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Medical Device-Related Pressure injuries in adult intensive care units

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Abstract

Aim and Objective: This study was conducted to examine the development, characteristics, and risk factors of medical device-related pressure injury (MDRPI) in intensive care units (ICU).

Background: The number of individuals admitted to ICU increased in the last years all over the world. In parallel with this need, the frequency of the use of life-support and therapeutic medical devices in the ICU also increases. This situation may lead to the development of MDRPI in the ICU and an increase in its prevalence.

Method: The study, which was conducted observationally, prospectively and descriptively, included 302 patients who were hospitalised in an ICU within a year. The study was reported according to the STROBE Declaration.

Results: It was observed that MDRPI developed in 27.2% of the patients. It was found that MDRPI developed the most in the nose (26.8%) and mouth (15.9%) regions of the patients. It was determined that MDRPI was diagnosed in 28% of the patients within 3–5 days. It was determined that mostly orthopaedic devices (plaster, cervical collar, splint) (62.5%), fasteners (57.1%), non-invasive ventilation/oxygen masks (51.2%) caused the development of MDRPI. It was found that the number of medical devices used was higher, and the number of hospitalisation days in the ICU was also higher, and these factors explained 28.3% of the total variance in the development of MDRPI.

Conclusion: It was determined that MDRPI developed in approximately one of four patients in the ICU and that the numbers of medical devices and hospitalisation days were important determinant risk factors.

Relevance to Clinical Practice: The high rate of development of MDRPI is worrying in terms of nursing care quality. It is recommended that nurses recognise risk factors in order to prevent the development of MDRPI, evaluate the suitability, necessity, and safety of the devices to be used is located.

KEYWORDS
care, intensive care, nursing, pressure injury, risk assessment

1 | INTRODUCTION

Pressure injuries continue to be a common complication of health care despite the developing technology in intensive care units (ICU), intensive prevention strategies, and applied quality of care studies (Fletcher, 2012). Many patients from all ages treated in the ICU may have a pressure injury due to the presence of comorbidity, inactivity, sedation, and compulsory use of medical devices for treatment (Amirah et al., 2017; Barakat-Johnson et al., 2019). The development of pressure injuries is a cause of concern in health institutions due to its negative effects on patients and families such as pain, delayed functional recovery, and infections, as well as prolonged hospital stay, higher costs to institutions, and increased morbidity and mortality (Amirah et al., 2017; Galetto et al., 2019; Pittman et al., 2015).

A significant part of the pressure injuries that are common in the ICU develop due to medical devices (Erbay et al., 2019). In many recent studies, it has been stated that medical devices are an extrinsic risk factor for the development of pressure injuries and that the presence of a medical device alone or the entry site of the device increase the risk of pressure injuries (Black et al., 2015; Black & Kalowes, 2016; Padula et al., 2017;). In order to draw attention to this issue, in 2016, The National Pressure Ulcer Advisory Panel defined Medical Device Related Pressure Injury (MDRPI) as "arising from the use of devices designed and applied for diagnostic or treatment purposes" (National Pressure Ulcer Advisory Panel, 2016). In this respect, MDRPI is distinct from general pressure injuries. General pressure injuries are related to immobility and often occur on a tissue or bony tissue subjected to pressure from a support surface. MDRPI is usually caused by mucosal tissue and reflects the shape and location of the medical device (Delmore & Ayello, 2017; Erbay et al., 2019).

As is known, more than one medical device is used for diagnosis, treatment, follow-up, and care in the ICU. Medical devices, which are important for the treatment and survival of the patient (Gefen et al., 2020), are made of hard materials such as plastic rubber or silicones that can cause friction or pressure on soft tissues. In addition, adhesive tapes used to attach the device can irritate sensitive skin and lead to injuries and oedema in that area (Black et al., 2015; Black & Kalowes, 2016; Delmore & Ayello, 2017; Fletcher, 2012). With these features, medical devices can cause heat, moisture, and pressure between the device and the patient's skin, making the patient susceptible to developing pressure injuries due to medical device (Barakat-Johnson et al., 2019; Black & Kalowes, 2016). Similarly, moisture from sweat or secretions under the medical device can soften the skin and accelerate the formation of pressure injuries (Black et al., 2015). In addition to medical device and patient's skin characteristics, factors such as incorrect selection of medical device, incorrect placement (placing the medical device in an area with low adipose tissue), incorrect fixation method, incorrect use of adhesive tape, use of many medical devices, prolonged use of medical device in the same exact region, patient's inability to feel pressure, friction and tearing on the skin due to sedation may also increase the risk of developing MDRPI (Gefen et al., 2020; Karadag et al., 2017; Kim et al., 2019). In a systematic study, it was found that the incidence of MDRPIs in the ICU ranged between 0.9%–41.2%, and its prevalence ranged between 1.4%–121% (Barakat-Johnson et al., 2019). In another study, it was observed that MDRPIs developed seven times more than normal pressure injuries in patients.

