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RISK FACTORS ASSOCIATED WITH MEDICAL DEVICE–RELATED PRESSURE INJURIES AMONG PATIENTS IN INTENSIVE CARE UNIT, NISHTAR HOSPITAL, MULTAN

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ABSTRACT

Background: Medical device–related pressure injuries (MDRPIs) represent a critical yet often underrecognized source of patient morbidity in intensive care settings. Critically ill patients are frequently exposed to multiple invasive and non-invasive medical devices, increasing their vulnerability to pressure-induced skin damage.
Objective: This study aimed to identify the risk factors associated with the development of MDRPIs among adult patients admitted to the Intensive Care Unit (ICU) at Nishtar Hospital, Multan.
Methods: A case-control observational study was conducted over six months, involving 44 ICU patients, including 22 cases with MDRPI and 22 controls without MDRPI. Data were collected using a structured checklist assessing demographic information, clinical parameters, device type, Braden scale scores, and physiological characteristics. Logistic regression analysis was performed to determine significant predictors of MDRPIs.
Results: MDRPIs most frequently occurred in the oral cavity (36.36%), followed by the neck, arms, hands, and femoral region. Stage II pressure injuries were predominant (59.09%). Significant predictors included sedation administration ($p < 0.05$), mechanical ventilation ($p < 0.05$), edema ($p = 0.05$), GCS score ($p < 0.05$), Braden risk score ($p = 0.05$), and prolonged ICU stay ($p = 0.05$). Patients with extended hospitalization and multiple medical devices were at higher risk of developing MDRPIs.
Conclusion: MDRPIs are influenced by both device-related and patient-specific risk factors. Early risk screening using standardized assessment

tools, vigilant skin monitoring, minimizing device pressure, and timely repositioning are essential to reduce MDRPI incidence. The study underscores the need for structured prevention protocols and continuous staff education to enhance ICU patient safety.

INTRODUCTION

Pressure injuriescaused bymedicaldevicesareamajor problemin healthcare systems across the world. As a consequence of pressure, shear, or both, pressure ulcers (also called bedsores)develop inspecificareasoftheskinalongwithunderlyingtissues, oftenover abony prominence.Medicaldeviceusage, poornutrition, and immobilityarecommonrisk factorsfor these injuries. According to (VanGilder et al., 2021) these conditions often manifest on the sacrum,shoes,hips,andotherbonyprominences.Inmedicine,anytoolwithaspecific function is considered a medical device. From basic tools like tongue depressors to very complex computerized medicalequipment,theymaycover therange. Modifying thebody'sstructureor functionforhealthgoals,thesetechnologiesareusedinillnessdiagnosis, mitigation,treatment, and prevention. Critical care units (ICUs) use a wide range of technology to perform life-sustaining operations on patients, making them very demanding clinical environments. Pressure injury (PI) is a common complication of the medical equipment used inthese units. The number ofmedicaldevicesused in intensive care units (ICUs) often put critically sick patients under prolonged pressure, which may lead to medical device-related pressure disorders (MDRPI) (Temiz et al.,2024).

According to (Özyürek and Kisacik, 2024) health care facilities and patient outcomes are impacted by pressure injuries, which persist on a global scale. There was no change in the number or burden of injury due to pressure according to the World Burden of Disease Study,2017. This research confirms what many wound clinics and plastic surgeonsalreadyknow:pressureinjuriesareabig issue.The incidenceandseverityofpressure injuries decreased compared to one another from 1990 to 2017, albeit this decline was not statisticallysignificant (Siotoset al., 2022).

Nurses in the ICU performchallenging tasks. Due to their intensive atmosphere, they frequently experience stress. Their concerns include ensuring that patients and their families receive the necessary support, handling death frequently, and operating all sophisticated technologies correctly. It is also difficult forthem to focusonbecause ofhow hectic their job is and how much is going on allthe time. Sometimes, if theyare forced to performtasks that theydo not believe would benefit patients, they mayexperience guilt. The psychologicaland emotional strains that these critical care environments place on nurses highlight the need for unique coping mechanisms (Vincent, 2024).

