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Journal of Tissue Viability xxx (xxxx) xxx

Contents lists available at ScienceDirect

Journal of Tissue Viability

journal homepage: www.elsevier.com/locate/jtv

Determination of medical device-related pressure injury in COVID-19 patients: A prospective descriptive study

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ARTICLE INFO

Keywords:
COVID-19
ICU
Medical device-related injury
Pressure injury

ABSTRACT

Background: COVID-19 patients are at risk for the development of pressure injuries (PI).
Aim: The aim of this study was to determine the incidence of medical device-related pressure injury (MDRPI) in patients treated in the COVID-19 Intensive Care Unit (ICU)s.
Methods: The sample of the study consisted of 132 patients, and each with a maximum follow-up of 7 days. Data were collected in the COVID-19 ICU of a university hospital between January and May 2021 by using a Patient Characteristics Form, the MDRPI Follow-up Form, the Braden Pressure Ulcer Risk Assessment Scale, and the Pressure Ulcer Staging Form.
Results: Of the patients, 59.1% (n = 78) developed at least one MDRPI. MRDPI was observed in those with a mean age of 65.45 ± 2.462 years who were invasively ventilated (51.3%), enterally fed (46.2%), placed in the prone position (78.2%), and had a Braden score ≤12 (50%). The most common medical devices that caused MDRPIs included endotracheal tube (ET) (31.2% n = 44), non-invasive mechanical ventilation (NIVM) (23.4% n = 33), nasal high-flow (11.3% n = 16), nasogastric tube (10.6% n = 15), the ET connection (8.5% n = 12), respectively. The most common sites for pressure injuries were the nose (28.8% n = 34), mouth (25.8% n = 34), ear (12.9% n = 17), lip (9.1% n = 12), and cheek (8.3% n = 11). The most common gradings of MDRPIs were stage 2 (28.8% n = 38), stage 1 (19.7% n = 26), stage 3 (9.1% n = 12) mucous membrane injuries (12.9% n = 17) and suspected deep tissue injuries (9.1% n = 12), respectively. The time to PI was 3 days (25.7% n = 36).
Conclusions: MDRPI was common among COVID-19 patients. It was found that the most common cause of pressure injury was ventilators, and PI developed in the mouth and lip sites most frequently in patients in prone position, stage 2 and suspected deep tissue damage was the most common grade. It is important to evaluate the skin in contact with medical devices in COVID-19 patients and to take the necessary interventions to prevent PI.

1. Introduction

With the COVID-19 pandemic, medical device-related pressure injury (MDRPI) has come into focus [1]. In patients with COVID-19 nasal cannulas, medical devices such as endotracheal tubes (ET) and continuous positive airway pressure (CPAP) masks have been observed to cause tissue injury [2]. MDRPI started to be reported in COVID-19 patients in the literature.

While a systematic review conducted by Jackson et al. [3] before the COVID-19 pandemic reported the incidence of MDRPU as 12%, another systematic review by Barakat-Johnson et al. [4] found the incidence and prevalence rates ranging from 0.9% to 41.2% in incidence and 1.4%–121% in prevalence.

An Iranian study reported an MDRPI rate of 20.54% (n = 404) [5]. In another study conducted in India, the rate of MDRPI was 19.2% (n = 146) and MDRPIs were caused by NIVM (20%) and NGT (12.3%).[2] In Australia, Baraket Johnson et al. [6] reported an overall prevalence of MDRPI among hospitalized patients as 27.9% (n = 50/179), with 68% (34/50) occurring in the intensive care unit. Assis et al. [7] found that 34% (43/125) of ICU patients developed MDRPI. Another study demonstrated that 11.3% (71/631) of patients developed at least one hospital-acquired MDRPI, and the most common devices to cause injury were nasogastric/nasojejunal tubes (41%) and endotracheal tubes (27%) [8].

The incidence and prevalence of MDRPI vary depending on the population (adult or pediatric) and the type and shape of the device. ICU

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https://doi.org/10.1016/j.jtv.2022.10.004
Received 16 February 2022; Received in revised form 18 October 2022; Accepted 24 October 2022
Available online 28 October 2022

patients are at high risk for the development of MDRPI due to immobility, medications, sedation, and mandatory use of medical devices for treatment [9].