What does this paper contribute to the wider global community?

- Medical device-related pressure injury was high in patients treated in the intensive care unit.
- The presence of orthopaedic devices, fasteners, and non-invasive ventilation/oxygen masks were important risk factors for MDRPI development.
- The numbers of medical devices and hospitalisation days were important determinant factors for MDRPI development.
- Prevention of Medical device-related pressure injury can be possible with effective nursing care.
- For this reason, it is very important for nurses to be informed about medical device-related pressure injury and to recognise risk factors.

The devices that cause MDRPIs vary greatly. These devices, including non-invasive mechanical ventilation masks, endotracheal tubes, tracheostomy tubes and ligaments, nasogastric tubes, oxygen masks, foley catheters, faecal containment devices, orthopaedic splints and cervical collars, can cause the development of pressure injuries (Coyer et al., 2014). In a systematic review and meta-analysis study, it was stated that commonly identified medical devices associated with the risk of developing MDRPIs include ventilators, cervical collars, tube devices, splints, and intravenous catheters (Jackson et al., 2019).

MDRPI development can occur in various parts of the body (Galetto et al., 2019). Many medical device-related pressure injuries occur in the head or neck and are less associated with bone protrusion, as opposed to pressure injuries that occur more frequently under the waist and are not related to medical devices (Apold & Rydrych, 2012). In a systematic review, it was stated that the ear was the most common location in the incidence studies related to MDRPI, and the nose was the most common location in the prevalence studies (Barakat-Johnson et al., 2019).

MDRPI is among the main indicators of patient safety and nursing quality in health institutions (Jackson et al., 2019; Kim et al., 2019). However, MDRPIs can be missed by nurses (Amirah et al., 2017). The prevention and management of MDRPIs is complex because it originates from medical devices, which are an important part of treatment. All health professionals, especially nurses, are obliged to take care to not harm the patient during the treatment and care process (Young, 2018). Nurses play an important role in identifying patients at risk of MDRPIs and preventing the occurrence of these injuries (Karadag et al., 2017).

Having examined the literature, there are limited studies on the risks and rate of development of MDRPIs in Turkey (Dalli et al., 2022; Hanonu & Karadag, 2016). This study is important in terms of reflecting the example of a public hospital located in the most geographically crowded region of Turkey and in terms of being conducted on a large sample group. In addition, it is predicted that the study will contribute to the literature and health professionals in order to prevent and manage the development of MDRPIs in the ICU in the early stage.

2 | METHOD

2.1 | Purpose and type of study

The study was conducted observationally, prospectively and descriptively in order to examine the rate of development and risk factors of MDRPI in patients receiving treatment in the adult ICU. STROBE checklist for observational research was used to guide this study (File S1).

In this study, answers to the following research questions were sought:

1. What is the development rate of MDRPI in the ICU?
2. What are the characteristics of MDRPIs?
3. What are the risk factors for MDRPI in regard to the patient, treatment, and care in the ICU?

2.2 | Population and sample

The population of the study consisted of 27-bed capacity adult intensive care patients hospitalised in the Anaesthesia and Reanimation ICU of a public hospital between February 15, 2021 and February 15, 2022. Three hundred and two patients who were admitted to the Anaesthesia and Reanimation intensive care unit in the institution where the study was conducted, who were 18 years of age or older, who had undergone treatment and care process in the intensive care unit for at least 24 h, who did not have a pressure injury anywhere in their body when admitted to the ICU, and who agreed to participate in the study themselves or through their legal representatives were included in the study. Patients who were treated in the ICU for less than 24 h due to reasons such as exitus or discharge were excluded from the study.

2.3 | Data collection tools

The data were collected using the patient descriptive characteristics form, Glasgow Coma Scale (GCS), medical device-related pressure injury diagnostic form, the Braden Scale for Predicting Pressure Sore Risk (BS-PPSR), and pressure injury staging form.

Patient Description Form: The form consists of two parts. In the first part, eight questions including personal information about the patient (age, gender, marital status, educational status, employment status, smoking status, weight, and height information); in the second part, 12 questions including information about the disease (reason for admission to the intensive care unit, duration of hospital stay before intensive care unit, name of the chronic disease, how long the chronic disease has been present, mechanical ventilation status, diet, skin type, mobilisation status, drugs used in intensive care unit, number of intensive care hospitalisation days, and prognosis) are included.