Additional research on pressure injuries sustained in critical care units has been published recently. It found that out of 594 patients surveyed, 29% had all types of pressure injuriesover a12-monthperiod, whereas16% did not (meaning no skin loss). Fifteen percent ofallpatientshad pressure injuries caused bymedicalequipment, withelevenpercent ofthose patients suffering from classification II or worse. Medical devices such as nasogastric tubes and compression stockings were the most commonly reported in relation to pressure injuries. Lengthierstaysinintensivecareunits(OR1.06,95%CI[1.04;1.08])andvasoactivemedication infusions(OR11.84, 95% CI [1.59;88.13])weresignificantlyassociated withthe formationof pressure injuries the level II or worse (Flæten et al., 2024).

Pressure injuries caused by medical devices affected 30.6% of patients in a Temiz research, with 73.7% of those patients suffering from stage I trauma from pressure. Within 8-11 days, they

discovered that 36.8% of patients had pressure injuries caused by medical devices. The majorityof medical device-related pressure injuries were found to be caused by endotracheal tubes (61.4%), non-invasive ventilation/oxygen masks (52.6%), Foley catheters (48.1%), and nasogastric tubes (36.6%). Pressure injuries caused by medical devices were shown to be significantly influenced by patients' demographic traits ($p < .05$) (Temiz et al., 2024).
Pressure injuries were reported by 237 individuals in separate research that was carried out in2023. Pressureinjuriesusing breathing equipment accountedforasmuchas32.5percentof all such injuries. pressure injuries resulting from immobilization and support accounted for about 32.5 percent. The following causes were identified: 13.5% from feeding and nutrition, 7.6% from vascular access, 4.2% from urine catheters, 3.0% from anti-embolic devices, and 1.3% from monitoring devices (Jung, 2023).

1.2. Objectives:

- To identifytherisk factorsassociated withpressure injuries relatedto medicaldevices in intensive care patients.

1.3. ResearchQuestion:

- What risk factors are associated with developing pressure injuries related to medical devices in intensive care patients?

1.4. OperationalDefinition:

(a) Medical devices:

Medical devices will be defined as the equipment's used for diagnostic and treatment purpose that are in direct contact with skin or mucous membrane and if stayed for longer duration may lead to pressure injuries. These medical devices are endotracheal tubes, O_2facemasks,BiPAP,CPAP,nasalcannulas, splints, urinary catheters, feeding tubes, casts as well as vascular access devices.

METHODOLOGY

Study Design:
The research strategy used was an observational case-control study. A checklist included questions about the patients' demographics, clinical features, and any medical devices they had attached to their bodies. Patients in critical care units were evaluated for their potential to acquire pressure injuries using the Braden Risk Assessment scale. For participant participation, this study design uses outcome status. So, whereas some individuals (called cases) do in fact experience injuries, others (called controls) do not. The prolonged exposure in both groups is then evaluated by the investigator (Elston, 2021)

StudySetting:
Thestudywasconductedatmainintensivecareunitat NishtarHospital,Multan,Punjab Pakistan. This is a teaching hospital and the largest public hospital in South Punjab.ICU consisted of 20 beds with 2 isolation rooms.

Study Population:
The studypopulation was adult patients admitted at ICU ofNishtar Hospital, Multan with age of 18 years and older than 18 years. The study wascompletedwithin06monthsafterapprovalofsynopsis.

Sample Technique & size:
Non probability Convenience sampling of intensive care patients meeting the

selectioncriteria.Conveniencesamplingiscategorizedasanonrandomsamplingmethod where the target population bounded by time interval. Open epi software was used to calculatesamplesizeandsamplesize is44 including22casesand22controls(Omair, 2025).

Study variables:
Independentvariables:

ICU length of stay, BMI, type of admission, use of mechanical ventilation, sedation, anemia, and edema were the independent variables collected from previous literature.
Dependentvariables:

Pressureinjuries inpatientswithmedicaldevices.
DataCollectionProcedure:

