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ADDRESSING BURNOUT AND PTSD AMONG PARAMEDICS AND EMERGENCY STAFF AFTER THE COVID-19 PANDEMIC: THE ROLE OF OCCUPATIONAL HEALTH SERVICES AND WORKPLACE HEALTH PROMOTION PROGRAMS

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The COVID-19 pandemic, a once-in-a-lifetime worldwide health disaster, has tremendously influenced many aspects of life, particularly healthcare workers (HCWs). Amid the plethora of frontline workers battling this virus, paramedics, often the first point of contact in emergencies, have been subjected to exceptional stressors [1]. Ambulance personnel and emergency service workers played a crucial and essential role in the frontline healthcare response to COVID-19, enduring heightened risks and workplace pressures amid the pandemic [1].

Paramedics have always run the risk of experiencing burnout syndrome (BOS) and elevated rates of mental health disorders, particularly post-traumatic stress disorder (PTSD) [2]. The high prevalence of burnout syndrome, characterized by energy depletion or exhaustion, increased mental distance or feelings of negativism or cynicism related to clients or one's job, and reduced professional efficacy, is due to prolonged and excessive workplace stress that has not been successfully managed [3].

During the COVID-19 pandemic, paramedics and emergency medical staff were thrown into chaos. They faced increasing workloads due to the rise in emergencies, longer working hours due to personnel shortages, and a greatly increased risk of infection. At the same time, they were dealing with an increased number of severely sick and dying patients, sometimes in painful and chaotic settings [4–6].

Furthermore, due to the immense burden on the healthcare system, many paramedics were forced to take on jobs outside their customary responsibilities,

adding to their stress. In some regions of Poland, for example, paramedics needed to give immunizations, undertake mass testing, or transfer the remains of deceased patients. For example, in Italy, the pandemic prompted numerous paramedics and emergency medical workers to be summoned back to duty, assisting in managing the significant number of infected individuals requiring hospitalization and preventing even more deaths from COVID-19 [7].

Fear and uncertainty associated with the epidemic also contributed to BOS. Paramedics had to grapple with the fear of contracting the virus and passing it on to their loved ones, causing high anxiety and stress levels. They also had to deal with the public stigma of being a healthcare professional during a pandemic, often resulting in isolation and emotional suffering.

Despite the multiple precautions used, paramedics faced a significant risk of infection owing to their direct contact with patients. This, coupled with the lack of sufficient personal protective equipment (PPE) in the early stages of the pandemic, further increased stress levels and anxiety.

While necessary, personal safety precautions added another difficulty to the paramedics' duties. Wearing full PPE for extended periods is physically exhausting and often uncomfortable, exacerbating work-related stress and BOS [6].

Lastly, the pandemic amplified pre-existing issues contributing to BOS among paramedics and emergency personnel. This includes a lack of institutional support, limited career progression opportunities, and inadequate coping mechanisms to deal with the emotional toll of their work.

Emergency medical workers, including paramedics, operate in settings with significant physical and emotional strain. Therefore, relevant psychosocial risk factors in their job, including workplace violence from thirds, high emotional demands and work-related stress, and exposure to potentially psychologically traumatic events, may harm their mental well-being [6, 8].

Public health crises, like pandemics, impose extra stress on this category of workers. Implementing individual and organizational resources of volunteers, paramedics, and emergency medical professionals working during disasters and public health emergencies is critical to ensure successful disaster preparedness. Investing resources in the emergency sector is crucial to address new pandemics and emerging global health crises [9].

In conclusion, the pandemic has significantly exacerbated BOS among paramedics by increasing their workloads, exposing them to higher levels of risk and emotional distress, and amplifying pre-existing issues.

Healthcare institutions must recognize this issue and implement strategies to mitigate BOS and PTSD symptoms among paramedics and emergency medical staff. Policymakers must address the shortage of HCWs employed in emergencies, improve their motivation and provide mental health support.

Healthcare institutions should develop tailored occupational health programs conducted by occupational physicians. Furthermore, workplace health promotion programs like mindfulness-based programs (MBPs) for employees may help intercept mental health problems and prevent an early diagnosis of BOS and PTSD symptoms [10].

Improving working conditions and fostering a culture that values self-care and work-life balance is needed, too. This will improve the well-being of paramedics and emergency medical workers and enhance the quality of care they provide, lowering the high rates of medico-patient litigation and improving the effectiveness of healthcare systems worldwide.

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ORIGINAL ARTICLE

DISASTER PREPAREDNESS ASSESSMENT IN EMERGENCY DEPARTMENT: A CROSS-SECTIONAL STUDY

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ABSTRACT

INTRODUCTION: The increasing incidence of natural and non-natural disasters has become a new challenge for nurses in the emergency department (ED). The efficiency of health services provided to the community is needed to optimize disaster preparedness management by nurses in ED. This study aimed to assess the level of disaster preparedness assessment among emergency nurses in Padang of Indonesia.

MATERIAL AND METHODS: A cross-sectional study design was conducted in three emergency departments: a teaching hospital, a public hospital, and a referral hospital in Padang of Indonesia. Fifty nurses in ED were selected using a purposive sampling technique. A self-administered questionnaire was used to measure the sociodemographic of nurses. Meanwhile, the Emergency Preparedness Information Questionnaire (EPIQ) was used to measure emergency nurses' disaster preparedness assessment. Data were analyzed using independent T-test and One-way ANOVA.

RESULTS: The finding of this study indicated there were no differences in the level of assessment preparedness for disaster among nurses by nursing education. However, there were differences in the level of assessment preparedness for disaster among nurses by places of work, especially sub-dimension familiarity with isolation, quarantine, and decontamination (p = 0.045), psychological issues (p = 0.029), and communication and connectivity (p = 0.018).

CONCLUSIONS: Familiarity is associated with isolation, quarantine, decontamination, psychological issues, and communication and connectivity among nurses in ED. Therefore, the hospital can utilize the planning and disaster-based programs services used as an instrument to adjust for potential disasters in the hospital region. Furthermore, nurses' self-efficacy can increase psychological issues to optimize disaster knowledge and skill.

KEY WORDS: emergency assessment; disaster preparedness; nurses

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INTRODUCTION

In 2020, Indonesia is faced with non-natural disaster conditions which also attack other parts of the world [1]. Currently, in Indonesia, there has been another increase in cases of COVID-19 cases. As of November 2022, there was an increase of 6,179 cases in Indonesia during November 2022 [2]. Not only non-natural disasters such as COVID-19, Indonesia is also under threat of natural hazards due to Indonesia's geographical condition, which is a potential disaster zone. Based on National Agency for Disaster Management of Indonesia or Badan Nasional Penanggulangan

Bencana (BNPB) data, during 2022, Indonesia experienced 3,208 natural disasters with 220 fatalities, and as many as 4,524 thousand people were displaced and impacted [3]. On the others hand, disasters and emergencies can be caused by human factors, microorganisms, climate change, and geology. Geographically, Indonesia is situated between two large continents and two oceans and is located on the equator, making Indonesia has a tropical climate with extreme weather conditions [4, 5].

BNPB in 2018 states that almost 98% of disaster events in Indonesia are hydrometeorological disasters such as tornadoes with a total of 90 incidents, 67 floods, and 45 landslides. Hydrometeorology is a disaster influenced by weather and climate, such as increased rainfall, hurricanes, floods, and landslides. In addition to hydrometeorological disasters, some earthquakes and tsunamis threaten Indonesia. This condition made Indonesia vulnerable to earthquakes due to the shift of the plates [4].

Padang is the capital city of West Sumatera Province. Padang is located on the coast, in the form of hills, directly facing the Indian Ocean, and Padang is in Mentawai Megathrust. This condition causes Padang to be vulnerable to floods, extreme weather, abrasion, earthquakes, tsunamis, forest and land fires, droughts, landslides, and other geological disasters. In 2019, nearly 60 drought events were recorded in Padang City, followed by 20 coastal abrasions and extreme weather, which increased until 2019. In 2020 were recorded 14 flood events and 17 landslides [6].

Many people who suffer and evacuate due to disasters also bring post-disaster health problems. Nurses can carry out triage or act as coordinators of health services, as information providers, and counselors [6]. To carry out these roles and tasks, nurses' understanding of knowledge, skills, and preparedness in managing disasters is as optimal as possible [7].

The many groups of people affected by natural hazards and non-natural disasters also impact the health system. In Indonesia, the health service system must adapt to existing conditions by coordinating across agencies [1]. Based on minimum service standards by Regional Disaster Management Agency (BPBD), disaster management is coordinated at the sub-district level. So disaster information services are sub-district based. Disaster data are divided into natural disasters, non-natural disasters, and social disasters [6]. In the community-based health fa-

cilities, one of the forms of health efforts carried out by the Padang Health Office is preventing the occurrence of non-communicable diseases (NCDs) through health screening activities/early detection of PTM risk factors, intervention/modification of NCDs risk factors [6].

Preparedness is a series of activities carried out to anticipate the impact of disasters through organization and appropriate steps [8]. Disaster preparedness management and the readiness of nurses in the emergency room in dealing with disasters are integrated into each other [9]. The hospital as a unit in the health care system, has a role in a disaster, one of which is to maintain the function of the hospital optimally and normally when the disaster occurs [10]. Hospitals are health facilities with a high risk of responding to disasters that can increase the severity of injuries or even death if not implemented optimally. Nurses are health workers who are widely available in hospitals. As many as 33% of the total nurses are estimated to be involved in disaster management [11].

Health Office manages disaster prevention and preparedness efforts at the community level [11]. Nurses as one of health workers in the hospital, have emergency skills in hospital settings, not disaster settings. So it can be chaos in the health system in hospital services when a disaster occurs. This condition happened when the non-natural disaster of the COVID-19 Pandemic occurred when nurses faced non-natural disaster situations without knowledge [12].

In the study of Nekoie-Moghadam et al. in 2016 hospital disaster preparedness consists of several indicators, namely procedures and protocols, command and control, coordination, communication, triage, surgical capacity, logistics, human resources, safety, and security, structural and nonstructural resilience, training and exercise, evacuation, transportation, and recovery [10]. Emergency nurses are one of the first health services to respond during a disaster. Emergency Preparedness Information determines the familiarity and competence of emergency room nurses in disaster conditions, such as triage and first aid, detection of biological agents, access to critical resources and reporting, incident command system (ICS), isolation, quarantine and decontamination, psychology issues, epidemiology, and clinical decision making, and communication and connectivity [9].

Nursing care in the Emergency Department (ED) is essential in prevention, preparedness, and recovery response. Nurses have an important role in

reducing the impact of a disaster. In the early stages of a disaster, nurses must make life-saving efforts. The impact of disasters on health service providers such as hospitals also affects health services to the community. However, good quality disaster management depends on the hospital's preparedness, in this case, emergency nurses' preparedness in a crisis. Emergency preparedness in dealing with disasters can be identified in planning, knowledge, capabilities, infrastructure, and training of relevant resources as part of the level of disaster preparedness [13]. The readiness of emergency nurses in dealing with disasters is in line with disaster preparedness. Emergency assessment for disaster preparedness has sub-dimensions: triage knowledge, detection of biological agents, reports, isolation, quarantine and decontamination, psychological issues, epidemiology and clinical decision-making, communication, and connections [9]. This study aimed to assess the level of disaster preparedness assessment among emergency nurses in Padang of Indonesia.

MATERIAL AND METHODS
Study design and setting
This research is a descriptive-analytic study with a cross-sectional approach. This research was conducted in three emergency departments of three hospitals in Padang: A teaching hospital, a public hospital, and a referral hospital. The hospitals were selected based on the Padang City Government, which stated that these three hospitals were disaster referral hospitals in Padang City in 2020. The data collection time was due to a COVID-19 outbreak in Padang in June–September 2020.

Participants
The sampling method used a purposive sampling technique with inclusion criteria. The inclusion criteria were nurses who worked in the emergency department during the COVID-19 outbreak, the 1st level disaster nurses, and nurses who participated in the disaster team in their hospital. The population of this study initially came from three ED in three hospitals were 57 nurses. The respondent who agreed to participate in this study filled in the agreement to the informed consent in Microsoft Form. All of the respondents filled out questionnaires, but 7 questionnaires were invalid. To ensure all 1st level disaster nurses in three hospitals had equal opportunities to participate in this study. So as

many as 57 respondents consist of 13 respondents from a public hospital, 37 from a referral hospital, and 7 from a teaching hospital. Furthermore, 50 respondents were followed up in data analysis. The research team came to the three hospitals to seek approval from the head of the Emergency Department (ED). The researcher team distributed the Microsoft Form instrument link to each respondent.

Instrument and data collection
Sociodemographic data were collected using a questionnaire to identify age, gender, places of work, and education level. The assessment of nurses' disaster preparedness in the emergency department was measured using Emergency Preparedness Information Questionnaire [9, 14–16]. The instrument was translated into Indonesian and used the validity and reliability test values contained in the original and adapted from Giorgino, et.al study in 2015 [9].

Emergency Preparedness Information Questionnaire (EPIQ) determines the relationship of independent variables including triage and first aid, detection of biological agents, access to critical resources and reporting, incident command system (ICS), isolation, quarantine and decontamination, psychological problems, epidemiology and clinical decision-making, and nurse communication and connectivity regarding the disaster measured at the same time. This instrument aims to the measured familiarity of nurses with disaster preparedness in the emergency department [15]. The instrument used 5 Likert Scale, 1 = I have never heard of this topic, 2 = I have heard the terminology but have no knowledge of this information, 3 = I know the terminology but have limited knowledge of this topic, 4 = I am familiar with this topic but not extremely proficient in all subject matter, 5 = I am very familiar with this topic; I am an expert in proficiency on this topic [9]. Interpretation of EPIQ instruments were 1–12 slightly familiar, 13–24 familiar neutral, 25––36 somewhat familiar, and 37–48 very familiar [13].

Ethical consideration
This study was approved by the Medical Research Ethic Committee of M.Djamil Hospital with number LB.02.02/5.7/459/2022.

Data analyses
This research used multivariate analysis test independent t-test, and One-Way ANOVA using statistics analysis software.

Table 1. Characteristic respondent

Variable	Category	(N)	(%)
Gender	Male	9	18
	Female	41	82
Nursing education	Nursing diploma	25	50
	Registered nurse	25	50
Hospital	Referral hospital	23	46
	Public hospital	17	34
	Teaching hospital	10	20
Age (mean, SD)		(35.18; 5,546)	

N (number of respondents) — 50 respondents

Table 2. Level of emergency disaster preparedness among ED nurses in Padang of Indonesia

Level of emergency disaster preparedness	(N)	(%)
Slightly familiar	1	18
Familiar neutral	4	72
Somewhat familiar	36	8
Very familiar	6	2
Total	50	100

N (number of respondents) — 50 respondents

Table 3. Differences in nurses' disaster preparedness assessments based on their education level

The factor of Preparedness for a disaster	Nursing Education		t-value	p-value	95% C.I for a difference of mean
	Diploma mean	RN (Mean)			
Familiarity with triage and basic aid	3.89	3.85	0.791	0.852	(−1.406–1.166)
Familiarity with biological agent detection	3.76	3.43	0.950	0.170	(−4.007–0.727)
Familiarity with accessing critical resources and reporting	3.80	3.84	0.125	0.887	(−0.525–0.605)
Familiarity with the Incident Command System (ICS)	4.94	4.59	0.974	0.212	−3.627–0.827
Familiarity with isolation, quarantine, and decontamination	3.88	3.64	0.334	0.392	−0.799–0.319
Familiarity with psychological issues	3.98	3.64	0.811	0.202	−1.738–0.378
Familiarity with epidemiology and clinical decision making	3.28	3.56	0.682	0.377	−0.352–0.912
Familiarity with communication and connectivity	4.08	3.76	0.447	0.265	−0.891–0.251

RESULTS

Table 1 presents the characteristic of respondents of this study, and showed that the mean of the respondent was 35. 18 years old, the majority were women, half of the respondents were registered nurses, and 46% came from a referral hospital.

Table 2 showed the emergency disaster preparedness among ED nurses in Padang of Indonesia. Most respondents have a neutral familiarity to assess disasters (72%), and 18% of respondents are slightly familiar with assessing the disaster.

Table 3 shows the results of the independent t-test, which aims to identify differences in nurses' disaster preparedness assessments based on their education level. Table 3 showed that there were no significant differences in nurses' assessment in each dimension of disaster preparedness, which is indicated by the p-value > 0.005. In addition, respondents indicated an average sub-dimension of disaster preparedness at each level of education, as much as 3.95 for diploma education and 3.78 for registered nurse education. All no means, there

was a significant difference for most of EPIQ dimensions except Familiarity with Accessing Critical Resources and Reporting, Familiarity with Epidemiology and Clinical Decision Making, and Familiarity with Communication and Connectivity. This finding showed nurses with a diploma degree were more familiar with the sub-dimensions as compared to registered nurses (RN). Because it could be the subject and competencies of disaster management are not being emphasized by diploma nurses and registered nurses. Both of them are at the 1st disaster nurses.

Table 4 showed the difference in the level of preparedness among nurses by place of work. The one-way ANOVA showed differences in the assessment of disaster preparedness by nurses in the ED. The differences especially in the sub-dimensions of Familiarity with Biological Agent Detection (p-value 0.014), Familiarity with Communication and Connectivity (0.018), Familiarity with Psychological issues (p-value 0.029), and Familiarity with Isolation, quarantine, and decontamination (p-value 0.045).

Table 4. Differences in level of preparedness among nurses by place of work					
The factor of Preparedness for a disaster	Place of Work (Hospital)			F	p-value
	Referral Hospital	Regional Public Hospital	Teaching Hospital		
Familiarity with triage and basic aid	11.83	11.53	11.30	0.206	0.814
Familiarity with biological agent detection	19.22	18.24	14.70	4.690	0.014
Familiarity with accessing critical resources and reporting	4.04	3.71	3.50	1.251	0.296
Familiarity with the Incident Command System (ICS)	20.35	18.35	17.30	2.670	0.080
Familiarity with . isolation, quarantine, and decontamination	4.09	3.65	3.20	3.306	0.045
Familiarity with psychological issues	8.35	7.18	6.70	3.815	0.029
Familiarity of epidemiology and clinical decision making	3.39	3.59	3.20	0.391	0.679
Familiarity with communication and connectivity	4.35	3.59	3.50	4.407	0.018

F — F test is used to ascertain the combined (simultaneous) impact of the independent factors on the dependent variable

DISCUSSION

The study indicates that nurses working at the referral hospital were more familiar with disaster preparedness factors than those working in other hospitals. There were indicated the referral hospital in the city of Padang is central, and managed by The Republic of Indonesia Health Ministry. Therefore, nurses working in the ED at this referral hospital are nurses who are more likely to participate in emergencies. In addition, access to information related to disaster knowledge and skills is more often done in referral hospitals. This suggests that large hospitals have committees for disaster prevention, just as is the case in Japan, that committees play an essential role in the method of preparation for emergencies. Some hospitals even have instruments to measure disaster-based services in a state of readiness. Disaster preparedness consists of planning, organizing, equipping, training, exercising, evaluating, and improving [17]. Each stage of disaster management requires protocol and planning. The stages in disaster management are mitigation, preparedness, emergency response during the disaster, and recovery and support after the disaster [10]. Nurses have an essential role in every phase of disaster preparedness management from mitigation, emergency response, and recovery [14].

