.8-59.3	9.8	57.5	56.4-58.6	9.9	56.2	54.6-57.8	9.4	0.0111
CISS-EOS	50.5	49.2-51.9	10.1	45.5	42.9-48.1	11.4	48.4	47.1-49.7	11.3	49.1	47.2-51.0	11.3	0.0063
CISS-AOS	49.2	47.8-5.5	10.1	46.0	44.3-47.7	7.4	42.8	41.6-43.9	10.2	47.5	45.8-49.2	10.2	0.0000
CISS-DS.	19.3	18.5-20.0	5.7	17.7	16.8-18.7	4.1	16.3	15.7-17.0	5.4	18.8	17.9-19.7	5.3	0.0000
CISS-SD	17.6	17.0-18.2	4.6	16.6	15.6-17.6	4.4	15.8	15.2-16.3	4.8	17.1	16.3-18.0	4.8	0.0001

p – test probability value calculated using the ANOVA test; Task-oriented style (TOS); emotion-oriented style (EOS); avoidant-oriented style (AOS); engaging in distraction seeking (DS) activities; social diversion (SD)

characteristics. Detailed values of psychometric measures depending on the field of study are presented in Table 4.

When analyzing the Spearman rank correlations between individual psychometric measures, it should be noted that they are not extraordinarily strong. The measure of emotional intelligence is most strongly correlated ($r_s = 0.53$) and focus on task-oriented coping style ($r_s = 0.56$) with a sense of self-efficacy. On the other hand, the AOS measure is the least correlated with the other measures. Correlations of SSE with other measures are negative, which means that the strategy focused on emotions is a negative feature, co-occurring with lower self-esteem ($r_s = -0.42$). It can also be stated that the correlations between psychometric measures are at a similar level in the group of women and men. The gender factor does not differentiate the values of most of the correlation coefficients and does not seem to affect the relations between them. It is worth noting that there are relatively stronger correlations between psychometric measures in the group of emergency medicine students, which implies a more expressive personality of this group. It may be somewhat surprising that the weakest correlations occurred in the group of medical students, where, for example, EOS correlations with other measures are much weaker. Another important observation is that in all fields of study there is a negative correlation between EOS and TOS, which means that students more focused on emotional problem solving have lower self-esteem, but in the medical field this correlation is very weak ($r_s < 0.30$).

DISCUSSION

The conducted study confirms the research hypothesis that emotional intelligence and coping with stress are differentiated among students of the Medical University of Białystok. Emotional intelligence includes the ability to understand, manage and control oneself and one's emotions, self-motivation, empathy, and social skills. EI consists of 5 elements: intrapersonal intelligence, interpersonal intelligence, coping with stress, adaptability and general mood.

Emotional intelligence has a great impact on our personal and professional lives. Differences in these characteristics can influence our decisions and interactions with other people. This may be important in the education process, especially during studies, where we acquire knowledge and skills that will allow us to for the performance of work and the performance of official duties. In the INTE emotional intelligence questionnaire, it can be obtained a low score of up to 77 points, an average score of up to 121 points and a high score of over 121 points. The average for the entire surveyed population was 120.5 points, i.e., on the border of medium and high scores, with the highest scores, i.e. 365 (50.0%), which was obtained by exactly half of the respondents, slightly less average scores, i.e. 359 people (49.2%), and 6 people (0.8%) scored low. A study of 274 nursing and emergency medical students in Saudi Arabia similarly found that

over 97% of those surveyed had a medium or high level of emotional intelligence, especially in the field of nursing. The results do not differ statistically significantly in terms of gender or direction, but it has been estimated that a higher level of emotional intelligence is correlated with a lower level of stress [17].

According to the CISS questionnaire, inhabitants of large cities (58.5) are most strongly focused on the task style in stressful situations, followed by small towns (55.6) and villages (54.8). In the case of the emotional and avoidance strategies, the results are at a similar level, with no statistically significant differences. A Polish study conducted on a group of 570 medical students at the Medical University of Lublin showed that the place of residence significantly affects the strategy of coping with stressful situations. Among the respondents from large cities, schizotypal and narcissistic personality tendencies were most common [18]. The results by Kun et.al. showed that greater difficulties in coping with stress and empathy predicted higher frequency of tobacco, alcohol, and cannabis use [19]. Also, for the assessment of emotional intelligence, there are no statistically significant differences between the fields of study or women and men, while the interaction of gender and field of study turns out to be statistically significant. In all faculties, except for emergency medicine, women have higher scores of emotional intelligence in the INTE questionnaire. The average result for women is higher in the fields of nursing (men 117.3, women 121.8), medicine (men 114.7, women 120.4) and medical analytics (men 116.8, women 123.1), while men have a higher average in the field of emergency medicine (men 125.4, women 125.4, women 117.8) and this is the highest average of all groups. The lowest score in men is in the field of medicine, while in women the highest average is in medical analytics, and the lowest in emergency medicine. A study conducted in Rome on a group of 71 students of nursing and midwifery showed that women have 0.2 points higher level of emotional intelligence than men, which is also associated with better academic performance [20]. In another study by Sa et.al. the results of emotional intelligence were higher among men than among women [21].

As for the first measure of the CISS questionnaire, i.e., the use of task-oriented coping style in stressful situations, no statistically significant differences were found. However, some differences can be noticed, because the task-oriented style dominates more in men than women in the field of emergency medicine (men 59.5, women 53.8) and medicine (men 58.0, women 57.3), and more in women than men in the fields of nursing (men 54.5, women 54.7) and medical analytics (men 55.3, women 56.3). Among men, emergency medicine students recorded the highest score, and the lowest by nursing students, while among women, medical students recorded the highest average, and the lowest by emergency medicine students. However, since these differences are not statistically significant, more general conclusions should not be drawn on their basis. Studies from three Brazil-

ian universities also show that nursing students usually choose the avoidance-oriented coping style, which is also associated with a greater sense of self-preservation and moral power [22]. A study of nurses from hospitals in Brunei also showed the dominance of the avoidant style. Interestingly, the respondents who were married showed a higher level of confrontational coping behavior [23]. In the case of the emotion-based style, the results are easy to interpret and regardless of the field of study, the level of the EOS measure is different in terms of gender. In each field of study, women solve problems more emotionally and the results are similar, starting with the highest in nursing (men 50.2, women 50.5), emergency medicine (men 42.5, women 49.6), medical analytics (men 46.7, women 49.5) medicine (men 46.7, women 49.2). It is worth noting that men studying emergency medicine are definitely the least susceptible to experiencing emotions, and men studying nursing are the most susceptible. Among women, emotions most often relate to nursing students, and least often to female medical students. In the case of the avoidance-oriented style of coping with stress, statistically significant differences occur both between women and men, but also between fields of studies. Irrespective of gender, the avoidant style is the least frequently used by medical students, less often by men than women (men 39.7, women 44.2). Nursing students are most oriented towards the avoidance style, more women than men (men 45.8, women 49.4), but it is difficult to say for men, because the group is small. In the field of emergency medicine, women use the avoidance-oriented style slightly more often than men (men 45.7, women 46.5), while in medical analytics much more often (men 44.0, women 48.2). A study of Polish students proved that dependent personality tendencies were significantly more frequent in women, as was the style of coping by avoiding and seeking contacts [19].

In a study by Piekarska [24] conducted on a sample of 228 adults, gender differences in stress coping strategies were observed. Women more often than men indicated that they seek social support, focus on emotions, and release them, and try to distract attention. In this study, different relationships between emotional abilities and stress coping strategies were observed in the group of women and men [24]. It can be concluded that there are no statistically significant differences in the distribution of the level of emotional intelligence by field of study. A high level of emotional intelligence is presented by students of nursing (51.6% of students of this field of study) and medical analytics (57.4%). In the field of emergency medicine, it is a comparable medium and high level (49.3%), while in medicine the average level of emotional intelligence prevails (53.6%). Researchers from India proved on a group of 207 medical students that their emotional intelligence is also rather on medium than high level. Interestingly, the study showed that students from state universities have a higher level of EI than students from private schools

[25]. Differences in the distribution of the use of the task-oriented coping style are on the verge of statistical significance. Most groups use this style at an average level (38.2% of medical analytics students, medical students 36.8%, emergency medicine 36.0%), but it is different in nursing, where TOS is at a low level (39.6%). The differences in the level of using an emotional style of resolving stressful situations are statistically significant. Emergency medicine students stand out here, where the share of high EOS values is by far the smallest (29.3%). Respondents in the field of nursing use the emotional style mostly at the average level (43.8%), but slightly less at the high level (42.4%), while the high level definitely prevails in the field of medicine (39.7%) and medical analytics (40.4%). There are noticeably clear differences in the use of the avoidance strategy in stressful situations. Students of nursing (58.1%) and medical analytics (52.2%) do so most often, while students of nursing (13.4%) and emergency medicine (14.7%) are the least likely to do so. Interestingly, AOS is evenly distributed at the average and high level (42.7%). On the other hand, in medical students, the emotional style is most often at an average level (35.8%).

The measure of emotional intelligence is most strongly correlated and focus on task-oriented coping style with a sense of self-efficacy. A strong correlation between emotional intelligence and self-efficacy was found in a study of 129 students from the Faculty of Health Sciences in Iran, which was also associated with better academic performance [26]. Many studies conducted among medical and nursing students clearly indicate a strong correlation of a high level of emotional intelligence with better clinical skills, communication skills, and better academic performance [27]. According to a study on a group of 1,392 Chinese medical students, EI is strongly correlated with empathy and gratitude [28].

In our study the AOS measure is the least correlated with the other measures. Correlations of SSE with other measures are negative, which means that the strategy focused on emotions is a negative feature, co-occurring with lower self-esteem. It can also be stated that the correlations between psychometric measures are at a similar level in the group of women and men. The gender factor does not differentiate the values of most of the correlation coefficients and does not seem to affect the relations between them. It is worth noting that there are relatively stronger correlations between psychometric measures in the group of emergency medicine students, which implies a more expressive personality of this group. It may be somewhat surprising that the weakest correlations occurred in the group of medical students, where, for example, EOS correlations with other measures are much weaker.

Another important observation is that in all fields of study there is a negative correlation between EOS and TOS, which means that students more focused on emotional problem solving have lower self-esteem, but in the medical field this correlation is very weak. Kurt-

ses Gürsoy [29] believes that during medical education, focusing on approaches that increase the student's self-confidence in the face of stress they will face throughout their professional life will undoubtedly increase the level of empathy [29]. Toriello et al. [30] found that higher EI is probably associated with better clinical reasoning, and higher EI contributes to more effective coping with stress.

A higher level of EI in nursing students results in a lower tendency to consume alcohol and have protected sex and have a balanced diet [31]. Finally, these students have less risk to have suicidal thoughts and EI may have a protective effect against stress for nursing students [32]. Therefore, it is necessary for students to be trained in emotional intelligence training and coaching to build their emotional competence [33]. There is a consensus that a high level of EI is beneficial for medical students in the development of social competences [34, 35]. On the other hand, psychological variables may be correlating with motivation, attitudes toward COVID-19 vaccination, and the choice of reliable sources of information about COVID-19 vaccination. The study by Gotlib et. al. demonstrates the key role of two psychological variables, self-efficacy and resilient coping, in this context [36].

The study may be limited by practical conclusions drawn from the obtained results, i.e. one should be aware that the observed differences may be influenced by the different gender structure of people from particular fields of study.

CONCLUSIONS

Half of the surveyed students are characterized by a high level of emotional intelligence; slightly fewer participants have an average level. Women are characterized by higher emotional intelligence; the highest level of emotional intelligence is found in students of emergency medicine and medical analytics. Most of the respondents choose the avoidance-oriented style of coping with stressful situations, and in particular the style of seeking social contacts. In stressful situations, women present mainly an emotional attitude, while men - a task-oriented style. Stress management training is recommended, especially in the female population.

The assessment of social competences, including EI and strategies for coping with stress among students of medical universities, as well as training adapted in this area, may help in the future in better clinical decision-making and prevent burnout.

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**CONFLICT OF INTEREST**

The Authors declare no conflict of interest.

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RISK OF CONTACT WITH FIREARMS AND AMMUNITION DURING FIRE AND RESCUE OPERATIONS IN PRACTICE OF FIRE PROTECTION UNITS - OBSERVATIONS FROM 2017-2022

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ABSTRACT

Aim: Analysis the interventions of fire protection units during fires and local threats involving firearms and ammunition from 2017-2022.

Material and methods: The study utilized data from the Decision Support System of the National Fire Service (DSS NFS) provided by the Operational Planning Office. Events from January 1, 2017, 00:00 to December 31, 2022, 23:59 were analyzed. Quantitative data were described using the Mean and standard deviation (SD). The analysis is anonymous for both the victims and the officers involved in the operations.

Results: Between 2017 and 2022, firefighters carried out 248 (Mean 41.3; SD 7.3) interventions, of which local threats (LC) were n=191 and fires (F) were n=57, during which firefighters came into contact with firearms and ammunition. These were primarily fires in rooms with firearms inside n=57, collisions of civilian and military vehicles transporting weapons n=26, assistance other services n=84, other n=81.

Conclusions: Weapons and ammunition in the context of firefighter interventions are infrequently encountered hazards. However, they add to the extensive list of dangers faced by this unit. The presence of such threats during operations did not translate to tangible risks of gunfire or explosion. This may be attributed to effective collaboration with other units and well-established procedures. Firefighters' personal protective equipment is not designed to address the risk of gunshot wounds, but within the studied group, no such risk was observed. Firefighter medical protocols and kits are equipped to handle hemorrhages resulting from injuries.

KEY WORDS

firearm, health hazards, ammunition, fire brigade, gunshot wound

INTRODUCTION

Health risks in firefighters' service arise from various factors: chemical, biological, ergonomic, physical, and psychological. Due to the dynamics of many fire and rescue operations, there's a risk of workplace accidents and other unforeseen random events. Firefighters have individual protection and follow specific procedures [1]. The firefighter profession is particularly exposed to factors negatively affecting its functioning. Adverse factors are classified as burdensome or dangerous. These groups include: fire smoke, carbon monoxide, dust, noise, vibrations, and harmful factors such as corrosive and poisonous substances, adverse weather conditions (extreme temperatures). Exposure to these factors affects the firefighter's work quality and overall health status. Among the adverse clinical symptoms, early ones include a decline in well-being, loss of concentration, confusion, and later ones predispose to the occurrence of occupational diseases over time [2, 3].

The International Occupational Risk Card for firefighters does not have an entry for "gunshot," and the "explosion" entry pertains to the explosion of compressed gas in a fire event. In Poland, firefighter interventions related

to the presence of firearms and ammunition are rare, as firefighters are not the primary service for addressing consequences of armed incidents. It's also hard to find terms like "firearm" and "ammunition" in scientific studies analysing such risks in firefighter practice. However, the dynamics of incidents mean there can be unplanned contact with firearms and ammunition during firefighter operations [4-7].

According to Police statistics, there has been a growing interest in obtaining firearm permits in Poland over the past year. This phenomenon may be linked to the armed conflict in Ukraine. The increase in the number of firearms held by an ever-growing number of firearm owners among civilians increases the exposure risk for firefighters during fire and rescue operations (Table 1).

Improperly secured or stored firearms and ammunition in a burning room, weapons in the wrong hands, criminal acts, or armed victims, for instance, a convoy guard, pose a gunshot injury risk to the firefighter-rescuer. Among the risks for firefighters, it's worth noting the owners of black powder weapons. Current laws, apart from being of age, do not set requirements for these weapon owners in terms of storage [10].

The main risks associated with firearms during fire and rescue operations depend on the firefighter's distance from the shooting or explosion site. The largest range will be characterized by ballistic injuries (fired or detonated projectiles and fragments of fragmenting projectiles), followed by the impact of a shockwave (explosion of stored ammunition, gunpowder), while the thermal impact has a shorter range. The energy of a fire carries the risk of igniting the gunpowder in the ammunition. This could result in a direct hit to the firefighter, a ricochet, or shrapnel injuries. Another kind of threat comes from armed criminals, for instance, an active shooter, as well as injured soldiers and service officers to whom firefighters may provide direct medical assistance. Given the proximity of the armed conflict in a neighboring country, there seems to be an imminent risk of conducting fire and rescue operations in the area of military operations, including providing aid to injured armed soldiers [11].

Besides the direct risk of health and life loss, there's also an indirect health risk. Among firefighters' health threats, explosions (blasts) are noted, but these events are not attributed to armed-related causes but to energy releases during fires, or damages to pipelines or pressure vessels, which commonly affect mainly the central nervous system (CNS) and hearing organ in the firefighters' working environment. An explosion from a gas cylinder releases a burden at a level of 160 dB, and a landing helicopter is 120dB. For comparison, a gunshot from both short and long guns is an impulsive noise at the level of 150-160 dB, with the pain threshold being 110-120 dB,

often causing acoustic injuries on par with industrial noise and firecracker explosions [12-16].