ResearcherDatawasobtainedfrompatientshospitalizedtoNishtarHospital'sintensive care unit in Multan after clearance from Nishtar Medical University's synopsis editorial committeeandIERB. Followingparticipants'informedconsent, a convenience sample was used to choose research subjects based on predetermined inclusionand exclusioncriteria. We made surethat participants understoodthe study'sgoals, risks, benefits, and confidentiality of thattheir personalinformationmaintained. They were also notified of the withdrawal at the same time. At admission, researchers recorded participants' demographic information. Over the next 14 days, participants'vitalsigns were monitored, including the number ofdays they spent in the ICU, the number oftimes they were sedated, whether or not they experienced oedema, GCS, RAMSAY sedation score, and Braden risk assessment. After that, participants had been separated into two groups: those who developed pressure injuries and those who did not. Day of insertion, day of removal, location, day of pressure injurydevelopment,andstageofpressinjuryasdetermined bytheNPIAPstagingsystemwere the components that comprised the medical devices checklist.
RESULTS
4.1. Results:
Thisresearchsetouttoidentifypotentialdangersignsforintensivecareunitpatientswhocould sustain pressure injuries as a result of their medical equipment.
4.1.1. Demographicdata ofparticipants

It can be observed in Table 4.1 that 54.54% of participants were of age 18-40,36.36% were of 41to60 years,and9.09%werebetween61to80years.68.18%participantswerefemalesand31.81% were males.18.18 % participants were admitted to operation theater,31.81% to emergency,36.36% to ward and13.63%wereadmittedtootherhospital.36.36%patientsdidnothavediabeteswhile63.63% suffering from diabetes.86.36 % participants were anemic but 13.63 % were non-anemic.72.72 % patients had no liver disease but 27.27 % had liver disease.63.63% patients hadrenaldiseasewhile36.36%hadnorenaldisease.77.27%patientsweresmokerswhile 22.72 % were non-smokers.90.90% patients had history of moderate tobacco use and 9.09% patients had history of mild tobacco use.

Table4.1.Frequencyofinjurieswisedistributionofstudyparticipants(n= 22).

Variables		Frequencyofinjuries	%age
Age	18-40	12.00	54.54
	41-60	8.00	36.36
	61-80	2.00	9.09
Gender	Female	15.00	68.18
	Male	7.00	31.81
Admissiontype	OT	4.00	18.18
	Emergency	7.00	31.81
	Ward	8.00	36.36
	Other hospital	3.00	13.63
H/ODiabetes	Yes	14.00	63.63
	No	08.00	36.36
H/OAnemia	Yes	19.00	86.36
	No	3.00	13.63
H/OLiverDisease	Yes	6.00	27.27
	No	16.00	72.72
H/ORenalDisease	Yes	14.00	63.63

	No	8.00	36.36
H/OSmoking	Yes	17.00	77.27
	No	5.00	22.72
H/OTobaccouse	Severe	0.00	0.00
	Moderate	20.00	90.90
	Mild	2.00	9.09

Table4.2.TypesofattachedmedicaldevicesandrateofMRDPI.

Attachedmedicaldevice	**n=44**	**%age**
Respiratory		
ETT	22	50.00
Tracheostomy	5	11.36
O2facemask	5	11.36
Vascularlines		
Peripheralvenouslines	4	18.18
Centralvenouslines	4	18.18
Arteriallines	1	2.27
CPAP	3	6.81

Table4.3.Demographicandhealthstatusofstudyparticipants(n=44).

		MDRPI(case group)	Non-MDRPI (controlgroup)
Gender	Male	8	14
	Female	14	8
Age	18-40	17	18
	41-60	5	3
	61-80	0	1
Admissiontype	OT	4.54	27.27
	Emergency	54.50	22.72
	Ward	40.90	40.90
	Other hospital	0.0	9.09
Co-morbidities	Diabetes	17	19
	Anemia	07	12
	Liverdisease	01	05
	Renaldisease	04	08
Smoking		04	13

4.1.1. MDRPIdata

Thefollowing informationisshownintable4.4:1.0participant ofBMI18.5,12.0of18.5-24.9 BMI,6.0participantsof 25-29.9BMIdevelopedMDRPIand3.0participantsof>29.9 developed MDRPIs. While 1.0 participant of BMI 18.5,16.0 of18.5-24.9, 3.0 participants of 25-29.9and2.0of>29.9werenon-MDRPI.ForMRDPI,theaverageGCSscorewas 9.34±0.45.butfornon-MRDPI,itwas7.42±0.93.ForbothMRDPIandnon-MRDPI,the average sedation administration value was 18.0±0.95, and 15.0±0.78respectively. Both the MRDPI and non-MRDPI groups had an average oedema value of 17±0.96 and 17±0.56, respectively. While the mean values for the RAMSAY score and non-MRDPI groups were 5.70±0.69, and 3.50±0.51, respectively, the mean values for the MRDPI and non-MRDPI groups' Braden risk was 20.1±1.45, and 19.21±1.67 respectively. The longer length ofstay in the hospital

caused patients to develop MDRPI (12.0±4.0) when comparison was made with shorter stay in hospital who did not develop MDRPI (3.0±2.0).

