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MDRPU -an uncommonly recognized common problem in ICU: A point prevalence study

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ABSTRACT

Background: Pressure ulcers (PU) usually occur over bony prominences in hospitalized patients. But they may occur due to medical devices referred also as Medical device related pressure ulcers (MDRPU). The United States National advisory panel (NPUAP) recognizes it as an important entity. MDRPU is one of the key quality indicators of hospital care, so far no data is available on MDRPU from the Indian Sub-continent.

Aim: The primary objective of the study was to examine prevalence and Risk factors of MDRPU in critically sick patients.

Design: A Cross-sectional point prevalence study.

Methods: All patients above 18 years of age admitted in Intensive care units (ICU) on the date of the survey were included in the study. It was conducted in medical, cardiothoracic and neurosurgical ICUs. Demographic and MDRPU data were recorded. MDRPU was staged as per National Pressure ulcer advisory panel staging system. Ethics Committee approval was obtained prior to the start of the study.

Results: One hundred and forty-six patients were included. The prevalence of PU was 26.0%. The prevalence of MDRPU was found to be 19.2%. MDRPUs most commonly occurred with non-invasive ventilation mask (NIV) and nasogastric tube (NGT) (20% and 12.3% respectively). MDRPUs were associated with a longer ICU Stay.

Conclusions: MDRPUs pose a significant burden on healthcare. Our study showed significant prevalence rate of MDRPU which is comparable to those seen internationally. There is a compelling need to have continuous audits and structured training programs among healthcare professionals to prevent MDRPUs in critically sick patients.

1. Introduction

The Skin has been recognized as the largest organ of the body, but is quite often neglected. Skin breakdown is a common and unfortunate phenomenon in vulnerable hospitalized patients. This is clinically recognized in the form of pressure ulcers (PU) which may be postural, occurring due to pressure over bony prominences. PUs are found to occur across all age groups and all care settings. Occurrence of any PU can lead to mental agony and discomfort to the patient. It may easily affect the length of stay and level of care [1,2].

With the health science development and the technology/medical devices available MDRPU (medical device related pressure ulcers.) has become a new challenge, especially in ICU environment. MDRPUs have been defined as areas of localized injury to the skin or underlying tissue as a result of sustained pressure due the devices designed and applied for diagnostic or therapeutic purposes. Resultant tissue injury appears in the shape of the device and has a propensity to progress rapidly due to the minimal adipose tissue at the various sites of ulceration [3,4].

MDRPUs develop due to several reasons. Firstly, devices are usually made up of rigid material which may cause rubbing, or create pressure on the underlying soft tissue. Adhesive tapes used to secure these devices may also irritate the susceptible skin, especially in presence of edema. Secondly, these medical devices need to be secured tightly for ensuring a proper seal. This may result in creating excessive pressure on the underlying skin, which may worsen further if the patient becomes edematous. Humidity and heat between the device and the skin further deteriorates matter.

Other contributing factors are poor device selection (in terms of size

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and location), prolonged use, poor use, poor tissue oxygenation, reduced sensory perception, malnutrition and limited ability to communicate [3–5]. Preventing MDRPUs is more complex and difficult as compared to postural PUs. This is due to the fact that most of the times these medical devices are essential for survival.

MDRPU is now recognized as an important quality indicator, especially in the ICUs.The United States National advisory panel (NPUAP) has distinguished PUs related to medical devices as found on mucous membranes with history of a medical device in use at the location of the ulcer. The United States National advisory panel (NPUAP) 2014 clinical practice guidelines in fact has recommendation on identification and prevention of MDRPUs. There are several studies on MDRPU especially in ICU and pediatric population [3,4],[6–8]. However, there is a lack of data on MDRPU prevalence in India. So, the main aim of this study was to gain more insight into prevalence and risk factors of MDRPU in a tertiary hospital of Northern India.

2. Materials and methods

2.1. Sample and settings

It was a cross-sectional point prevalence study conducted at Medanta The Medicity, a 1200 bedded tertiary care hospital in Northern India. All patients admitted in intensive care units (medical, cardiovascular, neurosurgical) of the hospital were surveyed on the predetermined single day. All necessary approvals were obtained from the Institutional Ethics Committee prior to the conduct of the study. Standard informed consent was obtained from patient or patient kin prior to the data collection. The study was registered with the Clinical trial registry of India with vide Ref. No (CTRI/2016/07/007063).

2.2. Data collection

All patients above 18 years of age admitted in medical, neurosurgical, cardio thoracic ICUs were included. A three page proforma was filled by two of the investigating team members including demographics, investigations, and device related information. Both the members were fully trained in assessing/treating PUs.

Postural as well as medical device related PUs were recorded. PUs were classified as per United States National Pressure Ulcer Advisory staging system [9]. Information regarding co-existence of congestive heart failure, Chronic liver diseases, chronic kidney diseases, autoimmune diseases, prolonged steroids usage were also recorded. A note was also made of certain bio-chemical parameters like coagulation profile, serum albumin, kidney function tests and hemoglobin levels [10,11].