A retrospective study by Kiraner and Kaya [10] found that 56.8% (N = 111) of COVID-19 ICU patients developed pressure injury and 49.4% of the developed pressure injuries were MDRPI. In addition, the study reported the most common injury site as the lip edge (44%), of which 46% were stage 2 [10].

A study conducted with 30 patients during the COVID-19 pandemic found that half of all pressure injuries (n = 15) were medical device-related, and ET and fixation devices were the most common cause of injury. Moreover, patients placed in the prone position (PP) in the study had a higher rate of pressure injuries [11].

In 17% of COVID-19 cases, patients were commonly placed in the prone position to treat hypoxemic respiratory failure consistent with pneumonia, acute respiratory distress syndrome (ARDS) [12,13]. For the prone position to be effective, patients remained in the prone position for at least 10–12 h, which resulted in potential ischemic lesions in tissues exposed to pressure for a long time, especially on the face [12]. The fact that patients placed in the prone position are exposed to pressure injuries at a higher rate has been included in the literature [14–16]. A study with 109 patients who were treated in COVID-19 ICU in China reported that 42.2% (n = 46) of patients had PI, which developed on the face (23.9%), heel (21.7%), and hip (8.7%) due to the prone positioning [17].

The aim of this study was to determine the incidence of medical device-related pressure injury in patients treated in the COVID-19 ICU. To our knowledge, there are a limited number of publications on the MDRPI rate for patients treated in the COVID-19 ICU. This prospective, descriptive study investigates the following research questions:

1. What is the incidence of MDRPIs in the COVID-19 ICU?
2. What is the effect of prone position on MDRPIs?

2. Materials and methods

2.1. Study design

This study was conducted as an observational, prospective and cross-sectional study.

2.2. Sample and setting

The COVID-19 ICU of the university hospital where the study was conducted has 21 beds. The study included 134 patients hospitalized in the COVID-19 ICU between January–May 2021. The study was completed with 132 patients (two patients died within 24 h). Medical device-related pressure injuries of patients were evaluated. Patients were evaluated by the researcher, a COVID-19 ICU nurse, and a stoma and wound care nurse. Considering the prolonged length of stay, each patient was followed up daily for 7 days. Patients discharged from the ICU during this time remained in the study. However, their follow-up was stopped. Data were collected so as not to hinder the treatment process. Patients over the age of 18 years who were treated in the COVID-19 ICU and who were admitted to the ICU before 24 h were included in the study.

2.3. Data collection tools

A Patient Characteristics Form, the MRDPI Follow-up Form, the Braden Pressure Ulcer Risk Assessment Scale, and the Pressure Ulcer Staging Form were used to collect data. The forms were filled out by the researchers.

Patient Characteristics Form: The form developed by the researchers based on the literature consisted of items related to the demographic and health status of the patients (eg, gender, age, body mass index (BMI), comorbidities, nutrition) [18–21].

A table was created to be used for the daily follow-up of patients. The table shows the patient's pressure injury risk assessment score, vital signs (body temperature, heart rate, blood pressure, SpO_2), blood values (hemoglobin, CRP, albumin, protein), prone position time, and the type of device location, and stage of the injury if the patient has a medical device-related injury.

Braden Pressure Ulcer Risk Assessment Scale: Bergstrom et al. (1987) Turkish validity and reliability study of the scale developed by Oğuz and Olgun (1998). The scale is the most widely used risk assessment tool to determine the risk of pressure injury. The scale examines six risk factors: sensory perception, moisture, activity, mobility, friction, and shear. The total possible score of the scale used to assess PI risk ranges from 6 to 23 points. Accordingly, 12 points and below indicate very high risk, 13–14 points high risk, and 15–16 points low risk. For patients aged 75 years and older, a score of 15–18 points is considered low risk for PI [22].