THE AIM

Analysis the interventions of fire protection units (FPU) to fires and local threats in Poland with the presence of firearms and ammunition from 2017-2022.

MATERIAL AND METHODS

DESIGN

The data used in the study comes from the Decision Support System of the National Fire Service (DSS NFS), made available to the authors by the Operational Planning Office (OPO) with the consent of the Chief Commander of the National Fire Service obtained in May 2023. The observations cover the years 2017-2022 in Poland [15]. The database was prepared in Microsoft Excel using the MS Office 2016 package for Windows 10. Quantitative data were described using Mean and standard deviation (SD). Data analysis is fully anonymous for those involved in the events (victims, firefighters, cooperating entities), so no request was made for the opinion of the ethics committee.

STUDY PROCEDURE - SEARCH CRITERIA

Included phrases: firearm; ammunition; rifle. Phrases searched by the system could be synonyms of proper names: names, streets, or other everyday objects with the same name in Polish. The authors determined that in Polish, the word 'pistol' and its synonyms referring to devices held with one hand and having a trigger (a

Table 1. Police statistics on firearm permits and ownership in Poland [8, 9].

Year	Issued permits	Total permits	Total numer registered weapons
2018	16023	215 t	505 t
2019	15222	224 t	551 t
2020	15330	234 t	587 t
2021	19939	252 t	658 t
2022 *	37402	286 t	760 t

t- thousands * armed conflict in Ukraine

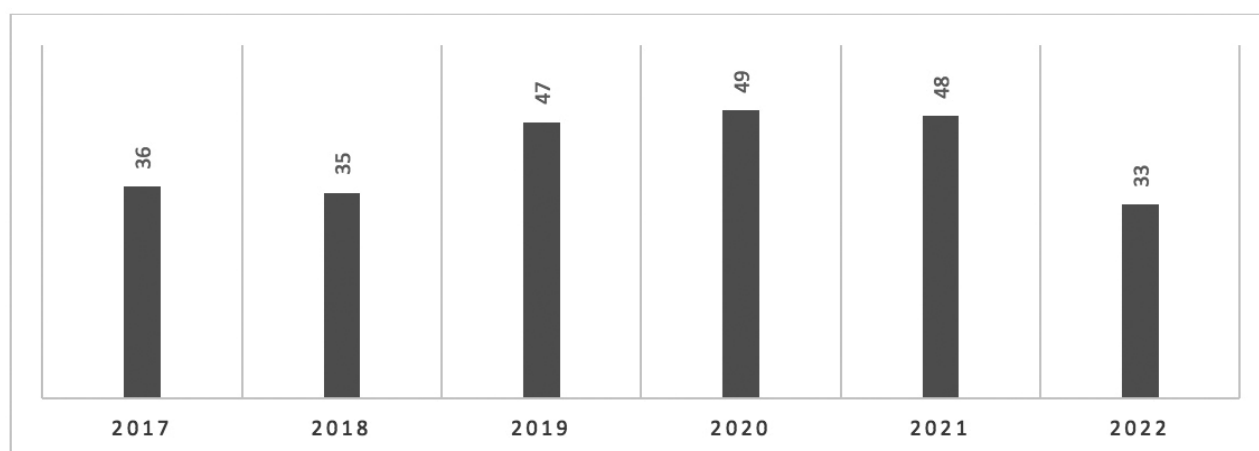


Fig. 1. Number of incidents related to the presence of weapons and ammunition during firefighters' interventions between 2017-2022.

dispensing/activating mechanism) are so common that they could significantly distort search results. The search for this term was abandoned.

ETHICAL CONSIDERATIONS

Data concerning personnel composition of FPU, co-operating services during interventions, and precise event locations have not been disclosed in the analysis, which is fully anonymous, consistent with the principles of the Helsinki Declaration; therefore, no request was made to an ethics committee for opinions and consent to conduct the study.

EXCLUSION CRITERIA

1. Events beyond the date range of 01.01.2017, 00:00 - 31.12.2022, 23:59.
2. Joint operations with the police and other services whose officers are equipped with service weapons. The authors treat such a weapon specimen as a lack of health risk for firefighters. Furthermore, the number of joint operations with the police annually amounts to thousands, and including all interventions with the police, border service, and the army in the analysis would significantly distort observations, producing many false positives.

Table 2. Reason for dispatching FPU to an incident with the risk of contact with weapons and ammunition.

Year	Cause for firefighters' intervention					
	Police assistance	Assistance to hunters and veterinary services	Civil road	Military transport	Fire	Other
2017	6	0	4	2	8	16
2018	13	0	4	0	11	7
2019	10	1	4	0	16	16
2020	22	1	5	1	7	13
2021	14	1	3	1	7	22
2022	15	1	2	0	8	7
Total	80	4	22	4	57	81

Examples of incidents qualified for categories:

- "OTHER" - securing found ammunition in a public place (warehouses, forest area, agricultural waste, earthworks), revealed weapons during other actions (room searches)
- "CIVIL ROAD" - road collisions and traffic accidents of vehicles carrying weapons of civilians
- "MILITARY TRANSPORT" - collisions or traffic accidents of military vehicles
- "ASSISTANCE TO HUNTERS and VETERINARY SERVICES" - firefighter assistance in incidents involving wild or domestic (breeding) animals that were injured due to contact with machines, vehicles, were trapped, got stuck, and the mentioned services used weapons to cull the animals. Firefighters' assistance consisted of evacuation, catching or restraining animals.

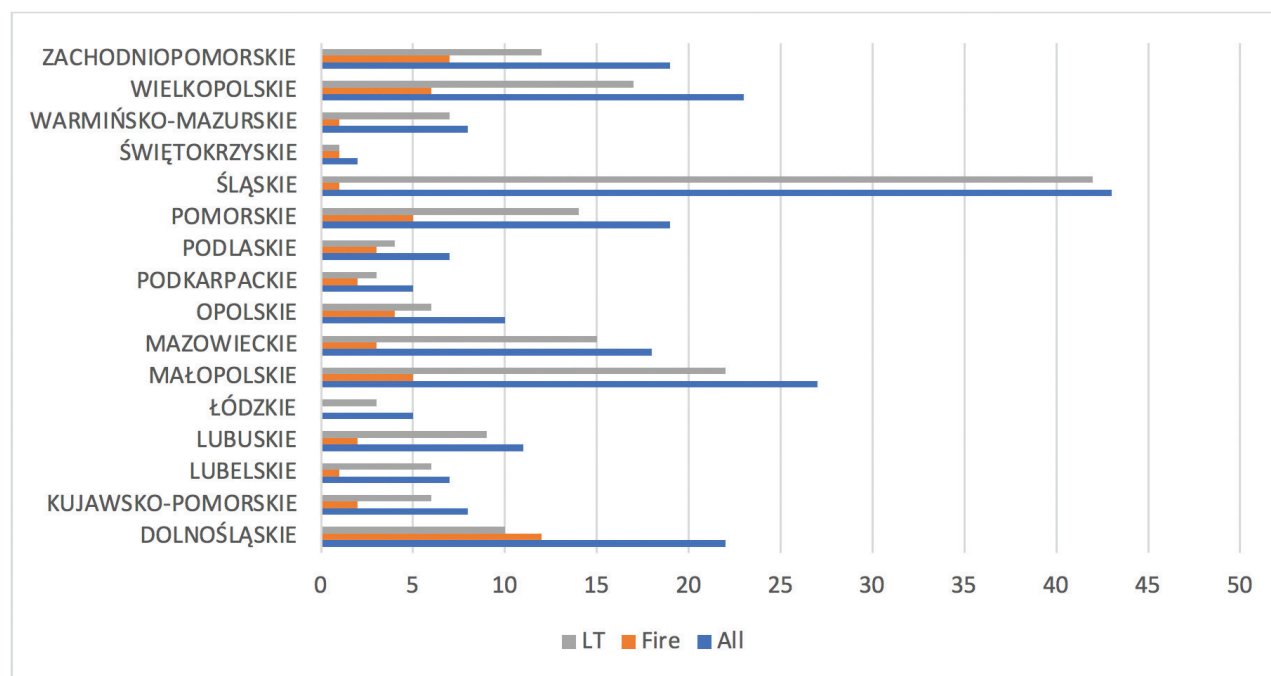


Fig. 2. Interventions meeting the criteria for inclusion in the analysis broken down by province.

LT - local threat

- Events featuring unexploded ordnance, aerial, and mines (mostly from the World War II era).

RESULTS

According to the NFS records, taking into account the search keywords between 2017-2022, firefighters conducted 248 interventions (Mean 41.3; SD 7.3), including local threats (LC) $n=191$ (collisions of civilian and military vehicles transporting weapons $n=26$, assistance other services $n=84$, other $n=81$), and fires (P) $n=57$ during which there was contact with firearms and ammunition (Fig. 1). The nature of these types of actions remains at a similar rate per each year.

The reasons for the FPU call-outs included in the analysis were grouped according to the following classification: assistance in police service tasks, help to other entities (veterinary services, hunting circles), civilian road incidents, military road transport, other events, fires (Table 2).

The obtained data allowed for area observations related to the provinces of Poland. Illustrated data is presented in figure 2.

In figure 2, the overall number of interventions with the occurrence of weapons or ammunition is presented, divided by provinces and 2 general categories: F and LT (other events than fire).

DISCUSSION

Due to the limited number of sources of knowledge about the risk of health threats associated with the use of weapons against firefighters in Poland, the authors focused on foreign publications related to the issue, i.e., the participation of firefighters in actions with an active shooter, prevention related to such a threat, tactical training coordinating with other services (medical rescue, police), personal protection of firefighters, and the possibility of medical assistance in injuries related to gunshot or ammunition explosion.

The dominant cause of firefighter interventions with the observed specific risk of the presence of weapons and ammunition in the event in the analysis was cooperation with other entities (police, army) in securing or transporting weapons and ammunition, and fire incidents with the mentioned hazardous materials inside the burning building.

Przyjemczak presents a model of services in the USA, mainly police cooperation with firefighters against current threats, including military ones. The author draws attention to the necessary skills and broad knowledge required from soldiers, policemen, firefighters, and multi-dimensional vocational training covering many areas [18].

Marino's observations also concern firefighters from the USA. The authors estimate the risk of injury or death in emergencies involving hazardous materials requiring urgent medical intervention. However, this risk is inherent in the profession, and firefighters, when taking the oath upon entering the profession, are fully aware of the risk [19].

Firefighters participate in events that are criminal or terrorist in nature, which translates into the risk of being shot or the need to provide medical assistance to a shot person. These are peace-time events of a local nature. Konstantinos analyzed an event from September 2012 in the USA. There was an attack by an active shooter. The event put the police, fire department, and medical services on operational readiness, and the need for cooperation of all three services. It was necessary to develop guidelines for stemming bleeding in injured civilians, including techniques for gunshot wounds (manual pressure, tourniquets) [20].

Korba describes situations reminiscent of battlefield events in peacetime. Increased crime and acts of terrorism using firearms, increased risk of gunshot injuries, indicating policemen as the first endangered during patrol service. First aid for gunshot wounds is especially important for the final therapeutic success [21].

Gryz et al. [22] draw attention to injuries related to military operations and the ability to secure such injuries. The study involved a group of Polish soldiers whose task was to stop simulated bleeding on the battlefield using pressure bandages: Combat Application Tourniquet (CAT) and special operations forces tactical tourniquet (SOFTT). Conclusions from the study: putting on a SOFTT type band takes less time (CAT in an average time of 38.13 seconds $SD \pm 11.19$, SOFTT in an average time of 29.31 seconds $SD \pm 7.18$), which, in terms of providing assistance on the battlefield in securing limb bleeding, is crucial. Importantly, in the medical kits of Polish firefighters, there is a CAT type bandage, and the procedures for Qualified First Aid (QFA) concerning the procedure in the event of injuries and post-traumatic bleeding. However, the quality and effectiveness of first aid in this type of injuries was not an indirect goal of our study, but the conclusions obtained by the cited authors may be useful in the training of Polish firefighters [23].

Another analysis also concerns the USA. The authors, using the example of firefighters from California, conclude that low service exposure to severe injury cases, e.g., in an incident involving an active shooter, can adversely affect skills, which complicates pre-hospital assessment and lowers the quality of basic (BLS) and advanced (ALS) medical actions [24].

A similar threat concerning Europe from 2015 is described by Lesaffre. Services, including firefighters, were dispatched to suicide bombings and shootings with a large number of casualties (130 people died and 495 were injured). The conclusions from this analysis were aimed at better integration of emergency chain operators (communication), better organization of mass actions, and joint exercises of services to better prepare for potential similar threats in the future [25].

Wypyszewska, describes the implementation of civilian rules for dealing with trauma patients on the battlefield. Emergency medical services guidelines have proven to have little application in a tactical environ-

ment. This was the reason for numerous analyzes and the introduction of TCCC standards, which were issued in Polish on June 2, 2014. However, this topic has not been made compulsory for the fire brigade. Our analysis does not indicate that a firefighter or a person involved in the incident was shot during the observed events, but with the increasing scale of events and weapons permits, the risk will increase [26].

Specific numbers of injuries from gun incidents are presented by Jasani. The global terrorism database identified 42 attacks involving firefighters, resulting in 26 deaths and 95 injuries. Of the 42 attacks, 12 (28.6%) were secondary attacks in which the firefighters themselves were targeted. Attacks on firefighters are rare, but greater efforts must be made to protect firefighters from future terrorist attacks. This conclusion is consistent with our own research. Even though no gunshots were reported among Polish firefighters, it is necessary to have ready solutions and procedures in case firefighters intervene in terrorist activities [27].

LIMITATIONS

Our observations have 4 main limitations:

1. The data provided to the authors was obtained by filtering through keywords characteristic for weapons and ammunition and popular synonyms. However, there's a possibility that a percentage of events wasn't included in the analysis due to the descriptive content of the information from the event drafted by the person in charge the rescue operation (CRO). The authors had no influence on the content and nomenclature used in the report content.
2. Firefighters are not the primary service in events where firearms and ammunition are present, e.g.,

assisting the Police in accessing premises with an armed tenant present. Therefore, some reports could be prepared in the scope of FPU tasks, omitting issues fitting the methodology established by the authors.

3. The observed events constitute a small percentage of all firefighter interventions. However, this compilation supplements the known and characteristic threat spectrum in firefighter service with ballistic danger.
4. The authors have no information that the firemen had any accidents during their job with described events. Information on health risks and injuries to firefighters is published in the form of annual accident rate reports by Department for Safety, Occupational Health, and Health Prevention. The information contained therein concerns injuries to firefighters related to the explosion of gas cylinders and pressure vessels in fires. The reports did not contain any information about firefighters who were shot.

CONCLUSIONS

Weapons and ammunition in the context of firefighter interventions are infrequently encountered hazards. However, they add to the extensive list of dangers faced by this unit. The presence of such threats during operations did not translate to tangible risks of gunfire or explosion. This may be attributed to effective collaboration with other units and well-established procedures. Firefighters' personal protective equipment is not designed to address the risk of gunshot wounds, but within the studied group, no such risk was observed. Firefighter medical protocols and kits are equipped to handle hemorrhages resulting from injuries.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest.

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NEEDS AND CHALLENGES IN DISPATCHING EMERGENCY MEDICAL SERVICES IN SITUATIONS OF POTENTIAL MILITARY DANGER

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ABSTRACT

The article analyzes the current legal status of the operation of medical dispatch centers in situations of internal security danger, with particular emphasis on the possibility of their operation during hostilities on the territory of Poland. The forms of threats of a military nature are included in the set: international interstate conflict, local armed conflict, border conflict, onslaught by informal groups, border clash, limited use, border incident, military provocation, military blackmail, military blockade, military diversion and demonstration of force. The responsibility of the state administration authorities for the safety of citizens in relation to the provision of health care in situations of direct health threat was determined. An assessment of the possibility of effective disposal of forces and resources of the State Medical Rescue System in the realities of a military threat on the territory of Poland was undertaken. The question was asked whether the Armed Forces of Poland, as a guarantor of internal security in the event of an armed conflict, are prepared to cooperate with the civilian health care system. The article reveals possible areas for further research work in the above area.

KEY WORDS

Poland, emergency medical services, medical rescue team, military danger, medical dispatch center, emergency medical condition

INTRODUCTION

The Republic of Poland places protection of independence and inviolability of its territory on an equal footing. It ensures freedom and respect for human and civil rights, and ensures the security of citizens [1]. The claim that the defense of the country consists of both military and non-military aspects seems to be as correct as possible [2]. The comprehensive formation of the national security of the Republic of Poland in a multifaceted space is based on several fundamental pillars [3]. Development and securing access to medical infrastructure for every citizen in need of health care are the tasks that the Polish health care system faces on a daily basis. In addition, the pressing issue of ensuring continuity and comprehensiveness of patient care cannot be forgotten [3]. The protection of citizens' health is independent of their material situation, and public authorities must ensure equal access to health care, which is financed from public funds [4]. The protection of human health involves the action of medical entities in various aspects of medicine. Primary health care, outpatient specialized

care, or inpatient treatment stand directly alongside emergency medical services [4].