Glasgow Coma Scale: The scale, which was used to determine the patient's level of consciousness in the study, evaluates three different parts: eye opening, verbal, and motor response. The total GCS score is obtained by summing the scores of the patient from each part. The total score of the patient varies between 3–15. However, changes in consciousness level are categorised according to the score obtained from GCS, 15 points are evaluated as full consciousness, 13–15 points as lethargy, 9–12 points as stupor, and 3–8 points as coma (Martins et al., 2016; Sepit, 2005).

Medical device-related pressure injury diagnostic form: It was prepared by the researchers in line with the literature review (Arnold-Long et al., 2017; Black et al., 2010; Black & Kalowes, 2016; Fletcher, 2012; Galetto et al., 2019; Hanonu & Karadag, 2016; Kayser et al., 2018; Kim et al., 2019). The form includes four questions (medical devices used in the intensive care unit, the status of pressure injury development due to the medical device used, MDRPI development site and cause) containing information about the development of pressure injuries due to medical devices.

The Braden Scale for Predicting Pressure Sore Risk: It was developed by Bergstrom et al. (1987) and Turkish reliability and validity study was conducted by Oguz and Olgun (1998). In the BS-PPSR, six risk factors are scrutinised: sensory perception, moisture, activity, mobility, nutrition, friction, and irritation. The total score of the scale varies between 6–23. In total, 15–16 points are considered low risk (15–18 points required for low risk in people over 75), 13–14 points risky, and 12 points and below are considered high risk (Oguz & Olgun, 1998).

Pressure injury staging form: In this form, the six-point staging system recommended by the European Pressure Ulcer Advisory Panel was adopted. These stages are defined as follows: stage I (rash that usually occurs in a limited area on the bone protrusions and does not fade by pressing with fingers, the skin integrity is intact), stage II (partially thick dermis loss with a reddish pink coloured wound bed), stage III (tissue loss at full thickness), stage IV (tissue loss with bone, tendon or muscles affected at full thickness), stage that cannot be defined (the actual depth of the wound is unknown due to the fact that the wound bed is completely covered with yellow necrotic tissue, the stage with tissue loss in all layers) and deep tissue damage (intact skin, colour changes into purple or dark brown/burgundy, blood-filled vesicle; NPUAP-EPUAP, 2014).

2.4 | Data collection

The data form to be used in the study was collected within the first 24 h of admission to the intensive care unit by an experienced nurse in the ICU where the study was conducted. Sociodemographic data of patients treated in the ICU for more than 24 h were obtained by interviewing the patients themselves or their legal representatives face to face. The medications used by the patient were taken from the physician treatment plan. The patients were evaluated by the research nurses within the first 24 h and then followed up until they left the ICU at 48 h intervals. In the evaluation, the patient's skin was completely checked from head to toe and the tissue under and around all medical devices was examined and palpated. Removal of short-term removable devices such as oxygen masks, nasal cannulas, and pulse oximeters allowed the examination of the underlying tissue. BMI was calculated for the body structures of the patients and was accepted as BMI <18.5 kg/m^2 weak, BMI 18.5–24.9 kg/m^2 normal weight, BMI 25.0–29.9 kg/m^2 overweight, and BMI ≥30.0 kg/m^2 obese.

2.5 | Evaluation of data

The data were analysed in the SPSS 22.0 program. The normal distribution of the data was assessed using the Kolmogorov–Smirnov test. The distributions of the sociodemographic, disease-related, and intensive care-related characteristics of the participants were evaluated by median (25th–75th percentiles) and frequency values. Since the data were not normally distributed, the Mann Whitney U Test was used in the variables that did not show normal distribution in paired groups. Chi-square test and Fisher's Exact test (in cases in which the values observed in the cells could not meet the chi-square test assumptions) were used to compare some characteristics in patients with and without MDRPI. In addition, logistic regression analysis was used to evaluate the explanatory effect of some variables on the development of MDRPI. Statistical significance was examined at 0.05 significance level in the evaluation of the data.

2.6 | Ethics statement

Written permission was obtained from the Non-Interventional Clinical Research Ethics Committee of the university before collecting the data (Decision No: 2021-01/08). In addition, before collecting the data, each patient or legal representative involved in the study was informed about the content of the study and the voluntary participation, verbal and written consents were obtained.