The focus of preparedness is policies and programs that aim to minimize the impact caused by disasters [10]. The results of this study also have similarities with Baker's research which shows that there are differences in the location of hospitals with the level of disaster preparedness, namely in hospitals with a high number of visits during the Hajj season, so nurses are very familiar with disaster preparedness assessment [15].

Based on the finding of this study, familiarity with communication and connectivity is a sub-dimension related to disaster preparedness assessment. Appropriate communication can be one of the foundations for health emergency intervention planning, decision-making, and evaluation processes [18].

Psychological aspects often appear when a disaster occurs and in the phase after the disaster. Nurses are expected to screen patients with psychological problems so they do not burden the healthcare system when a disaster occurs [7]. Psychological problems that often arise in disaster preparedness are nurses who feel they are not ready to face disaster situations. They also think some challenges must be faced personally and by their families later when involved in disaster management [19]. The problem is that nurses feel they are not qualified enough to participate in a disaster. Therefore, disaster seminars and training need to be considered to update the disaster potential in each area [20]. Research from Aykan et al. [19] in 2022, that nurses' self-regulation can increase nurse readiness in disaster management. In addition, the psychological aspect is also one of the competencies of 1st disaster nurses [21]. Knowledge and skills related to psychological factors during and after a disaster are essential for increasing awareness so that nurses can provide the best care for the community and themselves [22].

Based on the results of the independent t-test, it was found that there was no difference in education level with the level of disaster preparedness assessment among nurses in the ED. The International Council of Nurses in 2009, explains disaster nurses are not differentiated based on their nursing education

but are distinguished according to authority in managing disasters and hospital policies, regional policies, and experience in managing disasters. Disaster nurse 1st Level Disaster Nurse is a certified professional nurse and a nurse assigned to work a disaster if it occurs [21].

The results of Brewer's research suggest that one of the factors that can be linked to the assessment level of disaster preparedness is disaster experience [23]. This is also in line with ICN in 2009, which suggests that experience in leading disaster management distinguishes the level of disaster nurses. Based on the ICN in 2009 and ICN version 2.0 about core competencies in disaster nursing and nurses who can manage disasters at the unit level are 2nd level disaster nurses, and the 3rd level disaster nurses are nurses who have fulfilled the 1st level, the 2nd level disaster nurses competencies, and have competencies at the national or international disaster level management, or military nurses [21, 24]. Research from Al-Hajj in 2020 suggests that there is a need for Hospital Disaster Emergency Preparedness which is expected to reduce the impact of a humanitarian crisis from a disaster. Build human resources, in this case, nurses and hospital capacity to overcome deficiencies in the health care system [25].

Awareness regarding effective disaster preparedness is by adapting disaster preparedness training and education to the workplace, by providing knowledge to health workers and nurses regarding the response describing the ED and the hospital to an emergency. Hospitals can have a better prepared and more confident workforce [26].

Almost all hospitals have emergency and disaster plans, but not all have programs related to special hazard sub-plans. The hospital may require this to plan and simulate certain potential hazards that the hospital can handle [18]. The finding research of Ali-akbari et al. in 2022, showed that a disaster training program for nursing students has a positive impact on increasing disaster nursing competency [27].

Because this study was conducted in the disaster hospital of Padang by the Padang Government, the finding describes the nurses' assessment of disaster preparedness in the emergency department in Padang of, Indonesia. The advantage of this study was determined nurses' emergency department disaster preparedness at hospital in Padang of, Indonesia. Furthermore, the hospital or health service centers can utilize the findings of this study to develop planning and evaluation instruments for disaster-based services. The programs and policies related to disaster-based services are appropriate to the hospital's level, such as teaching hospitals, public region hospitals, and referral hospitals. On the other hand, nurses can improve their self-regulation and self-efficacy to optimize their disaster knowledge and skills. But, this study can still be developed in various other regions in Indonesia considering that Indonesia is a country with a high potential for natural hazards and non-natural disasters.

The study involves some limitations. Firstly, the present study has conducted in the government hospital in Padang of Indonesia. The finding can not generalized to other hospitals in West Sumatera. Furthermore, there was no verification to measure the emergency disaster competencies of ED nurses.

CONCLUSIONS

We can conclude that nursing education has no significant differences in assessing disaster preparedness, but places of work have. Sub-dimensions include isolation, quarantine, decontamination, psychological issues, and communication and connectivity. Therefore, the hospital can utilize the planning and disaster-based programs services used as an instrument to adjust for potential disasters in the hospital region. Furthermore, nurses' self-efficacy can increase psychological issues to optimize disaster knowledge and skill.

Article information and declarations

Conflict of interest
None.

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ORIGINAL ARTICLE

COMPARISON OF CONVENTIONAL RADIOGRAPHY AND COMPUTED TOMOGRAPHY IN PATIENTS ADMITTED TO THE EMERGENCY DEPARTMENT WITH EXTREMITY TRAUMA — A RETROSPECTIVE STUDY

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ABSTRACT

INTRODUCTION: This study aims to compare conventional radiography (X-ray) and computed tomography (CT) on diagnosis, operation plan, and hospitalization of patients with isolated extremity trauma admitted to the emergency department (ED).

MATERIAL AND METHODS: This study was designed retrospectively. Patients with trauma involving extremities presenting to a tertiary ED between January 2019 and 2020 for twelve months who underwent both extremity CT and X-ray imaging were included in the study. The sensitivity, specificity, PPV, NPV, and Kappa coefficients were calculated on the CT reports.

RESULTS: A total of 1306 patients were included in the study. Extremity fractures were detected in 620 (47.6%) and 775 (59.3%) patients evaluated with X-ray, and CT scans respectively. The diagnostic accuracy of the X-ray of all extremity fractures by anatomical region was evaluated. For the shoulder region compared with CT, X-ray had a sensitivity of 95%, specificity of 98%, PPV 98%, and NPV 96% [AUC: 0.969, 95% CI 0.935 to 1.000) in diagnosing proximal humeral fractures. For the elbow joint region compared with CT, X-ray had a sensitivity of 95%, specificity of 98%, PPV 88%, and NPV 99% in diagnosing supracondylar fracture (AUC: 0.973, 95% CI 0.924–1.000). X-ray had a sensitivity of 94%, and specificity of 100%, compared with CT at the wrist region, PPV of 100%, and NPV of 98% in diagnosing distal ulnar fractures (AUC: 0.974, 95% CI 0.941 to 1.000). The most common knee fracture was a proximal tibia fracture on X-ray. Compared with CT, X-ray had a sensitivity for the diagnosis of proximal fibular fractures with 85% sensitivity, 100% specificity, PPV 100%, and NPV 98% (AUC: 0.925, 95% CI 0.832 to 1.000). At the ankle region, distal tibia fracture was the most common fracture on X-ray. Compared with CT, X-ray had a sensitivity of 85%, specificity of 98%, PPV 96%, and NPV 94% (AUC: 0.922, 95% CI 0.879 to 0.966) in the diagnosis of distal fibular fractures. The sensitivity of the X-ray was very low compared to CT in the talus, calcaneus, navicular, and cuneiform bones.

CONCLUSIONS: For upper extremities, X-ray can be useful to determine diagnosing proximal humerus, supracondylar, distal radius, and ulna fracture. Additionally for lower extremities, it can be used in the diagnosis of proximal fibular fractures and distal tibia-fibular fractures. X-ray is beneficial for long bones and CT for carpal and tarsal bones.

KEY WORDS: extremity trauma; fracture; computed tomography; x-ray; emergency department

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INTRODUCTION

Extremity traumas are one of the most common presentations to emergency departments worldwide. Extremity fractures constitute a high cost in terms of public health [1]. It is essential to make an early and accurate diagnosis to prevent mortality and morbidity that may develop following trauma.

Conventional radiography (X-ray) often provides important information in assessing trauma patients in the emergency department (ED). These patients are initially evaluated with X-ray for diagnosis and treatment due to easy accessibility, straightforward interpretation, and low radiation dose. Studies have focused on the misinterpretation of fracture identification in X-rays [2–4].

Misinterpretations cause a delay in treatment in the emergency department and increase the risk of operation in patients, in addition to an increase in their pain. In long-term results, a poor outcome may occur [5–8]. In a study of 905 patients following lower extremity trauma, the mortality rate was 3.9%, and the overall complication rate was 15% [9]. The mortality rate is low in isolated upper extremity injuries. Mortality is highest in the presence of accompanying complications and arterial injury. In a review, the mortality rate was 2.2% in upper extremity traumas involving arterial injury [10].

Conventional radiography is insufficient in evaluating the joint areas related to each other. However, computed tomography (CT) is a valuable imaging modality for detecting or excluding occult fractures and surgical planning. It also provides additional information for the complete assessment of intra-articular fractures, the accuracy of fracture extension, and occult fractures [9]. Computed tomography can provide additional information like hemarthrosis or fracture-related fluid collection. However, high radiation dose and high cost are among the disadvantages of CT [10, 11]. A limited number of studies compare X-ray with CT in the literature's comprehensive evaluation of extremity fractures. These studies showed that CT scanning helps detect isolated wrist and knee fractures [12, 13]. Although multislice CT has a higher diagnostic efficiency than X-ray in the diagnosis and treatment phase, it is still debatable in which situations it would be used in patients with extremity trauma. Therefore, in this study, we wanted to compare X-ray and multislice CT on diagnosis, surgical intervention, and hospitalization of patients with isolated extremity trauma admitted to the ED.

MATERIAL AND METHODS

Study design and protocol

This study was designed as a retrospective observational study. Among the extremities trauma patients who underwent both extremity CT and X-ray imaging applied to the tertiary ED between January 2019 and 2020 for twelve months were included in the study. The sample size was not calculated, and patients were selected by investigating the hospital information system of all patients admitted to the emergency department. Approval for the study was obtained from the ethics committee of our institution.

This study retrospectively analyzed and recorded demographic data, complaints, and radiological images of patients in all age groups at admission in the ED records. Patients with multiple trauma and central pathology, pelvic, vascular, and non-traumatic radiological imaging were accepted as exclusion criteria (Fig. 1).

A protocol form was created to interpret for patients whose X-ray and extremity CT were studied. Trauma mechanism, presence of bone fracture on conventional radiography, anatomical localization, type of bone fracture, relationship with joint space, diagnosis at the time of admission, indications for CT, surgical treatment, and hospitalization requirement
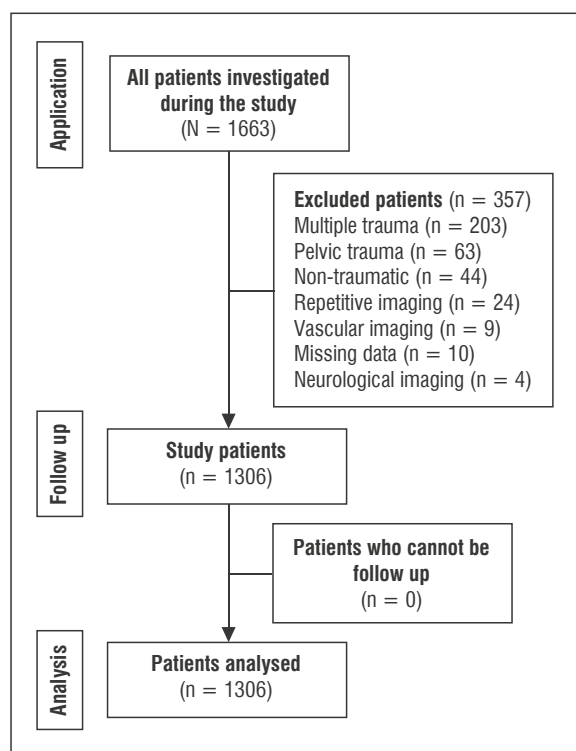
FIGURE 1. Study flow chart

were recorded in the protocol form. An X-ray was done using the brand (NOVA-FA, Prognosis Medical Systems Pvt. Ltd, India) in the emergency department. A multisection extremity CT scan Siemens Definition AS was performed. All CT images were interpreted by an expert radiologist at our institution and recorded as a report in the hospital's patient record management system. X-ray images were evaluated by a 4th-year emergency medicine residents and a specialist, blinded to extremity CT scan reports, and recorded their findings in the protocol form. Fracture findings in conventional X-rays were compared with the CT reports recorded in the patient record management system, using them as the gold standard.

Outcomes

The study's primary outcome was the diagnostic accuracy of X-ray and evaluation of CT in patients with isolated extremity trauma. Secondary outcomes were the decision of surgical intervention and hospitalization based on CT and X-ray findings.

Statistical analysis

All statistical analyzes were performed in SPSS 20 (Statistical Package for Social Sciences, IBM Corporation, IL, USA) and MedCalc 20 (MedCalc Software, Ostend, Belgium) program. Normality analysis of the data was studied with the Kolmogorov-Smirnov test. Numbers and percentages were given for categorical variables. For the diagnostic accuracy of X-ray the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and Kappa (K) coefficients were calculated based on the CT reports. Conventional radiography images were compared with CT scans. A coefficient graded the compatibility. Good compatibility was accepted if the (K) value was more significant than 0.75. A range of 0.75–0.40 was considered moderate compatibility, and less than 0.40 was considered bad compatibility [14]. The Chi-square test was used for all categorical variables.

RESULTS

During the study period, 1663 patients with extremity trauma admitted to ED were investigated. After 357 patients were excluded from the study according to the exclusion criteria, 1306 patients were included (Fig. 1). Of them, 824 (63.1%) were male. The mean and standard deviation (SD) age of

patients was 35.9 ± 19.6 years. The most common injury mechanism was falling from the same level in 513 patients (39.3%). The elbow joint was the most frequently injured area in 286 (21.9%). The demographic data of the patients are shown in Table 1.

Table 1. Baseline characteristics of patients	
Patient Characteristic	n (%)
Age (mean ± SD) [years]	35.9 ± 19.6
1–17	225 (17.2)
18–64	954 (73.0)
65–102	127 (9.7)
Male gender	824 (63.1)
Female gender	482 (36.9)
Mechanism of injury	1306 (100)
Motorcycle accident	133 (10.2)
Motor vehicle accident	44 (3.4)
Bicycle accident	86 (6.6)
Pedestrian accident	37 (2.8)
Fall on same level	513 (39.3)
Fall from height	127 (9.7)
Fall from the ladder	100 (7.7)
Assault	9 (0.7)
Firearm injury	15 (1.1)
Penetrating	11 (0.8)
Sprain	117 (9.0)
Blunt trauma	114 (8.7)
Location of trauma	
Elbow	286 (21.9)
Foot	27 (2.1)
Ankle	81 (6.2)
Foot and ankle	219 (16.8)
Hand	12 (0.9)
Wrist	216 (16.5)
Hand and wrist	125 (9.6)
Knee	203 (15.5)
Shoulder	137 (10.5)
Computed tomography indications	
Suspected fracture	691 (52.9)
Fractures extending to the joint space	133 (10.2)
[Co-existence of fracture	483 (37.0)
Operation planning	372 (28.5)
Surgical intervention	407 (31.2)
Hospitalization	424 (32.5)

SD — standard deviation

All extremity fractures were analyzed in this study according to their anatomic location. Identification of all lower extremity fractures by anatomical location was shown in Table 2. In the shoulder location, 61 (82.4%) fractures were found in X-ray, and the most common fracture was in the proximal humerus. Compared with CT, X-ray was 95% sensitive and 98% specific with a PPV 98%, and NPV 96% in diagnosing proximal humeral fracture [area under the curve (AUC): 0.969, 95% confidence interval (CI) 0.935 to 1.000] (Tab. 3). The radial head fracture was the most frequent at the elbow joint region, with 53 (35.5%) fractures on X-ray (Fig. 2). However, when compared with CT, X-ray was

Table 2. Evaluation of all extremity fractures on conventional radiography (X-ray) and computed tomography (CT)						
Variables	X-ray n (%)	CT n (%)	Missed fracture on X-ray (%)	False negative	False positive	p value
Shoulder fractures						< 0.001
Proximal humerus	61 (82.4)	63 (78.7)	3 (3.9)	3	1	
Clavicula	5 (6.7)	5 (6.2)	0 (0)	0	0	
Scapula	8 (10.9)	12 (15.1)	5 (3.9)	5	1	
Total	74 (100)	80 (100)				
Elbow Fractures						< 0.001
Olecranon	20 (13.4)	44 (18.6)	25 (9.4)	25	2	
Radial head	53 (35.5)	79 (33.4)	27 (11.5)	27	0	
Ulna proximal	6 (4.0)	12 (5.1)	7 (2.5)	7	0	
Supracondylar	25 (16.9)	23 (6.8)	1 (0.4)	1	3	
Lateral condyle	20 (13.4)	33 (13.9)	13 (4.9)	13	0	
Medial condyle	21 (14.1)	33 (13.9)	13 (4.9)	13	1	
Epicondyle	4 (2.6)	12 (5.1)	8 (2.8)	8	0	
Total	148 (100)	236 (100)				
Hand and wrist fractures						< 0.001
Distal radius	108 (41.9)	127 (38.3)	19 (7.8)	19	0	
Distal ulna	55 (21.7)	58 (17.5)	3 (1.0)	3	0	
Carpal bones	42 (16.8)	88 (26.8)	52 (17.2)	52	6	
Metacarp	38 (14.9)	44 (13.2)	9 (2.8)	9	1	
Phalanx	12 (4.7)	14 (4.2)	2 (0.6)	2	0	
Total	255 (100)	331 (100)				
Knee fractures						< 0.001
Proximal tibia	49 (48.5)	66 (52.4)	17 (11.0)	17	0	
Distal femur	10 (9.9)	13 (10.3)	4 (2.1)	4	1	
Patella	25 (24.7)	27 (21.5)	6 (3.4)	6	4	
Proximal fibula	17 (16.9)	20 (15.8)	3 (1.6)	3	0	
Total	101 (100)	126 (100)				
Foot and ankle fractures						< 0.001
Distal tibia	83 (24.7)	104 (23.1)	23 (9.4)	23	2	
Distal fibula	81 (24.1)	91 (20.2)	13 (5.3)	13	3	
Tarsal bones	73 (21.9)	125 (28.6)	58 (22)	58	6	
Lisfranc	4 (1.1)	5 (1.1)	1 (0.3)	1	0	
Metatars	55 (16.3)	78 (17.3)	29 (9.9)	29	6	
Phalanx	40 (11.9)	44 (9.7)	6 (2.0)	6	2	
Total	336 (100)	449 (100)				