During the analysis of the material, the most important information on the responsibility of public administration bodies for the safety of citizens in strategic terms was collected and the crisis management system operating in Poland was characterized. The paper also deals with the subject of the State Medical Rescue system with the emergence of details on the disposition of Medical Rescue Teams. An analysis of the availability and competence of the units of the Armed Forces of the Republic of Poland and medical dispatchers in the event of the need for joint operations is presented. Consideration was given to the legitimacy of such cooperation and the determination of the legal authority of the coordination of services.

THE AIM

The aim of the article was to present the current legal status of the operation of medical dispensaries in situations of national internal security threats. The main area

of interest of the authors is to present the possibility of operation of dispensaries during possible military actions on the territory of the country.

REVIEW AND DISCUSSION

To further support the claim that the inclusion of the disposition of forces and resources of the State Emergency Medical Service system in the discussion of the country's internal security is legitimate, it is necessary to point out the assumptions giving rise to the National Security Strategy of the Republic of Poland. The study of the defense and protection system of the state brings us to the identification of possible recognized threats and, in the event of their actual occurrence, the use of appropriate resources to remove them [5]. The analysis of security should be considered holistically from the international, to the national, to the individual.

Currently in Poland there is no legal definition of resilience or state defense systems. An interesting take on this issue can be found in the now-defunct 2009 defense strategy of the Republic of Poland. The document states that the structures of the state defense system consist of three subsystems [6]:

- State defense management subsystem - consists of authorities and public administration and the Armed Forces of the Republic of Poland;

- Military subsystem - it consists directly of the Armed Forces of the Republic of Poland;

- Non-military subsystem - it consists of the executive structures of the public administration, entrepreneurs, as well as other organizational units such as services, guards, with particular emphasis on the need to provide services of the rescue type [6].

The clearly siloed design of the above strategy carries the danger of not having established horizontal flows, between the different subsystems. It is true that this approach allows each entity to maintain internal order. It is, after all, responsible only for its narrow domain needed to preserve the country's security. However, shouldn't the issue of cooperation between subsystems be leaned on? A clear balanced structure based on partnership and joint action seems much more efficient [7]. The common interpenetration of subsystems does not exclude their precise activities in a narrow field, but allows them to make a partial transformation of their circle of interest under the influence of an overlapping subsystem from the same level. Thus, the defense and security subsystems should have developed a common space where cooperation is possible for the complete success of the country's security planning. Otherwise, we will be left in a situation where, despite the correctly planned operation of the defense and security subsystems, coordination of the available forces and resources will be difficult or impossible.

Visions and optimistic assumptions of the absence of potential military threats and, in particular, potential open aggression against another state by Russia have placed too much faith in international optimism. China's

rise in the interstate arena has put the brakes on Russia's dominant potential as a superpower. The shift of global optics to heavily developed countries, such as the US and fast-growing China, probably contributed to the awakening of unpredictable, aggressive behavior on the part of Russia toward neighboring states [8]. Utopian dreams of international perennial peace, subjected to expressions of uncertainty more than a decade ago, have come true in a frightening way. February 2022 definitively confirmed that belief in eternal peace will not guarantee us peace for future generations. Earlier claims that we should now consider non-military threats contributing to the development of various conflicts should be revised again [2].

The forms of threats of a military nature are included in the set: international interstate conflict, local armed conflict, border conflict, onslaught by informal groups, border clash, limited use, border incident, military provocation, military blackmail, military blockade, military diversion and demonstration of force [9]. As can be seen, the military nature of the threat to the state does not necessarily refer to a full-scale armed conflict on the territory of our country. Different forms of danger bring different constraints to the health system. In addition, in addition to the challenges of conventional actions, non-traditional conflict techniques cannot be forgotten. Cyber, terrorist and criminal activities can occur independently or contribute to the development of hybrid warfare [10]. An interesting issue of hybrid threats is the possibility of conducting them below the threshold of war. This means so much that the possibility of using the military to counter them will be significantly hampered. In this context, it is necessary to take into account the broad spectrum of actions that an adversary can take to paralyze strategic state structures [11].

Already the 2009 Strategy for the Defense of the Republic of Poland, in its assumptions, pointed to the need to develop competence in preserving state security on both military and civilian grounds [6]. Looking at this claim through the prism of time, it is impossible to deny it. Any warfare on home territory will naturally involve civilian resources and, in a mirror image, civilian emergencies may, of necessity, require the involvement of the Armed Forces of the Republic. A synthetic approach, linking the planes of state defense, dictates that units subordinate to the Minister of Defense should not be excluded as a competent participation in itself. Ensuring the security of citizens remains an object of interest for both representatives of state power and public administration.

The purpose of the Armed Forces of the Republic of Poland to ensure the security of the Polish Nation in both peacetime and wartime is clear and indisputable. The law details this purpose with the possibility of using the Armed Forces to, among other things, save or protect human health and life and for things in the field of crisis management [12]. To enable the effective fulfillment of the purpose for which the Armed Forces have

been established, efficient operational planning contained in advance defense planning is necessary. Only by analyzing and assessing threats and challenges can such a course of development be set that will enable an appropriate response at the time of immediate need [2].

The Armed Forces, under the authority of the Minister of Defense, is only one component, competent to respond to a crisis situation from the national security element of crisis management. The legislator defines crisis management as: the activities of public administration bodies that are an element of national security management, which consists of preventing crisis situations, preparing to take control of them through planned actions, responding in case of crisis situations, and restoring infrastructure or restoring its original character [13]. At the national level, the decision-making body in the aforementioned area is the Council of Ministers. In the departmental space, the minister of the relevant government administration is responsible. Further down the line, depending on the level, the provincial governors, district governors and mayors are responsible for crisis management.

The crisis management system also has, at each level, crisis management teams. They function as consultative and advisory bodies. They include, among others, managers of services responsible for security and experts in these areas. In addition, staff bodies in the form of crisis management centers have been established at each level of the crisis management system. These institutions, which maintain twenty-four-hour readiness, are responsible for uninterrupted monitoring of emergency situations. In addition, in the event of an emergency, they respond by activating appropriate procedures and embodying decisions made by decision-makers who are appropriate in scope and competence [14]. At the provincial level, activities of the type of prevention, response and reconstruction in the event of emergencies are parameterized by provincial crisis management plans. In addition, the Government Security Center publishes, and at least once every two years updates, the National Crisis Management Plan.

Emergency situations are inherently characterized by their surprising onset, determination to act under time pressure, and the lack, at least in the initial period, of sufficient forces and resources to effectively confront the threat [14]. In the most common sense, emergencies can be handled by one or in coordinated cooperation between several emergency systems. Among these are the National Medical Rescue System, the National Fire and Rescue System and, in an intermediary role, the Emergency Notification System.

The State Emergency Medical Service system was established to carry out the tasks of the state's need to provide assistance to citizens in a state of emergency [15]. Within the framework of the State Medical Rescue System, there are government administration bodies (at the national level in the person of the Minister responsible for health affairs and at the provincial level in the per-

sons of voivodes), system units (as hospital emergency departments and ground and air medical rescue teams), as well as medical dispensaries. The State Emergency Medical Service system itself is based in the areas of specific provinces on provincial plans for the operation of the system. The plans include detailed information on the number and distribution of the system's units in the provincial area, as well as specifying how public administration bodies and the system's units are to cooperate to ensure effective and efficient rescue of life and health. In addition, according to the law, the Provincial Action Plans of the State Medical Rescue System indicate joint exercises of the system units with cooperating units, and specify the manner of cooperation, notification, alarming and disposition of units cooperating with the system [15]. Importantly, information on the way in which system units cooperate with cooperating units (taking into account the organization of rescue operations, the way in which units are notified, alerted and dispatched), according to the law, is a legally protected secret, which means it is not subject to public information [15].

Medical dispatch centers are organizational units of locally competent provincial offices. The provincial governors are responsible for their establishment, operation and supervision. Each province has one medical dispatch center. The exceptions are the Mazovian and Silesian provinces, where two medical dispensaries are allowed to operate [15]. In terms of organization, detail and planning, the medical dispensary is headed by the head of the medical dispensary and, if employed, his deputy [15]. In each medical dispensary, a chief medical dispatcher is appointed. His tasks include coordinating the operation of the unit (ongoing, while on duty), coordinating the handling of incidents with a large number of victims, ongoing analysis of the tasks performed by medical dispatchers and providing them with substantive assistance, as well as the necessary information. The chief medical dispatcher can perform his tasks with the assistance of the deputy chief medical dispatcher [15]. In addition, to coordinate, among other things, events involving forces and resources from more than one province, there are provincial medical rescue coordinators in provincial offices, 24 hours a day [15]. The cooperation of provincial medical rescue coordinators may be supported by a national medical rescue coordinator appointed by the minister responsible for health [15].

The daily handling of emergency calls and incident notifications is carried out by medical dispatchers. These activities are performed by medical dispatchers according to their current function, the receiving medical dispatcher and the sending medical dispatcher. The main part of the activities that belong to the receiving medical dispatcher (leaving aside the subtle differences based on whether we are dealing with an emergency call or an incident notification) is to determine the location of the incident or to confirm the information obtained from the emergency number operator, to determine the main reason for the call, to determine the number of people

potentially in need of medical assistance, and to conduct a medical history, which has been promulgated in the form of a notice by the Minister of Health [15-17].

It is up to the receiving medical dispatcher, without exception, to make the final decision as to whether or not to accept the call. Notifications accepted for handling are handled, from the execution side, by the sending medical dispatcher. His tasks include, based on the information in his possession, confirmed or gathered by the receiving medical dispatcher, dispatching the appropriate forces and resources to the scene. It is also within the competence of the sending medical dispatcher to activate the units cooperating with the system. This activity can be performed in special situations, including during the unavailability of medical rescue teams or if he sees such a need due to the competence of units cooperating with the system [16].

Units cooperating with the State Emergency Medical Service system are statutorily established for this purpose [15]. Specifically mentioned here are organizational units of the State Fire Service, fire protection units included in the National Rescue and Firefighting System, entities authorized to perform mountain rescue, entities authorized to perform water rescue, and other units that are under the authority or supervision of the Minister of the Interior and the Minister of Defense [14]. It follows directly from the law that units cooperating with the State Emergency Medical Service system must have the communications means necessary to ensure operational readiness up to 30 minutes from the time the notification of an incident is transmitted [15].

As of today, the units of the State Medical Rescue system, in the type of medical rescue teams and medical dispensaries, use a unified teleinformatic Command Support System for State Medical Rescue. This system allows receiving emergency calls and notifications of incidents. In addition, it allows dispatching of medical rescue teams and electronic recording of incidents. It also supports geographic presentation of the location of the incident site, as well as positioning of medical rescue teams. The Command Support System of the National Medical Rescue Service is compatible and allows the exchange of information on incidents with the Command Support Systems of the Police and the National Fire Service [18].

A potential military threat that would extend to the territory of the Republic of Poland would be a huge challenge for the national defense system. It is an undeniable fact that any military action carries a high potential for injury both in the ranks of soldiers and among civilians. It should also not be overlooked that the mere occurrence of a military conflict within a country will not result in the cessation of illnesses among citizens. The preservation of the continuity of health care during the war depends on many factors, however, the state, as the absolute guarantor of caring for the life and health of citizens, cannot simply stop providing health care services to the full extent. Hence arises the need to consider

whether the system of dispatching emergency medical teams is prepared to cooperate with units subordinate to the Minister of Defense.

The authors of other studies unequivocally pronounce the opinion that the conduct of rescue operations, especially during emergencies, requires the improvement of coordination and cooperation between units. These activities should involve all entities that will carry out joint tasks. The goal before them is to fully utilize the forces and resources of all specialties [14]. Only the consolidation and use of resources already gathered and complementing each other will allow to face serious threats [19]. Simulations and exercises are also an opportunity to identify possible shortfalls, which will enable changes in equipment and planned conduct. Using the example of the war in Ukraine, which began in 2022, it can be reported that about 30,000 of the health care workers have joined the armed forces or become volunteers [20]. It turns out that civilians with medical qualifications overnight either replenish the ranks of the army or continue to practice their profession with the difference that close cooperation with the military awaits. Such a situation should not be considered solely from the point of view of civilian workers. The state's operational capabilities, those that have so far been exclusively the domain of the military, should be supplemented by elements of public systems on an accelerated basis.

The provision of medical care in a crisis situation, including during a military conflict, should be the ground for discussions on security architecture. Today, in times of peace, however, in moments of tremendous instability in Poland's immediate neighborhood, we should reflect on this process. The main topic of the article is the disposition of emergency medical teams during a military conflict. The data presented clearly indicate that in the event of a potential conflict in our country, the State Medical Rescue system must be used to help those affected by military action. In addition, the preservation, to a feasible degree, of daily pre-hospital care must be pursued. The tasks facing emergency medical teams include, first and foremost, the use of available transportation means and personnel to evacuate and transport the injured. These means can also be effectively used for transporting hospitalized patients from emergency areas [20]. Transport elements used by emergency medical teams are supervised by medical dispensaries. With teleinformation systems in place, it is possible to locate resources in real time and work on digital map systems. Even anticipating cyber activities aimed at disabling computer systems, it should be remembered that medical dispatchers have proficient knowledge and familiarity with the dislocation of medical rescue teams and health care delivery units. In emergency situations, they maintain continuity of operations based on the emergency procedures in place and the substitutability of medical dispensaries [15].

After analyzing the current legal status, it can be expected that the State Emergency Medical Service system

and units cooperating with the system and under the Ministry of Defense are comprehensively prepared for mutual cooperation. It is expected that a proper system of exercises is ensured, and the practice patterns are approved at the executive level. Unfortunately, due to legal restrictions governing access to key information on the subject, it becomes impossible to verify the above. It is reckless to trust in the proper execution of the provisions of the law in an area so crucial to the security of citizens, given the current tensions in the international arena. A statement by Lieutenant General Prof. Dr. Grzegorz Gielera, director of the Military Medical Institute in Warsaw: It is necessary to modify as soon as possible the national medical system of health care and defense of the population against the effects of crisis events, does not indicate to us the precise elements that should be looked at, however, he points out that it is necessary to analyze the culture of strategy of such sensitive issues [19]. To grasp the legitimacy of raising the topic of the article, it can be referred to the results of the inspection of the Supreme Audit Office, which dealt with the organization and preparation for emergency operations on highways and expressways [21].

Among other things, the review examined the principles, procedures and plans for conducting rescue operations. In addition, the rules for coordinating rescue operations between different services and formations were examined. The audit showed that while procedures for rules and organization when conducting rescue operations on highways and expressways are created, there is a lack of system solutions for exchanging information and coordinating operations between services. The lack of a unified digital radio communication system for all the emergency services taking part in the analysis was demonstrated. To summarize the Supreme Audit Office's assessment of the above, the services have the required equipment, the correct plans are defined, but the architecture of cooperation and information exchange is based on local practical solutions that are hard to scale up to larger challenges.

One more reference will be used to confirm the conclusions of the article and the Supreme Audit Office audit results cited above. The current National Security Strategy of the Republic of Poland comprehensively, in a formal way, characterizes current threats. A clear emphasis has been made on security without overlooking the challenges for non-military units. This is a direct result of the issue of blurring the line between the state of peace and war [3]. Analyzing the crisis management strategies, it is not difficult to conclude that the leading rescue organization in Poland, is the National Fire and Rescue System. Research analysis reveals that, according to the current state, this system is prepared for peacetime operations only. It is indicated that there is a lack of training and equipment that would allow operations during armed conflicts throughout the country. Further conclusions lead us to believe that also in the case of hybrid operations, the operation of the National Res-

cue and Firefighting System would be, if not impossible, then significantly hampered [11]. Deficiencies in the unification of firefighter training with the Polish Army and the Territorial Defense Forces have been demonstrated. In addition, the possibility of efficient coordination of activities due to different service subordinations was questioned [22]. As in the case of the cited audit results of the Supreme Audit Office, the aspect of the need to maintain continuity of contact even in the case of cyber threat operations was noted [23].