3 | RESULTS

The median age of the intensive care patients was 67 (58–76) years and 61.9% (n = 187) were 65 years old or older. Fifty-one percent (n = 154) of the patients were male and 32.5% (n = 98) were active smokers, whereas 44.4% (n = 134) had stopped smoking. While 46.4% (n = 140) of the patients were overweight, 8.3% (n = 25) were obese, 95% (n = 287) had a chronic disease, and 68.6% (n = 207) had multiple chronic diseases. It was assessed that 62.7% (n = 180) of the patients had hypertension, 44.6% (n = 128) had diabetes, 20.2% (n = 58) had COPD/asthma, 19.2% (n = 55) had heart failure, 10.8% (n = 31) had cancer, 7.7% (n = 22) had Alzheimer's, and 4.9% (n = 14) had kidney failure. According to the first diagnosed chronic diseases of the patients, the median duration of chronic disease of the patients was 7 (4–11) years. Table 1 shows the characteristics of the patients regarding their treatment and care in the ICU.

It was observed that MDRPIs developed in 27.2% (n = 82) of the patients during their treatment and care in the ICU. It was found that MDRPI developed the most in the nose (26.8%, n = 22), mouth (15.9%, n = 14), and neck (14.6%, n = 12) regions of the patients. When diagnosed, 65.9% (n = 54) of the patients were in stage II. MDRPI were diagnosed in 29.3% (n = 24) within 10–14 days (Table 2).

Having examined the medical devices for treatment, follow-up and care used by the patients treated in the ICU, it was detected that faecal retention material (100%, n = 302), electrodes (99.7%, n = 301), intravenous catheterization (99.3%, n = 300), Foley catheterization (99.0%, n = 299), pulse-oximeter (99.0%, n = 299), and arterial catheterization (92.4%, n = 279) were frequently used. Having examined the pressure injury development status of the patients according to the medical devices used, it was found that mostly orthopaedic devices (plaster, cervical collar, splint; 62.5%, 5 out of 8 patients), fasteners (57.1%, 8 out of 14 patients), and non-invasive ventilation/oxygen masks (51.2%, 21 out of 41 patients) caused the development of MDRPI. In addition, the rate of MDRPI was observed to be higher in the patients who developed MDRPI due to non-invasive ventilation/oxygen masks (25.6%, n = 21) and endotracheal tubes (15.8%, n = 13; Table 3).

The comparison of the risk factors for the development of pressure injuries in patients with and without MDRPI is shown in Table 4. Accordingly, it was observed that the BS-PPSR score of the patients who developed MDRPI was low, the number of medical devices used was higher, and the number of hospitalisation days in the ICU was higher (p < .05). However, it was determined that age, GCS score, body structure, the status of being attached to mechanical ventilator, nutritional status, and mobilisation status were not associated with the development of MDRPI (p > .05).

In the regression analysis performed, it was found that the BS-PPSR score, the number of medical devices used and the number of intensive care hospitalisation days were the factors that significantly affected the development of MDRPI and explained 28.3% of the total variance in the development of MDRPI (R = 0.550, R^2 = 0.283, F = 15.866, p < .001; Table 5).

4 | DISCUSSION

The development of MDRPI, which is encountered due to the medical devices widely used for treatment, follow-up, and care in

TABLE 1 Characteristics of patients regarding treatment and care in the ICU

Characteristics	*n*	%
Reason for admission to ICU		
Respiratory failure	130	43.2
Neurological disorder	54	17.8
Gastrointestinal disorder	29	9.6
Postoperative follow-up	20	6.6
Cardiovascular failure	19	6.3
Multiple trauma	16	5.3
Electrolyte disorder	11	3.6
Kidney failure	10	3.3
Other (coagulation disorders, infections, diabetic complications)	13	4.3
Number of days of hospitalisation before ICU		
None	27	8.9
1–2 days	38	12.6
3–5 days	90	29.8
6–10 days	115	38.1
11–19 days	32	10.6
State of being connected to a mechanical ventilator		
Yes	206	68.2
No	96	31.8
Nutritional status		
Oral	66	21.9
Enteral	189	62.5
Parenteral	47	15.6
Skin type		
Normal	147	48.7
Dry	107	35.4
Sweaty	37	12.3
Cold	8	2.6
Odematous	3	1.0
Mobilisation status		
Immobile	216	71.5
Mobile in bed	86	28.5
Glasgow Coma Scale		
Full consciousness	34	11.3
Latergy	29	9.6
Stupor	34	11.3
Coma	205	67.9
The Braden Scale for Predicting Pressure Sore Risk		
No risk (≥19)	9	3.1
Low risk (15–18)	52	17.2
Moderate risk (13–14)	65	21.5
High risk (≤12)	176	58.2
Number of medical devices used		
5–6	14	4.6
7	63	20.9
8	151	50.0
9	9	20.2
10–11	13	4.3
Medications used in ICU[a]		
Antibiotic	294	97.3
Steroids	243	80.5
Bronchodilators	195	64.6
Sedatives	154	51.0
Anticoagulant	83	27.5
Cytotoxics	17	5.6
Antihypertensive	10	3.3
Diuretic	8	2.6
Number of days treated in ICU		
3–9 days	101	33.4
10–19 days	158	52.3
20–20 days	35	11.6
30 days and above	8	2.7
Prognosis		
Sent to the clinic	216	71.5
Exitus	86	28.5