Pressure Ulcer Staging Form: It is based on the National Pressure Ulcer Advisory Panel/European Pressure Ulcer Advisory Panel (2019) (NPUAP-EPUAP) staging system standards. The stages include stage 1, stage 2, stage 3, stage 4, unstageable stage, and suspected deep tissue injury. In addition, If MDRPI was in the mucous membrane, it was recorded as mucosal membrane injury [23].

2.4. Data collection

Data were collected using the systematic observation method. The patient's skin was examined from head to toe. The tissues under and around all attached medical devices were examined. When the patients in the prone position were placed in the supine position for care, the skin around the medical devices was checked. Using the Braden risk assessment scale throughout the follow-up of patients, the risk of PI, and if the patient developed PI, the stage, body region, and the medical device that caused injury were recorded. BMI data were categorized based on the World Health Organization (WHO) classification criteria. Accordingly, BMI was evaluated as follows: underweight BMI, <18.50; normal BMI, 18.50–24.99; overweight BMI, 25.00–29.99; obese BMI, 30.00 [24]. The vital signs of patients were obtained from the bedside monitor every day, and the laboratory results were obtained from the patient file.

2.5. Data analysis

Statistical analyses were carried out using the IBM SPSS Statistics (Statistical Package for the Social Sciences) version 22.0 (Istanbul University-Cerrahpasa) software and reported at a significance level of 0.05. Statistical analysis of descriptive data was performed with frequency and percentage distributions. The student's t-test or Mann-Whitney *U* test was used to compare quantitative data, and the chi-square and Fisher's exact tests were used to evaluate the correlation between variables.

2.6. Ethical considerations

The study was conducted in accordance with the principles of the "Helsinki Declaration." In order to conduct the study, ethics committee approval (decision no: E−83045809-604.01.02–7771), and institutional permission of the department head of the intensive care unit, where the data will be collected, were obtained. During the study, conscious patients were informed about the purpose of the study, and their verbal consent was obtained for participation. Permission was obtained from the relatives of unconscious patients via telephone.

3. Results

The study included 132 patients. The sociodemographic and clinical characteristics of the participants are given in Table 1.

MRDPI developed in patients with a mean age of 65.45 ± 2.462

Table 1
Sociodemographic and clinical characteristics of patients with and without prone position (N = 132).

	All (n = 132)	PP (n = 81, 61.4%)	Others (n = 51, 38.6%)	
	n(%)	n(%)	n(%)	p-value
Gender				
Famale	42(31.8)	20(24.7)	22(43.1)	
Male	90(68.2)	61(75.3)	29(56.9)	**0.043***
Age				
<60	61(46.2)	40(49.4)	21(41.2)	0.654
60–69	26(19.7)	15(18.5)	11(21.6)	
70+	45(34.1)	26(32.1)	19(37.3)	
BMI				
Normal	29(22)	15(18.5)	14(27.5)	0.389
Overweight	71(53.8)	47(58)	24(47.1)	
Obese	32(24.2)	19(23.5)	13(25.5)	
Diabetes				
Yes	38(28.8)	21(25.9)	17(33.3)	0.473
No	94(71.2)	60(74.1)	34(66.7)	
Hypertension				
Yes	54(40.9)	36(44.4)	18(35.3)	0.390
No	78(59.1)	45(55.6)	33(64.7)	
Chronic renal failure				
Yes	7(5.3)	5(6.2)	2(3.9)	0.706
No	125(94.7)	76(93.8)	49(96.1)	
Malignancy				
Yes	28(21.2)	15(18.5)	13(25.5)	0.462
No	104(78.8)	66(81.5)	38(74.5)	
Respiratory				
Yes	14(10.6)	7(8.6)	7(13.7)	0.527
No	118(89.4)	74(91.4)	44(86.3)	
Cardiac				
Yes	24(18.2)	12(14.8)	12(23.5)	0.302
No	108(81.8)	69(85.2)	39(76.5)	
Peripheral vascular				
Yes	2(1.5)	0(0.0)	2(3.9)	0.147
No	130(98.5)	81(100)	49(96.1)	
Ventilation				
Non Invaziv	79(59.8)	43(53.1)	36(70.6)	0.070
Invaziv	53(40.2)	38(46.9)	15(29.4)	
Nutrition				
Oral	74(56.1)	44(54.3)	30(58.8)	0.541
Parenteral	10(7.6)	5(6.2)	5(9.8)	
Enteral	48(36.4)	32(39.5)	16(31.4)	

PP: Prone Position Others: lateral and supine position.