CONCLUSIONS

Summarizing the collected materials and conclusions, it should be noted that it seems necessary to revise the way of thinking about the disposition of medical rescue teams in special situations, which include military threats. After all, it turns out that the State Medical Rescue system, in the case of covering the territory of the Republic of Poland with a conflict, will remain one of the guarantors of preserving the safety of citizens with significantly changed boundary conditions of operation. A broader debate is needed over the above, since the disposition of forces and resources within the State Medical Rescue system is only one component of a number of links, implicitly civilian, units that secure the country's population. Given the need to ensure the security of the country, a certain part of the plans and strategies remain classified, open discussion and analysis of available sources will help revise the mental maps of decision-makers. In the current highly unstable international situation, an extremely controversial discussion awaits, the development of a workshop adequate to the challenges and threats. While the national security paradigm has been formally redefined, it can be pointed out that little has been practiced on the practical side. The interdisciplinary nature of the issue stands in opposition to the departmentalism and siloed nature of the current security philosophy. The priority should be to strive for the interaction of procedures and planning that will complexly cover the management, military and non-military aspects of national security. Real-world, responsive exercises of all security actors are a prerequisite for practical implementation of tasks and acquisition of decision-making skills. It will also enable the detection of weaknesses in current plans and strategies and increase situational awareness of current threats.

The disposition of emergency medical teams in situations of potential military conflict is only a small part of the necessary influence of civilian units to ensure national security. Changing from a reactive to a proactive philosophy may be the optimal starting point for reflecting on the above issues.

This study identifies many questions and elements affecting public security that are worth addressing in the near future. Areas not currently developed in the literature were observed. In addition, due to the many legislative changes, publications that present an outdated state of knowledge were singled out. The authors

unanimously confirm their willingness and great enthusiasm for further work for research, including systematizing knowledge and indicating possible directions for development.

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CONFLICT OF INTEREST

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VENTILATOR-ASSOCIATED PNEUMONIA AMONG PATIENTS WITH COVID-19: A SYSTEMATIC REVIEW

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ABSTRACT

The aim of this study is to investigate the characteristics, epidemiology, and the diagnostic criteria for VAP used most often among patients with COVID-19. PubMed, Embase, Scopus, and Google Scholar were searched between December 2019 and 1 July 2023 with the keywords ventilator-associated pneumonia, COVID-19, VAP, VAP in COVID-19, pneumonia, coronavirus, and SARS-CoV-2. Retrospective and prospective studies, case reports, and randomized controlled trial (RCT) of adults with confirmed cases of COVID-19 and VAP were selected for further analysis. Sixty-nine studies with 21,627 patients were included. The occurrence of VAP with COVID-19 ranged from 6%–91%; the mortality of patients with VAP with COVID-19 was 0%–100%. The difference between the ranges is wide owing to differences in study settings and VAP diagnostic criteria used. The bacterial strains responsible for infection were *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Enterobacter species*, and *Staphylococcus aureus*. The percentage of pneumonia associated with multidrug-resistant bacteria varied from 4% to 76%. Most studies were conducted in Europe. The diagnostic criterion used for VAP most often was that of the European Centre for Disease Prevention and Control.

To reduce the incidence and mortality of VAP, it is crucial to create new empiric antibiotic therapy guidelines and place a focus on adopting VAP prophylaxis in the intensive care unit.

KEY WORDS

COVID-19; ICU; Ventilator-associated pneumonia

INTRODUCTION

The coronavirus disease (COVID-19) has dramatically strained the global health system since December 2019. There were 642,794,281 confirmed cases globally and 6,625,286 victims as of 19 November 2022 [1]. The hospitalisation rate of individuals with COVID-19 was 6%, of which 20% required intensive care treatment [2]. Mechanical ventilation was required for patients who developed acute respiratory distress syndrome (ARDS) due to COVID-19. Moreover, prolonged mechanical ventilation is associated with a higher risk of development of ventilator-associated pneumonia (VAP), which is a pulmonary infection in patients exposed to invasive mechanical ventilation for at least 48 h and is a type of hospital-acquired pneumonia. The condition remains one of the most common acquired infections among patients requiring invasive mechanical ventilation. VAP increases the duration of mechanical ventilation and length of hospital stay and is an important factor responsible for increased mortality [3]. Individuals with COVID-19 complicated with VAP are a new group of patients, and the course of the disease varies significantly between patients. Many studies present conflicting results, and there are no systematic results that can be applied to a broad population.

THE AIM

The aim of this systematic review was to investigate the characteristic of VAP among patients with COVID-19 and to determine the epidemiology and most commonly used diagnostic criteria for VAP.

METHODS

The current study adopted the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. We searched the electronic databases PubMed, Embase, Scopus, and Google Scholar. We conducted study selection between December 2019 and 1 July 2023.

The inclusion criteria were: studies in the English language; observational, retrospective, and prospective studies, randomized controlled trials (RCTs), or case reports; adult patients on mechanical ventilation with confirmed cases of COVID-19 and VAP.

The exclusion criteria were: review articles, research protocols, studies with unclear research designs and unavailable data, and studies with possible VAP and unclear VAP criteria.

The following keywords were used for the search: ventilator-associated pneumonia, COVID-19, VAP, VAP in COVID-19, pneumonia, coronavirus, and SARS-CoV-2.

Two independent reviewers screened the titles and abstracts of all studies retrieved from the database searches. Full texts of potentially eligible articles were independently assessed by the two reviewers. Any disagreement was resolved through discussion or, if necessary, arbitration by a third reviewer. Data from the selected studies were extracted using a standardized form. Study investigators were contacted for data confirmation or acquisition of missing data when necessary. We collected the following data items from each included study: first author's name, year of publication, country where the study was conducted, study design, sample size, the prevalence of VAP, mortality of VAP, diagnostic criteria for VAP, and the bacteria responsible for VAP development. When data

were missing or unclear, we assumed that the study did not contain that particular information.

Studies were categorized and synthesized based on their study design, the diagnostic criteria used for VAP, and the reported outcomes. The results of individual studies and syntheses were displayed using tables.

The quality of the included studies was assessed using the Joanna Briggs Institute critical appraisal tool for studies reporting prevalence data. The criteria include sample frame appropriateness, sample size, detailed description of the subjects and setting, data analysis with sufficient coverage of the identified sample, valid methods for the identification of the condition, standard and reliable measurement of the condition, appropriate

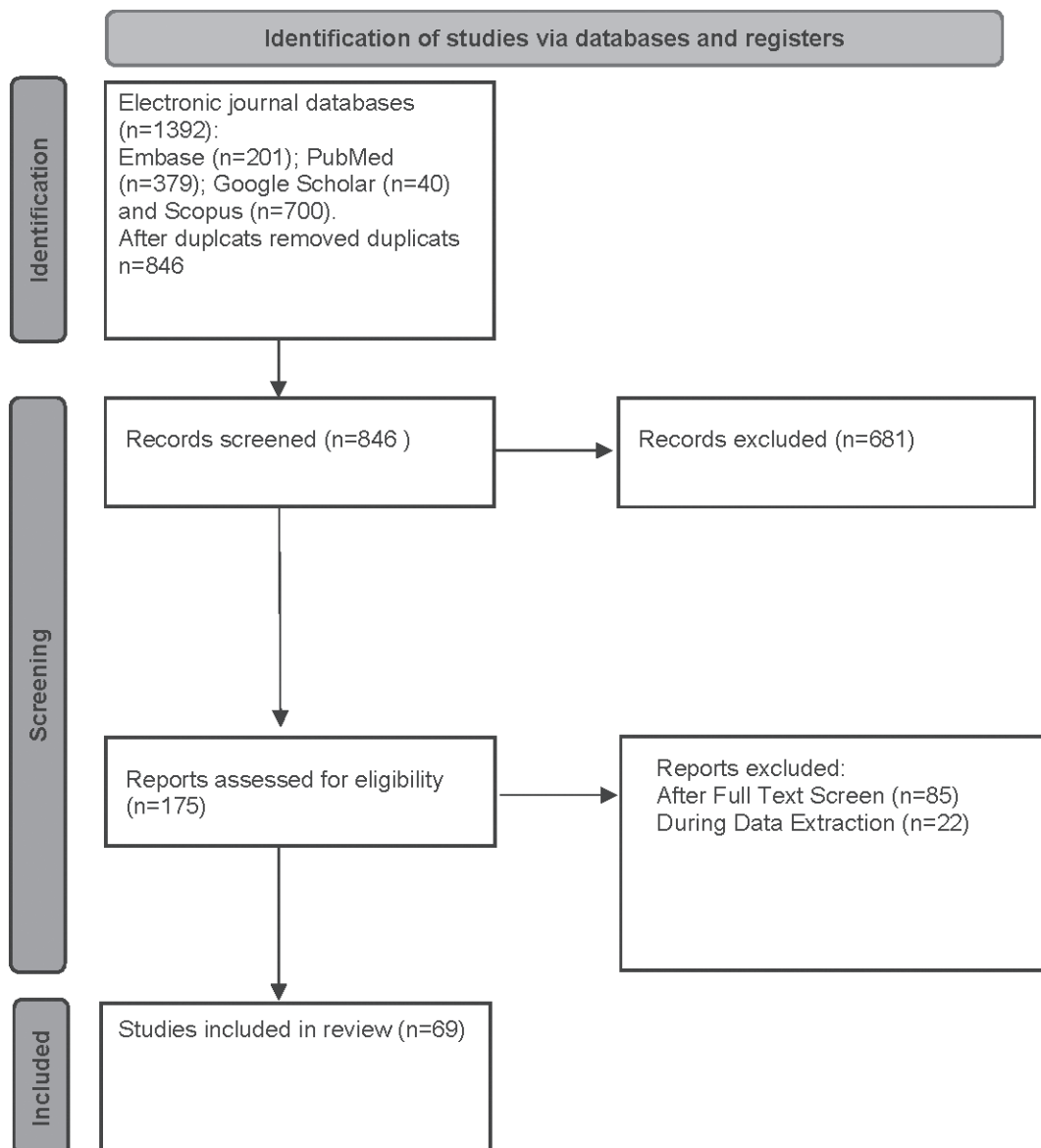


Fig. 1. Study selection flow diagram.

statistical analysis, and response rate. Each study was assessed as “high”, “moderate”, or “low” quality.

REVIEW

Table 1 displays an overview of all 69 studies including 21,627 patients. All included studies were published between 2020 and 2023. The articles were derived from three electronic journal databases: PubMed (n=379), Embase (n=201), Scopus (n=700), and Google Scholar (n=112). Figure 1 represents the data extraction process. Of the 1392 articles identified, 69 met the inclusion criteria. This systematic and meticulous selection process is detailed in the PRISMA flow diagram.

The studies represented a broad geographical range, with research conducted in countries such as Denmark, Argentina, Switzerland, Spain, France, China, Italy, Brazil, Mexico, the USA, UK, Japan, Turkey, Germany, Israel, Belgium, Russia, Austria, Croatia, Iran, and Egypt. Most studies were conducted in France, Italy, and other high-income European countries.

The number of patients in each study ranged from a low of 16 (in Pedersen et al. [4]) to a high of 4643 (in Schmidt et al. [5]), with the majority of participants being admitted to the intensive care unit (ICU). The table 1 includes study designs such as observational studies, retrospective cohort studies, prospective cohort studies, and randomized controlled trials (RCTs). The full characteristics of the included studies are presented in Table 1 and 2. Most studies were retrospective, single-centred cohort studies. A propensity-matched retrospective cohort study (Scaravilli et al. [6]) and planned ancillary analysis of a multicenter retrospective European cohort (Nseir et al. [7]) were included.

From the table 1, the occurrence of VAP among COVID-19 patients requiring mechanical ventilation varied widely across studies. For example, in studies by Roger et al. [8] and Giacobbe et al. [9], there were relatively high numbers of patients with VAP (415 and 171, respectively). In contrast, smaller studies such as those conducted by Bisso et al. [10] and Pedersen et al. [4] reported low occurrences of VAP (11 and 1, respectively). In research, all patients developed VAP, such as in the studies by Pascale et al. [11], Jamnani et al. [12], and Meawed et al. [13]. The number of patients developing VAP within the sample varied across the studies the highest being 1523 (in Garnier et al. [14]). The study by Vacheron et al. [15] had 1,879 patients, but only 550 had VAP, providing a contrasting view to the general trend.

The table 1 presents the VAP mortality rates. High mortality rates were seen in the study conducted in Egypt [13], which reported rates 100% respectively. Conversely, Zhou et al. [16] from China reported no VAP-related deaths among 10 patients with VAP. Studies with smaller samples like Le Pape et al. [37] reported high mortality of 18 out of 69 VAP cases. VAP mortality rates were compared between different countries (e.g., higher mortality was observed in Italy's Giacobbe et al. [10] study vs. lower in France's Luque-Paz et al. [23] study).

The European Centre for Disease Prevention and Control (ECDC) established the most popular VAP diagnostic criteria (Table 2). Other popular guidelines were presented by the Centers for Disease Control and Prevention (CDC) and The American Thoracic Society and Infectious Diseases Society of America (ATS/IDSA). Clinical Pulmonary Infection Score (CPIS) was used only once [17]. Use of ECDC Guidelines was preferred within European settings, for example, see Grasselli et al. [18].

The most common bacteria responsible for VAP development were *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Enterobacter species*, and *Staphylococcus aureus*.

Multidrug-resistant (MDR) bacterial strains were identified in 4% (19) to 76% [20] of cases. Only one study identified extremely drug-resistant bacteria, in 4.76% of cases [21]. A significant percentage of the pathogens causing VAP are MDR, and a subset of these are MRSA (Methicillin-resistant *Staphylococcus aureus*) or extended-spectrum beta-lactamases (ESBL)-producing Enterobacterales. Gram-negative bacteria were a common group of pathogens identified in these studies, with instances such as *Pseudomonas aeruginosa*, *Klebsiella spp.*, *Enterobacter spp.*, and *Escherichia coli*. In study [9], a high percentage of MRSA was reported. A study mentioned Enterobacterales as the primary causative pathogen, marking their importance in VAP. Their resistance to third-generation cephalosporins (3GC) is reported. *Staphylococcus aureus*, including MRSA, was found in various studies and presented as both methicillin-sensitive *Staphylococcus aureus* (MSSA) and Methicillin-Resistant *Staphylococcus Aureus* (MRSA). Variability: Differences in pathogens identified was seen across studies, including rare or region-specific pathogens like *Burkholderia cepacia*, *Stenotrophomonas maltophilia*, *Viridans streptococcus*, etc.

DISCUSSION

The studies span from 2020 to 2023, reflecting the evolution of the COVID-19 pandemic. This diversity might contribute to the variability in VAP occurrence and mortality rates. Earlier studies from 2020 (e.g., Gamberini et al. [18]) might capture the initial response to COVID-19. Recent studies from 2023 (e.g., Wicky et al. [65]) may include improved medical interventions and protocols.

VAP is responsible for higher mortality and increased time of mechanical ventilation and ICU length of stay [6]. The findings of the present study offer important insights into VAP and COVID-19. Throughout the analysis, the findings confirmed that the risk of the development of VAP was higher among patients with COVID-19 [22]. However, another study [7] indicated that VAP mortality was not significantly different among patients with SARS-CoV-2 pneumonia, influenza pneumonia, and no viral infection. During the second and third waves of COVID-19, the occurrence of VAP increased [23]. Some studies such as Ochoa-Hein et al. and Delić et al. report

Table 1. Occurrence, mortality, and characteristics of VAP in COVID-19 studies included in the systematic review.