[a]More than one option is marked.

the ICU, is one of major complications. In this study, the ratio of development of MDRPI in a public hospital in Turkey was examined, and it was observed that MDRPI developed in approximately one in every four patients (27.2%) treated in the ICU. In other studies conducted in Turkey, the prevalence of MDRPI was assessed to be 40%–48.8% (Dalli et al., 2022; Hanonu & Karadag, 2016), and it was observed that this rate differed in other countries. For example, the prevalence of MDRPI was 47% in Northeastern, Southeastern, and Midwestern United States (Arnold-Long et al., 2017); 32.4% in Saudi Arabia (Amirah et al., 2017); 20.1% in the Netherlands (Ham et al., 2017); 9.7% in Australia (Ackland et al., 2007); 3.1% in Australia and USA (Coyer et al., 2014); 2.2% in the United Kingdom (Walker, 2012); 1.9% in the USA (Black et al., 2010); and 0.6% in the USA and Canada (Kayser et al., 2018). Although the rate obtained in this study is lower than the findings of other studies conducted in Turkey, it is considered high due to the fact that these are actually preventable complications. However, the fact that medical devices themselves are pressure factors alone necessitates this problem to be addressed in the ICU (Black et al., 2010). In fact, MDRPI constitutes more than 30% of all pressure injuries occurring in the hospital environment (Erbay et al., 2019). In a study, it was reported that approximately one-third (29%) of pressure injuries were caused by medical devices

TABLE 2 Characteristics regarding the development of MDRPI

Characteristics	*n*	%
Development status of MDRPI		
Yes	82	27.2
No	220	72.8
Anatomical region		
Nose	22	26.8
Mouth	14	15.9
Neck	12	14.6
Perineum	8	9.8
Ear	7	8.5
Arm	7	8.5
Finger	3	7.7
Leg	5	6.1
Prefrontal region	2	2.4
Back	1	1.2
Foot	1	1.2
Abdomen	1	1.2
Stage of MDRPI		
Stage I	13	15.9
Stage II	54	65.9
Stage III	3	3.7
Deep tissue damage	12	14.5
Number of days detected of MDRPI		
3–5 days	23	28.0
6–9 days	21	25.6
10–14 days	24	29.3
15–28 days	14	17.1

(Apold & Rydrych, 2012). Similarly, in another study, it was found that patients using medical devices were 2.4 times more likely to develop pressure injuries than patients who did not use them (Black et al., 2010).

In descending order according the level of the frequency of use, it was observed in the study that orthopaedic devices (plaster, cervical collar, splint; 62.5%), fasteners (57.1%), and non-invasive ventilation/oxygen masks (51.2%) caused the development of MDRPI. In other studies, conducted on 172 and 175 patients in Turkey, MDRPI was observed in patients due to endotracheal tubes (45.0% and 49.2%), non-invasive ventilation/oxygen masks (10% and 17.5%) and nasal cannulas (6.6% and 28.1%) the most (Dalli et al., 2022; Hanonu & Karadag, 2016). In the review study by Black and Kalowes (2016), it was stated that the use of neck collars caused the development of MDRPI at a rate of 9.7%–23.7%, elastic socks 12%, endotracheal tube 10.5%, faecal containment devices 14.7%, nasal cannula 12.9%–47%, noninvasive ventilator masks 19%–97%, splints 12%–17%, and urinary catheter 14.7%. In other studies, it has been emphasised that the most common devices associated with MDRPI were endotracheal tubes, plaster/splint/cervical collar, urinary catheters, non-invasive ventilation/oxygen masks, saturation probe, nasogastric tubes, and electrodes (Amirah et al., 2017; Arnold-Long et al., 2017; Black et al., 2015; Coyer et al., 2014; Dang et al., 2022; Galetto et al., 2019;Kayser et al., 2018; Kim et al., 2019). The study finding shows that the medical devices that cause the development of MDRPI are different from those of other studies. This difference may be due to the characteristics of the ICU where the study was conducted.