Table 4.4.ClinicalCharacteristicsofstudyparticipants(n=44).

		DPI(Casegroup) n=22 (%age)	Non-MRDPI(Control group) n=22 (%age)
BMI	18.5orless	1	1
	18.5-24.9	12	16
	25-29.9	6	3
	>29.9	3	2
GCS		9.34±0.45	7.42±0.93
Mechanical Ventilation		19.0±2.30	15.0±1.47
Sedation		18.0±0.95	15.0±0.78
Edema		17.0±0.96	17.0±0.56
RAMSAY score		5.70±0.69	3.50±0.51
Bradenrisk		20.1±1.45	19.21±1.67
ngthof stay		12.0±4.0	3.0±2.0

According to Table 4.5 and the results, the MDRPI was anatomically positioned in the following areas: the oral cavity (n=8,36.36%), neck, left arm, right hand and femoral (n=3,13.63%) and the face (n=2, or 9.09%) as shown in Figure 4.2.

Table4.5.DistributionofMDRPIbyanatomicallocation(n= 22).

Anatomicalposition	N	%age
Oralcavity	8.0	36.36
Neck	3.0	13.63
Face	2.0	9.09
Ltarm	3.00	13.63
Rt.Hand	3.00	13.63
Femoral	3.00	13.63

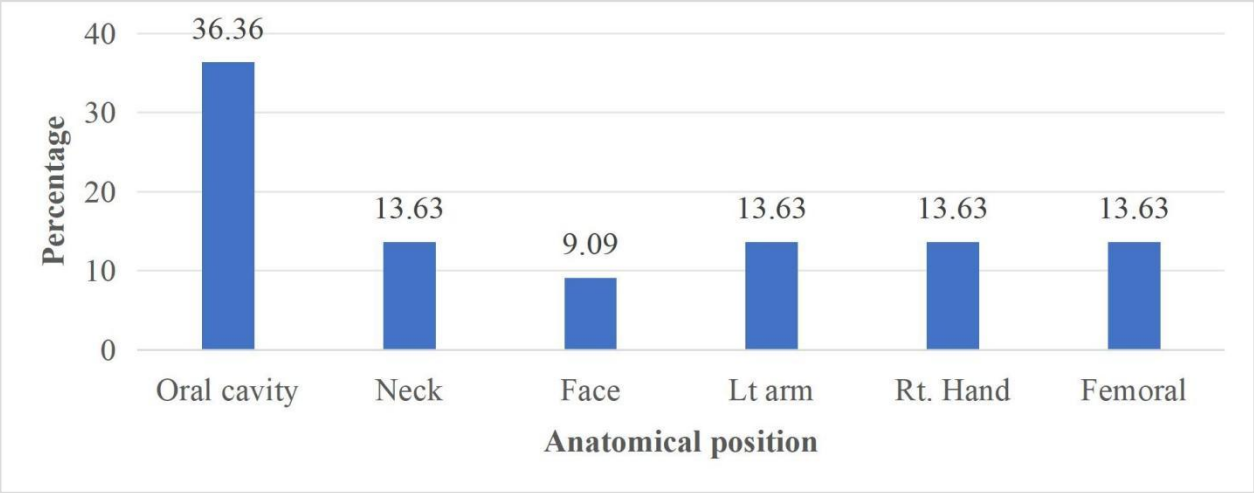

Figure4.2.GraphicalrepresentationofanatomicallocationofMRDPI.