Authors	Year	Country	Design	Number of patients	No. of patients requiring mechanical ventilation	No. of patients with VAP	VAP mortality
Gudiol et al. [36]	2021	Europe, North America and South America	MC observational combined prospective/retrospective cohort study	133	No information	10	No information
Carbonell et al. [23]	2021	Spain, Andorra and Ireland	MC retrospective cohort study	3795	2888	775	No information
Schmidt et al. [5]	2021	France, Belgium, and Switzerland	MC prospective cohort study	4643	2101	1209	No information
Roger et al. [8]	2021	France	MC prospective cohort study	966	721	415	69
Grasselli et al. [37]	2021	Italy	MC retrospective study	774	692	389	No information
Lamouche-Wilquin et al. [38]	2022	France	MC retrospective study	670	670	349	
Giacobbe et al. [9]	2021	Italy	MC observational retrospective study	586	586	171	78
Rouzè et al. [39]	2021	France, Spain, France, Portugal, and Ireland	MC retrospective cohort study	568	568	205	No information
Weidmann et al. [40]	2022	USA	Retrospective cohort study	3273	555	215	No information
Nseir et al. [7]	2021	European cohort	Planned ancillary analysis of a MC retrospective European cohort	No information	568	521	205
Rollas et al. [41]	2022	Turkey	SC retrospective analysis	370	370	135	97
Scaravilli et al. [6]	2022	Italy	Propensity-matched retrospective cohort study	316	316	144	100
Martínez Martínez et al. [42]	2021	Spain	SC cohort study	353	250	100	35
De Santis et al. [30]	2022	Italy	MC prospective observational study	248	242	62	21
Gamberini et al. [43]	2020	Italy	MC prospective study	391	240	206	No information
Ochoa-Hein et al. [44]	2021	Mexico	Before–after observational study	620	205	138	No information
Meawed et al. [24]	2021	Egypt	Cross-sectional study	197	197	197	197
Blonz et al. [25]	2021	France	MC retrospective cohort study	188	188	92	28
Martínez-Guerra et al. [26]	2021	Mexico	SC prospective cohort study	794	188	56	No information
Luque-Paz et al. [45]	2022	France	RCT	178	178	66	19
Litjós et al. [17]	2021	Europa	MC retrospective cohort study	176	176	92	No information
Delić et al. [46]	2022	Croatia	RCT	175	175	149	No information
Pickens et al. [47]	2021	USA	SC observational study	179	162	72	No information
Beaucote et al. [48]	2021	France	Monocentre retrospective study	119	161	119	66
Gragueb-Chatti et al. [33]	2021	France	MC observational retrospective study	No information	151	91	No information
Ruiz-Santana et al. [49]	2022	Spain	MC retrospective observational cohort study	265	141	72	No information
Bardi et al. [50]	2021	France	SC retrospective cohort study	141	134	21	No information
Seife Yohannes et al. [19]	2022	USA	MC retrospective cohort study	132	132	41	20
D'Humie`res et al. [2]	2021	France	SC retrospective cohort study	197	129	65	34
Risa et al. [51]	2021	USA	MC retrospective cohort study	208	126	69	No information
Copaja-Corzo et al. [52]	2021	Peru	SC retrospective cohort study	124	124	37	21
Lessa da Costa et al. [27]	2022	Brazil	SC retrospective cohort study	191	115	33	21
Bisso et al. [10]	2021	Argentina	SC retrospective cohort study	168	114	11	8
Suarez-de-la-Rica et al. [53]	2021	Spain	SC retrospective observational study	107	107	35	No information
Le Pape et al. [54]	2022	Germany	Retrospective cohort study	101	101	69	18

Authors	Year	Country	Design	Number of patients	No. of patients requiring mechanical ventilation	No. of patients with VAP	VAP mortality
Cohen et al. [55]	2021	Israel	Retrospective observational study	93	93	64	33
Signorini et al. [56]	2021	Italy	Retrospective analysis of prospectively collected observational data	92	92	75	No information
Razazi et al. [57]	2020	France	MC retrospective study	90	90	58	32
Temperoni et al. [58]	2021	Italy	SC retrospective analysis	89	89	48	No information
Maes et al. [59]	2021	U.K.	Retrospective observational study	81	81	39	No information
Rouyer et al. [60]	2021	France	MC retrospective cohort study	No information	79	42	34
Garcia-Vidal et al. [61]	2021	Spain	SC retrospective observational cohort study	144	74	11	
Sarton et al. [62]	2022	France	MC retrospective observational study	65	65	43	10
Zhou et al. [16]	2020	China	MC retrospective study	191	63	10	0
Sharov et al. [63]	2020	Russia	SC retrospective study	1204	62	48	No information
Karolyi et al. [35]	2022	Austria	Retrospective observational study	No information	60	48	18
Luyt et al. [31]	2020	France	Retrospective cohort study	50	54	43	4
Baccolini et al. [64]	2021	Italy	SC retrospective cohort study	62	53	17	No information
Buetti et al. [65]	2020	Switzerland	SC retrospective study	48	48	33	No information
Tanaka et al. [29]	2020	France	SC retrospective study	48	46	29	No information
Pascale et al. [11]	2021	Italy	MC prospective study	40	40	40	14
Buehler et al. [66]	2021	Switzerland	SC prospective study	45	40	22	No information
Moretti et al. [21]	2021	Belgium	SC retrospective observational study	39	39	27	11
Søgaard et al. [67]	2021	Switzerland	SC retrospective study	41	34	5	No information
Dargent et al. [68]	2021	France	SC prospective observational study	33	33	21	4
Cour et al. [32]	2021	France	SC prospective study	32	32	28	No information
Tsitsiklis et al. [69]	2021	USA	Case–control	84	28	15	No information
Jamnani et al. [12]	2022	Iran	SC retrospective cohort study	22	22	22	10
Ito et al. [70]	2021	Japan	SC retrospective observational study	32	19	10	No information
Sari et al. [22]	2022	Turkey	SC retrospective cohort study	17	17	9	No information
Pedersen et al. [4]	2020	Denmark	SC retrospective study	16	16	1	No information
Vacheron et al. [15]	2022	France	MC cohort exposed/nonexposed study	1,879	1,879	550	No information
Wicky et al. [71]	2023	France and Switzerland	MC retrospective study	1424	540	229	110
Ferliçolak et al. [72]	2023	Turkey	Retrospective observational study	254	121	78	55
Moreno et al. [73]	2023	France	SC retrospective cohort study	161	161	80	21
Andersen et al. [74]	2023	Denmark	SC retrospective cohort study	50	50	21	12
Biagioni et al. [75]	2023	Italy	SC retrospective cohort study	348	348	113	68
Garnier et al. [14]	2023	European cohort	MC retrospective observational study	3388	3388	1523	456

SC, single centred; MC, multi-centred; RCT, randomised controlled trial

very high VAP rates (more than 65% of patients requiring mechanical ventilation), suggesting these studies involved a particularly vulnerable patient population, aggressive pathogens, or less effective infection control practices [44, 46].

VAP mortality among patients with COVID-19 on mechanical ventilation in developing countries (Egypt, Iran) was 100% [12, 13, 24]. By contrast, a significantly lower prevalence and death rate from VAP were observed in Europe, ranging from 6% to 90% [7, 25]. Data

Table 2. Epidemiology of VAP among patients with COVID-19 and VAP diagnostic criteria.

Authors	VAP diagnostic criteria	Identified VAP Pathogens
Gudiol et al. [36]	No information	<i>Pseudomonas aeruginosa</i> , <i>Enterobacter aerogenes</i> , <i>Burkholderia cepacia</i>
Carbonell et al. [23]	International ERS /ESICM / ESCMID / ALAT guidelines for the management of HAP and VAP	Not specified
Schmidt et al. [5]	No information	<i>Pseudomonas aeruginosa</i> (24.9%), <i>Enterobacter</i> (18%), <i>Klebsiella</i> (12.7%), <i>Staphylococcus aureus</i> (12.7%), <i>Escherichia coli</i> (9.2%) MDR 20.7%, with 2.9% of MRSA
Roger et al. [8]	ECDC	Not specified
Grasselli et al. [37]	ECDC	<i>S. aureus</i> (28%), <i>P. Aeruginosa</i> (21%), <i>Klebsiella species</i> (11%)
Lamouche-Wilquin et al. [38]	ECDC	No information
Giacobbe et al. [9]	ECDC	<i>P. aeruginosa</i> (15%), <i>S. aureus</i> (1.5%), <i>K. pneumoniae</i> (8.7%) MRSA 10% CR gram-negative bacteria (32%)
Rouzè et al. [39]	ATS/IDSA 2005	<i>P. aeruginosa</i> (31%), <i>Enterobacter spp.</i> (26%), <i>S. aureus</i> (17%)
Nseir et al. [7]	Clinical Criteria & Microbiology	Not specified
Rollas et al. [41]	ECDC	<i>A. baumannii</i> , 68 (5%); <i>K. pneumoniae</i> , 35 (27.4%); <i>P. aeruginosa</i> , 1 (7.4%); <i>S. aureus</i> , 12 (8.8%); <i>C. striatum</i> , 8 (5.9%); and <i>E. coli</i> , 5 (3.7%)
Martínez Martínez et al. [42]	ATS/IDSA	No information
De Santis et al. [30]	CDC	<i>P. aeruginosa</i> (22%), <i>S. Aureus</i> (16%), <i>E. coli</i> (13%), <i>K. pneumoniae</i> (12%)
Gamberini et al. [43]	ECDC	Not specified
Ochoa-Hein et al. [44]	No information	Not specified
Meawed et al. [24]	CDC	<i>K. pneumoniae</i> (24.4%), <i>A. Baumannii</i> (16%), <i>P. aeruginosa</i> (12%)
Blonz et al. [25]	ECDC	<i>P. aeruginosa</i> (33%), <i>S. aureus</i> (3%), <i>E. coli</i> (28%), <i>K. pneumoniae</i> (17%) MRSA 1.5%, Enterobacterales 3GC-resistant (52.5%)
Martinez-Guerra et al. [26]	CDC	<i>P. aeruginosa</i> (14%); <i>Klebsiella spp.</i> (13%); <i>E. coli</i> (13%) AmpC producers (37.7%), ESBL producers (8.7%), CRE (4.3%)
Luque-Paz et al. [45]	No information	<i>Enterobacteriaceae</i> (65%), <i>S. aureus</i> (16%), <i>P. aeruginosa</i> (15%)
Llitjos et al.]	CPIS	<i>Enterobacteriaceae</i> (54.3%), Gram-positive cocci (30.4%)
Pickens et al. [47]	Clinical Criteria& Microbiology	<i>Staphylococcus aureus</i> (39%), <i>Viridans streptococcus</i> (36%), <i>Enterobacteriaceae</i> (28.6%) MSSA 39%, <i>Streptococcus spp.</i> 44%, <i>Enterococcus</i> 4%
Beaucote et al. [48]	ATS/IDSA	<i>P. aeruginosa</i> (8%), <i>K. Aerogenes</i> (4%), <i>S. aureus</i> (3%)
Gragueb-Chatti et al. [33]	ATS/IDSA	<i>S. aureus</i> (22%), <i>P. aeruginosa</i> (17%), <i>K. aerogenes</i> (9%), <i>K. pneumoniae</i> (8%)
Ruiz-Santana et al. [49]	No information	<i>Pseudomonas aeruginosa</i> , <i>Stenotrophomonas maltophilia</i> , <i>Escherichia coli</i> , <i>Klebsiella pneumoniae</i> , <i>Pseudomonas putida</i>
Bardi et al. [50]	CDC	<i>Pseudomonas aeruginosa</i> (24.9%), <i>Enterobacter</i> (18%), <i>Klebsiella</i> (12.7%), <i>Staphylococcus aureus</i> (12.7%), <i>Escherichia coli</i> (9.2%) MDR 20.7%, with 2.9% of MRSA
Seife Yohannes et al. [19]	CDC	4% MDRO; <i>Staphylococcus aureus</i> (28), ESBL
D'Humie`res et al. [2]	No information	No information
Risa et al. (51)	No information	<i>S. aureus</i> (57%), <i>K. aerogenes</i> (15%)
Lessa da Costa et al. [27]	No information	<i>Acinetobacter baumannii</i> , <i>Pseudomonas aeruginosa</i> , <i>Klebsiella pneumoniae</i> , <i>Stenotrophomonas maltophilia</i> , <i>Staphylococcus aureus</i> , <i>Enterococcus faecalis</i> , carbapenem-resistant <i>Acinetobacter</i> (CRABAcinetobacter)
Suarez-de-la-Rica et al. [53]	CDC	<i>P. aeruginosa</i> (31%), <i>Klebsiella spp.</i> (25%), MDR bacteria were detected in 15.9% patients: Enterobacterales ESBL; VIM-producing <i>K. pneumoniae</i> ; MRSA.
Le Pape et al. [54]	No information	<i>Enterobacterales</i> (6.8%), <i>Pseudomonas aeruginosa</i> (18.2%), <i>Staphylococcus aureus</i> (11.4%), and <i>Stenotrophomonas maltophilia</i> (1.8%)
Signorini et al. [56]	Clinical Criteria& Microbiology	<i>P. aeruginosa</i> (34%), <i>S. maltophila</i> (18%), <i>Enterococcus spp.</i> (14%)
Razazi et al. [57]	ECDC	<i>Enterobacter spp.</i> (39%), <i>E. coli</i> (17%)
Temperoni et al. [58]	No information	The majority of VAP (64.5%) and BSI were caused by MDR microorganisms
Maes et al. [76]	ECDC	<i>P. aeruginosa</i> (14%), <i>E. coli</i> (14%), <i>K. pneumoniae</i> (12%)
Rouyer et al. [60]	No information	<i>Enterobacteriaceae</i> (54%), <i>P. aeruginosa</i> (19%)
Garcia et al. [61]	No information	<i>S. aureus</i> (36%), <i>P. aeruginosa</i> (27%)

Authors	VAP diagnostic criteria	Identified VAP Pathogens
Sarton et al. [62]	Clinical Criteria& Microbiology	<i>Staphylococcus aureus</i> (25%) and <i>Haemophilus influenzae</i> (25%). in the COVID-19 group; nonfermenting gram-negative bacilli: <i>Pseudomonas aeruginosa</i> , <i>Stenotrophomonas maltophilia</i> , <i>Acinetobacter baumannii</i> (41%) and <i>Enterobacteriaceae</i> (8%)
Luyt et al. [31]	ECDC	<i>P. aeruginosa</i> (37%), <i>K. aerogenes</i> (25%), <i>E. cloacae</i> (7%), <i>S. aureus</i> (7%)
Baccolini et al. [64]	CDC, ECDC	Not specified
Buetti et al. [65]	No information	Not specified
Buehler et al. [66]	No information	<i>Enterobacterales</i> (14%), <i>Pseudomonas aeruginosa</i> (13.3%), <i>Burkholderia cepacia</i> (6.5%)
Moretti et al. [21]	CDC	<i>K. pneumoniae</i> (25%), <i>P. aeruginosa</i> (18%), MDR 66.67% including ESBL <i>Klebsiella spp.</i> (29%); XDR 4.76% (1 <i>P. aeruginosa</i> VIM-producer)
Søgaard et al. [67]	Clinical Criteria& Microbiology	Not specified
Cour et al. [32]	No information	MRSA; <i>Streptococcus pneumoniae</i> , <i>Corynebacterium species</i> , <i>Acinetobacter species</i> , <i>Pseudomonas species</i> , <i>Klebsiella species</i> , <i>Enterobacter species</i> , <i>Proteus species</i> , <i>Stenotrophomonas species</i> , <i>Morganella species</i> , <i>Elizabethkingia species</i> , <i>Escherichia coli</i> , <i>Achromobacter xylosoxidans</i> , and <i>Serratia species</i> . <i>Klebsiella species</i> , <i>Streptococcus pneumoniae</i> , <i>Enterobacter species</i> , <i>Proteus species</i> , <i>Morganella species</i> , <i>Escherichia coli</i> , and <i>Serratia species</i>
Jamnani et al. [12]	Clinical Criteria& Microbiology	<i>Acinetobacter spp.</i> (41%), <i>Pseudomonas aeruginosa</i> (9.1%), <i>Klebsiella spp.</i> , <i>E. coli</i> , <i>Staphylococcus aureus</i> , <i>Staphylococcus epidermidis</i> (4.5%), <i>Candida spp.</i> (18.2%), and diphtheroid (13.6%)
Vacheron et al.]	ECDC	<i>P. aeruginosa</i> (22%), <i>Enterobacter spp.</i> , (14%) <i>Klebsiella spp.</i> (1%), <i>S. aureus</i> (1%)
Bychinin et al. [20]	No information	<i>A. baumannii</i> (51%), <i>K. pneumoniae</i> (27%), <i>Pseudomonas aeruginosa</i> (12%). All the <i>Acinetobacter baumannii</i> , <i>Klebsiella pneumoniae</i> , and <i>Stenotrophomonas maltophilia</i> strains were multidrug-resistant.
Wicky et al. [71]	ATS/IDSA	<i>Enterobacterales</i> (49.8%), <i>P. aeruginosa</i> (24.8%), and <i>S. aureus</i> (22%).
Ferliçolak et al. [72]	Clinical Criteria& Microbiology	Highly resistant <i>Acinetobacter spp.</i> and <i>Klebsiella spp.</i>
Moreno et al. [73]	ECDC	Gram-negative bacteria (62%), <i>Pseudomonas spp.</i>
Andersen et al. [74]	Clinical Criteria& Microbiology	<i>Pseudomonas aeruginosa</i>
Biagioni et al. [75]	No information	<i>Staphylococcus aureus</i> , <i>Pseudomonas aeruginosa</i> <i>Klebsiella spp.</i> , MDR 42.5%
Garnier et al. [14]	ECDC	<i>Enterobacteriaceae</i> , <i>Staphylococcus aureus</i> , <i>Pseudomonas aeruginosa</i>

ECDC - European Centre for Disease Prevention and Control; CDC - Centers for Disease Control and Prevention; HAP - hospital-acquired pneumonia; MRSA - methicillin-resistant *Staphylococcus aureus*; VAP - ventilator-associated pneumonia; ESBL - extended-spectrum beta-lactamases; CRABA *Acinetobacter* - carbapenem-resistant *Acinetobacter*; MDR - Multidrug resistant; MSSA - methicillin-sensitive *Staphylococcus aureus*; XDR - extensively drug-resistant; ATS/IDSA - The American Thoracic Society guidelines and Infectious Diseases Society of America; CPIS - Clinical Pulmonary Infection Score; ERS - European Respiratory Society; ESICM - European Society of Intensive Medicine; ESCMID - European Society of Clinical Microbiology and Infectious Diseases; ALAT - Latin American Thoracic Association

from low-income countries (Mexico, Brazil) showed infection rates similar to European data [26, 27]. There are a few reasons for this phenomenon. First, an overwhelming number of patients requiring ICU treatment exceeded ICU capacity during the pandemic [28]. Second, the lower level or absence of restrictions in the critical initial phase of the pandemic effectively precipitated dissemination of SARS-CoV-2. This resulted in an increasing number of individuals requiring mechanical ventilation.