Depending on the device used in the ICU, MDRPI may develop in body parts such as lips, nose, ear, neck, occipital region, jaw, forehead, cheeks, clavicle, thigh, and perianal region (Black et al., 2015). In a study, it was detected that pressure injuries developed at a rate of 70.3% in the head/face/neck related to device, 7.8% not related to device; 20.3% in the heel/ankle/leg related to device, 16.9% not related device; 7.8% in the coccyx/hip related to device, 67.5% not related to device; 1.6% in the sacrum related to the device, 16.9% not related to device (Apold & Rydrych, 2012). In this study, it was found that MDRPI developed at a rate of 26.8% in the nose, 15.9% in the mouth, 14.6% in the neck, 9.8% in the perineum, and 8.5% in the ear. The findings of the study are in line with the literature. Having examined the anatomical prevalence of MDRPI in conducted studies, it was found that MDRPI developed at a rate of 10%–32.6% in the nose (Dang et al., 2022; Hanonu & Karadag, 2016; Kayser et al., 2018; Kim et al., 2019), 18.2% in the jaw (Ham et al., 2017), 44.0% in the lips (Hanonu & Karadag, 2016), 6.1%–35% in the ears (Black et al., 2010; Hanonu & Karadag, 2016; Kayser et al., 2018; Kim et al., 2019; VanGilder et al., 2009), 3.1%–5.1% in the neck (Kayser et al., 2018; Kim et al., 2019), 4.4%–32.7% in the fingers (Dang et al., 2022; Hanonu & Karadag, 2016; Kim et al., 2019), and 27.2% in the perineum (Dalli et al., 2022). The study finding shows that MDRPI often develops in the head and face regions. At the same time, this finding alerts nurses to take measures to support and protect the areas at risk of MRDPI.

The pressure injury caused by medical devices is iatrogenic, that is, caused by treatment and care. However, MDRPI may worsen due to lack of inspection and care. In the study, it was determined that 65.9% of the patients were in stage II when MDRPI was diagnosed. In other studies, it was observed that MDRPI was frequently diagnosed in stage II and this rate varied between 32%–51% (Arnold-Long et al., 2017; Black et al., 2010; Hanonu & Karadag, 2016; Kim et al., 2019). In the study by Dalli et al. (2022), it was stated that most of the MDRPIs (63.7%) developed in the mucosa and therefore could not be staged. In the study by Apold and Rydrych (2012) as well, it was detected that more than half (52.7%) of the patients who developed MDRPI could not be staged, 20.3% were in stage II, and 20.3% were in stage III. This finding of the study may have been due to the observation of patients by the researchers every 48 h, instead of daily. However, the findings of the study suggest that patients should be observed more frequently in regard to MDRPI, which is a preventable complication.

In the literature, it has been stated that the development of MDRPI may occur three days faster than normal duration of pressure injury development (Kayser et al., 2018). In the study, it was

TABLE 3 Medical devices used in the ICU and the development of MDRPI

Medical devices	Using medical device[a] (*n* = 302) *n*	Developing pressure injury due to the medical device used (*n* = 302) *n*	MDRPI rate by medical device use %	MDRPI rate by medical device use (*n* = 82) %
Faecal containment devices	302	7	2.3	8.5
Electrodes	301	0	0.0	0.0
Intravenous catheterization	300	2	0.7	2.4
Foley catheterization	299	2	0.7	2.4
Saturation probe (pulse-oximeter)	299	3	1.0	3.6
Arterial catheterization	279	4	1.4	4.8
Endotracheal tubes	200	13	6.5	15.8
Nasogastric tube	179	7	3.9	8.5
ID wristbands	84	0	0.0	0.0
Nasal cannula	76	2	2.6	2.4
Non-invasive ventilation/oxygen masks	41	21	51.2	25.6
Anti-embolic socks	25	2	8.0	2.4
Fasteners (restrictors)	14	8	57.1	9.7
Tracheostomy cannula	11	3	27.3	3.6
Orthopaedic devices (plaster, cervical collar, splint)	8	5	62.5	6.0
Percutaneous endoscopic gastrostomy tube	7	1	14.3	1.2
Negative pressure wound therapy equipment	6	2	33.3	2.4

[a]Since the patients had more than one medical device, the number of "*n*" increased.