4.1.2. Riskfactors:

The following factors were considered as potential predictors: body mass index (BMI), oedema, sedative medication, pre-existing comorbidities, mechanical ventilation, RAMSAY score,GCS score, andthe Bradenrisk score.Alogistic regressionapproachwascarried outto determinewhichcharacteristicssubstantiallypredictedtheoccurrenceofanMDRPI. Inclusion in the model was contingent upon variables meeting certain criteria, such as a Pearson's Correlation value of 0.2 or higher, a chi-square test for dependence for categorical variables, orat-testwithindependent samples for categoricaldatawithap-valueof0.05orlessrequired for statistical significance.

Six factors were included in a multivariate analysis based on the results of the univariate analyses: sedative administration (r = 0.071, p =0.001), edema (the r = 0.092, p >0.05), RAMSAY score (r= 0.065, p= 0.00), GCS score (r = 0.091, p >0.05), length of stay (r= 0.041, p= 0.05)and Braden risk score. (r = 0.378, p =0.01).

Sedation administration [Wald (1) = 17.43, p < 0.05], edema [Wald (1) = 15.21, p =0.05], GCS

score[Wald (1)=5.67,p<0.05], mechanicalventilation[Wald (1)=11.45,p=0.00]andBraden risk score [Wald (1) = 3.21, p =0.05] were the significant predictors of MRDPI as shown in table 4.6.
Table4.6.LogisticRegressionpredictingthedevelopmentofanMDRPI.

	B	S.E.	Wald	Df	Sig.	Odds ratio	95%CIfor oddsratio	
Sedation administration	0.57	0.81	17.43	1	.00	1.571	1.146	2.155
Mechanical Ventilation	0.32	0.21	11.45	1	0.00	1.117	0.883	1.543
Edema	0.76	0.43	15.21	1	0.05	0.686	0.205	2.295
RAMSAYScore	0.53	0.37	13.42	1	0.00	0.345	0.237	0.567
GCSscore	0.42	0.05	5.67	1	0.00	0.697	0.212	2.275
Bradenriskscore	0.53	0.32	3.21	1	0.05	5.4	1.372	21.26
Lengthofstay	0.23	0.31	2.45	1	0.001	4.67	0.989	9.0±1.2
Constant	21.203	2.63	.000	1	.09	16.12		

The most commonly detected MDRPIs were categorized as stage II (59.09%), followed by stage I (22.72%), stage III (13.63%), and unstageable (4.540%). PI staging differed among research participants. No deep tissue PIs or stage IV cases were reported. It is crucial to remember that severalpatients experienced multiple MDRPIs;onlythe most severe staged PI was included in this study's analysis, which could have overestimated the severity of the PIs described here.
Table4.7.DistributionofMDRPIbystage(n= 22).

Stages	N	%
StageI	5	22.72

StageII	13	59.09
StageIII	3	13.63
Unstageable	1	4.540

It can be seen in table 4.8 that there was found significant differences in BMI (0<0.001), sedation(p<0.001),edema(p<0.001),GCS(p<0.001),lengthofstay(p=0.001)andBradenrisk score (p<0.001) of MDRPI and non-MDRPI groups as p value was less than 0.001.But there was not significant differences in historyof diabetes (p=0.002),anemia (p=0.04),liver disease (p=0.05),renal disease (p=0.01),smoking (p=0.05), tobacco use(p=0.01).

DISCUSSION

Thisresearchsetouttoidentifypotentialdangersignsforintensivecareunitpatientswhocould sustainpressureinjuriesasaresultofmedicalequipment.Tracheostomy(n=22,50.00%), arteriallines,centralarteriallines, O_2 face masks, peripheralarteriallines and continuous positive airway pressure (CPAP) masks were found to be the most common causes of medical devices related pressure injuries (MDRPIs): Medical equipments were therefore exposed to patients at higher levels. 1.386% of the medical devices linked to theemergenceofMDRPI were located.O2face masks, endotrachealtubes, andtracheostomies wereamongthe1386medicaldevicesidentifiedascontributingtothedevelopmentofmedical devicesrelated-relatedcomplications(MDRPIs),whichareinlinewiththesefindings(Brophy etal.,2021).Amedicaldevicesrelatedinjuries(MDRPI)isbecomingmorecommonaspatients are exposed to more medical devices (Brophy et al., 2021).Despite the widespread use of healthcare devices in intensive care units, onlya smallpercentage ofpatients actually have an MDRPI. Therefore, from a clinical and cost-effectiveness standpoint, knowing risk factors to produce an MDRPI, evaluating for risk should be thoroughly investigated.