In 2020, the violent pandemic spread caused a higher mortality rate and occurrence of VAP [29] than what was observed in late 2022 [30]. The decline in the number of

critically ill patients was parallel to the development of COVID-19 vaccines and the increase in the percentage of fully and partially vaccinated individuals. Moreover, the natural evolution of the SARS virus led to a lower level of virulence. As a result, the numbers of mechanically ventilated patients with COVID-19 and patients with COVID-19 requiring hospitalisation decreased. The prevalence of VAP in COVID-19 is decreasing to the level observed before the COVID-19 period [3].

The use of extracorporeal membrane oxygenation (ECMO) has increased owing to the rising number of patients with COVID-19 with ARDS. VAP mortality is identical among patients requiring ECMO in patients with

ARDS caused by SARS-CoV-2 and that caused by other viruses [31].

The use of corticosteroids (especially dexamethasone) increased the risk [6] and decreased the time [32] to VAP. By contrast, an Italian study [33] indicated that dexamethasone did not affect the occurrence of VAP and blood stream infection.

The incidence of individual pathogens varies greatly between the studies, reflecting differences in patient populations, geographic region, and the time of the study. A high variance in the reported percentage of individual pathogens causing VAP was observed. This could be influenced by several factors including hospital settings (ICU, non-ICU), geographic variations, different patient populations, varied sample sizes, and methods of pathogen identification. The identified bacterial strains were similar to the microorganisms responsible for VAP before the COVID-19 era [3]. Antibiotics are overused in high-income countries, and they are insufficient in low-income ones. In the long-term perspective, a consequence of this is the increasing number of MDR microorganisms. Mortality due to coinfection with MDR bacteria was higher than that observed before the COVID-19 period. The cost of incorrect antibiotics must be paid, and more expensive antimicrobial agents are required.

Careful attention must be paid to antibiotics guidelines because they were overlooked during the pandemic. The findings of our systematic review indicate a high percentage of MDR organisms among patients with VAP and COVID-19 (Table 2), which was higher than that in patients without SARS-CoV-2 infection [3]. A step forward could be the use of rapid detection methods for microbes [34, 35].

LIMITATIONS

Most of the studies were conducted in Europe: France, Italy, and Spain. Additionally, there were only a few studies from other parts of the world. Therefore, future studies and research must focus more on the regions not included in the current studies and identify the region-specific prevalence, mortality, and epidemiology of COVID-19. Another limitation is that most of the reviewed studies were mainly retrospective cohort studies, and only two were randomized control trials (Table 1).

CONCLUSIONS

The development of new antibiotic therapy guidelines for the treatment of VAP and emphasis on implementing VAP prophylaxis in the ICU is important to lowering its occurrence and mortality.

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REGISTRATION

This systematic review has been registered on PROSPERO registry (ID: CRD42023449977).

DATA AVAILABILITY STATEMENT

The full dataset can be made available from the corresponding author for justifiable reasons. The necessary computation was done by Excel 2021 and RevMan 5.4.1.

CONFLICT OF INTEREST

The Authors declare no conflict of interest.

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AUTOMATION IN EMERGENCY MEDICINE - OUR FUTURE OR THREAT?

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ABSTRACT

Automation in the 21st century is a rapidly evolving phenomenon that leverages advanced technologies, artificial intelligence, robotics to enhance the functioning of our world and simplify daily lives. The first signs of this progress can also be observed in emergency medicine. The use of drones, which has made it possible to deliver equipment more quickly and safely to remote and hard-to-reach areas, has become an invaluable tool in response to crisis situations. The concept of self-service ambulances, capable of checking a patient's basic vital signs and transporting them to a hospital, holds the promise of revolutionizing first aid. The use of computer technology, particularly artificial intelligence, enables rapid and precise analysis of medical data, significantly supporting the process of patient triage and diagnosis process. Robotic assistants for medical personnel not only have the potential to improve the quality of care but also allow for the performance of precise medical procedures, which can be crucial for critically ill patients. The ongoing automation of emergency medicine is undeniable. Modern technologies open up new perspectives in emergency medicine in terms of both the speed and efficiency of interventions and the quality of care provided to patients. However, to fully harness the potential of these solutions, it is necessary to adequately prepare medical personnel, society, and consider the ethical, legal, and moral aspects associated with their application. This paper analyzes the impact of automation on emergency medicine, with a focus on its potential benefits, challenges, and threats to both patients and medical personnel.

KEY WORDS

emergency medicine, automation, new technologies

INTRODUCTION

Automation appears to be our future, where machines will take over human tasks and responsibilities. At present, fields such as medicine are partially shielded from full automation due to the nature of the services provided. However, we are slowly witnessing the introduction of new technologies to provide better assistance to patients.

In emergency medicine, automation has the potential to revolutionize patient care in critical situations, improving the speed of diagnosis, access to treatment, and the effectiveness of interventions. Nevertheless, there are also concerns about the loss of a strong patient-provider relationship and the ethical aspect of applying advanced technologies in medicine.

THE AIM

The aim of this scientific work is to analyze the current state of automation in emergency medicine and to present research on future innovations, with a particular focus on addressing the question of whether automation represents our future or poses a potential threat.

REVIEW

FIRST STEPS IN THE AUTOMATION OF EMERGENCY MEDICINE

Modern medicine relies heavily on advanced medical devices, which form the foundation of effective patient care. Currently used diagnostic devices allow for efficient analysis of a patient's vital signs, enabling quick and precise diagnoses.

Revolutionary in this regard are automated external defibrillators (AEDs), the benefits of which have been demonstrated in numerous scientific studies [1-5]. Their impact on expediting cardiorespiratory resuscitation before the arrival of an ambulance and increasing survival rates among patients with out-of-hospital cardiac arrest has been proven. The effectiveness of automated external defibrillators results from their intuitive design and the provision of voice prompts, making it possible for untrained individuals to save lives. Once the AED is activated, it analyzes the victim's heart rhythm to determine whether defibrillation is necessary. While the device monitors the patient's condition, the presence of someone to assist with cardiorespiratory resuscitation and provide additional care is essential.

It's also important to note the existence of devices that automatically perform patient examinations but do not analyze the results themselves, as is the case with AEDs. An example of such equipment is the increasingly common use of electronic blood pressure monitors in emergency medical vehicles replacing traditional manual devices [6]. This type of device simplifies obtaining systolic and diastolic blood pressure values as well as the patient's pulse rate without the need for knowledge of traditional, more complex methods of measuring these parameters, such as the Korotkoff method or pulse measurement. Electronic blood pressure monitors have gained immense popularity, especially among individuals with cardiovascular diseases, but it's important to note that the analysis of the results requires a trained individual. Furthermore, devices designed to assist with chest compressions during cardiorespiratory resuscitation (CPR) are becoming increasingly available [7]. These devices relieve medical rescue teams from performing manual chest compressions during rescue operations. The equipment alleviates issues related to fatigue, insufficient workforce, and the safety and quality of CPR during patient transport. The examples provided represent the initial attempts at automation in emergency medical care. While these devices do not offer full automation, they provide the advantages of rapid diagnostics, reduced error risk, and continuous patient monitoring.

CONDUCTED RESEARCH AND PROJECTS

In the context of rapid technological advancement, automation in emergency medical services has become an essential element in the enhancement of healthcare. With the progress of artificial intelligence, robotics, telemedicine, and advanced medical devices, new perspectives are opening up for effective patient care in crisis situations. Research into the development of automation in emergency medicine centers around optimizing diagnostic processes, delivering medical assistance in hard-to-reach locations, and developing systems and devices for rapid responses to life-threatening situations [12-29].

THE USE OF DRONES

In the past decade, drones have become an innovative tool that has revolutionized various fields, including emergency medical services. Currently, in the context of rescue operations in Poland, such devices are used by the Mountain Volunteer Search and Rescue Service (pol. Górskie Ochotnicze Pogotowie Ratunkowe GOPR) [6]. Drones have proven to be valuable in searching for missing individuals and delivering necessary equipment to the scene of an incident. Equipped with thermal imaging cameras, they enable locate people faster and more effective in hazardous or hard-to-reach areas. Additionally, GOPR drones come with signaling lights, spotlights, and speakers, allowing the rescue team to illuminate search areas, indicate paths, and issue voice commands. Drones have found similar applications in situations involving mass casualties and in countries affected by natural disasters,

where they were used for terrain analysis, threat assessment, victim location, and the delivery of medical aid [8].

Numerous studies are currently underway regarding the use of drones in emergency medical services. The key advantages presented in most available publications on this topic include the unmanned nature of drones, their speed, and their ability to reach hard-to-access locations [9-11]. In addition to the real-world examples mentioned earlier, there are simulation studies analyzing the results of using drones in water rescue scenarios [12, 11]. Tests have confirmed the assumptions that drones can reduce rescue operation times, enhance safety by providing buoyancy equipment to victims before the arrival of rescue teams, and improve the identification of drowning individuals in need of assistance.

The capabilities of drones in delivering necessary equipment to the scene of an incident, as described above, are extended to computer-simulated research. In 2016, a study was published regarding the effectiveness of drones in delivering automated external defibrillators (AEDs). The study's results confirmed the efficacy of flying devices in delivering AEDs to up to 96% of the population in Salt Lake County, Utah, within less than one minute, provided there is the proper distribution of AED stations [12]. Automated external defibrillators are currently available in many public places such as shopping centers, hotels, office buildings, and some public transportation vehicles. Their operation is intuitive and does not require specialized knowledge, as the device provides voice prompts to those rendering aid. Many studies have shown an improvement in the prognosis of patients in out-of-hospital cardiac arrest when AEDs are used [13, 14]. Swift and easy access to an AED delivered by a drone would significantly increase the chances of survival for those in need of such equipment.

Some of the research on this topic explores the benefits of using drones to transport specific medications, substances known for their easy administration and exceptional efficacy in saving lives. Scientific articles discuss the use of epinephrine for anaphylactic shock, naloxone as an antidote for opioid poisoning, and anti-epileptic drugs [14-16]. Prehospital procedures, life-saving interventions, and the transportation of injured individuals constitute a crucial stage in the process of saving a patient's life. According to data provided by the government on the Gov website, the average response time in urban areas with a population exceeding 10,000 residents in Poland is approximately 8 minutes. In rural areas, where access is more challenging or complex geographical terrain poses a challenge, this time can exceed 15 minutes [17]. Similar observations are made in the United States [15]. In life-threatening situations, time is of the essence, which is why the development of automated drone-based emergency medical services appears to be highly promising.

The current technological and legal situation does not permit drones to operate without the supervision of a controlling human operator. The era in which these

devices will be managed solely by algorithms, excluding human involvement in rescue operations, seems to be distant. Nevertheless, the research presented here opens up new possibilities for the standard use of drones in emergency medical services.

USE OF SELF-SERVICE EMERGENCY VEHICLES

Self-service ambulances represent an innovative solution in the field of emergency medicine, offering patients with rapid access to basic healthcare in critical situations. Unlike traditional ambulances, where medical personnel play a crucial role, such vehicles leverage advanced technologies to improve the response time and transportation of patients to healthcare facilities. Traditional ambulances currently play a key role in providing basic medical care in emergencies. However, there are certain limitations associated with human control that can affect the effectiveness and speed of responses in crisis situations.

Self-driving ambulances represent the future of emergency medical services, harnessing the potential of autonomous driving technology and artificial intelligence [18]. By utilizing machine learning-based systems and neural networks, self-driving medical vehicles can make rapid and precise decisions. Prototypes being developed are equipped with advanced sensors and high-resolution cameras, enabling precise environmental recognition and obstacle detection. With built-in GPS systems and the ability to analyze traffic data, these ambulances can choose the most optimal route, reducing response times to patients or healthcare facilities. In emergency situations, the vehicle can automatically select the route with the lowest traffic density, which can be crucial for the patient's outcome (fate?) [18]. The high accuracy of autonomous systems in self-service ambulances ensures increased safety and reduces the risk of accidents compared to traditional ambulances.

Intelligent vehicles equipped with healthcare systems have the potential to be a breakthrough in providing urgent medical care during transportation. The advent of 5G wireless communication opens up new possibilities for implementing intelligent vehicles [19]. Within the proposed healthcare monitoring system in the vehicle, various sensors will be installed, such as blood pressure sensors, pulse oximeters, thermometers, and airflow measurement devices. Additionally, capturing images, sound, and video from inside the vehicle and its surroundings will be possible. The data received will be processed in real-time to identify potential medical emergencies and take immediate action. It is expected that children, the elderly, and individuals with physical disabilities will be the main beneficiaries of this innovative solution. In emergency situations, self-service ambulances will be able to respond quickly and alert the need for medical assistance.

The introduction of a health monitoring system in self-service ambulances may contribute to increased trust in autonomous ambulances without human drivers.

The use of such vehicles raises many ethical questions. The priority in developing the automation of emergency medical services should be the comfort and safety of patients. Self-driving ambulances equipped with passenger monitoring systems can enhance independence and control over one's own healthcare, improving the quality of dignity in emergency situations. However, it may also evoke a sense of lack of support in more serious medical cases. When creating systems and legal regulations regarding the introduction of self-service ambulances into medical standards, the presence of medical personnel and careful consideration on a case-by-case basis would be important.

The outlook for the further development of self-service ambulances points to their increasing importance in providing access to basic healthcare in emergencies. Further research, field testing, and collaboration with medical personnel are essential for the optimal utilization of this innovative approach in emergency medicine. Nevertheless, the concept represents a promising step towards the automation of this medical field.

USE OF ARTIFICIAL INTELLIGENCE

Emergency medicine is characterized by a high degree of unpredictability. The development of this field should be directed towards creating systems that enhance safety and improve the prognosis for potential victims.

Among the available tools and artificial intelligence (AI) algorithms, artificial neural networks (ANNs) are the most popular [20, 21]. They are a computational model inspired by the structure and functioning of biological neurons in the brain. Neural networks learn by being provided with training data along with desired outcomes. During the training process, the connection values between neurons are adjusted to minimize the error between the network's outputs and the expected results. This allows the network to generalize and make precise predictions for new, unknown data. Medical rescuers working in emergency departments and in the field bear significant responsibility for conducting initial assessments, diagnosing, and providing on-the-spot treatment to patients with varying degrees of health conditions. The decisions made under pressure have an impact on the patient's future.

According to specialists, one of the primary problems that artificial neural networks could help solve is patient prioritization and the severity of their cases [22, 23]. Such use of this tool would reduce wait time for people whose medical conditions require prompt action.

In resource planning and crowd management in emergency departments, the key is to use various diagnostic methods and available tools. In a study, time series analysis was employed using autoregressive integrated moving average (ARIMA) to develop workload forecasting models for hospital emergency departments (EDs) [24]. The results indicated the effectiveness of these models in shaping staffing schedules and resource

planning. In a study conducted by Jones and Evans, the issue of ED overcrowding was analyzed by evaluating the impact of medical staff configuration using simulation tools [25]. It was found that the simulated system effectively mirrors patient waiting times, providing relatively accurate forecasts.

It is worth noting that creators of automated systems should be aware that the real difficulty in diagnosing and treating serious conditions, such as sepsis, lies in the precise supervision of experts, which is a challenging aspect to accurately replicate or examine [26]. There is a high likelihood that within five years, protocols utilizing artificial intelligence will replace many currently used algorithms that serve as the basis for diagnostic and therapeutic decision-making by healthcare professionals in acute care.

The introduction of AI into emergency medicine opens new perspectives and prospects to streamline diagnostic and therapeutic processes but also raises a range of ethical concerns. Thanks to advanced algorithms and data analysis, artificial intelligence can quickly identify and respond to various health threats. As a result, it can provide faster and more precise patient care, which is crucial in cases requiring immediate intervention. Additionally, the use of artificial intelligence can contribute to the optimization of resource allocation, leading to a more effective emergency medical system.