| Variables	Sensitivity %	Specificity %	PPV %	NPV %	Kappa	AUC (95% CI)
Table 3. The diagnostic accuracy of Conventional Radiography (X-ray) of all extremity fractures by anatomical location						
Shoulder fractures	93	98	98	92	0.911	0.968 (0.936–0.999)
Proximal humerus	95	98	98	96	0.941	0.969 (0.935–1.000)
Clavicula	100	100	100	100	1.000	1.000 (1.000–1.000)
Scapula	58	99	87	96	0.677	0.788 (0.611–0.964)
Elbow Fractures	69	100	100	68	0.642	0.845 (0.845–0.890)
Olecranon	41	99	90	90	0.526	0.705 (0.604–0.806)
Radial head	65	100	100	88	0.736	0.829 (0.763–0.895)
Ulna proximal	41	100	100	97	0.578	0.708 (0.520–0.897)
Supracondylar	95	98	88	99	0.909	0.973 (0.924–1.000)
Lateral condyle	60	100	100	95	0.731	0.803 (0.698–0.908)
Medial condyle	60	99	95	95	0.715	0.801 (0.696–0.906)
Epicondyle	33	100	100	97	0.489	0.667 (0.476–0.857)
Hand and wrist fractures	78	97	98	73	0.718	0.881 (0.844–0.917)
Distal radius	85	100	100	92	0.879	0.925 (0.888–0.962)
Distal ulna	94	100	100	98	0.968	0.974 (0.941–1.000)
Scaphoid	60	99	96	95	0.721	0.803 (0.710–0.897)
Triquetrum	28	99	80	97	0.409	0.641 (0.466–0.817)
Hamatum	33	100	100	97	0.491	0.667 (0.477–0.857)
Psiforme	25	100	100	99	0.397	0.625 (0.300–0.950)
Trapezium	16	99	50	98	0.244	0.582 (0.323–0.841)
Trapezoid	33	99	50	99	0.396	0.665 (0.288–1.000)
Capitatum	0	98	0	99	−0.008	0.497 (0.243–0.751)
Lunatum	0	100	0	98	0,000	0.500 (0.215–0.785)
Metacarp	79	99	92	97	0.836	0.890 (0.718–0.997)
Phalanx	85	100	100	98	0.857	0.928 (0.871–0.986)
Knee fractures	82	96	97	81	0.816	0.881 (0.830–0.932)
Proximal tibia	74	100	100	88	0.796	0.871 (0.806–0.936)
Distal femur	69	99	90	97	0.770	0.844 (0.690–0.997)
Patella	77	97	84	96	0.779	0.878 (0.783–0.972)
Proximal fibula	85	100	100	98	0.911	0.925 (0.832–1.000)
Foot and ankle fractures	82	98	98	77	0.766	0.903 (0.868–0.938)
Distal tibia	77	99	97	90	0.814	0.885 (0.836–0.934)
Distal fibula	85	98	96	94	0.874	0.922 (0.879–0.966)
Talus	42	100	100	96	0.584	0.714 (0.572–0.857)
Calcaneus	75	99	93	96	0.817	0.875 (0.795–0.954)
Navicular	41	99	83	97	0.544	0.707 (0.519–0.895)
Cuneiforms	38	99	85	93	0.498	0.679 (0.471–0.889)
Cuboid	47	99	81	96	0.582	0.734 (0.586–0.881)
Lisfranc	80	100	100	80	0.887	0.900 (0.691–1.000)
Metatars	66	98	94	90	0.754	0.824 (0.681–0.967)
Phalanx	91	92	68	98	0.757	0.934 (0.843–0.982)
Hospitalization	81	100	98	76	0.853	0.906 (0.883–0.928)
Surgical intervention	84	100	100	93	0.879	0.920 (0.899–0.941)

AUC — area under the curve; PPV — positive predictive value; NPV — negative predictive value; CI — confidence interval

FIGURE 2. The elbow images of a 25-year-old male patient; **A.** Lateral conventional radiography (X-ray) image; **B.** Anterior-posterior X-ray image; **C.** Axial computed tomography (CT) image, arrow: a linear fracture in radial head; **D.** Coronal CT image, arrow: a linear fracture in radial head; **E.** Sagittal CT image, arrow: a linear fracture in radial head that extends into the joint space

95% sensitive, 98% specific, PPV 88%, and NPV 99% in diagnosing supracondylar fracture (AUC: 0.973, 95% CI 0.924–1.000). When the hand and wrist locations were examined, the most common region in X-ray was distal radius fractures 108 (41.9%). However, compared with CT, X-ray was 94% sensitive, 100% specific, PPV 100%, and NPV 98% (AUC: 0.974, 95% CI 0.941 to 1.000) in the diagnosis of distal ulna fractures. According to the K value, X-ray showed high compatibility compared to CT in identifying the fracture in the proximal humerus, supracondylar, and distal ulna fractures. The diagnostic accuracy of the X-ray of all extremity fractures by anatomical region was shown in Table 3. Among the knee fractures, the most common one was proximal tibia fracture, with 49 (48.5%) fractures on X-ray

(Tab. 2). However, compared with CT, X-ray was 85% sensitive, 100% specific PPV 100%, and NPV 98% (AUC: 0.925, 95% CI 0.832 to 1.000) in the diagnosis of proximal fibular fractures (Tab. 3). At the ankle region, distal tibia fractures were the most common 83 (24.7%) fractures on X-ray. However, compared with CT, X-ray was 85% sensitive, 98% specific, PPV 96%, and NPV 94% (AUC: 0.922, 95% CI 0.879 to 0.966) in the diagnosis of distal fibular fracture. Demonstrative images of the ankle fracture are shown in Fig. 3. According to the K value, in the distal tibia and fibula fractures, the X-ray showed a higher similarity than CT in the definition of the fracture. The diagnostic accuracy of the X-ray of all extremity fractures by anatomical region was shown in Table 3.
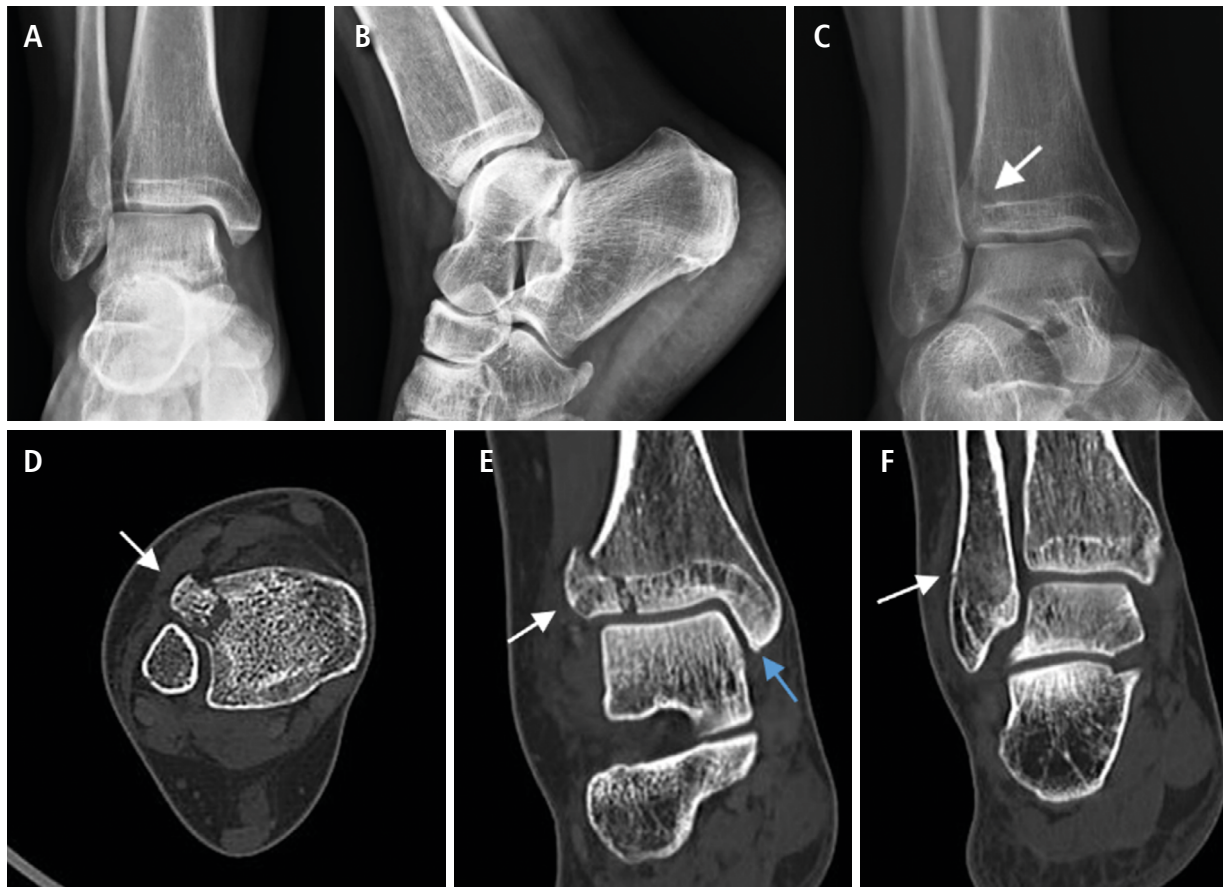
FIGURE 3. The ankle images of a 38-year-old female patient; **A.** Anterior-posterior conventional radiography (X-ray) image; **B.** Lateral X-ray image; **C.** Ankle stress X-ray image, arrow: tibial plafond fracture (oblique fracture); **D.** Axial computed tomography (CT) image, arrow: the displaced fracture in tibial plafond; **E.** Coronal CT image, white arrow: an oblique displaced fracture in tibial plafond that extends into the joint space, blue arrow: an avulsion fracture in the medial malleolus; **F.** Coronal CT image, arrow: an oblique fracture in the lateral malleolus

Extremity fractures were detected on the X-ray images in 620 (47.6%) patients. On CT, fractures were found in 775 (59.3%) patients. When the detected fractures on X-ray and CT were compared, X-ray was 78% sensitive 98% specific, PPV 98%, and NPV 76% (AUC: 0.885, 95% CI 0.866 to 0.904, K:0.736) in diagnosing fracture. In our study, the ability of X-ray to diagnose fracture according to the K value was shown to be highly compatible with CT. In addition, the effect of fracture on X-ray at the decision of hospitalization and operation plan was evaluated. The hospitalization prediction of X-ray was 81%sensitive 100% specific, PPV 100%, and NPV 91% (AUC: 0.906, 95% CI 0.883 to 0.928, K:0.853). The prediction on the operation decision was 84% sensitive 100% specific, PPV 100%, and NPV 93% (AUC: 0.920, 95% CI 0.899–0.941, K:0.879) (Tab. 3). In our study, X-ray was highly compatible with CT in hospitalization and surgery according to the K value.

DISCUSSION

Recent studies on the evaluation of bone fractures suggest that CT scanning is the most commonly used imaging modality following X-ray. However, CT scanning has been recommended in selected patients due to its high radiation dose and high cost [10, 11, 15].

There are many studies in the literature comparing imaging methods in the evaluation of extremity traumas. However, the extremity regions were evaluated separately [9, 12, 13, 16–18]. This study focused on the diagnosis, and localization of all extremity fractures in the emergency department (ED), and it was found to be important because it was a comprehensive study in terms of results. In this study, all extremity bones were evaluated separately according to anatomical localization.

In this study, proximal humeral fractures were the most common fracture in the shoulder. X-ray sensitivity in diagnosing proximal humeral fracture

was 95%, and the specificity was 98%. The number of studies in the literature on this subject is limited. In a study conducted with 44 patients, CT, and X-ray were compared in the diagnosis of proximal humeral fractures, and it was shown that X-ray was helpful in the initial diagnosis of the fracture, but the diagnostic feature of CT was better in complex fractures [19].

In our study, when compared with CT at the elbow joint location, X-ray was found to have a high sensitivity of 95% and a specificity of 98% in diagnosing supracondylar fracture. However, X-ray has been found to have low sensitivity for fractures of the medial condyle, lateral condyle, epicondyle, radial head, olecranon, and proximal ulna. It is identified that elbow joint fractures cannot be adequately identified and evaluated with an X-ray. In a study conducted on patients with minor trauma who applied to the ED, the most common misdiagnosis was found in upper extremity fractures at 30%. Elbow joint fractures are among the most frequently missed injuries at this location, with 10% [20]. Etli et al. [13], in their study comparing the diagnostic efficiency of fractures due to wrist injuries with X-ray and CT, found that the most commonly identified fractures were in the distal radius and ulna. Compared with CT, the highest sensitivity of 95% with X-ray in diagnosing radius fractures [13].

Similarly, X-ray had the highest sensitivity and specificity in our study compared to CT in diagnosing the distal radius and ulna fractures. Standard posteroanterior, lateral, and oblique radiographs are usually sufficient to diagnose distal radius fractures [21]. Carpal bone fractures are common among wrist injuries. Early diagnosis and appropriate management of these fractures prevent the delayed union, pseudoarthrosis, avascular necrosis, and delayed healing [22]. Studies have revealed that X-ray has low sensitivity and specificity in identifying particularly lunate, triquetrum, capitate, and hamate fractures of the carpal bones [23]. Similar to our study, the sensitivity of X-ray in diagnosing carpal bone fractures in hand and wrist trauma was evaluated as less than 60% [13]. The reason for the low sensitivity of X-ray in diagnosing carpal bone fractures here is that the patient group with CT was composed of patients with a higher risk for fracture. Moreover, fractures in the hand and wrist region may be overlooked due to the superimposition of the adjacent bones of the metacarpal bone bases [20].

Knee traumas are among the common causes of admission to the ED. Early and accurate diagnosis is vital because delayed diagnosis causes shortened knee joint range of motion and deformity [15, 24, 25]. In this study, proximal tibial fractures with low sensitivity were found with 78% sensitivity as the most common fracture in X-ray at the knee location. Proximal fibular fractures had the highest value with 85% sensitivity. In a study comparing the diagnostic efficiency of X-ray and CT for knee traumas, the most common fracture was tibia fractures, and the diagnostic efficacy of X-ray in all bones had 89% sensitivity. In the same study, the diagnostic efficiency of X-ray for fibular fracture was similar to ours, with 82% sensitivity [26].

Early diagnosis of ankle trauma can minimize the risk of inadequate or delayed treatment. X-ray is the standard imaging method for the initial evaluation of bones after trauma [5]. Our study compared the diagnostic efficiency of fractures of the bones in the foot and ankle locations in X-ray and CT. In X-ray, distal tibia and fibula fractures were among the most common fractures. When the diagnostic efficiency of X-ray was compared with CT, their sensitivities were 77% and 85%, respectively. In another study, the effectiveness of ankle traumas in diagnosing fractures in X-ray and CT were compared, and the most common fractures were found to be distal tibia, lateral and medial malleolus. The sensitivity of the X-ray in identifying distal tibia and fibula fractures was 57% and 100%, respectively. In addition, the sensitivity of the talus and calcaneus was found to be very low [12]. Ankle fractures may go unnoticed on X-ray images due to overlapping structures, possible suboptimal position, technique, and other problems. Although the anatomical integrity is damaged due to trauma, CT could provide a quick evaluation [10, 11]. In our study, the sensitivity of X-ray was very low compared to CT in the talus, calcaneus, navicular, and cuneiform bones, following the literature.

The decision-making process regarding the operation plan is related to some characteristics of the fractures: Fracture type, angulation, fracture stabilization, fracture length, loss of function, and displacement are essential factors in treating bone fractures. In addition, the extension of the fracture to the joint area and the fracture involving the epiphyseal line affect the treatment decision. In this study, 84% sensitivity and 99% specificity were the most common fragmented type of fracture in X-ray when

the fracture types were examined in all extremity traumas. Nevertheless, compared with CT, X-ray had a higher 100% sensitivity and 99% specificity for the diagnosis of segmental fracture. The sensitivity was low in oblique, linear, and avulsion-type fractures. Etli et al. compared the sensitivity of X-ray to CT in fissure type, avulsion, and circular type were lower than 60%. Similar to our study, the sensitivity and specificity of X-ray in evaluating the extension of fractures into the joint space were 75% and 90%, respectively [13]. Therefore, we recommend evaluation with CT to determine the type of fracture in fractures extending into the joint space.

Limitations

This study had some limitations: The first is a single-center and retrospective study. Secondly, since the patients were evaluated retrospectively, only X-ray images were examined without physical examination. The lack of expertise of the observers evaluating the X-ray images may have affected the interpretation of the results. If the fracture is so obvious on X-ray, CT may not be indicated. Also if no obvious fracture on the X-ray, those patients may not undergo a CT scan. All such cases were not included in this study. So the diagnostic accuracy of X-rays in patients with extremities trauma may differ. When a fracture is missed on CT, the accuracy of CT and X-ray can not be compared.

CONCLUSIONS

In this study, conventional X-ray and CT were compared in diagnosing extremity fractures in patients admitted to the emergency department due to isolated extremity trauma and predicting the decision for hospitalization and operation. When the images of all bones in X-ray were compared with CT, it was found that X-ray had low sensitivity and high specificity in determining fracture diagnosis. Also, the ability of X-ray to diagnose fracture according to the K value was shown to be highly compatible with CT These results showed high compatibility between X-ray and CT in diagnosing bone fractures. The sensitivity and specificity of the X-ray were high in identifying fractures of the proximal humerus, supracondylar, distal radius, and ulna. However, the sensitivity of X-ray in adjacent bones is low in fractures extending into the joint space and also of the fractures involving carpel and tarsal bones. In addition, it has been revealed

that X-ray has lower sensitivity in hospitalization and operation decision than CT.

Article information and declarations

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Conflict of interest

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ORIGINAL ARTICLE

THE IMPACT OF THE COVID-19 PANDEMIC ON THE LENGTH OF MANAGEMENT OF POLYTRAUMATIZED PATIENTS IN THE EMERGENCY DEPARTMENT

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ABSTRACT

INTRODUCTION: The personal protective equipment used by healthcare workers and special institutional protocols during the COVID-19 pandemic could potentially slow down the usual management of trauma patients.

To examine the difference in the length of management of polytraumatized patients in the emergency department (ED) before and during the COVID-19 pandemic.

MATERIAL AND METHODS: The study was designed as a case-control study and included 52 polytraumatized patients who were admitted to the intensive care unit (ICU) after being managed in the ED of Osijek University Hospital. Data were collected from the hospital information system and included patients from March 2019 to February 2020 (pre-pandemic group) and from March 2020 to February 2021 (COVID-19 pandemic group).

RESULTS: Differences in the duration of diagnostics in the ED, the duration of surgery, and the time required for admission to the ICU before and during the COVID-19 pandemic were examined. The duration of diagnostics of polytraumatized patients in the ED before vs during the pandemic was 98 (76–120) and 92 (68–167) minutes, p = 0.79, respectively. 16 (64%) patients in the pre-pandemic and 18 (67%) in the pandemic group needed emergency surgery. The time required for admission to the ICU from the beginning of management in the ED, after accounting for the duration of surgery was 128 (91.5–208.5) and 145 (110–755) minutes, p = 0.09, in pre-pandemic vs pandemic group, respectively.