found that MDRPI was seen in 28% of the patients within 3–5 days, in 25.6% within 6–9 days, and in 29.3% within 10–14 days. In another study, it was found that MDRPI developed between 3 and 13 days subsequent to admission (Coyer et al., 2014). In another study, it was found that MDRPI occurred 24 h after admission to the ICU and the rate of body regions developing MDRPI increased sevenfold (from 11.8%–82.3%) until the 11th day (Hanonu & Karadag, 2016). In a study conducted on patients connected to non-invasive mechanical ventilation, it was determined that if the application exceeded 18 h, 26.7% of the patients developed pressure injuries in the facial region and the mean initial duration of the pressure injuries was 3.3 days (Martins et al., 2016). In a study conducted on trauma patients with suspected spinal cord injury, the incidence of MDRPI in the first week was found to be 97% (Ham et al., 2017). In a study conducted on patients with major trauma, it was found that the risk of MDRPI increased by 66% in each day of increase in the use of neck collars (Ackland et al., 2007). These findings indicate that the development of MDRPI may occur in the early stage of ICU admission. In this study, it was thought that the presence of an average of eight devices for treatment and care in patients and the fact that 67.9% of the patients were in a coma shortened the period prior to first observation of MDRPI.

Numerous risk factors are identified for the development of pressure ulcers. Advanced age, inactivity, obesity, low haemoglobin, low albumin, low BS-PPSR score, chronic diseases, used drugs, length of hospital stay, and clinic type are the factors that increase the formation of pressure injuries (Apold & Rydrych, 2012; Black et al., 2010; Delmore & Ayello, 2017; VanGilder et al., 2009). These factors also apply to MDRPI. In a study, it was determined that pressure injury risk factors such as age, gender, diagnosis, BMI, edema, diabetes mellitus, and serum albumin levels were similar for MDRPI (Black et al., 2010). In this study, it was observed that a low BS-PPSR score and high numbers of used medical devices and intensive care hospitalisation days were the factors that significantly affected the development of MDRPI. In the literature, the findings related to risk factors for the development of MDRPI differ. For example, in the study by Dang et al. (2022), it was stated that low BS-PPSR score, longer stay in the ICU, use of many medical devices, parenteral nutrition, and the presence of edema were risk factors for MDRPI. In the study by Hanonu and Karadag (2016), it was found that the development of MDRPI was 1.23 times more common in male patients, 2.07 times more common in patients connected to mechanical ventilators, 2.07 times more common in patients using anticoagulants, and 2.56 times more common in patients receiving sedation, additionally, it was found that it was 1.02 times higher with increasing age and 1.17 times higher with decreasing haemoglobin levels. In the study by Dalli et al. (2022), having compared patients with and

TABLE 4 Comparison of risk factors in patients with and without MDRPI

Characteristics	With MDRPI Median (25th and 75th percentiles)	Without MDRPI Median (25th and 75th percentiles)	Test	*p*
Age	67 (59–77)	68 (58–76)	$Z = -0.238$	.812
Glasgow Coma Scale	0 (0–10)	0 (0–12)	$Z = 0.262$	.793
The Braden Scale for Predicting Pressure Sore Risk	8 (7–18)	10 (8–19)	$Z = 3.434$	**.008***
Number of medical devices used	8 (7–11)	7 (5–10)	$Z = -2.330$	**.020***
	(*n* = 82) (%)	**(*n* = 220) (%)**		
Body structure				
Weak	1 (50.0)	1 (50.0)	$\chi^2 = 0.553$**	.907
Normal weight	36 (26.7)	99 (73.3)		
Overweight	38 (27.1)	102 (72.9)		
Obese	7 (28.0)	18 (72.0)		
State of being connected to a mechanical ventilator				
Yes	57 (27.7)	149(72.3)	$\chi^2 = 0.767$	.441
No	25 (26.0)	71(74.0)		
Nutritional status				
Oral	17 (25.8)	49 (74.2)	$\chi^2 = 2.173$	.337
Enteral	56 (29.69	133 (70.4)		
Paranteral	9 (19.1)	38 (80.9)		
Mobilisation status				
Immobile	60 (27.8)	156 (72.2)	$\chi^2 = 0.699$	.407
Mobile in bed	22 (25.6)	64 (74.4)		
Medications used in ICU				
Steroids	66 (27.2)	177 (72.8)	$\chi^2 = 0.995$	.568
Sedative	44 (28.6)	110 (71.4)	$\chi^2 = 0.572$	.332
Anticoagulants	26 (31.3)	57 (68.7)	$\chi^2 = 0.315$	.194
Number of days treated in ICU				
3–9 days	4 (4.0)	97 (96.0)	$\chi^2 = 65.942$**	**<.001***
10-19 days	49 (31.0)	109 (69.0)		
20–20 days	22 (62.9)	13 (37.1)		
30 days and above	7 (87.5)	1 (12.5)		

* $p < .05$.; ** Fisher's Exact test.

without MDRPI, it was found that GCS scores and BS-PPSR scores were lower in patients with MDRPI, the rate of patients who were applied vasopressors and needed mechanical ventilation, the length of stay in the intensive care unit and the number of devices used by the patient were higher. In other studies, it was found that MDRPI developed in male, elderly, overweight patients and patients who used medical devices for a long time and were hospitalised for a long time (Coyer et al., 2014; Martins et al., 2016). According to other studies, the fact that factors such as age, GCS score, body structure, and status of being connected to mechanical ventilator are not related to the development of MDRPI may be due to the specificity of the sample and the fact that the study was conducted in the anaesthesia and reanimation ICU.