Table 2
Sociodemographic and clinical characteristics of patients with/without MDRPI (N = 132).

	Non-MDRPI		MDRPI			
	n	%	n	%	x^2	p
Gender						
Famale	19	35.2	23	29.5		
Male	35	64.8	55	70.5	.478	.490
Age						
<60	41	75.9	46	59.0		
70+	13	24.1	32	41.0	4.08	**.043**
BMI/gr						
Normal	9	16.7	20	25.6		
Overweight	30	55.6	41	52.6		
Obese	15	27.8	17	21.8	1.694	.429
Diabetes						
Yes	14	25.9	24	30.8		
No	40	74.1	54	69.2	.365	.546
Hypertension						
Yes	17	31.5	37	47.4		
No	37	68.5	41	52.6	3.360	.067
Chronic renal failure						
Yes	2	3.7	5	6.4		
No	52	96.3	73	93.6	–	.700
Malignancy						
Yes	12	22.2	16	20.5		
No	42	77.8	62	79.5	.056	.813
Respiratory						
Yes	4	7.4	10	12.8		
No	50	92.6	68	87.2	.986	.321
Cardiac						
Yes	8	14.8	16	20.5		
No	46	85.2	62	79.5	.696	.404
Peripheral vascular						
Yes	1	1.9	1	1.3		
No	53	98.1	77	98.7	–	–
Ventilation						
Non invaziv	41	75.9	38	48.7		
Invaziv	13	24.1	40	51.3	9.830	**.002**
Nutrition						
Oral	37	68.5	37	47.4		
Parenteral	5	9.3	5	6.4		
Enteral	12	22.2	36	46.2	7.897	**.019**
Braden Scale score						
<12	14	25.9	39	50.0	8.23	**.016**
13–14	4	7.4	6	7.7		
15+	36	66.7	33	42.3		
Prone position						
Yes	20	37	61	78.2	22.810	**< .001**
No	34	63	17	21.8		

years (p = .004), who were invasively ventilated (51.3% n = 40 p = .002), enterally fed (46.2% n = 36 p = .019), lying on prone (78.2% n = 61 p < .001) and had a Braden score ≤12 (50% n = 39 p = .016) (Table 2).

Medical devices that caused MDRPI were Endotracheal Tube, (ET) (31.2% n = 44), Non-Invasive Mechanical Ventilation (NIMV) (23.4% n = 33), Nazal High Flow (NHF) (11.3% n = 16), Nasogastric Tube (NGT) (10.6% n = 15), ET connection (8.5% n = 12), respectively and the most common sites of pressure injuries were the nose (25.8% n = 34), mouth (25.8% n = 34), ears (12.9% n = 17), lips (9.1% n = 12), cheek (7.8% n = 11). When compared according to the position status, it was determined that MRDPI developed in the mouth (40.7% n = 33 p < .001) and lips (13.6% n = 11 p = .028) sites of the patients in the prone position. When compared according to PI stages, it was determined that there was a difference between stage 2 (37% n = 30 p = .015), suspected deep tissue damage (14.8% n = 12 p = .003) (Table 3). The time to PI was 2nd follow-up (72 h) (25.7% n = 36) (Table 4).

4. Discussion

During the COVID-19 pandemic, the increase in the number of patients requiring ICUs, the prone positioning of patients to treat ARDS, and the exposure of patients to more devices for therapeutic purposes have increased MDRPI rates [25]. COVID-19 positive patients have been found to have endothelial dysfunction with the essential features of cytokine storm, decrease in oxygen saturation, hypercoagulation leading to micro thrombosis, and naturally increased fragility of soft tissues due to effects on cardiac output [1]. It has been observed that ischemia and tissue death could occur even with minimal pressure [26]. In the study, 59.1% (n = 78) of the patients developed at least one MDRPI. A retrospective study conducted in the COVID-19 ICU in our country showed that 56.8% (n = 54) of the sample had pressure injuries and 49.4% (n = 39) of this rate were medical device-related [10].