CONCLUSIONS: The COVID-19 pandemic did not have a significant impact on the length of management for polytraumatized patients admitted to the ICU.

KEY WORDS: COVID-19; pandemic; polytrauma; emergency medicine; intensive care

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INTRODUCTION

The COVID-19 pandemic has caused disruptions in the global healthcare system [1, 2]. In Croatia, during the first wave (April 2020 to May 2020) and the second wave (September 2020 to February 2021), there were recorded nearly 2,000 and over 13,000 SARS-CoV-2 positive patients, respectively. The high number of hospitalized COVID-19 patients exceeded the standard capacity of the healthcare system [3], resulting in a significant strain on the availability of hospital beds. Numerous studies have demonstrated an increase in non-COVID patient mortality during the pandemic, possibly attributed to factors such as limited healthcare availability, staff shortages, and the postponement of medical interventions due to lockdown measures [4–8]. Furthermore, as SARS-CoV-2 primarily spreads through droplets and contact with body fluids in the case of viremia, the use of personal protective equipment (PPE) is mandatory when in contact with positive patients [9, 10]. In our institution, all patients admitted to the ED underwent a nasopharyngeal swab sample for PCR detection of SARS-CoV-2. The recommended protocols by the CDC for donning and doffing PPE [11] were followed until a negative nasopharyngeal swab result was obtained. The PPE ensemble included an isolation gown, gloves, an N95 facemask, a protective cap, goggles, and a face shield. Additionally, radiological diagnostics for patients without a nasopharyngeal swab were conducted in a separate building located outside the ED. Since healthcare institutions are a suitable environment for the transmission of infectious diseases, including SARS-CoV-2, it is necessary to protect vulnerable patients who may be disproportionately affected by an outbreak of infectious diseases [12]. To ensure the safety of other patients, only patients with a negative nasopharyngeal swab were admitted to the ICU. Patients without swabs were treated in a dedicated area equipped with the same level of staffing and equipment as the ICU. The objective of this study was to examine whether the implementation of special care protocols in the ED during the COVID-19 pandemic resulted in the extended initial management of polytraumatized patients, delayed ICU admissions, and impacted ICU mortality rates in comparison to the pre-pandemic period.

MATERIAL AND METHODS

The study was designed as a case-control study, and conducted according to the STROBE guide-line [13]. Study settings and participants: Medical data of polytraumatized patients admitted to the surgical ICU of Osijek University Hospital were collected for two periods: March 2019 to February 2020 (pre-pandemic group) and March 2020 to February 2021 (COVID-19 pandemic group). The collected data included demographic information, time elapsed from ED admission to radiographic findings (CT scan), duration of surgery, time elapsed from ED admission to ICU admission (adjusted for the duration of surgery), and ICU outcomes of the patients.

Categorical data were presented using absolute and relative frequencies, while numerical data were presented using median and interquartile range. The normality of the distribution for numerical variables was assessed using the Shapiro-Wilk test. Differences in categorical data were analyzed using Fisher's exact test, and continuous data were evaluated using the Mann-Whitney U test. The significance level was set at alpha < 0.05. Statistical analysis was conducted using IBM SPSS software, version 28.0.

The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the Faculty of Medicine University Josip Juraj Strossmayer Osijek, No 2158-61-07-21-104. The collection of retrospective data on hospitalized patients was permitted based on the decision of the Ethics Committee of Osijek University Hospital (No. 25-2852-4/2015), with the condition that patient personal data remains protected. In accordance with the retrospective nature of the study, patient consent was waived. Prior to accessing the database, patients included in the study were deidentified, and no personal information of the patients is stored within the database.

RESULTS

A total of 52 polytraumatized patients were included in the study, 25 pre-pandemic and 27 during the COVID-19 pandemic. There were no significant differences in demographic characteristics, mechanism of injury, and affected organ systems as shown in Table 1.

There were no statistically significant differences observed in the time from ED admission to the computed tomography (CT) scan between the pre-pandemic and pandemic groups, as well as in the time required for the validation of the CT scans by the radiologist. 16 (64%) patients before the pandemic

Table 1. General characteristics of patients, mechanism, and type of injury			
	Median (IQR) or n (%)		
	Pre-pandemic (n = 25)	Pandemic (n = 27)	p value*
Age [years]	53 (27.5–64.5)	30 (23–52)	0.09
Sex [male/female]	20 (80%)/5 (20%)	21 (77.8%)/6 (22.2%)	0.56
Mechanism of injury Traffic accident Fall Other	19 (76%) 3 (12%) 3 (12%)	19 (70.4%) 6 (22.2%) 2 (7.4%)	0.44 0.27 0.46
Injured organ system Neurotrauma Thoracic trauma Abdominal trauma Limb trauma	18 (72%) 18 (72%) 9 (36%) 13 (52%)	18 (66.7%) 22 (81.5%) 13 (48.1%) 11 (40.7%)	0.45 0.31 0.27 0.30

* Mann-Whitney U test for continuous and Fisher's exact test for categorical data

Table 2. Duration of diagnostics in ED, surgery, ED to ICU admission time, and ICU outcome			
	Median (IQR) or n [%]		
	Pre-pandemic (n = 25)	Pandemic (n = 27)	p value*
ED admission to CT-scan [minutes]	98 (76–120.5)	92 (68–167)	0.79
CT-scan validation [minutes]	37 (22–49.5)	42 (29–66)	0.23
Duration of surgery [minutes]	185 (111.2–263.7)	132 (65–173.7)	0.11
ED admission to ICU admission reduced for the length of surgery [minutes]	128 (91.5–208.5)	145 (110–755)	0.09
Outcome [survived/died]	21 (84%)/4 (16%)	23 (85.2%)/4 (14.8%)	0.60

ED — emergency department; ICU — intensive care unit; * Mann-Whitney U test for continuous and Fisher's exact test for categorical data

and 18 (67%) during the pandemic needed emergency surgery. The length of the surgery did not exhibit a statistically significant difference between these two patient groups, nor did the time from ED admission to ICU admission (adjusted for the length of surgery) (Tab. 2).

DISCUSSION

The results of this study indicate that the COVID-19 pandemic did not have an impact on the length of management for polytraumatized patients in the ED. As anticipated, larger trauma centers experienced a decrease of over 30% in polytrauma admissions during the pandemic [14, 15]. This decline in ED admissions can be attributed to government-imposed restrictive measures, stay-at-home orders, and reduced mobility of the population. Various studies have demonstrated a decrease in traumatic injuries caused by traffic accidents during the pandemic, while the incidence of off-road accidents and assaults has shown an increase [15–17]. In our institution, no differences were observed in the frequency of polytrauma ED admissions or injury mechanisms during the pandemic compared to the pre-pandemic period.

A study conducted by Aukstakalnis et al. [18] showed that during the pandemic, three times more patients required emergency surgery compared to the pre-pandemic period, and the time from ED admission to the CT scan was significantly longer, with durations of 33 minutes during the pandemic and 23 minutes before the pandemic. Similar findings regarding the time from ED admission to the CT scan were reported in the study by Halvachizadeh et al. [19], with durations of 23.8 minutes during the pandemic and 17.3 minutes before the pandemic. This prolongation from ED to CT-scan time may be caused by the loading of the CT room with COVID-19 patients, the need for disinfection and ventilation of the room, as well as the loss of valuable time on donning PPE. In our study, there

was no difference in the duration of radiographic diagnostics of polytrauma, even a CT for patients without a nasopharyngeal swab was in a building outside the ED. The same CT device was used for imaging of COVID-19 patients, with prior disinfection of the device and ventilation of the room. Nevertheless, our study revealed a significantly longer median time from polytrauma ED admission to CT scan compared to the studies. This extended duration may be attributed to the heterogeneity of the patient population included in our study. Hemodynamically unstable polytraumatized patients required stabilization of vital functions prior to undergoing whole-body CT scans [20]. However, in this study, patients were not stratified based on the severity of their injuries or their hemodynamic stability.

Although the pandemic led to the reorganization of the healthcare system, reduced hospital capacity, and a shortage of healthcare personnel, studies examining the impact of the pandemic on the outcomes of polytraumatized patients have yielded inconclusive results. A multicenter study conducted by Berg et al. [14] demonstrated a significant increase in mortality among polytraumatized patients during the pandemic compared to the pre-pandemic period, with mortality rates of 3.6% during the pandemic and 2.8% before the pandemic. Furthermore, the study also revealed a significant increase in the severity of injuries during the pandemic. A multicentric study by Sheets et al. [21] also showed higher mortality in polytraumatized patients during the pandemic. Conversely, a study conducted in Lombardy demonstrated no statistically significant difference in hospital mortality among polytraumatized patients before and during the pandemic, but there was a significant increase in pre-hospital deaths [22]. Additionally, Ojima et al. [23] found no significant difference in in-hospital mortality for major trauma patients before and during the pandemic. The varying impact of the pandemic on the mortality of polytraumatized patients is likely attributed to the different reorganization strategies implemented by trauma centers, changes in pre-hospital polytrauma management, varying levels of healthcare system overload due to COVID-19 patients, and differences in the availability of medical personnel. In our study, we found no difference in the ICU mortality rate among polytraumatized patients before and during the pandemic. The organization of work in the ICU involved a dedicated area for patients without a nasopharyngeal swab, which shared the same level of staffing and equipment as the main ICU. This contributed to the equally successful treatment of polytraumatized patients during the pandemic within our institution. The relatively higher overall mortality rate observed in our study, compared to the previously mentioned studies, can be attributed to the specific selection criteria of our patient population. Only patients who required ICU treatment, mechanical ventilation, and vital function support were included in our analysis. Similar or even higher mortality rates have been reported in other studies investigating the mortality of polytraumatized patients admitted to the ICU [24, 25].

Because critical illness of any cause and frailty is one of the most important risk factors for severe COVID-19 disease [26], policymakers have mandated PCR testing and isolation of all patients without a nasopharyngeal swab prior to ICU admission. Additionally, asymptomatic positive patients are often a source of infection, and testing and quarantine of these patients with often high viral load is necessary in order to protect the most vulnerable individuals [27, 28]. Although our institution's protocol mandated that patients could be admitted to the ICU only after obtaining a negative PCR result from a nasopharyngeal swab for SARS-CoV2, we did not observe a significant difference in the time from ED admission to ICU admission. This could be partially attributed to the utilization of rapid PCR tests for prompt virus detection. Therefore, the recommended strategy for protecting staff and patients, and preventing the spread of SARS-CoV-2, which includes technical, administrative, and environmental controls, as well as the application of personal protective equipment [29], will be implemented in the future in the ED and ICU in the event of new pandemics.

However, this study has several limitations, including the relatively small sample size and the significant heterogeneity of patients in terms of injury severity. Furthermore, the analysis only included patients who were admitted to the ICU, excluding those who did not require mechanical ventilation and those who died during ED treatment.

CONCLUSIONS

The re-organization of the ED and ICU during the pandemic did not have an impact on the duration of diagnostics for polytraumatized patients, nor did it affect the mortality rate in the ICU. A larger study with a homogeneous sample of patients, along with

the inclusion of all polytraumatized patients admitted to the ED, will be necessary to draw a valid conclusion regarding the impact of the pandemic on the overall mortality of polytraumatized patients in our institution.

Article information and declarations

Data availability statement

The data presented in this study are available on request from the corresponding author.

Ethics statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of Osijek University Hospital No No 25-2852-4/2015. Patients included in the study were deidentified before access to the database, and personal information of the patient is not stored in the database.

Author contributions

Nenad Nešković: writing, visualisation, formal analysis, interpretation, final validation; Davor Klepo: writing, conception, formal analysis and interpretation; Tamara Janošević: writing, analysis and conception; Josip Kocur: writing, analisys and conception; Dino Budrovac: writing, analysis and conception; Ivana Haršanji Drenjančević: writing, conception, interpretation, final validation.

Conflict of interest

The authors declare no conflict of interest.

Supplementary material

No.

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VM VIA MEDICA

MANAGEMENT OF THE DIFFICULT AIRWAY IN THE PEDIATRIC PATIENT — REVIEW OF EXISTING SCALES

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ABSTRACT

There are numerous anatomical, physiological, and clinical differences between pediatric and adult airway management. Airway obstruction in children is unquestionably a stressful situation for the medical staff and the patient's family. Therefore, caregivers must be able to accurately assess the risk of such an occurrence.

To date, there is no consensus on a single ideal pediatric airway assessment scale that could help identify children with the highest risk for intubation-related adverse events. Instead, a few classifications and methods were proposed, with some employing the same techniques proven effective for adults and others emphasizing the differences in the pediatric population. This article compares the data used to support the use of various perioperative airway assessment techniques in pediatric patients. The majority of these remedies rely on anatomical measurements, bedside tests, and in-depth patient histories.

This narrative review highlights the need for standardized and reliable pediatric airway assessment scales and stresses the significance of structured airway assessment in pediatric patients.

KEY WORDS: pediatric airway assessment; pediatric intubation; difficult airway; airway management

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INTRODUCTION

Airway management in pediatric patients has many anatomical, physiological, and clinical differences compared to the adult population [1]. For example, analysis of closed pediatric and adult anesthesia malpractice claims shows a considerably different distribution of respiratory events — they are more common in children (43% vs 30% in adult claims; P < or = 0.01) and have higher — mortality rates (50% vs 35% in adult claims; P < or = 0.01) [2]. The difficult airway in children is an undoubtedly stressful situation for the medical team [3] and the patient's family. Therefore, caregivers must be able to assess the risk of this kind of event thoroughly.

The PeDI registry suggested a range of 2–5 difficult tracheal intubations per 1000 anesthetized children.

The first intubation attempt was successful in only 30% of cases in the registry cohort. However, 98% of the patients were eventually intubated [4]. A recent APRICOT study analyzed more than 31 000 anesthetic procedures in Europe and found that 0.9% of patients required three or more attempts for tracheal intubation. Difficult intubation was reported in 0.28% of patients, with incidence significantly higher in neonates [1%, 95% confidence interval (CI): 0–2.2%] and infants (1.1%, 95% CI: 0.6–1.6%) than in any other age group, proving that the youngest population is at highest risk for airway management problems [5].

Many catastrophic complications during airway management in pediatric patients may be preventable with proper assessment, planning, and execution [6]. In the general population, perioperative airway assessment has become crucial in predicting difficult intubation. Multiple assessment tools have been proposed for the general population, and their usefulness was confirmed in extensive studies. For example, Rose and Cohen proved that if four characteristics (including thyromental distance, mouth opening, neck movement, and hypopharynx visualization) were typical, the chance for easy tracheal intubation was 95.2%. However, if only one of these parameters was abnormal, the ease to intubate was significantly lower — e.g., only 62.4% of patients with limited mouth opening had easy intubation, demonstrating the importance of a multi-level approach in perioperative risk calculation [7].

Nevertheless, bedside airway assessment tests tend to have low sensitivity, moderate specificity, and high variability. Moreover, their accuracy vastly depends on the patient's efforts and cooperation [1]. Therefore, it may be significantly limited in the pediatric population, especially in neonates and infants, who are already at higher airway management risk in the first place.

To this day, no consensus for one ideal pediatric airway assessment scale could help spot children with the most important chances for intubation-related undesired events. Instead, a few methods and classifications were proposed, some using the same techniques proven effective in adults and some highlighting the differences in the pediatric group. Most of these solutions rely on anatomical measurements, bedside tests, and detailed history taking. The following review outlines the techniques of perioperative airway assessment in children, comparing the data used to support their use in the pediatric population.

MATERIAL AND METHODS

A comprehensive literature search was conducted up to May 2023 to identify relevant studies on the techniques of airway assessment in pediatric patients. Electronic databases, including Medline (PubMed), Embase, Scopus, Web of Science, and Cochrane Central Register of Controlled Trials (CENTRAL), were searched using appropriate search terms such as 'pediatric airway assessment', 'pediatric intubation', and 'difficult airway'. The search was limited to articles published in English up to the search date.

Two independent researchers reviewed the selected studies, and data relevant to the objectives of this narrative review were extracted. The extracted data included study characteristics (e.g., study design, sample size), patient characteristics (e.g., age, comorbidities), and outcomes related to airway assessment techniques. Any discrepancies or disagreements were resolved through discussion and consensus.

RESULTS
Risk factors — the role of history taking and clinical exam

Difficult airways can be anticipated and unanticipated. The latter situation is undoubtedly more stressful for medical professionals and prone to errors, as teams often need to be prepared and ready with equipment. Although unanticipated tracheal intubations have more severe complications and require more attempts, studies show that most difficult airways in children are, in fact, predictable. Anticipated situations may result from congenital syndromes and anatomical airway dysfunctions [8, 9]. In addition, children with pre-existing respiratory risk factors have an increased likelihood of critical respiratory events (regardless of the airway device used). Therefore, such factors require better preoperative assessment and planning [5].

The detailed clinical exam should evaluate the symmetry of the head, face, and neck, the presence or absence of oral pathologies, oral hygiene, or adequacy of neck movements. Specific changes might be due to temporary conditions, including facial burns, oral tumors, or head and neck swelling. However, many pediatric patients undergoing anesthesia are children with congenital syndromes. Some of them have an impact on airway management, as they are associated with features like limited neck

length or mobility (Klippel-Feil syndrome), micrognathia, tongue retraction, and mandibular hypoplasia (Pierre-Robin syndrome and Treacher Collins syndrome), or macroglossia and small mouth opening (Beckwith-Wiedemann syndrome and Goldenhar syndrome). In addition, multiple dysmorphic features might be present in the same patient — in trisomy 21, macroglossia, short neck, and atlantoaxial instability often coexist. What is more, some abnormalities affecting airway management — such as subglottic stenosis in Down syndrome or respiratory secretions in mucopolysaccharidosis – are not easily visible and may require assessing the difficulty of airways based on snoring, wheezing, sleep apnea, or other signs noted by the parents [1].

Perioperative assessment should include observing the face from the front and the side to evaluate the chin and lower and upper teeth alignment. In addition, visualizing the child from the lateral profile prevents missing subtle signs of mandibular hypoplasia and can detect the most potentially difficult intubations [10, 11].

Taking airway-focused history helps identify respiratory issues encountered during previous admissions [6]. Nevertheless, as some parents may not recall or understand the details, reviewing medical documentation in search of the type of airway management method, size of the equipment, number of attempts, and obtained laryngoscopic views should help medical providers determine previous dangerous airway events. It is equally essential for practitioners to include information about any difficulties encountered during airway management in their medical notes, as they can have crucial meaning for further teams caring for the patient.