4.1 | Limitations of the study

This study is one of the limited studies examining the development, characteristics, and risk factors of MDRPI on a large population during a one-year follow-up period in the adult ICU in Turkey. However, the research has several limitations. Due to the fact that this study was conducted on patients treated in a single ICU affiliated to a

TABLE 5 Logistic regression analysis of risk factors associated with MDRPI development

Variables	B	SE	ß	t	p value
Age	−0.001	0.001	−0.033	−0.656	.512
Glasgow Coma Scale	−0.002	0.013	−0.029	−0.167	.867
The Braden Scale for Predicting Pressure Sore Risk	−0.047	0.019	−0.098	−2.136	**.037***
Body Mass Index	−0.001	0.007	−0.007	−0.144	.786
Number of medical devices used	−0.051	0.026	−0.101	−1.978	**.049***
State of being connected to a mechanical ventilator	−0.172	0.128	−0.180	−1.338	.182
Nutritional status	0.015	0.041	0.020	0.362	.717
Mobilisation status	0.126	0.041	0.128	1.070	.286
Number of days treated in ICU	−0.036	0.003	−0.539	−10.793	**<.001***
$R = 0.550$, $R^2 = 0.283$, $F = 15.866$, $p < .001$					

* $p < .05$.

public hospital in Turkey, the findings cannot be generalised to other ICUs. Another limitation of the study is that it was not performed in other types of ICU other than the anaesthesia and reanimation. The evaluation of risk factors such as skin, consciousness, and nutrition of the patients was limited to the first evaluation and the patient was monitored in terms of the use of medical devices and the development of MDRPI in subsequent evaluations. In addition, the evaluation of the patients in terms of the development of MDRPI every other day and the fact that the evaluation was based on the observation, examination and evaluation processes of the researchers also constituted one of the important limitations. In addition, preventive measures taken by nurses working in the ICU to prevent MDRPI were not addressed within the scope of this study. Therefore, it is recommended to monitor the prevalence of MDRPI with preventive measures in subsequent studies.

5 | CONCLUSION

The findings obtained from this study provide current and important information on the development of MDRPI in an ICU in Turkey. In this study, it was determined that MDRPI developed in one of approximately four patients treated in the ICU, and the rate of development of MDRPI was still high. It was found that MDRPI, which is frequently caused by orthopaedic devices, fasteners and non-invasive ventilation/oxygen masks, develops in the head and face region. It was observed that the risk factors for MDRPI were the number of medical devices used on the patient and the number of hospitalisation days in the ICU. In this study, it was aimed to draw nurses' attention by demonstrating the development rate, characteristics, and risk factors of MDRPI in the ICU.

6 | RELEVANCE TO CLINICAL PRACTICE

Due to the characteristics of medical devices that are necessary and compulsory to use in treatment, follow-up and care, it is important that all nurses be vigilant about the possibility of developing MDRPI in the ICU. Also in this study, the high development rate of MDRPI is worrying in terms of nursing care quality. Nurses should closely monitor each patient admitted to the ICU from the moment of hospitalisation, identify risky patients and risk factors, and implement evidence-based nursing interventions in care in order to prevent the development of MDRPI. It is important for nurses to use medical devices for the patient in the ICU when necessary, to evaluate the technical suitability of medical devices, and to act in accordance with their attachment protocols. It can be realised that the needs of the patients who are expected to be hospitalised in the ICU for a long time are evaluated and prophylactic interventions are performed within the framework of cooperation with the physician. In addition, nurses' opinions on the development of biomedical products with low pressure on and less damaging to the skin can be obtained and nurses can be involved in the process to prevent MDRPI. In addition, it is recommended that a study be conducted on a larger population in different types of ICUs, and that interventional nursing studies be conducted, especially to prevent pressure injuries due to the use of orthopaedic devices, fasteners, and non-invasive ventilation/oxygen masks.

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CONFLICT OF INTEREST

The authors declared that there is no conflict of interest.

DATA AVAILABILITY STATEMENT

Data available on request from the authors;The data that support the findings of this study are available from the corresponding author upon reasonable request.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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