THE USE OF ROBOTS

In response to new challenges in healthcare and the provision of medical support, innovative tools are being sought that can effectively aid in treatment and the delivery of medical resources. In this context, the intelligent product that is a medical assistant robot takes on particular significance. The design of robots with the function of medical assistants opens up new perspectives in patient care processes, introducing innovative solutions in logistics, maintaining social distance, and supporting the healing process.

Examples of robot applications in medicine have been in use for some time, including machines that assist surgeons by reducing the time required for surgery, ensuring precision and the ability to perform complex procedures with greater control. This leads to the minimization of complications and reduced patient recovery time [27]. As part of robotics development projects, hospitals have also implemented the Patient Drug Management Robot, which extends the capabilities of medical staff in managing medication delivery for patients, MERC, which aids medical personnel in delivering appropriate meals to patients within the hospital, and the Humanoid Robot serving as support for elderly patients, communicating with them empathetically and alleviating their stress [28, 29].

In the context of medical rescue, projects are underway to develop a robot with a delivery function for AED (Automated External Defibrillator) devices [27]. In cases of sudden cardiac arrest, time is a crucial factor in determining a patient's chances of survival. Therefore, the

developed robot has been optimized for the rapid and precise delivery of an automated external defibrillator. The ambulance robot represents an innovative solution, aligning with the concept of automating emergency medicine, leveraging advanced technologies to provide effective medical assistance in urgent situations.

The use of robots in medicine represents a step toward the potential replacement of medical responders with robot medics, which can significantly increase the efficiency of patient care in emergency situations.

DISCUSSION

Automating emergency medical services represents a promising direction in technological advancement, which hypothetically can enhance the efficiency and speed of providing medical assistance. However, with this progress, questions arise about the ethical, legal, and moral aspects associated with such automation.

The modernization of emergency medicine brings many benefits, but there is a rising concern that individuals or communities with limited access to modern technologies may be marginalized. Therefore, we need to consider whether the advancement of automated technologies will be reserved for the elite, or if the benefits will be made available to everyone. The issue of accessibility of automated, state-of-the-art technologies requires an integrated approach that takes into account various social, economic, and technological aspects.

In the context of automation, we must contemplate who is responsible for making critical medical decisions. Currently, all tools available to medical teams are merely aids, and the decision regarding further treatment steps lies with the physicians. Should algorithms make autonomous decisions, or should they be tools that support doctors and rescuers?

Ethical considerations become salient in this context, commencing with the inception of technological advancements, we have been questioning whether a machine, algorithm, or artificial intelligence will make ethical decisions toward humans. Automation can be programmed to make decisions in emergencies, but we need to consider the limits of such decisions and whether machines should have the authority to choose which patients have priority.

Automation involves the collection and processing of medical data to make more accurate decisions. Physicians are subject to medical confidentiality, while machines are susceptible to data theft. Protecting the privacy and confidentiality of this information is essential, and a system that respects patients' rights must be developed.

Another crucial issue is determining who is responsible in cases of errors or accidents related to medical rescue automation. Should the blame lie with the technology creators, system operators, or the doctors and rescuers who use these tools?

With the introduction of automation, medical personnel will need to adapt to new tools and procedures.

What competencies and training will be required to ensure the safe and effective use of this technology?

Introducing automation into emergency medical services requires setting standards and certificates that should be used to assess and approve the technology in use. Establishing institutions and agencies to oversee and regulate this process is also necessary.

Should automation in emergency medicine replace or only support the efforts of human medical staff? How can we balance the benefits of automation with the need for empathy, support, and understanding that healthcare workers provide?

The modernization of emergency medicine brings many promising possibilities but also raises several important ethical, legal, and moral questions. It is crucial that these issues are openly discussed and resolved in collaboration with experts from various fields. Such an approach will dispel doubts about whether technological development serves the public good and aligns with the highest ethical and legal standards.

The integration of automation entails the assimilation and analysis of medical data to enhance decision-making precision. Medical professionals are bound by principles of medical confidentiality, whereas automated systems are susceptible to data breaches. Safeguarding the privacy and confidentiality of such information is imperative, necessitating the development of a system that upholds patients' rights.

An additional pivotal concern centers on the delineation of responsibility in instances of errors or accidents related to automated medical rescue interventions. Allocation of culpability among technology developers, system operators, and the healthcare practitioners deploying these tools necessitates careful consideration.

The advent of automation in emergency medical services imposes a requirement for medical personnel to adapt to novel tools and procedures. Identifying the requisite competencies and training essential for ensuring the secure and efficacious utilization of this technology becomes paramount.

The introduction of automation into emergency medical services underscores the necessity for establish-

ing standards and certifications to assess and endorse the deployed technology. Concurrently, the establishment of institutions and agencies tasked with oversight and regulation of this process assumes critical significance.

An overarching inquiry emerges concerning the role of automation in emergency medicine—whether it should supersede or merely complement the endeavors of human medical staff. Striking a balance between the advantages of automation and the imperative for human attributes such as empathy, support, and understanding in healthcare provision becomes a pressing concern.

The modernization of emergency medicine not only portends promising prospects but also engenders a litany of ethical, legal, and moral quandaries. Candid and collaborative discourse involving experts from diverse fields is imperative for the resolution of these issues. Such an approach is instrumental in dispelling uncertainties surrounding whether technological advancements truly serve the collective welfare and align with the loftiest ethical and legal standards.

CONCLUSIONS

In the contemporary era, we are observing a dynamic progression in technology and automation. Emergency medical services, due to the nature of the care they provide, are shielded from complete automation. Devices currently being introduced into use are designed to only assist emergency response teams.

Ongoing scientific research and projects in this field offer promising prospects for the future. However, it is important to remember that, despite the immense potential of automation, ethical factors, technological risks, and the need to strike a balance between innovation and traditional care are crucial for the harmonious development of this area.

The popularization of automatic solutions and education among professional medical personnel and laypeople becomes an indispensable element of future emergency care. It is through knowledge and skills in modern emergency medical technologies that we will be able to support patients even more effectively in critical situations.

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CONFLICT OF INTEREST

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PRE-HOSPITAL MANAGEMENT OF UNSTABLE TACHYCARDIA COMPLICATED BY CARDIOGENIC PULMONARY EDEMA BASED ON A CASE STUDY

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ABSTRACT

Aim: This work was aimed at presenting the standard of pre-hospital management for a patient with worrying symptoms who developed pulmonary edema as a result of circulatory failure in the hospital. The complication occurred despite the use of electrical cardioversion in unstable tachycardia.

Material and methods: The work was casuistic. The method of the undertaken research was based on a case study. The research material was obtained through the analysis of the Medical Rescue Card, the Departure Order Card of the Medical Rescue Team and the hospital treatment information card.

Conclusions: Pulmonary edema, especially in the acute phase, belongs to a clinical situation that is directly life-threatening and requires immediate medical intervention. Hospitalization of a patient with pulmonary oedema is important in order to implement appropriate diagnostics and treatment aimed at achieving circulatory and respiratory stability of the patient.

KEY WORDS

pulmonary oedema, pre-hospital management, dyspnoea, respiratory failure

INTRODUCTION

The situation in which pulmonary edema occurs is commonly defined as a state of abnormal accumulation of extravascular fluid, which is located in the lung parenchyma. Accumulated fluid as a result of the existing and progressive pathological process results in a disorder of the functioning of normal gas exchange at the level of the alveoli. This could potentially lead to acute respiratory failure due to a reduction in the gas diffusion surface. This situation with the passage of time becomes a state of immediate threat to life [1].

EPIDEMIOLOGY

The incidence of pulmonary edema in patients is estimated at 75,000 – 83,000 confirmed cases per 100,000 people who had heart failure with reduced ejection fraction, which is a total occurrence of nearly 80% of cases of pulmonary edema of cardiac etiology [2]. Based on the observation of hospital proceedings, it can be noted that effective implementation of appropriate treatment translates into an average of about 74% of patient discharges and survival at the level of about 50% after the

onset of complications in the form of pulmonary edema [3]. Statistics indicate an 85% survival rate in elderly people with congestive heart failure, who were highly likely to develop pulmonary oedema progressing as a result of respiratory failure to Sudden Cardiac Arrest (SCA). Observations show that pulmonary edema is more common in men than in women [4].

ETIOLOGY

Given the etiological basis of pulmonary edema, it is possible to distinguish the occurrence of cardiogenic and non-cardiogenic circumstances causing the development of this complication. Only early diagnosis and appropriate diagnostics to distinguish the etiology are crucial and indisputable for the implementation of appropriate causal treatment [5]. From the perspective of etiology, cardiogenic pulmonary edema can be defined as a consequence of the progression of circulatory failure, which causes the inability to perfuse sufficient blood volume in the pulmonary circulation [6]. Noncardiogenic pulmonary edema develops as a result of lung trauma in a direct or indirect mechanism. As a conse-

quence, changes occur in the permeability of capillaries. This, in turn, leads to the translocation of protein-free fluid into the alveolar and interstitial spaces. The most important causes of the development of noncardiogenic pulmonary edema include: drowning and the resulting aspiration, the consequence of direct damage to the respiratory tract, the acute course of an allergic reaction or aspiration of gastric contents. Cardiogenic pulmonary edema, otherwise known as overload, is initiated by factors causing a rapid increase in blood pressure in the left ventricle of the heart, which progresses towards the pulmonary capillaries and results in an increase in blood pressure within the lungs [7]. This phenomenon can be observed most often in all kinds of dysfunctions associated with both hemodynamic function of the left ventricle occurring, among others, during acute myocarditis, congestive myocardial insufficiency, cardiomyopathy of a different and non-ischemic etiology and Acute Coronary Syndrome (ACS). Other circumstances of increased pulmonary capillary pressure include heart valve dysfunction and arrhythmias [7, 8].

CRITERIA FOR THE DIAGNOSIS OF PULMONARY EDEMA

Characteristic symptoms differentiating the etiological background of pulmonary edema can be obtained by taking an X-ray (X-ray) of the chest. Analyzing the image obtained in this way, it can be seen that in the case of cardiogenic type of pulmonary edema, there is a widening in the mediastinum area in the form of vascular peduncle dilation, the presence of pleural effusion or cardiomegaly. However, with regard to the circumstances of development of noncardiogenic pulmonary edema, the X-ray image shows a typical pattern of blurring the image of the lungs in the shape of bat wings, which radiate in the centrifugal direction from the site of the cavity with an air bronchogram. In the case of noncardiogenic pulmonary edema, pleural effusion, mediastinal dilatation and cardiomegaly usually do not occur [7, 9]. A typical clinical picture in a patient with pulmonary edema is a sudden onset and increasing deterioration of general well-being and a feeling of severe shortness of breath, which may be accompanied by: cyanosis around the mouth, present cough with expectoration of foamy and pink-colored discharge. The patient is usually restless, pale and sweaty. He often takes a semi-sitting or sitting position to facilitate breathing. Breathing is greatly accelerated, shallow and often described as whining. There may also be symptoms typical of diseases that led to the development of pulmonary edema in the form of palpitations or chest pain. During the physical examination, characteristic changes can be heard, listening to places above the pulmonary fields audible as rattles. Sometimes the patient may also have increased or decreased blood pressure, swelling in the lower limbs in the case of coexistence of chronic circulatory failure or other ailments typical of arrhythmias [10,11]. The clinical criteria for the diagnosis of acute pulmonary edema in accordance with the guidelines of the European Society of Cardiology 2021 (ESC) include symptoms such

as feeling dyspnoe, signs of respiratory failure in the area of hypoxemia and/or hypercapni, tachypnoe in the range above 25 breaths per minute as well as increased respiratory muscle effort [12].

MATERIAL AND METHODS

The retrospective study included a case study to which the Basic Medical Rescue Team (EMT) was assigned due to symptoms indicating a sudden and life-threatening condition. The symptoms potentially indicated Acute Coronary Syndrome (ACS), which was confirmed by subsequent extended diagnostics in hospital conditions and a positive response to the implemented treatment. Shortly after the patient was transferred to the Emergency Department Admission Room (IP), a complication of heart failure in the form of pulmonary edema was also observed and treated. The research material was obtained through the analysis of the Medical Rescue Card (KMCR), the Departure Order Card of the Medical Rescue Team (KZW ZRM) and the hospital treatment information card. The research material was obtained after the consent of the Management of the E. Szczekliki Specialist Hospital in Tarnów.

AIM

The aim of this paper is to assess the implemented pre-hospital interventions by paramedics of the basic Medical Rescue Team in relation to a patient with symptoms indicating a developing state of sudden threat to health and life due to impaired circulatory and respiratory stability. In the patient in-hospital as a result of the consequences of circulatory failure interrupted initially by cardioversion, pulmonary edema developed. The aim of the study was also to analyze the hospital treatment undertaken and the therapeutic effects obtained.

CASE REPORT

On 01.01.2022 at 9:12 a.m., the basic EMT composed of two paramedics authorized to perform MCR, was disposed in code 1 to intervene with an interview: conscious, breathing differently than usual, pain and a feeling of tightness in the chest, cardiologically treated. In the description, the dispatcher also included information that the reporter hung up during the conversation and did not answer the phone afterwards. EMT was about 11 km from the place of the incident, and the travel time to the patient was 15 minutes. A man was found at the scene and confirmed the symptoms reported to the medical dispatcher, adding a feeling of sudden weakness along with a sweat sensation that preceded a sudden and severe chest pain. The incident was related to physical exertion undertaken by cycling.

MEDICAL RESCUE OPERATIONS THAT WERE TAKEN

In the subject examination performed by paramedics, it was found that the man remains conscious, logical verbal contact and is stable in breathing. The patient confirmed in the history of constant cardiac care due to chronically treated hypertension and post-coronagraphy

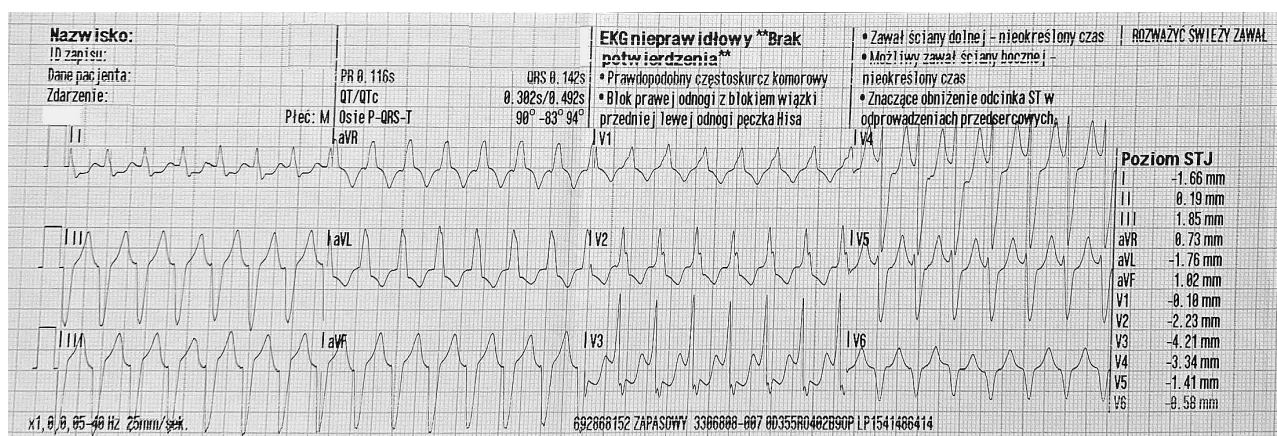


Fig. 1. ECG of the patient taken upon arrival at the place of call with visible tachycardia.

Source: patient's medical records.

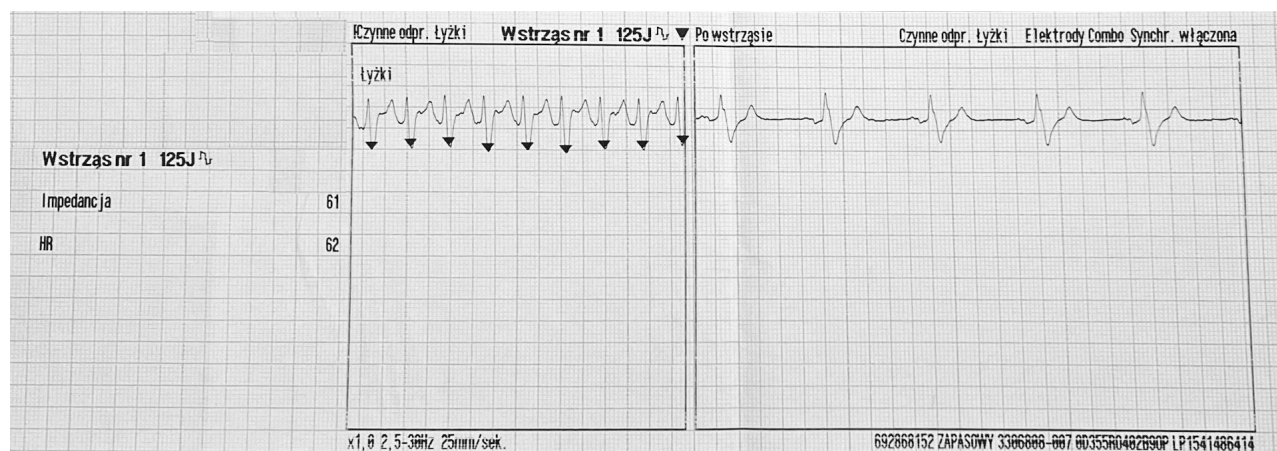


Fig. 2. ECG recording documenting the cardioversion procedure.