Some risk factors depend more on the environment or current health status — passive smoking and recent upper airway infections increase the risk of laryngospasm during anesthesia [1]. The influence of surgery type was also noted, as children undergoing oromaxillofacial, otolaryngologic, or cardiac surgery are at higher risk of difficult intubation. Airway management issues are also more common in patients with ASA III or IV — therefore, with more significant health issues in the first place [6]. Conclusions from the PeDI registry showed that patients weighing less than 10 kilograms had more tracheal intubations with complications than uncomplicated ones [4]. Unlike in adult patients, no evidence was found for factors like increased BMI or neck circumference to predict difficult intubation

in the pediatric population [6, 8]. In children, the risk is higher for underweight, not overweight patients — age-matched BMI lower than the 10th and 3rd percentile correlated with significantly increased incidence of difficult laryngoscopy [12].
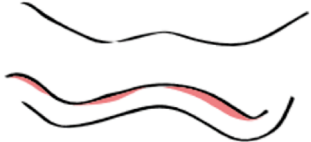
Yet not every pediatric patient at significant risk of the difficult airway has any pathologies at all — children might be generally healthy and well-developing, but some factors are simply due to demographics. Age is crucial, as the younger the patient is, the higher the risk of complications. However, although adult male patients are at risk of difficult intubation, there is no effect of gender in any pediatric group [12].

Laryngoscopy and Cormack-Lehane Test

Cormack and Lehane Classification was proposed in 1984 and was based on the view of indirect epiglottis laryngoscopy. The Cormack-Lehane grading scale is presented in Figure 1. Cases with grades 3 and 4 are considered as difficult laryngoscopy, but they rarely happen [1]. Although in difficult general, laryngoscopy might be even 2–20-fold less common in the pediatric population than in adults, it remains a significant issue in the youngest group. At the same time, 5% of infants have a Cormack and Lehane Grade 3 or 4 [8]. Age increases the incidence of cases with CLD grade 1 and decreases in those with grades 2 or 3. Therefore, as the child ages, the view in direct laryngoscopy improves, and intubation becomes generally easier. It is explained by the gradual reduction of anatomical differences in pediatric and adult airways, as they diminish after the age of 2 [8].

However, some causes of difficult laryngoscopy do not disappear with age because it is more common in children with congenital syndromes that often share a common feature of micrognathia. This abnormality causes difficulties in the laryngoscopic visualization of the glottis [8].

Difficult laryngoscopy might require more effort or requesting another person's help. Yet multiple tracheal intubations and direct laryngoscopy attempts were associated with more complications. More than two intubation attempts were linked to a high failure rate [4]. While the more intubation attempts are made, the worse the outcomes are; it seems crucial to be able to assess the difficulty beforehand. Unfortunately, Cormack and Lehane's grades can only be assessed during direct laryngoscopy. Therefore, it is not known in patients being prepared for

Grade	Description	Image
Grade I	Full exposure of glottis (anterior and posterior commissure)	
Grade II	Anterior commissure not visualized	
Grade III	Epiglottis only	
Grade IV	No glottic structure visible	

FIGURE 1. Cormack-Lehane grading scale

their first procedure. Nevertheless, the assessment is partially possible thanks to bedside tests — parameters measured in the anesthesia clinic during qualification visits.
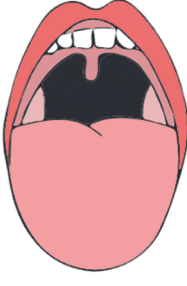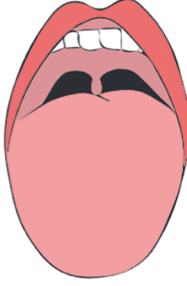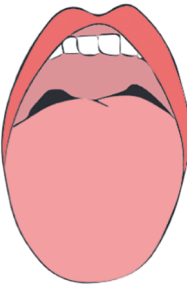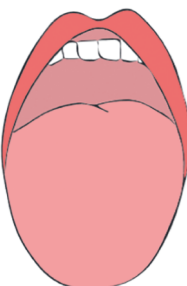
Bedside tests and measurements
Mallampati test (MMC) and Best Oropharyngeal View (BOV)

Mallampati first developed the Mallampati classification, which was later modified by Samson in 1987. The test is performed in patients sitting straight up who are asked to open their mouths and protrude their tongues out maximally. The result of the Modified Mallampati Classification (MMC) is marked as Classes I to IV, depending on the visible structures of the oropharynx [13]. The Mallampati classification system is presented in Figure 2.

The Mallampati test was found to be the most accurate assessment to predict difficult laryngoscopy in school-age children (over five years old) [14, 15]. Similar results were reported in one large study of over 11 000 patients, where Mallampati Classes III and IV correlated with Cormack Lehane Grade III and IV findings. However, the authors stated that the Mallampati test often could not be assessed due to the patient's young age and lack of cooperation. Hence,

the proportion of documented Mallampati results decreased in the younger age groups and could influence the results [12]. Overall, in patients from all pediatric age groups, the Mallampati test might show reduced accuracy in predicting a poor view of the glottis during direct laryngoscopy [8]. In addition, it was suggested that children under three years old are not cooperative enough to allow MMC assessment, and its results do not correlate with clinical outcomes. Therefore, Mallampati Modified Classification cannot sufficiently predict difficult laryngoscopy and intubation for all pediatric patients [8].

Aggarval et al. [8] proposed an alternative method, as the majority of their study group (1–5 years old) was too young to perform the classic Mallampati test. Their method was called Best Oropharyngeal View (BOV) and is similar to the MMC assessment — the mouth should be wide open, but this test skips the tongue protrusion. With the classic MMC test, authors managed to assess only 82% of the group, whereas the BOV assessment was successful in 96% of their patients. In addition, there was a statistically significant correlation between BOV and Cormack and Lehane Grade (CLG) and intubation difficulty score, and this new parameter was announced as a better pediatric airway assessment

Class	Description	Image
Class I	Complete visualization of the soft palate	
Class II	Complete visualization of the uvula	
Class III	Visualization of only the base of the uvula	
Class IV	Soft palate in not visible at all	

FIGURE 2. The Mallampati classification system

tool than MMC. However, further studies are necessary to validate the new test's use.

Thyromental distance (TMD) and ratio height to TMD (RHTMD)

Thyromental distance (TMD) is a very simple test measured when the patient fully extends the neck with the mouth closed. It is defined as the distance between the chin and the top of the thyroid notch and is used to estimate the size of the mandible floor. In adults, TMD of < 6 cm indicated the increasing difficulty of direct laryngoscopy, but in another research,

its role was rather unclear. The interobserver variability may be high, and especially in children, discrete values might be difficult to classify [1, 8]. One research did not find TMD value to correlate with easy or difficult airway groups. However, the study population comprised only 48 pediatric patients [16]. Many other research papers in children confirmed that as the TMD increased, intubation difficulty [8, 17] and Cormack and Lehane Grade [8, 15, 18, 19] decreased. TMD had the highest specificity (99.11%), positive predictive value (93.8%), and accuracy (95.2%) of multiple bedside tests that were assessed by Inal et al. [20]. In the PeDI study, increased TMD was independently associated with the occurrence of any complication [4]. TMD cut-off points proposed for children varied between studies and were estimated for 5 cm [14], 5.5 cm [20], and 6.3 cm [15].

It was also suggested to compare TMD to height in centimeters and create another parameter: ratio height to TMD (RHTMD). The conclusions are inconsistent – one research suggests a significant correlation between RHTMD value and Cormack Lehane Grade [15], and another denies it but then finds relationships with intubation difficulty scored by practitioners [8]. Proposed cut-off points for children were estimated at 18 cm, 21.5 cm, and 23.5 cm, but RHTMD had the lowest positive predictive value, low sensitivity, and low specificity. Therefore it was ranked a poor predictor of difficult laryngoscopy compared with other parameters [14, 15, 20].

Sternomental distance

Sternomental distance (SMD) is assessed in the same position as TMD but is measured between the chin and the upper border of the sternal notch. It helps examine the patient's ability to extend the neck — in adults, an SMD of < 12 cm suggests a decreased degree of neck extension [1]. Some authors find significant correlations between SMD in children and Cormack Lehane Grade III or IV [18] and intubation difficulty [8]; other authors do not prove similar links [8, 16]. However, relatively little research assessed SMD's usefulness compared to other parameters, and their results are inconclusive, so further studies on that topic are much needed.

Upper lip biting test (ULBT)

Upper lip biting test (ULBT) is one of the mandibular protrusion tests used to assess the functionality of the temporomandibular joint. The patient is asked to bite their upper lip with their lower teeth,

which estimates the ease of anteriorly lifting the mandible by simulating a movement similar to the one performed during laryngoscopy. ULBT's results depend on mandibular mobility and teeth structure. If the patient cannot perform the test, the temporomandibular joint's mobility is considered decreased, which suggests difficult direct laryngoscopy [1]. The result is grouped into three classes depending on the range of motion. Although many studies in adults prefer ULBT for its simplicity and show it to be more predictive than MMC or TMD, in pediatric patients, its use might be reduced because of the lack of cooperativeness. In one study, 80% of children who could not perform ULBT were under six years old, proving a significant limitation for the applicability of this test in younger groups [16]. Even in cases where ULBT is assessed, its usefulness is very unclear — its sensitivity ranged from 58.33% to 83%, specificity from 79.55% to 97.32%, accuracy from 77% to 94.4%, and positive prognostic value from 45.7% to 75% [14–16, 20].

Mouth opening and interincisor distance

Mouth opening is measured as the distance between incisors when the mouth is maximally opened. It should be evaluated in centimeters (and be ≥ 4 cm) or, in practice, as fingerbreadths (at least 3). It can be one of the most relevant tests for selecting an intubation technique and airway management tool [1]. In pediatric studies, interincisor distance (ID) correlated with Cormack and Lehane Grade [18] and differed significantly between the easy and challenging intubation group but had the lowest area under the curve of all assessed parameters. The authors calculated the cut-off value to 2.6 cm [16]. It should be taken into account that the inter-incisor distance is prone to essential changes because of the deciduous teeth development, shedding, and replacement with permanent teeth.

Distance from frontal plane to chin

Distance from frontal plane to chin (DFC or FPTC) is the shortest distance in centimeters between the chin and the bridge of the nose measured from the lateral view. It is used to assess retrognathia. DFC correlates with laryngoscopic difficulty — in one study, it was shown to be the best predictor for patients aged from 4 to 12 years. It was also suggested to divide this parameter by weight — in the youngest group (0–6 months), this DFC/weight ratio higher than 0.2 had 88.89% and 73.68% of speci-

ficity. Therefore, retrognathism might be an essential and reliable risk factor for laryngoscopic difficulty in very young patients [16, 18].

Anthropometric measurements

As all bedside tests mentioned above require some form of action from the patient (neck extension, mouth opening, etc.), a few other techniques to be measured at rest were also proposed. These anthropometric measurements may be helpful for non-cooperating children, but data is often limited to a single study.

Distance from the frontal plane to the chin (DFC or FPTC) is the shortest distance in centimeters between the chin and the bridge of the nose measured from the lateral view. It is used to assess retrognathia. DFC correlates with laryngoscopic difficulty — in one study, it was shown to be the best predictor for patients aged from 4 to 12 years. It was also suggested to divide this parameter by weight — in the youngest group (0–6 months), this DFC/weight ratio higher than 0.2 had 88.89% and 73.68% of specificity. Therefore, retrognathism might be an essential and reliable risk factor for laryngoscopic difficulty in very young patients [16, 18].

Hyomental distance (HMD) is the distance between the mentum (tip of the chin) and the hyoid bone and is used to estimate the mandibular space. In adults, it can be more sensitive in predicting difficult intubation than TMD, especially when measured with ultrasonography [21]. One study in children showed that HMD correlated with easy and difficult intubation groups [16].

Three proposed measurements depend on the ear position. Two of them (ear lobe or ear tragus to the corner of the mouth) significantly differed between easy and difficult intubation. Distance from the ear tragus to the corner of the mouth was directly associated with the difficult laryngoscopy. By contrast, parameters including an ear lobe had an inverse association [x]. Only in children younger than five years old, decreasing distance between ear tragus and nares (tn) correlated with increasing Cormack and Lehane Grades. According to the authors, this measurement can surrogate for mandibular length and larynx position: the shorter the Tn, the more anterior the larynx and more difficult intubation should be expected [19].

Position of the mouth understood as the distance from the lower border of the nose to the upper lip border and the lower lip border to the mentum,

showed no link to easy or difficult intubation group. However, the second parameter had a direct association with difficult laryngoscopy.

In 2011 Mirghassemi et al. [17] proposed the following equation to predict laryngoscopic difficulty: $Y = (0.015 \times L) + (0.007 \times T) - (0.015 \times E) + 0.179$, where L is the distance from the lower lip border to the mentum, T is the distance from ear tragus to the corner of the mouth, and E is the distance from ear lobe to the corner of the mouth. Using the multivariate regression analysis, the authors found that the probability of difficult laryngoscopy is greater if the Y tends toward 1.

COPURway Score

When difficult intubation is anticipated, it is helpful to rate the degree of difficulty. This allows planning primary and alternative airway management strategies, engaging experienced professionals, and ensuring the presence of required equipment. One of the systems to assess the degree of difficulty is the Colorado Pediatric Airway Score (COPURway Score — Tab. 1 and 2) which links the focus on history taking, bedside tests, and other measurements.

This anagram is used to describe five evaluated characteristics: C (chin size), O (opening — interdental distance between front teeth), P (previous intubation or obstructive sleep apnea), U (uvula visualization), and R (estimated range of motion of neck), each rated on a 4-point scale. The COPURway Score can predict glottic views in the Cormack and Lehane Classification. Scores above 12 predict difficult intubation (CL grade 3 and 4) and are grouped into suggested airway management care levels that include recommendations like fiberoptic or awake intubation [8, 11, 17]. Inventing scores similar to this one, which combines many types of risk factors discussed in this paper (including incidents of previous difficult airways, anthropometric measurements, and mobility tests), can be an element of a multimodal approach and a holistic view of the pediatric patient being assessed for intubation difficulty.

CONCLUSIONS

Difficult airways in children can be anticipated or unanticipated, with most difficult airways being predictable. These airways may result from congenital syndromes, anatomical airway dysfunctions, or pre-existing respiratory risk factorsA detailed clinical exam should evaluate the symmetry of the head, face, and neck, oral pathologies, oral hygiene, and neck movements. Children with congenital syndromes may have an impact on airway management, with features like limited neck length or mobility, micrognathia, tongue retraction, and mandibular hypoplasia. Multiple dysmorphic features may coexist in the same patient, and some abnormalities affecting airway management may not be easily visible.

Perioperative assessment should include observing the face from both the front and the side, as well as visualizing the child from the lateral profile. Taking an airway-focused history helps identify respiratory

Table 1. Colorado Pediatric Airway Score (COPUR)

Colorado Pediatric Airway Score (COPUR)	Points
C: chin From the side view, is the chin:	
• Normal size?	1
• Small, moderately hypoplastic?	2
• Markedly recessive?	3
• Extremely hypoplastic?	4
O: opening *Interdental distance between the front teeth:*	
• 40 mm	1
• 20–40 mm	2
• 10–20 mm	3
• < 10 mm	4
P: previous intubations, OSA (obstructive sleep apnoea)	
• Previous intubations without difficulty	1
• No past intubations, no evidence of OSA	2
• Previous difficult intubations, or symptoms of OSA	3
• Difficult intubation — extreme or unsuccessful; emergency tracheotomy; unable to sleep supine	4
U: uvula *Mouth open, tongue out, observe palate*	
• Tip of uvula visible	1
• Uvula partially visible	2
• Uvula concealed, soft palate visible	3
• Soft palate not visible at all	4
R: range *Observe line from ear to orbit, estimate range of movement, looking up and down*	
• > 120°	1
• 60°–120°	2
• 30°–60°	3
• < 30°	4
Modifiers: add point for	
• Prominent front 'buck' teeth	1
• Very large tongue, macroglossia	1
• Extreme obesity	1
• Mucopolysaccharidoses	2

Table 2. Colorado Pediatric Airway Score (COPUR)

Prediction points	Intubation difficulty	Glottic view
5–7	Easy, normal intubations	1
8–10	More difficult, laryngeal pressure may help	2
12	Difficult intubation, fibreoptic less traumatic	3
14	Difficult intubation, requires fibreoptic or other advanced methods	3
16	Dangerous airway, consider awake intubation, advanced methods, potential tracheotomy (Patients with hypercarbia awake, severe obstruction)	4
16+	Scores > 16 are usually incompatible with life without an artificial airway	

issues during previous admissions. Reviewing medical documentation and including information about difficulties encountered during airway management is essential for further care.

In light of these conclusions, it is evident that standardized and reliable pediatric airway assessment scales are crucial for accurately evaluating and managing difficult airways in children. By implementing structured airway assessment protocols, healthcare providers can better understand and address the challenges and risk factors specific to pediatric patients, thereby improving the safety and success of airway management. Furthermore, continued research and the development of specialized assessment tools tailored to the pediatric population are necessary to further enhance patient outcomes and minimize complications.

Article information and declarations

Author contributions

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Conflict of interest

None declared.

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REVIEW ARTICLE

FACTORS AFFECTING BURNOUT IN IRANIAN HEALTH CARE WORKERS DURING COVID-19: A SYSTEMATIC REVIEW

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ABSTRACT

INTRODUCTION: Working through the COVID-19 pandemic has exposed Health Care Workers to physical and psychological risks that can result in a broad range of mental health problems, including burnout. The aim of the present study was to investigate factors affecting burnout in Iranian Health Care Workers during the COVID-19 pandemic. Identifying the principal factors affecting burnout will assist efforts to prepare for, and, prevent harm, to staff participating in future healthcare emergencies.

MATERIAL AND METHODS: A systematic review of scientific literature using the PRISMA guideline was completed, and included literature published from January 2020 until December 2021. The articles related to burnout in Iranian Health Care Workers during COVID-19 were obtained through Google Scholar, SID, Magiran Scopus, PubMed, and Web of Science databases using related keywords. Thematic analysis was used to analyze the obtained data.

RESULTS: 203 articles were identified through an initial search and finally, 14 studies were entered into the analysis. Based on the literature review, the principal factors affecting burnout were divided into 2 main themes and 4 subthemes. The themes included human factors, and organizational factors, and the subthemes included individual characteristics, psychosocial factors, occupational conditions, and training.

CONCLUSIONS: Individual and psychosocial characteristics have important effects on burnout among Health Care Workers and this can cause negative flow-on effects on the quality of life of these workers, and the quality of medical services. The prevalence of burnout is relatively higher among medical practitioners and nurses, and it is important to enhance coping resources and health education activities that support the resilience of these clinicians in the challenging and stressful context of a pandemic.

KEY WORDS: burnout; Iran; health care worker; COVID-19; systematic review

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INTRODUCTION

COVID-19 is a serious and life-threatening infectious disease that has created a major global health crisis [1]. This disease has negative social, economic, and psychological consequences. Sociological effects of coronavirus include family relationship problems, increased rates of smoking and domestic violence, and economic effects, such as loss of employment or inability to work during quarantine, eviction, and other consequences of financial stress, and psychological effects including stress, anxiety, loneliness, depression and burnout [2]. As the coronavirus pandemic accelerated, global healthcare systems experienced increasing pressure, leading to severe stress for healthcare workers, especially nurses caring for seriously ill patients with COVID-19 [3]. High levels of psychological stress have been reported among nurses caring for infected patients during the pandemic. In Iran, several studies revealed high psychological distress and burnout among healthcare workers during the fourth peak of the COVID-19 pandemic [4–6].