In the present study, MDRPI was observed in patients with a mean age of 65.45 ± 2.462 who were invasively ventilated, enterally fed and had a Braden score ≤12. **(Table 2).** The systematic review of Serrano et al. [20] reported that individuals over 60 years of age were at higher risk of having PI. Likewise, the study of Coyer et al. [27] showed higher rates of MDRPI in patients over 60 years of age. There are studies in the literature stating that patients over the age of 60 are in the risk group [28]. The study of Hanonu and Karadag [18] showed that elderly patients developed MDRPI at a higher rate due to invasive ventilation. The literature supports that ventilation devices cause more MDRPI than other devices [5,18]. Patients with a low Braden pressure injury risk assessment score [29] and a very high Braden risk assessment score [15]

Table 3
MRDPI sites and stages of patients with and without prone position.

Stage	All (n = 132)	PP (n = 81, 61.4%)	Others (n = 51, 38.6%)	
	n(%)	n(%)	n(%)	p-value
Stage 1	26(19.7)	20(24.7)	6(11.8)	.111
Stage 2	38(28.8)	30(37)	8(15.7)	**.015***
Stage 3	12(9.1)	10(12.3)	2(3.9)	.127
Suspected deep tissue damage	12(9.1)	12(14.8)	0(0)	**.003***
Unstageable	5(3.8)	4(4.9)	1(2)	.648
Mucous membrane injury	17(12.9)	13(16)	4(7.8)	.194
Site				
Forehead	7(5.3)	4(4.9)	3(5.9)	.999
Nose	34(25.8)	25(30.9)	9(17.6)	.137
Mouth	34(25.8)	33(40.7)	1(2)	**<.001***
Chin	4(3)	3(3.7)	1(2)	.999
Lips	12(9.1)	11(13.6)	1(2)	**.028***
Neck	5(3.8)	4(4.9)	1(2)	.648
Cheeks	11(8.3)	9(11.1)	2(3.9)	.202
Ears	17(12.9)	8(9.9)	9(17.6)	.303
Chest	8(6.1)	7(8.6)	1(2)	.151
Breast	2(1.5)	2(2.5)	0(0)	.522
Abdomen	2(1.5)	2(2.5)	0(0)	.522
Legs	1(0.8)	0(0)	1(2)	.386

PP: Prone Position Others: lateral and supine position.
As patients used more than 1 medical-device, "n" increased.

Table 4
MRDPI development time.

Stage	Time (days)	
	Mean ± SD	Median(Range)
Stage 1	3.4 ± 1.6	3(1–7)
Stage 2	3.3 ± 1.2	3.4(1–6)
Stage 3	3.4 ± 0.9	3(2–5)
Suspected Deep Tissue Damage	3.5 ± 1.4	3.6(1–6)
Unstageable	3.7 ± 1.1	3.5(2–6)
Mucous Membrane Injury	3.6 ± 1.3	3(2–6)

have a higher risk of developing pressure injuries. A study conducted in Iran found that a low Braden Scale score significantly increased the likelihood of developing MDRPI in advanced age [5].