Source: patient's medical records.

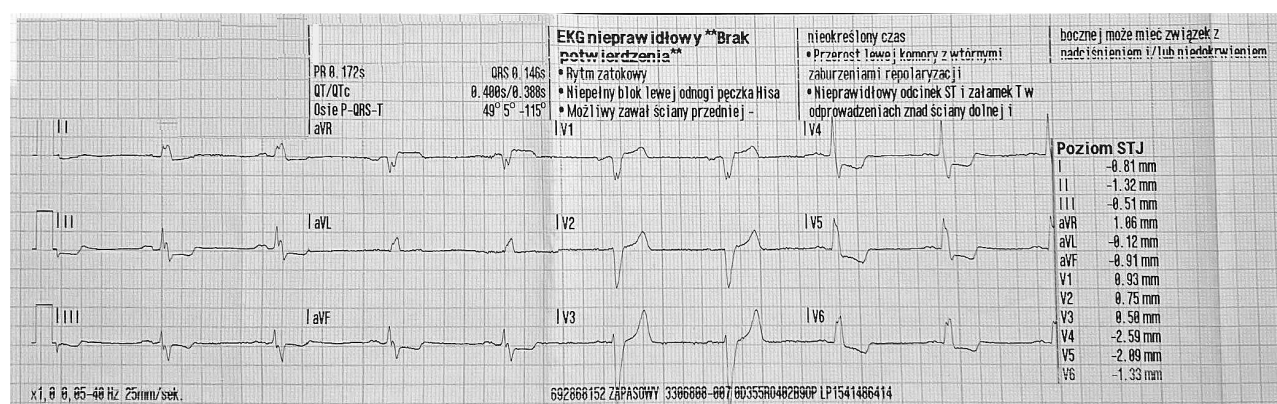


Fig. 3. ECG after cardioversion.

Source: patient's medical records.

condition in connection with ACS in 2017. In addition, he denied the occurrence of allergies and dependence on alcohol and nicotine. In accordance with medical recommendations, he confirmed the regular intake of prescribed medications for chronic diseases. As a result of examination of both the anterior and posterior walls of the chest, the presence of bilaterally symmetrical alveolar murmur without significant additional respiratory artifacts was confirmed auscultationally. Of the obtained vital signs in

the patient noted: 14 breaths per minute, blood pressure (BP) was not measurable, heart rate about 170 beats per minute, glycemic level 163 mg%, SpO₂ was undetectable. Symptoms typical of shock such as cool, moist and pale skin were also observed. In addition, the man reported chest pain, which in the assessment of the Numerical Rating Scale (NRS) was set at 7. The described pain began to gradually change its character, through radiation to the left upper limb. In the psychomotor assessment, the man

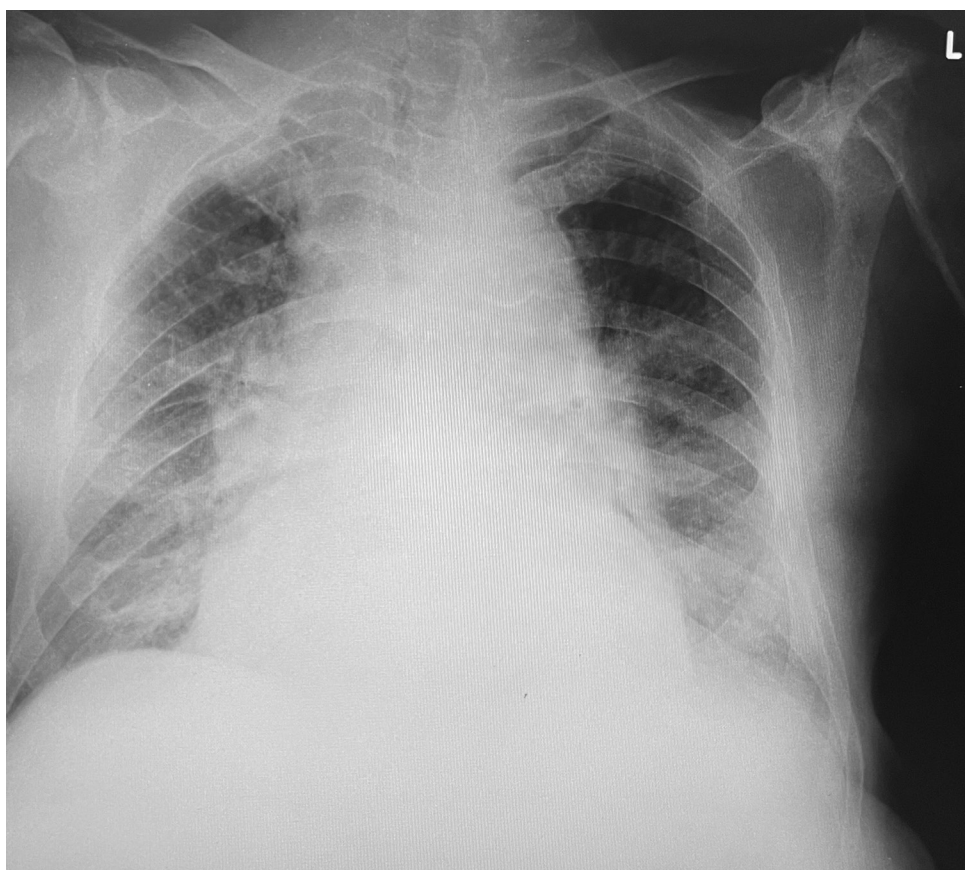


Fig. 4. X-ray photo.

Source: patient's medical records.

was slowed down. After intravenous access, fluid therapy was administered in the form of Optilyte fluid supply.

In the 12-lead ECG, tachycardia with cardiac dysfunction with features characteristic of the Right Bundle Branch Block (RBBB) was visible (Fig. 1). After consultation by teletransmission with a specialist cardiologist, the existing arrhythmia was confirmed. It was necessary to implement an algorithm for the management of alarming symptoms in tachycardia in accordance with the recommendations of the European Resuscitation Council (ERC) 2021. Therefore, it was decided that cardioversion should be carried out at the scene by EMT. According to the procedure preceding cardioversion, pharmacotherapy was applied by introducing the patient to analgosedation by administering 5 mg Midanium + 100 ug Fentanyl, achieving the abolition of the ciliary reflex. The presence of a pulse on the carotid artery was also confirmed and the patient's rhythm was not converted. R-wave synchronization mode was switched on and the energy was set to 125 J, after which an effective cardioversion was performed. After discharge, the patient was re-examined according to the ABC scheme. The control parameters collected were: BP 100/70 mmHg, measured heart rate between 50-60 beats per minute, return of the test pulse on the radial artery and testable SpO_2 of 95%. In the initial phase, after the introduction of analgosedation, the man underwent passive oxygen therapy with a

flow of 12 liters per minute, interrupting it for the time of cardioversion and continuing after discharge. After cardioversion, the patient's pain ceased (Fig. 2-3). The decision was made to quickly transport the patient to the hospital.

The patient was transferred for further diagnosis in IP at 10:48 a.m. in general good condition. In tests performed at the hospital, NSTEMI was confirmed. The echocardiographic examination revealed severe impairment of the left ventricular systolic fraction with ejection fraction within the range of about 30% and segmental contractility disorders from the surrounding branch basin and the right coronary artery. Despite the indications for urgent coronary angiography with coronaryoplasty, the patient initially did not agree to the procedure, hence conservative treatment - symptomatic was implemented. During further diagnosis and treatment, there was a rapid deterioration of the patient's health with high BP values. In the chest X-ray, pulmonary edema was found as a result of circulatory decompensation (Fig. 4). On the second day of hospitalization, the patient's consent was obtained to perform the previously recommended coronary angiography with coronary arthroplasty. Percutaneous angioplasty of the anterior interventricular branch of the left coronary artery with implantation of the releasing stent on 2.01.2022 and the right coronary artery with implantation of 3 antimitotic

drug-eluting stents on 5.01.2022 were performed. The procedures carried out took place without any complications. In the following days of hospitalization, however, cardiac arrhythmias in the form of atrial fibrillation occurred, hence additional treatment was implemented until stabilization of parameters and sinus rhythm. The duration of hospitalization was 13 days, after which the patient was discharged home in a hemodynamically stable condition. A sparing lifestyle and moderate physical activity were prescribed. The patient was instructed to introduce a Mediterranean diet with the elimination of easily digestible sugars and to take 2.5 liters of fluids per day. The need for reliable monitoring of BP and taking prescribed medications as recommended was indicated. It was also recommended to perform laboratory control tests, including lipidogram, creatinine, morphology and glucose tolerance test. A follow-up visit was recommended in 3 months for echocardiographic verification and control of antiarrhythmic treatment.

DISCUSSION

Both in foreign and Polish literature there are a number of scientific publications describing clinical situations accompanied by pulmonary edema. Most often, pulmonary edema of cardiogenic etiology is observed. This is related to the predominance of cardiovascular disease over other chronic diseases in the population. Referring to the selected literature, it is worth quoting the work of Platz E. et al. It concerns the assessment of the incidence of pulmonary oedema in cases of Acute Heart Failure (AHF). As the authors point out, in their work they aimed at a systematic review to determine the methods used to assess pulmonary edema in recent randomized clinical trials in patients with AHF and to describe its incidence between 2002 and 2013. It has been observed that AHF is the leading cause of hospitalization of patients over 65 years of age, both in the USA and Europe, but 20-30% of patients die within 6 months of hospital discharge. Early diagnosis of AHF in the face of correlating signs and symptoms confirmed by imaging and laboratory diagnostics has a positive prognosis for the patient's health and reduces the risk of death. The results of the studies indicated a significant occurrence of pulmonary oedema as the most common co-symptom in AHF in the study group. It is an important qualifying criterion for comprehensive treatment. In the group of people with heart failure with reduced ejection fraction (HFrEF), pulmonary edema was present in 75%-83% of patients. However, in combined studies of heart failure with preserved ejection fraction (HFpEF), from 51% to 100%. The authors emphasized the fact that clinical evidence of pulmonary edema can be found already during physical examination, where auscultation of the chest is present ruffling over the pulmonary fields, and this is confirmed by an X-ray. Researchers also observed that pulmonary edema is associated with an increased risk of death or rehospitalization. Therefore, it is crucial to quickly confirm the presence of pulmonary oedema and to initiate sympto-

matic treatment. The authors concluded that pulmonary oedema often co-occurs with AHF and is of significant prognostic importance for saving a patient's life [2].

In another review article written by Masip J. et al., the issue of assessing the correlation of arterial and peripheral blood gasometry with pulse oximetry (SpO_2) and estimating the limit values of blood gas in the first hours of admission of patients with acute cardiogenic pulmonary edema was raised. The retrospective study included a total of 34 patients admitted to the Intensive Care Unit (ICU) for continuous monitoring of their condition, where saturation was tested and venous and arterial blood samples were collected simultaneously immediately after admission and then at 1, 2, 3, 4, and 10 hours after the first collection. Interestingly, the results from venous and arterial blood showed high correlation coefficients in all time intervals. However, the obtained analysis showed that the venous samples were underestimated taking into account the pH value (mean difference - 0.028) and overestimated in terms of CO_2 pressure (+5.1 mmHg) and bicarbonate values (+1 mEq/l). The researchers observed an inverse in the SpO_2 assessment, which showed a tendency of underestimation with respect to SaO_2 , i.e. the degree of oxygen saturation of hemoglobin of blood (mean SD \pm : 93.1 ± 9.1 vs. 94.2 ± 8.4). In the studies conducted in patients, results based on differences were used, where arterial values were empirically calculated from venous samples, showing an acceptable degree of agreement according to the Bland-Altman test (performed between two different indicators or trials). The authors were among the first to assess the existence of a significant correlation between serial arterial and venous blood gases. Tests were performed in case of acute pulmonary edema within the first hours of hospitalization. According to the conclusions of the conducted research, it is worth including venous blood gasometry as an alternative to arterial blood gasometry in the diagnosis of patients with acute pulmonary edema. This is an easier way to obtain data for parameter analysis due to the possibility of taking samples for blood gas immediately after the insertion of a valve in a routine activity when admitting a patient to the ward [13].

It is also worth mentioning the work of Belice T. et al., where, based on a case study, the authors aimed to draw attention to the side effects of Sitagliptin, which in the described situation led to the development of noncardiogenic pulmonary edema. In the article the authors describe a 74-year old man with chronic diabetes type 2 and hypertension. He was admitted to the emergency room with symptoms of increasing dyspnoea, dry cough and swelling of the lower limbs after a week of using Sitagliptin, with no visible complaints typical of heart failure. From the obtained history, it is known that he took acarbose 50 mg 3 times a day and telmisartan hydrochlorothiazide 80/12.5 mg once a day. As the glycated haemoglobin (HbA1c) result was not normal, Sitagliptin was included in the therapy. From the subject-based examination, crackling, pretibial oedema, BP 120/80 mm Hg, heart rate 120 beats per minute and

respiratory rate of about 30 per minute were noted over the pulmonary fields. The oxygen saturation measurement was at the level of 80%, and the other vital signs tests performed did not show significant abnormalities. A chest X-ray ordered for further diagnostics confirmed pulmonary edema. Oxygen therapy and intravenous infusion of Furosemide were used, after which a rapid positive response to treatment and improvement of the general condition was achieved by alleviating the complaints reported by the patient. After reassessment, mild rattling in the subclavian region and preshyn oedema were shown. The saturation level increased to 99%. Due to a significant improvement in well-being, the patient refused hospitalization and was discharged home with recommendations. The case presented by the researchers indicates that dipeptidyl peptidase 4 inhibitors may cause complications in the form of noncardiogenic pulmonary edema. It is important to exercise caution in its use, especially in patients with known heart failure. It is also worth remembering that when using Sitagliptin in the treatment of diabetes, the possible side effect should be taken into account and in the event of cardiovascular or respiratory problems, the attending physician should be immediately consulted [14].

CONCLUSIONS

This case shows that:

1. Any call due to severe shortness of breath in the patient may be associated with progressive pulmonary edema or the possibility of its development. Pulmonary edema can be caused by various etiological backgrounds.
2. There are related determinants, among which the most common are: chest pain, shortness of breath and changes in the ECG.
3. A critical complication of progressive pulmonary edema correlating with circulatory stability disorder is increasing respiratory failure through progressive pulmonary edema.
4. The scheme of diagnosis and treatment as part of the intra-hospital management in the Admission Room or Hospital Emergency Department in

a patient with the symptoms of: chest pain, shortness of breath and tachycardia should be directed to comprehensive diagnostics. The respiratory and circulatory systems should be monitored to confirm or exclude the presence of a complication of cardiogenic pulmonary oedema. Important tests include chest X-ray and implementation of typical pharmacotherapy reducing the amount of transudate in the alveoli and the search for the initial cause of pulmonary edema.

The conclusion from the previously cited literature in relation to the case study carries clear. Pulmonary edema belongs to the group of complications that pose a direct threat to the patient's life. Many publications show that it is most often associated with cardiological diseases with symptoms typical of cardiorespiratory failure. The basic Medical Emergency Team being at the place of the call has the opportunity to notice the characteristic symptoms heralding the development or already progressive process of pulmonary edema, which can be diagnosed by performing medical rescue protocol and physical examination. The most important, apart from collecting a reliable SAMPLE interview and checking basic vital signs, is to perform a thorough physical examination. Accurate auscultation of the chest is important in this case. After determining the compliance of the patient's reported symptoms and visible symptoms with the clinical picture, confirmed by physical examination, EMT members have the opportunity to introduce appropriate treatment. The procedure describes the standards of diagnostic and therapeutic procedures in the event of pulmonary edema. In Emergency Departments conditions, apart from performing chest X-ray, a helpful tool is also arterial blood gasometry, which is an important role in the diagnosis of patients in respiratory failure as a result of cardiogenic pulmonary edema. Arterial blood gas analysis helps to determine the stage of ongoing pulmonary edema, providing information about the degree of tissue hypoperfusion (pH, bicarbonate, excess bases). This can be crucial in the selection of appropriate respiratory therapy (non-invasive or invasive ventilation) or the decision on the need for possible inotropic support.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest.



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