Nurses make up the largest proportion of the healthcare workforce, and they take on most of the frontline tasks associated with preventing the spread and providing treatment for, infectious diseases [7]. During the pandemic, nurses made heroic efforts, at times risking their lives, in emergency departments, infection control units, intensive care units, and COVID-19 patient wards, demonstrating their commitment to the profession and their patients [2, 8]. Nursing staff has been at the center of the pandemic crisis [9, 10] and overwork, inadequate resources, and stress in the workplace have negatively affected their mental health [5, 10, 11]. In addition to disrupting health care delivery in affected areas, a lack of resources such as personal protective equipment, Intensive Care Unit (ICU) beds, and ventilators has been shown to increase their psychological burden [12]. Rahmani concluded that a poor psychological state can result in less compliance with basic and important healthcare behaviors, which in turn can lead to poor health outcomes among patients [12].

Those who care for very seriously ill patients are prone to burnout due to the special context of this type of care, such as the criticality of illness and the associated high patient mortality, long hours of intense work, and regular exposure to trauma and moral issues [13–15]. The prevalence and infectivity of COVID-19 expose nurses to the risks of infection and may lead to increased levels of stress and to burnout among front-line nurses [4].

Burnout is a psychological syndrome that occurs as a negative reaction to job stressors, which is a combination of emotional burnout, personality decline, and a sense of diminished personal success. The consequences of burnout are dangerous for nurses, patients, and health care providers. Burnout can reduce the quality of care or services provided by nursing staff [16]. Burnout not only affects the ability to enjoy work but can also lead to depression, post-traumatic stress disorder, substance abuse disorder, and suicide. This can increase the workflow and lead to a shortage of nurses. The relationship between burnout and patient safety events is well known. Physicians and nurses with burnout are more likely to make medical errors, provide less quality care, and have poor communication with their patients. Burnout is associated with a 30-day higher mortality rate and nosocomial infections [17, 18].

According to the study of Hoseinabadi et al. [14], job stress is the main factor related to burnout and the second and third factors are hospital resources and the support of family and friends, respectively. Nurses working in intensive care units are exposed to the highest levels of stress during the pandemic [11]. Nurses' stress and fear increase over time and they are psychologically affected. Hence, they suffer from burnout due to uncertainty and hard work [2].

Another study suggests that being a woman and working on the COVID-19 frontline results in a higher burnout rate, while the level of burnout decreases with better socioeconomic status and more children [15].

The psychological impact of this unprecedented health emergency may be long-lasting. Addressing the consequences of COVID-19 on the mental health of healthcare workers is critical, as mental health issues may impede the ability of healthcare staff to work. For this reason, supportive interventions for healthcare workers are essential at this stage [19]. Due to the continuing epidemic of coronavirus and the uncertainty of the time of the end of the disease, it is necessary to study the prevalence of burnout and its underlying factors so that the results can be used in the next possible circumstances by health policymakers, to be placed. Therefore, this systematic review study was conducted to investigate the factors affecting burnout in nurses during the epidemic of COVID-19 disease in Iran.

Table 1. Search strategies in different databases	
Database	**Search strategy**
PubMed	[("Professional Burnout" OR "Occupational Burnout" OR "Career Burnout" OR "Job Burnout" OR Burnout) AND ("2019 novel coronavirus disease" OR COVID19 OR "COVID-19 pandemic" OR "SARS-CoV-2 infection" OR "COVID-19 virus disease" OR "2019 novel coronavirus infection" OR "COVID-19 virus infection") AND ("Health Personnel" OR "Health Care Provider*" OR "Health worker*" OR "Healthcare Provider*" OR "Healthcare Worker*" OR "Health care professional*" OR "medical staff" OR "Medical worker*") AND Iran]
Scopus	[ALL ("Professional Burnout") OR ALL ("Occupational Burnout") OR ALL ("Career Burnout") OR ALL ("Job Burnout") OR ALL (Burnout)] AND [ALL ("2019 novel coronavirus disease") OR ALL (COVID-19) OR ALL ("COVID-19 pandemic") OR ALL("SARS-CoV-2 infection") OR ALL("COVID-19 virus disease") OR ALL ("2019 novel coronavirus infection") OR ALL ("2019-nCoV infection") OR ALL ("Coronavirus disease 2019") AND (ALL ("Health Personnel") OR ALL ("Health Care Provider*") OR ALL ("Health worker*") OR ALL ("Healthcare Provider*") OR ALL ("Healthcare Worker*") OR ALL ("Health care professional*") OR ALL ("medical staff") OR ALL ("Medical worker*")] AND ALL (Iran)
Web of science	[(TS = ("Professional Burnout") OR TS = ("Occupational Burnout") OR TS = ("Career Burnout") OR TS = ("Job Burnout") OR TS = (Burnout)] AND [TS = ("2019 novel coronavirus disease") OR TS = (COVID-19) OR TS = ("COVID-19 pandemic") OR TS = ("SARS-CoV-2 infection") OR TS = ("COVID-19 virus disease") OR TS = ("2019 novel coronavirus infection") OR TS = ("2019-nCoV infection") OR TS = ("Coronavirus disease 2019") OR TS = ("2019-nCoV disease") OR TS = ("COVID-19 virus infection")] AND [TS = ("Health Personnel") OR TS = ("Health Care Provider*") OR TS = ("Health worker*") OR TS = ("Healthcare Provider*") OR TS = ("Healthcare Worker*") OR TS = ("Health care professional*") OR TS = ("medical staff") OR TS = ("Medical worker*")] AND TS = (Iran)

MATERIAL AND METHODS

In this study, a systematic review was performed [17]. Based on the PICO (Population or Problem, Intervention or Exposure, Comparison, Outcome) criteria, a search strategy was developed and executed using an electronic search. The PICO question was formulated as follows "What are the factors in creating burnout in Health Care Workers during COVID-19?".

Search Strategy

An electronic search of databases of Google Scholar, SID, Magiran, Scopus, PubMed, and Web of science was conducted. Valid English keywords and Persian equivalents were used in this study, including: "Professional Burnout", "Occupational Burnout", "Career Burnout", "Job Burnout", Burnout, "2019 novel coronavirus disease", COVID-19, "COVID-19 pandemic", "SARS-CoV-2 infection", "COVID-19 virus disease", "2019 novel coronavirus infection", "2019-nCoV infection", "Coronavirus disease 2019", "2019-nCoV disease", "COVID-19 virus infection", "Health Personnel", "Health Care Provider*", "Health worker*", "Healthcare Provider*", "Healthcare Worker*", "Health care professional*", "medical staff", "Medical worker*", Iran. Keywords, tag fields and operators were used to formulate the strategy search. The search strategy was first developed for PubMed and then other search strategies for other information sources were developed based on the PubMed version. The searches were conduct-ed from the beginning of 2020 to the end of Dec 2021. The search strategy for the database types is listed in Table 1.

Selection of articles and document

For the selection of articles and documents, independent reviewers (HS and FA) screened abstracts and titles for eligibility. When the reviewers determined that the abstract or title was potentially useful, full copies of the article were retrieved and considered for eligibility by both reviewers. If discrepancies occurred between reviewers, the reasons were identified and a final decision was made based on a review by a third team member (AS). Two authors (FA and AS) assessed the methodology, quality, and grade of evidence of included studies with the Critical Appraisal Skills Program (CASP) tools [20]. The CASP tool uses a systematic approach to appraise different study designs from the following domains: study validity, methodology quality, presentation of results, and external validity. Each of the items from the checklists was judged with yes (low risk of bias, score 1), no (high risk of bias), or cannot tell (unclear or unknown risk of bias, score 0). Total scores were used to grade the methodologic quality of each study.

Inclusion and exclusion criteria

Inclusion criteria included studies that in any way addressed burnout among Iranian healthcare workers during COVID-19. Exclusion criteria included studies
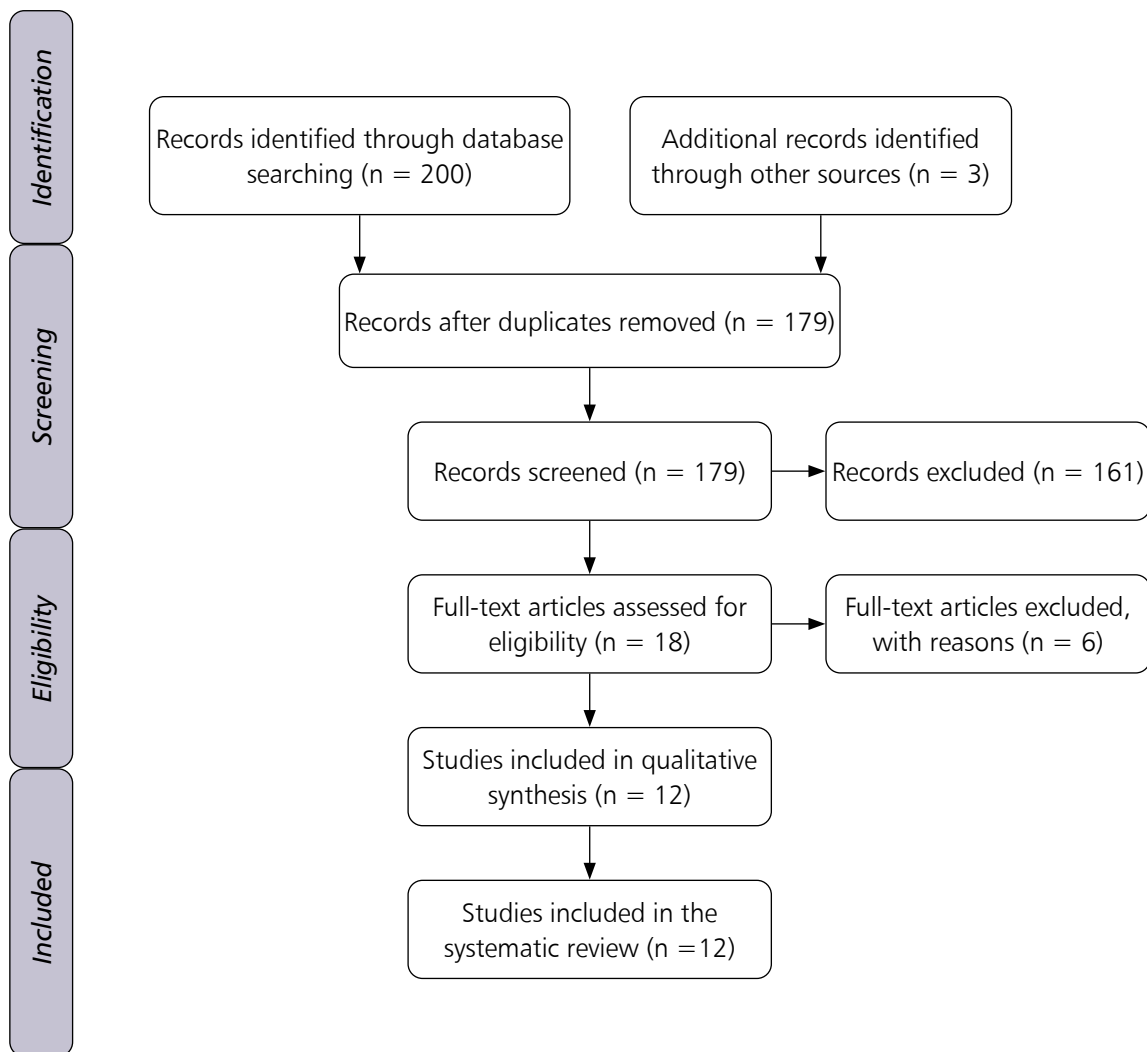
FIGURE 1. Flowchart of the selection of studies based on PRISMA

that examined burnout among healthcare workers during other epidemics as well as in other countries.

Data extraction

At this stage, the two researchers independently extracted all the required information from the final articles entered into the study process by a pre-prepared checklist, and this checklist included the first author, place of study, study design, sample size, title, and results.

RESULTS

The initial electronic database search of the literature resulted in a total of 203 documents. In the next step, duplicated, books, dissertations, and presentations were excluded and the number of documents in the sample decreased to 179 articles. Based on the systematic screening, described above, we re-

viewed the titles and abstracts and found 18 eligible articles. In the next step, all 18 selected full-text papers were considered and finally 12 papers included 2 qualitative [20, 21], 10 cross-sectional studies [14, 22–29] which reported rehabilitation of vulnerable groups in emergencies and disasters were selected. Figure 1 shows the search strategy and the selected articles in accordance with the PRISMA guidelines. The characteristics of the selected studies are listed in Table 2. Based on a literature review and consultation with experts, the factors affecting burnout among healthcare workers in Iran during COVID-19 were conceptualized into 2 themes, including 4 categories, as shown in Table 3.

DISCUSSION

The aim of this study was to investigate the factors affecting burnout in Iranian healthcare work-

Table 2. The information of studies that were selected for review

First author	Title	Publication year	Location	Design	Summary of findings
Yaser Sarikhani [22]	Burnout Among Physicians and Medical Interns: Comparing Time-Periods of Coronavirus Di sease Outbreak In Shiraz	2021	Shiraz	Cross-sectional	The present finding could remind policymakers of the importance of burnout issue among physicians during the pandemic it is suggested that focusing on strategies such as improving organizational resilience, improvement of the healthcare working environment, and development of coping skills among physicians could be helpful in this regard
Mohammad Jalili [23]	Burnout Among Healthcare Professionals During Covid-19 Pandemic: A Cross-Sectional Study	2021	Tehran	Cross-Sectional	Burnout is prevalent among healthcare workers caring for COVID-19 patients. Age, gender, job category, and site of practice contribute to the level of burnout that staff experience
Mohsen Khosravi [24]	Burnout In Hospital Medical Staff During The COVID-19 Pandemic: Diagnosis, Treatment, And Prevention	2021	Zahedan	Narrative Review	Results were provided on the burnout history and its major effects, causes, and prevalence among healthcare workers. In addition, some strategies were listed to be employed by hospital medical staff and organizations to deal with the COVID-19 pandemic burnout
Tahere Sarboozi Hoseinabadi [14]	Burnout And Its Influencing Factors Between Frontline Nurses and Nurses from Other Wards During the Outbreak Of Coronavirus Disease-COVID-19 — In Iran	2020	Torbat Heydariyeh	Cross-Sectional	The burnout level in frontline nurses was higher than other nurses, and the most important influencing factor was job stress. regarding negative effects of burnout on both physical and mental health nurses, it is suggested that a strong strategy be considered to reduce nurses' burnout to be able to control ongoing and future outbreaks successfully
Azizeh Alizadeh [43]	Psychological Distress Among Iranian Health-Care Providers Exposed To Coronavirus Disease 2019 (COVID-19): A Qualitative Study	2020		Qualitative Study	The results of this study found that there were some barriers and challenges to medical personnel exposed to COVID-19 that caused psychological distress. some of these problems are related to the nature of the illness, others are related to social and organizational demands and some the supportive resources buffer the relationship between occupational demands and psychological distress
Maryam Vizheh [25]	The Mental Health of Healthcare Workers in the COVID-19 Pandemic: A Systematic Review	2020		Systematic Review	During the SARS-CoV-2 outbreak, the healthcare workers face aggravated psychological pressure and even mental illness. it would be recommended to policymakers and managers adopt the supportive, encouraging & motivational, protective, and training & educational interventions, especially through information and communication platform
Ahmad Kalateh Sadati [21]	Nursing Experiences Of COVID-19 Outbreak in Iran: A Qualitative Study	2020	Shiraz And Kashan	Qualitative Study	In this case, the main experiences were related to defective preparedness, the worst perceived risk, family protection, social stigma, and sacrificial commitment. Urgent preparedness of facilities in such outbreaks is inevitable
Karimi Johani R [26]	Investigating The Relationship Between Burnout and Job Performance in The Corona Epidemic from The Perspective of Nurses	2021	Urmia	Descriptive-Analytical Study	Considering the significant relationship between COVID-19 with burnout and job performance, it is hoped that providing the necessary solutions and measures, to help prevent the effects of this disease

Table 2. cont. The information of studies that were selected for review

First author	Title	Publication year	Location	Design	Summary of findings
Seyyedeh Fatemeh Mousavi [27]	Psychological Well-Being, Marital Satisfaction, And Parental Burnout In Iranian Parents: The Effect of Home Quarantine During COVID-19 Outbreaks	2020	Tehran	Cross-Sectional	Supportive resources in family-based culture may play an essential role to reduce the negative effects of stressful situations on family interactions.
Ramin Rahmani [28]	Relationship Between COVID-19 –Caused Anxiety and Job Burnout Among Hospital Staff: A Cross-Sectional Study in The Southeast of Iran	2020	Zahedan	Cross-Sectional	It was found that there was a significant relationship between corona-caused anxiety and job burnout. According to the high prevalence of such disorders, it is suggested that more attention be paid to hospital staff due to their special role in the treatment of COVID-19
Mehrdad Sharifi [29]	Burnout Among Healthcare Providers Of COVID-19; A Systematic Review of Epidemiology and Recommendations	2021		Systematic Review	Paying attention to mental health issues, reducing the workload of hcps through adjusting their work shifts, reducing job-related stressors, and creating a healthy work environment may prevent or reduce burnout
Maryam Vizheh [25]	The Mental Health of Healthcare Workers in the COVID-19 Pandemic: A Systematic Review	2020		Systematic Review	Nurses, female workers, front-line healthcare workers, younger medical staff, and workers in areas with higher infection rates reported more severe degrees of all psychological symptoms than other healthcare workers

Table 3. Themes and sub-themes related to burnout during COVID-19

Theme	Subtheme	Sample codes
Human factors	Individual characteristics	Gender — marriage — age — work experience — personnel experience — organizational dependence of personnel
	Psychosocial factors	Depression — anxiety — emotional fatigue — depersonalization — flexibility — social welfare — religious values and beliefs
Organizational factors	Occupational conditions	Workplace clutter — congestion of patients — contact with patients' secretions — working in covid ward — communication with infected patients
	Training	Participate in resuscitation operations of COVID patients — participate in operational maneuvers — participate in service crisis care courses

ers during COVID-19 in a systematic review manner. In studies conducted in different parts of the world, the prevalence of burnout has been reported high among healthcare personnel during the COVID-19 period. This finding is in line with the results of studies reviewed in a recent review [23, 24]. However, other review studies have reported that the prevalence of burnout is between 6 and 25 percent [30, 31].

Due to the different dimensions of burnout, studies on burnout in the pre-epidemic period of COVID-19 also reported a high prevalence of burnout (about 40%) among nurses in intensive care units, which is a significant figure [32] and underlines the importance of investigating this issue among health care staff, especially nurses. In previous epidemics such as SARS and MERS, the prevalence of anxiety disorders and burnout among healthcare personnel was reported to be over 30%, which is a significant figure [25, 33, 34].