According to (Padula et al., 2024) respiratory devices are the leading cause of MDRPI in critically ill patients, accounting for 30% to 70% of cases. Retrospect analysis of a database which include 99,876 adult patients revealed a prevalence of PI due to ventilation that is noninvasivemasksof11.36%, whichwas lower thanprevious investigations' findingsof20% inastudyat146seriouslyillindividualsinmedical,cardiothoracic,andneurosurgicalintensive care units (Dang et al., 2022) and 50% in health care facilities in the US and Canada.

According to (Galetto et al., 2021) there is evidence in the literature that suggests invasive medical devices used in critical care increase the risk of PIs associated with use of medical devices.This study's results are in line with those of previous research showing that invasive ICU medical devices,suchasNGTsandETTs,aretheleadingcauseofMDRPIs(Rashvand et al., 2020).The available data indicatesthat medicalprofessionals must exercise more caution and attentiveness while caring for patients who have NGTs and ETTs.

Serious edema having (p =0.05),low braden(p=0.05), and Glasgow score(p=0.001) values, length of stay in hospital (p=0.01) were factors linked to injuries. There was a correlation between using more than one gadget (p<0.001) and using them for a longer duration (p<0.001).The study's conclusions that acute oedema (p = 0.005), low Braden (p>0.001) and the Glasgow score (p = 0.008) scores, duration of intensive care unit stay (p>0.001), and hospitalization diagnosis as other causes (p<0.001) were in line with these results. There was a correlation between using manydevices (p<0.001) and using them for a longer periodoftime (p<0.001).

CONCLUSION

The study's overarching goal was to catalogue the demographic and clinical features of ICU patients, differentiate between MDRPI and non-MDRPI, and to discover the variables linked to medical device-related pressure injuries in ICU patients. Intensive care unit MDRPIs and riskvariableswerebetterevaluatedinthisresearchstudy.The findingsofresearchshowedthat MDRPIdevelopmentpercentagewashigher intheoralcavityascomparedtootheranatomical location. Serious edema, low Braden score, increased BMI, length of stay in hospital, the use of many medical devices and GCS score were the main risk factors that were linked to develop MDRPI. Patients having edema and staying for longer period of time in hospital are more proneto developMDRPI.This studyshowedthepossibledifficultiesthat might develop from the useofmedicaldevices, eventhoughtheir goalistooffer appropriatetherapeutic treatment fortheseclients. Morestandardized methodologicalresearchshould beconducted inthis field to develop policies founded on protocols, risk assessments, and educational quality improvement efforts; this would assist to enhance healthcare standards, patient safety, and quality of life.

Limitations of study

This research contains a number of significant caveats. There was a lack of complete information for some factors since the data collection was based on a case-control research design. Using only one location reduces the study's external validity and generalizability. Finally, there was a lack of consideration for clinical practices that aim to prevent the emergence of MDRPI.

Implications for practice

It is believed that a higher number ofpatients likely have MDRPIs than what is recorded due to the underreporting of these conditions, which has emerged as a major concern among healthcare providers (Oweidat et al., 2023).Improving service quality, patient safety, and healthcare workers' opportunities for CPD and education depends on healthcare providers having a secure space to report incidents and having their experiences validated. Healthcare providerswillbebetterabletoevaluateMDRPIsandchoosemedicaldevicesbased on evidence to develop organizational policies, procedures, and quality improvement programs (Higgins et al., 2020).If medical device manufacturers are aware of the unique consequences of their invention, they may reevaluate it in light of these implications for practice, which might lead to an improvement in patient safety (Amrani and Gefen, 2020). Furthermore, it would be wise to create anMDRPI RAT apart fromthe prevailing pressure injury tests in order to aid healthcare providers in the evaluation and treatment of MDRPIs. Healthcare providers who evaluate the skin integrity of their patients would profit substantiallyfromarevised MDRPI RAT, whichwould incentivizethemtoregularlyevaluate and analyze the skin of those who have medical devices and enhance the identification and reporting of MDRPIs (Barakat-Johnson et al., 2020).

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