With the COVID-19 pandemic, the requirement for respiratory devices has increased, including BIPAP masks and ETs. The study of Kayser et al. [30] found the most common devices associated with MDRPI as NHF (26%). According to the results of the study conducted by Mehta et al. [2], MDRPIs occurred most frequently with the NIVM mask (20%). The study of Rashavand et al. [5], on the other hand, showed that MDRPIs occurred due to nasal oxygen face masks. Edsberg et al. [31] reported that 30%–70% of MDRPIs are caused by ventilators and are especially common in critical care units. The study conducted by Hanonü and Karadag [18] found that 40% of the sample (n = 70/175) developed MDRPI, and the devices that most commonly caused pressure injuries were ETs, CPAP masks, and SpO_2 probes. According to the results of a systematic review investigating the risk and development of MDRPI, respiratory devices such as NIVM and orotracheal tube were found to cause the most damage [32]. The most common cause of MDRPI is oxygen masks and endotracheal tubes [6]. Most of the studies have been conducted before the COVID-19 pandemic. According to the results of a retrospective descriptive study conducted in the COVID-19 ICU, 49.4% of the patients had MDRPI, and ET was the most common cause of injury [10]. In Martel et al.'s study, 50% (n = 15) of all pressure injuries were related to MDRPIs, and 11 were caused by MDRPI ETs and fixation devices [11]. There are studies in the literature that support our results.

Medical device-related injuries occur in and around the tissue under the attached device. In a systematic review on MDRPI, the posterior cervical region and nose had the highest injury rates with 66% and 40%, respectively [32]. The study of Kayser et al. [30] showed the most common sites of MDRPIs as the face and head (51%), especially in the ears (29%) and nose (10%). The study of Hanonu and Karadag [18] reported the most common sites of medical device-related pressure injuries as the lips, nose, and fingers. Another study reported the most common sites of pressure injuries as the lip (44%) and the nose (18%) [10]. In our clinic, prone position ventilation has been a widely used treatment to improve lung mechanics and gas exchange in COVID-19 ICU patients with ARDS. The mean prone time was in the form of sessions of 8–24 h. In our study, MRDPI developed in 78.2% (n = 61) of the patients lying in the prone position. In the literature, reports of pressure injury are increasing in patients lying in the prone position [11]. A randomized multicenter study by Girard et al. [28], comparing patients with ARDS in the prone (n = 237% 57.1) and supine (n = 229 42.5%) positions according to the occurrence of pressure ulcers, found more pressure ulcers per patient in the prone group.

In this study, the time to MDRPI was 72 h after admission to the ICU. While the most common PI stages in the study were stage 2 and stage 1, when the position conditions were examined, it was determined that stage 2 and suspicious deep tissue damage occurred especially in patients in the prone position. In the studies of Kayser et al. [30], Hanonu and Karadag [18] and Kıraner and Kaya [10], the most common pressure injury is stage 2. There is also a study stating that 64% of 74 patients using invasive ventilation and in the prone position had stage 2 pressure injuries [15].

In conclusion, the incidence of MDRPI is high especially in COVID 19 patients receiving ICU treatment. Healthcare professionals should protect and evaluate the skin and monitor for early signs of PI.

5. Limitations to the study

The observation lengths of these patients were different due to differences in mortality, discharge from the hospital, and transfer of patients to other departments. After the observation period (7 days in total) was completed, the patients were not re-evaluated. It was noted during the study that gel pads caused more pressure injuries in patients lying in the prone position. The use of gel pads has been discontinued. Instead, the bedsheet was made into a half-moon shape by the nurses and an absorbent pad was placed on it. This may have changed the results of the study. Responses to the care-related questions asked by nurses from other clinics during the observations may have affected the rates. Since this is a single-center study, the results cannot be generalized.

6. Conclusion

This study contributes to the determination of MDRPI rates of patients treated in the COVID-19 ICU. The most common devices that caused MDRPI in the study were ET and NIMV masks. MDRPIs mostly developed in the facial area and were most commonly stage 2 pressure injuries. The MRDPI rate was high in patients placed in the prone position. Evaluation of skin in contact with medical devices and efforts to prevent PI is important in COVID-19 patients. Prevention of MDRPIs, especially in patients lying in the prone position, is becoming increasingly important. There is a need for comparative studies with a larger sample to understand the processes that contribute to the development of pressure injuries in COVID-19 patients.

Funding

The research budget was met by the researchers.

Contributions

The authors have confirmed that all authors met final approval of the version to be published.

Declaration of competing interest

There is no conflict of interest.

Acknowledgements

The authors would like to thank all healthcare professionals working at the forefront of COVID-19. Also, the authors would like to thank Pelin Karaçay.

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