The results of reviewed studies indicate a high prevalence of burnout during the COVID-19 pandemic compared to the pre-pandemic period in healthcare workers. According to the results of a recent study, among the factors affecting burnout,

human factors play an important role, including individual characteristics and psychosocial factors. In the category of individual factors, items such as age, sex, marital status, work sector, and work experience were directly related to the prevalence of burnout, so that in women and at a younger age this prevalence was reported higher, and personnel in wards with higher rates of infection experienced more psychological symptoms and burnout, which is consistent with other studies in this field in other countries [34]. Also working on the COVID-19 frontline is associated with a higher burnout rate, while the level of burnout decreases with better socioeconomic status and more children. The findings suggest that being a woman and resilience, capacity for mentalizing, and burnout syndrome among HCWs are interrelated phenomena, which have important professional implications [15].

A meta-analysis by Pappa et al. [35], Which looked at 13 studies of 33,062 healthcare staff, reported that women were more anxious and depressed than men and that nurses had higher rates of psychological symptoms compared to other members of the healthcare team.

According to the results of a recent study, psychosocial factors are among the human factors that are associated with burnout in the COVID-19 era. Depression, anxiety, emotional fatigue, depersonalization, flexibility, social welfare, religious values, and beliefs, are among the subset of factors that were mentioned in the studies. Khasne et al. [36] also stated in their study that during the recent epidemic, fear and anxiety about transmitting the disease to family members and lack of staff increased workload and exacerbated the risk of the development of burnout among nurses. Family members and the use of support resources based on the culture of each community can play an important role in reducing the negative effects of burnout on staff.

Among other factors affecting the rate of burnout were organizational factors that included two subcategories of working conditions and education. Workplace pollution, congestion of wards, contact with patients' secretions, working in a COVID-19 ward, and communication with infected patients were among the occupational conditions mentioneds that increased the rate of burnout of the healthcare team in Iran. In other studies, nurses cited the unknown nature of the disease, lack of support resources, and lack of personal protective equipment as a cause of conflict between professional and personal needs, which in turn led to psychological stress and burnout [37].

Chirico [38] concludes that Spiritual resources can be used as a strategy for coping with the negative consequences of the COVID-19 pandemic, in the short and long term. Spirituality encompasses philosophical and cultural aspects that may contribute to tackling climate change and other emerging challenges, such as wars and other conflicts, advancing global health security, and achieving the Sustainable Development Goals.

The results of a recent study showed that education can be effective as an organizational response to the rate of burnout. Participation in resuscitation updates for patients, participation in operational maneuvers, and participation in in-service crisis care courses was among the codes extracted in this field. Escribà-Agüir [39] in his study pointed out that a history of presence in critical situations can be effective in reducing the rate of burnout in emergency department nurses. Also Chirico et al. [40] mention that workplaces represent the ideal arena for implementing mental health interventions, especially among high-risk working populations, through facultative workplace health promotion programs.

Training and stress reduction through participation in in-service training courses are among the effective interventions in reducing burnout during the COVID-19 period, which Maunder [41] has mentioned in his study. Receiving training through institutions and organizations improves the working environment and service delivery structure and improves staff resilience to cope with difficult conditions. Due to the fact that burnout increases the risk of medical errors and leads to patient dissatisfaction [36], reducing work stress and paying attention to the mental health of staff are among the items that have been mentioned in studies as strategies to reduce burnout [42].All of the items that are identified in recent studies can have positive effects on the rate of burnout in health care workers and so, for prevention of burnout, organizational interventions such as improving capacities and resources have effects on reducing burnout. Also, individual-level interventions include education and stress reduction techniques can help health care worker to adopt with stressful condition in COVID-19 epidemic.

Strengths and limitations

The present study was the first systematic review of Factors Affecting Burnout in Iranian Health Care

Workers. One of the limitations of this review was the number of studies that mention factors affecting burnout, and, also in this review, only Persian and English language articles were considered.

CONCLUSIONS

The results of this review showed a high rate of burnout among healthcare workers, particularly nurses, after the onset of the COVID-19 pandemic. The presence of risk factors derived from work challenges, including individual factors and workplace factors, can increase the likelihood of burnout syndrome and it is important to enhance coping resources and improve the ability of healthcare workers to adjust to changing circumstances and develop strategies to alleviate occupational stress and job burnout. Further studies are needed to examine the risk factors for burnout and evaluate ways to reduce the rate of burnout, but according to the results, strategies such as educational, supportive, and psychological interventions to reduce the rate of burnout in the recent pandemic demonstrated several possible solutions

Article information and declarations

Conflicts of interest
Nothing to declare.

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VM VIA MEDICA

CASE REPORT

PRE-HOSPITAL MANAGEMENT OF PENETRATING PELVIC INJURIES — A CASE STUDY

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ABSTRACT

INTRODUCTION: Penetrating pelvic injuries and the complications caused by them are a global problem in the provision of services by emergency medical teams. They often pose a significant challenge for medical personnel, particularly in patient evacuation and stabilization during transport.

CASE REPORT: The emergency medical service (EMS) was dispatched to a traffic accident — the report contained information about one conscious victim with a foreign body within the patient's body. At the accident scene, a delivery truck crashed into the tow bar of a trailer standing on the road, and one person was seriously injured due to the impact. The preliminary assessment confirmed a foreign body penetrating the right thigh, deformation and enlargement of the thigh contour, pain in the thigh, pelvis, and tenderness in the thoracic-lumbar spine with the end part of the tow bar hook palpable under the skin. The victim was suspected of having a femur fracture, pelvic injuries, and damage to internal organs. On neurological examination, sensation and motor functions were preserved in all limbs. The evacuation procedure was established after the Fire Department (FD) rescuers arrived. The injured person was removed from the vehicle on an orthopedic board with the help of eight rescuers. The victim was placed on his left side with the right side elevated, with continuous manual stabilization supported by a blanket, pillows, and orthopedic boar straps.

CONCLUSIONS: Each traumatic injury event requires selecting and using the appropriate equipment. A good compromise between speed and precision of actions should not significantly contribute to the worsening of the injury. An increase in a rescuer's substantive knowledge on how to proceed in the case of this type of trauma and injuries, as well as close cooperation with the fire department, will undoubtedly result in more appropriate actions.

KEY WORDS: traumatology; pelvic injury; pelvic fractures; foreign body

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FIGURE 1. Act at the scene — destroyed car

INTRODUCTION

Penetrating pelvic injuries and complications caused by them are a global problem in providing services by emergency medical teams and often pose a significant challenge for medical personnel. According to the World Health Organization, five million people die annually from injuries worldwide. In Poland, body injuries are the third leading cause of death. Poland is amongst the countries with the highest death rate due to road traffic accidents. In the 15–24 age group, deaths from accidents reach 70% [1]. There are currently fifteen trauma centers (TC) in the country to which victims with the most severe injuries should be referred. The criteria for admission to the TC are regulated by the order of the Minister of Health contained in the Act on State Medical Rescue [2, 3]. Trauma severity scales have been developed in order to standardize the assessment of patients with multiple injuries. The scale most frequently used by Medical Rescue Teams is the Revised Trauma Score (RTS) [4]. In contrast, hospital Emergency Departments (ED) and trauma departments use the Trauma Revised Injury Severity Score (TRISS) prognostic for the survival of patients with multiple, blunt, and penetrating injuries [5, 6].

CASE REPORT

In Autumn, at 6:45 am, the Emergency Medical Service (EMS) was dispatched to a traffic accident — with the highest priority. The report contained information about one conscious victim with a foreign body within the patient's body. The primary EMS team, consisting of three rescuers, arrived at the accident scene first. A preliminary accident assessment was performed; at the accident scene, a delivery truck ran into the tow bar hook of a trailer parked on the road (Fig. 1). The impact seriously injured one person, a young male passenger. Due to the enormous energy accompanying the impact, the trailer tow bar hook hit by the delivery truck pierced the front wall of the engine and the cabin. It penetrated the man's right thigh, went through the pelvis, and stopped at the passenger's back.

ASSESSMENT OF THE VICTIM

The assessment of the patient's condition by the paramedic revealed: AVPU scale — A, A — airway patent, SpO2 — 98%, B–HR–26/min., C — palpable pulse in the radial artery, HR — 100/min. BP — 110/80 mmHg, GCS — 15 points, RTS — 12 points. The preliminary International Trauma Life Support (ITLS) assessment revealed a foreign body penetrating the right thigh, deformation and enlargement of the thigh contour, pain in the thigh and pelvis, and tenderness in the thoracic-lumbar spine, with the end part of the tow bar hook palpable under the skin [9]. Due to a foreign body in the pelvis, it was impossible to assess the iliac plates' stability. The victim was suspected of having a femur fracture, pelvic injuries, and damage to internal organs. On neurological examination, sensation and motor function were preserved in all limbs. A decision was made to stabilize the foreign body

initially, insert two intravenous lines (18G cannula), implement passive oxygen therapy 12 L/min, and manually stabilize the cervical spine with an orthopedic collar. Due to the high risk of bleeding into the thigh and pelvis, crystalloid — NaCl 0.9% 500 mL was pre-administered. In the Numerical Rating Scale (NRS), the result was 7–8 points, and the following drugs were administered: 10 mg of morphine sulfate and 2.5 g of metamizole *i.v.* After the next three minutes, the NRS was assessed as 5 points.

The evacuation procedure was established after the FD rescuers arrived. A circular saw for cutting hardened steel was used. Previously fentanyl in a dose of 0.01 g and another 500 mL NaCl 0.9% were administrated. The pain reassessment was 5 points on the NRS. A rescuer achieved foreign body stabilization on the injured person with a blanket, a pillow, several gauze pads, and continuous manual stabilization. Due to his large body weight and the need for solid stabilization of the heavy foreign body, the injured person was removed from the vehicle with the help of eight rescuers. An orthopedic board was used at the height of the delivery truck seat for safe evacuation. The victim was placed on his left side with the right side elevated, with continuous manual stabilization supported by a blanket, pillows, and orthopedic board straps (Fig. 2) [12, 13]. After securing the patient, vital parameters were re-assessed: SpO2 — 97%, RR — 14/min, HR — 100/min, BP — 100/80 mmHg, GCS — 15 points, RTS — 12 points, assessment of bleeding intensity from the wound, PMS test (pulse, motor, sensorial) of the damaged limb. During the

5-minute transport to the hospital Trauma Center, the patient's condition did not deteriorate.

DISCUSSION

The speed of a victim's evacuation, and attention to avoiding worsening his condition, may significantly influence the subsequent treatment of injuries. It may also affect the chances of survival or severity of future disability for the accident victim. It is essential to consult between the EMS and FD rescuers to select an appropriate evacuation method [7–15].

Evacuation from the vehicle was a significant challenge. FD rescuers had to cut the side pillar and the wall separating the passenger compartment from the cargo compartment.

The critical moment in the presented case was the execution of the final cut of the steel hook, which, due to its internal and external stresses, could rapidly dislocate. The final cut could intensify the bleeding in the thigh and pelvis. The steel towbar connected both vehicles and therefore significant stresses appeared. This made it difficult to decide to cut the hook. Traditional hydraulic equipment used by FD rescuers, even high-powered equipment, did not meet expectations. The only optimal and accessible way was to use a circular saw for cutting hardened steel. Unfortunately, this solution carried the risk of vibrations transmitting through the metal rail to the inside of the wound, and because of the intense heating of the metal could lead to burns. Enabling access by cutting the steel towbar required

FIGURE 2. Trailer hook penetrating the man's right thigh, through pelvis, stopping at the back of the passenger's back — pictures after evacuation

intensive cooling. The situation was challenging and required the rescuers to cooperate closely to avoid aggravating the injuries. The precise approach to cutting off the hook caused the entire rescue to lengthen in time, which could have worsened the patient's condition.

The method of patient transportation on his left side was the only possibility. The metal hook could have moved inside the thigh and pelvis during transport, damaging its internal structures. Careful attachment with straps held the victim and foreign body stable, which provided a safe method of transporting the patient on his side to the hospital. There was a high risk of developing shock and cardiovascular decompensation despite the patient's vital signs being normal. In pelvic injuries, shock may be difficult to detect in the first phase, obscuring the destabilization of vital signs and leading to shock being overlooked. In this case, attention should be paid to the administration of fluids and possible shock development. Due to the increased body weight of the patient, there was a need for an increased administration of analgesics [16]. Because of the injury and the probable damage to at least two anatomical areas, i.e., the femur, pelvis, internal organs, and the spine, the patient was transported to the Trauma Center (Fig. 3A, 3B).

The preliminary ITLS examination may give incorrect information regarding the injury due to the substantial adipose tissue present. Therefore, it is vital to always pay attention to the mechanism of injury and the forces causing it. According to Tile's classification, the pelvic fracture is a type B "open book injury" considered rotationally unstable [4, 7]. This fracture risks blood loss into the peritoneal cavity or retroperitoneal space from one liter to even the total volume of the vascular bed. Large blood vessels, intestines, ureters, and urinary bladder can be damaged in such situations. Damage to the femur may lead to the rupture of blood vessels, which may hemorrhage one to two liters of blood [7, 12, 13]. Hypovolemic shock may occur in both cases, leading to sudden cardiac arrest (SCA). The inclusion of Tile's classification is essential for injury interpretation. It is helpful for initial stabilization, the next step of emergency examination, potential comorbid injuries, and planning for further surgical treatment.

CONCLUSIONS

The described case presents a serious challenge to medical personnel (EMS) and all services cooperating at the accident scene. Each event requires the ability to select and use the appropriate equipment. A good compromise between speed and precision of actions should not significantly contribute to the worsening of the injury. An increase in a rescuer's substantive knowledge on how to proceed in the case of this type of trauma and injuries, as well as close cooperation with the fire department, will undoubtedly result in more appropriate actions.
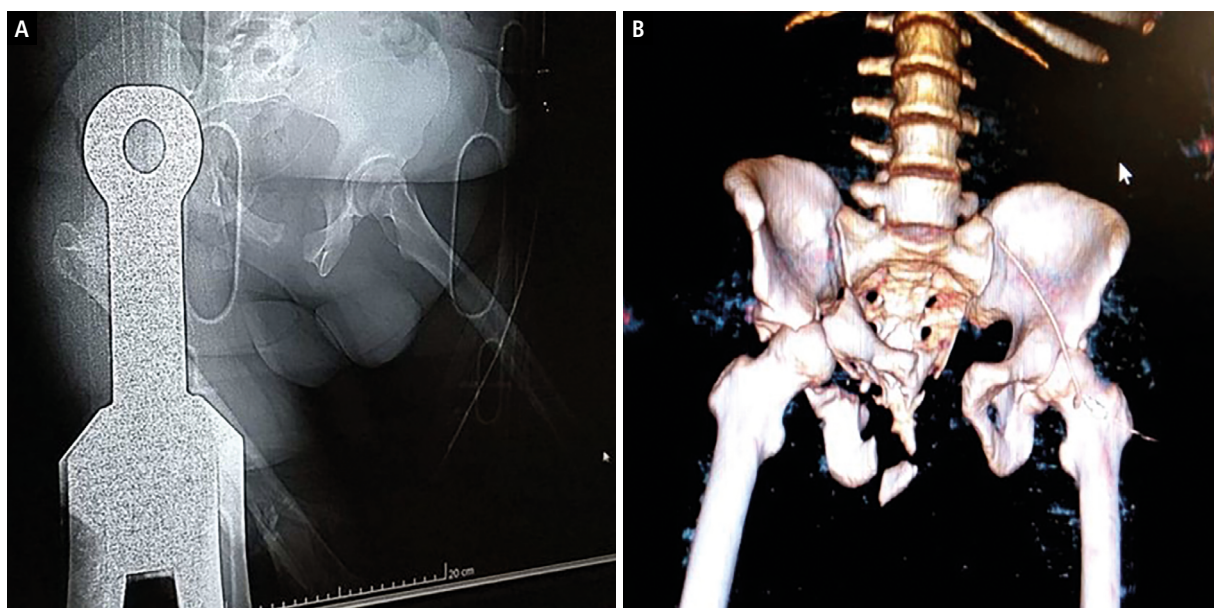
FIGURE 3. A. X-ray of victim pelvis with foreign body; **B.** 3D computed tomography reconstruction of patient's femur and pelvis

The take-home message from this case is to pay attention to the mechanism of the injury and select appropriate measures and treatment methods. The vital parameters of the injured person will not always go hand in hand with the injuries, which may be masked in the initial stage. The blunt end of a foreign body can damage the bones in its path, causing them to break. In the case described, there was a high-energy injury and a piercing towbar with a circular-shaped hook that caused fractures of numerous pelvic bone structures, including the pelvic ring, damage to the hip joint, and other organs in the path of the penetrating beam. Injuries with suspected severe damage to numerous intra-pelvic structures should be referred for interdisciplinary treatment at a trauma center.

Article information and declarations

Conflict of interest

The authors declare that they have no conflicts of interests.

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VM VIA MEDICA

CASE REPORT

RE-HYBRID THORACIC STENT GRAFT IMPLANTATION WITH TOTAL AORTIC ARCH DEBRANCHING IN URGENT PROCEDURE: CASE REPORT

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ABSTRACT

INTRODUCTION: Implementation of emergency endovascular aortic repair provides an opportunity to treat complicated acute aortic syndromes involving descending aorta.

CASE REPORT: A 40-year-old man with a history of aortic coarctation surgical repair as a child and an anastomosis aneurysm repair with a double endovascular stent graft implantation with hemi-arch transposition was urgently admitted with intensifying shortness of breath and hoarseness. A computed tomography study confirmed a blood leak into an aneurysm sac in proximal landing zones of implanted stent grafts (Type I endoleak). Therefore, he qualified for hybrid surgery. First, the ascending aorta brachiocephalic trunk was anastomosed with a 12 mm vascular prosthesis from an upper mini-sternotomy. In the next step, normothermic extracorporeal circulation was necessary to prevent cerebral circulation. Finally, a GORE stent graft (Gore Medical, Flagstaff, AZ, USA) was implanted with a proximal landing zone directly behind the anastomosis site of the vascular prosthesis and ascending aorta. The hospital course was uncomplicated, and the patient was discharged home 5 days after the procedure.

CONCLUSIONS: Complicated aortic pathologies requiring emergent interventions can be treated by a hybrid approach utilizing multistep surgical and endovascular techniques achieving optimal results.

KEY WORDS: hybrid treatment of aortic arch aneurysms; TEVAR; aortic arch debranching

Disaster Emerg Med J 2023; 8(3): 180–184

INTRODUCTION

Thoracic endovascular aortic repair (TEVAR), initially developed for elective descending aorta pathologies procedures, has become an attractive method of treating acute aortic syndromes (AAS) in emergency indications. The conventional surgical approach re-mains associated with high perioperative mortality and morbidity. TEVAR, since its introduction 20 years ago, has shown benefits in complex patients with comorbidities or a history of repeated surgical interventions.

CASE REPORT

A patient aged 40 was admitted urgently to the Department of Cardiac Surgery due to shortness of breath accompanied by hoarseness. The symptoms were intensifying in the previous 2 days. In the past history (Tab. 1), the patient was treated at the age of 6 years because of aortic coarctation (CoA). At the age of 29, the first implantation of a stent graft with coverage of the left subclavian artery ostium was performed (Fig. 1). After another 10 years, due to a type Ia endoleak, another stent graft was implanted with a covering of the left carotid artery outlet (Fig. 2). In addition, a patient with a history of cerebral stroke and congenital mental retardation is to a mild degree. During the admission (12 months after the last procedure), a control angio CT, showed a type Ia endoleak with blood flow into the aneu-

**Table 1. Patient past history including performed surgical interventions**

Patient age	Diagnosis	Procedure
6 y.o.	Aortic coarctation	Surgical anastomosis with patch aortic enlargement through left thoracotomy
29 y.o.	Aortic anastomosis aneurysm	Stent graft implantation with coverage of the left subclavian artery ostium (LZ2)
39 y.o.	Stent graft Ia endoleak	Carotid-to-carotid anastomosis grafting and stent graft implantation with coverage of the left carotid artery ostium (LZ1)
40 y.o.	Stent graft Ia endoleak	Total arch debranching and stent graft implantation with coverage of the brachiocephalic trunk ostium (LZ0)
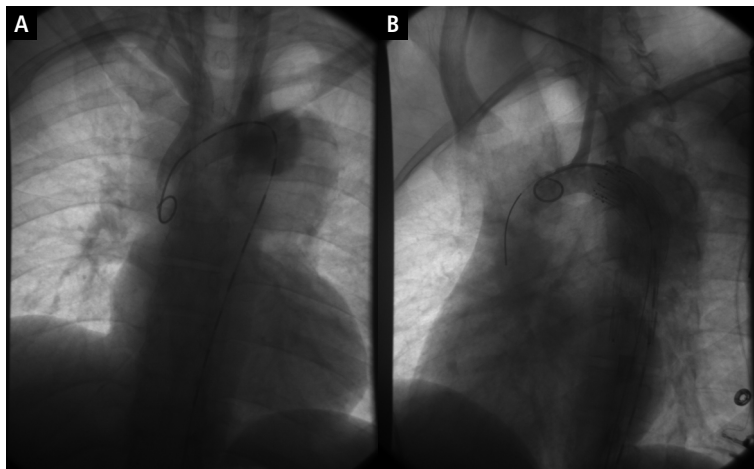
FIGURE 1. A. Fluoroscopy of landing zone (LZ) 3 aortic arch aneurysm; **B.** Fluoroscopy after LZ2 stent graft implantation
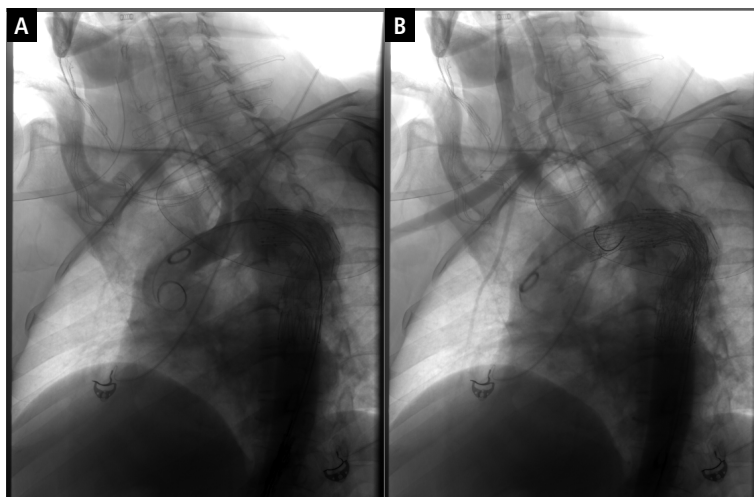
FIGURE 2. A. Fluoroscopy of landing zone (LZ) 2 aortic arch aneurysm; **B.** Fluoroscopy after carotid-to-carotid anastomosis grafting and LZ1 stent graft implantation
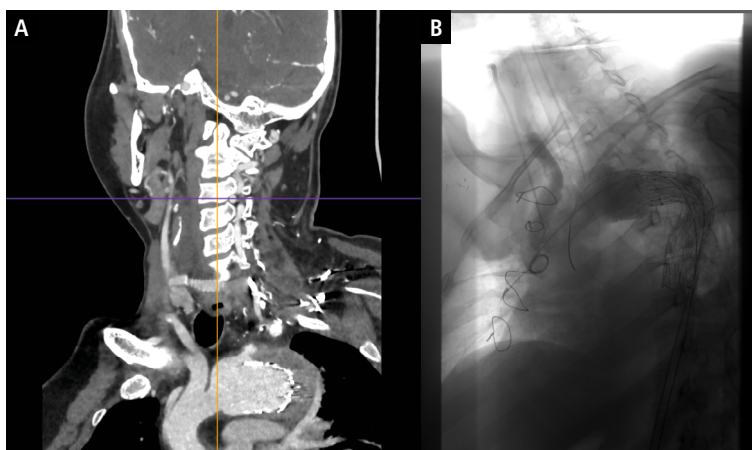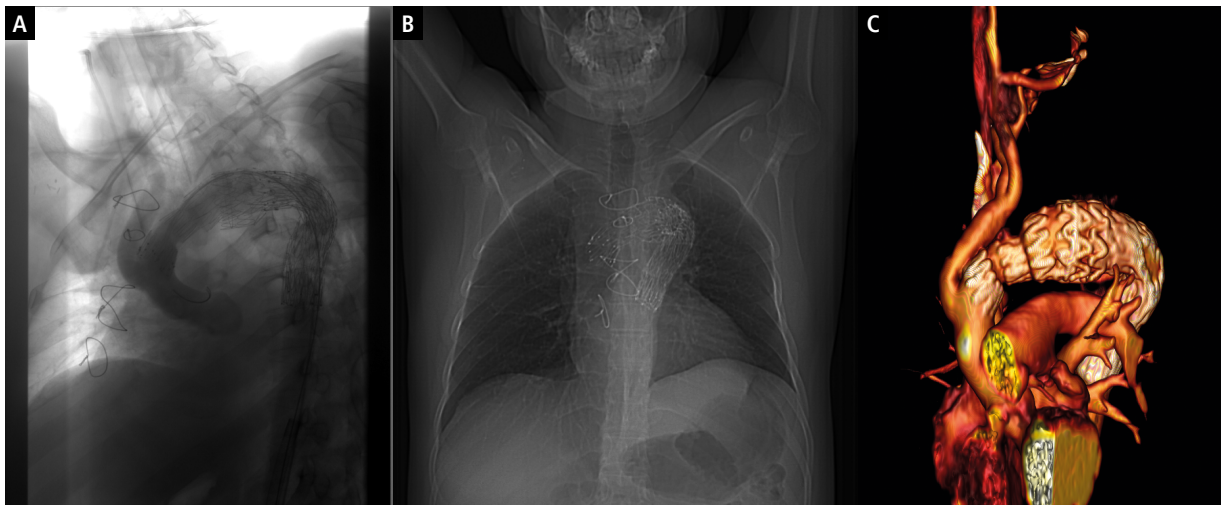
FIGURE 3. **A.** 2D reconstruction of landing zone (LZ) 1 aortic arch aneurysm; **B.** Fluoroscopy after total arch debranching before LZ 0 stent graft implantation

rysm sac most likely responsible for the reported symptoms (Fig. 3).

During this admission, one-year post-stent-graft implantation, a control angiography CT scan revealed a type Ia endoleak with blood flow into an aneurysm sac (Fig. 3); therefore, the patient qualified for a hybrid surgical repair. Standard antibiotic prophylaxis was used, and the patient received 10,000 IU of heparin. A mini-sternotomy through the upper right 2nd intercostal space exposed the ascending aorta above the sino-tubular junction, allowing the dissection of the brachiocephalic trunk (diameter 12 mm). Using a side clamp on a beating heart, a 12 mm vascular prosthesis was anastomosed with an ascending aorta about 2 cm above and laterally from the right coronary artery outlet. Subsequently, venoarterial extracorporeal circulatory support was initiated through the right axillary artery and femoral vein using a modified Sedinger technique to protect cerebral circulation. Extracorporeal circulation was continued with normothermia with a pump flow of 1000 mL/min. After placing two vascular clamps on the brachiocephalic trunk, the vessel was incised transversely. The proximal end was sewn with a Prolene 5–0 suture. The distal end was anastomosed to the vascular prosthesis previously connected with the aorta. Total extracorporeal circulation time was 17 min. Continuous blood pressures on the left and right radial and left femoral artery were monitored. Near-infrared spectroscopy (NIRS) was also used to monitor brain activity. The stent graft was implanted by surgical approach through the right common femoral artery in the next step. The left femoral artery was percu-

taneously punctured by Seldinger's technique for introducing a 6F straight catheter with side holes on a pigtail 5F one in the ascending aorta to position the landing zone target. The GORE (Gore Medical, Flagstaff, AZ, USA) stent graft was placed in the thoracic aorta over an Amplatz 0.35 guidewire. DSA (Digital Subtraction Angiography) was performed in five to ten series using an ionic contrast medium to confirm the final position and tightness of the prosthesis. The proximal end was located directly behind the anastomosis site of the vascular prosthesis with the ascending aorta, thus maintaining a large landing zone (Fig. 4). The course of hospitalization was uncomplicated. The patient reached primary clinical success — according to the Society of Vascular Surgery can only occur without any of the following: death as a result of treatment or as a result of the original pathology that was treated; type I or III endoleak, infection or aortic thrombosis; aneurysm expansion (diameter > 5 mm, volume > 10% or greater than two times interobserver variability) or rupture; conversion to open repair; or failure to arrest the original pathologic process (eg, embolization from penetrating ulcer) or causing a new thoracic aortic pathology as a result of the intervention (eg, pseudoaneurysm, dissection, intramural hematoma) [1]). The hospital course was uncomplicated, and the patient was discharged home 5 days after the procedure.

Currently, he is followed by the Cardiac Surgery Ambulatory team. Three months after the surgery, a control angiography CT of the chest was performed — confirming the good effect of the treatment and aortic aneurysm exclusion.

FIGURE 4. A. Fluoroscopy after total arch debranching an after landing zone (LZ) 0 graft implantation; **B.** X-ray after the final procedure; **C.** 3D reconstruction after the final procedure

DISCUSSION

In 2002, Mitchell et al. and Criado et al. proposed the division of the aorta into five landing zones (LZ) to properly plan the TEVAR strategy, including hybrid treatment [1–4]. During the 2004 Tokyo Consensus meeting, experts' opinion was presented in guidelines and recommended that the minimum length of the pathology-free aortic segment for safe fixation should be > 20 mm with an LZ aortic diameter of > 38/40 mm to minimalize the risk of leakage (Type 1 endoleak) [5–12]. The following expert consensus proposed the minimal proximal and/or distal landing zone length of more than 25 mm and a maximum diameter of the native aorta of less than 38 mm and no graft oversizing in type B dissection [6]. In rather rare cases when the aneurysm is located in the aortic arch and the proximal graft is in LZ 0-1, hemi-arch (LZ 1) or total-arch (LZ 0) transposition (debranching) precedes safe stent graft implantation [1–10]. An alternative procedure is a high-risk open surgical repair. However, even in high-volume cardiac surgical centers, TEVAR methods are preferable, especially in emergencies. One of the most severe complications following TEVAR procedures is an endoleak. Some publications suggest that it is provoked by incorrect procedure planning [1–4]. In this case, the 2nd and 3rd stent graft implantations were performed due to a Type Ia endoleak. The TEVAR procedure adopted in our center meets the Tokyo Consensus recommendations of a minimal proximal and distal Landing Zone of 25 mm (since 2019). As

reported in this case, these recommendations have positively impacted our center's emergent TEVAR results [6].

CONCLUSIONS

A complex hybrid approach requiring multistep surgical and endovascular techniques can treat complicated aortic pathologies requiring emergent interventions. Optimal results can be achieved with an experienced and dedicated team. After analyzing the treatment methods and late complications in the form of Type 1 endoleaks, the recommended landing zone for proximal and distal stent graft implantation should be more than 25 mm.

Article information and declarations
Conflict of interest
None declared.

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VIA MEDICA

LETTER TO THE EDITOR

DECODING DESTINY — UNVEILING THE RISK FACTORS THAT DETERMINE COVID-19 SURVIVAL

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To the Editor,

we read with great interest the manuscript by Karim et al. [1] which investigates COVID-19 survival and mortality risk factors and their relationship with the demographic characteristics of the subjects diagnosed with the disease.

The COVID-19 pandemic has impacted millions of people worldwide, leading to significant morbidity and mortality [2, 3]. While most individuals experience mild to moderate symptoms, certain factors increase the risk of severe illness and death. Understanding these risk factors is crucial for identifying high-risk individuals and implementing targeted interventions.

Demographic factors play a significant role in COVID-19 outcomes. Advanced age, particularly for individuals over 65, is associated with higher mortality rates. This may be due to age-related declines in immune function and the presence of underlying health conditions. Gender disparities also exist, with males experiencing higher mortality rates compared to females, though the reasons behind this remain unclear [4].

Various pre-existing health conditions contribute to the risk of severe illness and mortality in COVID-19 patients. Conditions such as cardiovascular disease, diabetes, chronic respiratory diseases, and obesity are associated with worse outcomes, likely due to their impact on immune response and respiratory function. Immunocompromised individuals, such as those undergoing chemotherapy or organ transplant recipients, face heightened risks as well [5, 6].

Socioeconomic disparities have a significant impact on COVID-19 outcomes. Individuals from disadvantaged backgrounds often face increased exposure to the virus and have limited access to healthcare resources. Low-income individuals, essential workers, and those in densely populated areas are more susceptible to infection, resulting in higher morbidity and mortality rates [7, 8]. Racial and ethnic minority groups also experience disproportionate effects, with higher rates of severe illness and death observed.

Behavioral factors influence an individual's risk of contracting and experiencing severe COVID-19. Smoking, for instance, has been linked to worse outcomes, as it impairs lung function and increases vulnerability to respiratory infections [7]. Adherence to preventive measures, such as mask-wearing, physical distancing, and vaccination, significantly reduces the risk of severe illness and mortality.

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Genetic factors may also contribute to the variability in COVID-19 outcomes. Certain genetic variations in the ACE2 receptor, the entry point for SARS-CoV-2 into human cells, have been associated with disease severity. Variations in genes related to immune response and inflammation may also impact an individual's susceptibility to severe illness [8, 9].

In conclusion, a complex interplay of various risk factors has an impact on COVID-19 survival and mortality [10]. Age, pre-existing health conditions, socioeconomic status, behavioral factors, and genetic factors all contribute to an individual's susceptibility to severe illness and death. Understanding these risk factors is crucial for implementing targeted public health strategies, including vaccination campaigns, prioritizing high-risk individuals, and providing support to vulnerable populations. Ongoing research should continue to explore the underlying mechanisms of these risk factors to enhance our understanding of COVID-19 and inform effective prevention and treatment strategies.

Article information and declarations

Author contributions

Conceptualization, K.S. and M.K.; methodology, M.K.; formal analysis, M.K.; resources, M.K. and A.K.; writing—original draft preparation, M.K., K.S., and A.K.; writing—review and editing, M.K., K.S. and A.K.; supervision, M.K.; project administration, A.K. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

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VIA MEDICA

LETTER TO THE EDITOR

C-REACTIVE PROTEIN AND OTHER BIOMARKERS FOR DIAGNOSIS AND PROGNOSIS IN COVID-19

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The COVID-19 pandemic has highlighted the need for reliable diagnostic and prognostic indicators to aid in disease management. C-reactive protein (CRP) has emerged as a viable biomarker for assessing disease severity and forecasting outcomes in COVID-19 patients [1]. However, it is critical to recognize the importance of other indicators in gaining a complete understanding of the condition. CRP levels have regularly been found to be elevated in severe COVID-19 cases [2]. Measuring CRP levels at the time of admission can help distinguish between mild and severe cases, allowing for the early identification of those at risk of developing severe illness. Furthermore, higher CRP levels have been associated with higher mortality rates, emphasizing their prognostic importance. A cut-off point of 40 mg/L has been determined to be the best for identifying those at increased risk. This early signal can help guide treatment decisions and advance care planning. While CRP is an important biomarker, other measures must be included to provide a more complete assessment of COVID-19 patients. Biomarkers such as D-dimer, lactate dehydrogenase (LDH), procalcitonin, interleukin-6 (IL-6), and ferritin provide further information on disease development and patient outcomes. D-dimer levels have been linked to an increased risk of thrombotic events, which are a typical consequence of severe COVID-19 cases. Screening D-dimer levels can help identify those who need thromboprophylaxis and aggressive thrombotic treatment [3, 4]. Another biomarker is LDH, which is an enzyme involved in cellular metabolism, and is found in high concentrations in COVID-19 patients with tissue damage and inflammation. LDH level monitoring can provide significant information about tissue damage and help guide therapy decisions [5]. Procalcitonin levels can distinguish between bacterial co-infections and viral inflammation. Elevated levels may signal the need for further testing and antibiotic medication [1]. In severe cases of COVID-19, IL-6, a pro-inflammatory cytokine, is increased and linked to cytokine release syndrome. Checking IL-6 levels can assist in identifying individuals who may benefit from immunomodulatory therapies [1, 6]. Ferritin, an iron-storing protein, is a marker of systemic inflammation. Ferritin levels have been found to be elevated in severe cases of COVID-19, which is associated with an excessive immunological response [7]. Ferritin levels can help determine illness severity and guide treatment methods. The incorporation of several indicators into patient care techniques provides for a more complete approach to caring for COVID-19 patients. Combining

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CRP with other biomarkers improves diagnostic accuracy, risk classification, and tailored therapy planning. In evaluating biomarker levels and making educated judgments, clinical examination and consideration of many circumstances remain critical. CRP is a helpful diagnostic and prognostic indication in COVID-19, offering insight into disease severity and mortality risk [8]. Other biomarkers, such as D-dimer, LDH, procalcitonin, IL-6, and ferritin, can improve diagnosis accuracy, guide therapy options, and predict patient outcomes. In addition to clinical evaluation, a multi-biomarker approach is needed to fully understand COVID-19 [9]. Ongoing research and investigations are important to improve the significance of these biomarkers and figure out their best clinical value in the context of COVID-19

Article information and declarations

Author contributions

Conceptualization, N.L.B., K.C., W.P. and U.S.; methodology, N.L.B., K.C., W.P. and U.S.; software, N.L.B., K.C., W.P. and U.S.; validation, N.L.B., K.C., W.P. and U.S.; formal analysis, N.L.B., K.C., W.P. and U.S.; investigation, N.L.B., K.C., W.P. and U.S.; resources, N.L.B., K.C., W.P. and U.S.; data curation, N.L.B., K.C., W.P. and U.S.; writing—original draft preparation, N.L.B., K.C., W.P. and U.S.; writing—review and editing, N.L.B., K.C., W.P. and U.S.; visualization, K.S., L.S. and K.A.; supervision, N.L.B.; project administration, K.C., W.P. and U.S.; All authors have read and agreed to the published version of the manuscript.

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