2.3. Statistical analysis

The analysis included profiling of patients on different demographic, clinical as well as laboratory parameters. Quantitative parameters were expressed as means and standard deviation whereas categorical data expressed as absolute number and percentage. The prevalence of MDRPU has been estimated for each medical device. The prevalence of risk factors was estimated for MDRPU. The association of MDRPUs with chronic liver disease, INR > 2, Platelet count < 100 and Hemoglobin of less than 9 g/dL were analyzed using Chi Square test. The association of ICU stay with MDRPU was studied using Student t – test. Logistic regression was used for estimation of risk. P-value < 0.05 is considered statistically significant. All analysis have been done using SPSS software version 24.0.

Table 1
Demographic details.

Characteristics	Values
Gender, n (%)	
Male	111 (76.0%)
Female	35 (24.0%)
Age(years)	57.2 ± 9.0 (Range: 16–88)
Mean ± SD (Range)	
Reason for admission, n (%)	
Medical	83 (56.8%)
Surgical	63 (43.2%)
Admission Status, n (%)	
Primary	62 (42.5%)
Secondary	16 (11.0%)
Ward Shift	68 (46.6%)
Length of ICU stay(days)	9.0 ± 9.2 (Range: 1–45))
Mean ± SD (Range)	
Co-morbidities, n (%)	
Chronic Liver Disease	13 (8.9%)
Chronic Kidney Disease	20 (13.7%)
Autoimmune Disease	8 (5.5%)
Congestive Heart failure	25 (17.1%)
Steroid Use	14 (9.6%)
Bio-Chemical Parameters, Mean ± SD (Range)	
Serum Albumin (g/dL)	3.32 ± 0.78 (Range: 1.5–4.6)
INR	1.2 ± 0.4 (Range: 0.9–2.7)
APTT (Secs)	33.1 ± 11.4 (Range: 21.2–62.6)
Platelet ("number" $*10^9$/dl)	233.2 ± 128.3 (Range: 50–691)
Hemoglobin (g/dL)	10.0 ± 1.8 (Range: 7–17.4)

INR- International Normalized Ratio, APTT-Activated partial thromboplastin time.

3. Results

3.1. Demographic profile of patients

A total of 146 patients was included in the study. Among these 111 were men and 35 were Women (Table 1). Mean age of patients was 57.2 years (± 9.0). Eighty-three patients (56.8%) had been admitted for medical reasons and remaining 43.2% for surgical reasons. Sixty-two patients (42.5%) were direct admissions to the ICU without exposure to prior healthcare facility during the current illness. Sixty-eight patients (46.6%) had been transferred from the hospital wards to the ICU. Remaining sixteen patients (11%) were transferred from ICUs of other hospitals. Average length of ICU stays was 9 days.

Of the 146 patients 38 were found to have pressure ulcers, indicating a prevalence of 26.0%. Of these 38, 10 patients had only postural ulcers, 14 had only MDRPU (Fig. 1) and 14 had both PU and MDRPU, Thus the point prevalence of PU was 16.4% and MDRPU was 19.2%.Our data showed that 28 patients had MDRPU comprised of 73.7% of the patients with Pressure Ulcers.

MDRPUs were most frequently associated with Noninvasive ventilation (NIV) mask (20%) then with Nasogastric tube (NGT)(12.3%) followed by Endotracheal tube (ETT) (7.1%), condom catheter (7.4%) and nasal prongs (8.7%){Table 2}. Frequency of MDRPU with wrist bands, Blood Pressure (B.P) cuff, tracheostomy tube fixation band, arterial line was quite low and varied between 1 and 4% (Table 2). Twenty-seven (18.5%) patients had more than one MDRPU. No MDRPUs were found related to the use of foot splints, fecal containment device, pressure stockings or cervical collar.

Twenty-four patients had stage I MDRPU; eight patients had Stage II MDRPU and three patients had suspected deep tissue injury.

3.2. Risk factors and assessment

Patients who had postural ulcers were more likely to also have MDRPUs (Chi-square value 24.29, $p < 0.0001$). Patients with Chronic liver disease (OR = 4.32, $p = 0.015$), and hemoglobin less than 9.0 (OR = 2.57, $p = 0.041$) had highest odds of having at least one

a) PU related to Ryles tube

b) PU related to Deep Venous Thrombosis Pump

c) PU associated with Arterial-Line fixation

d) PU associated with Endo tracheal tube fixation

e) PU associated with Non-Invasive Ventilation Mask

f) PU related with Identification Band

Fig. 1. MDRPUs at various sites.

MDRPU. A higher length of ICU stays was associated with presence of MDRPU (OR = 9.8, $p < 0.0001$).

4. Discussion

In our study, overall prevalence of MDRPU was 19.2%.MDRPU accounted for about half of all pressure ulcers in this cohort of patients. Stage I MDRPUs were most common though stage II MDRPUs were also found. MDRPUs were most commonly associated with the use of NIV Mask, NGT's and ETT. PUs of either types resulted in longer length of ICU stay.

In a recent study, Kayser et al. also found most of the MDRPUs to be superficial [4]. Our study showed comparable prevalence of MDRPU to several international studies. However, some studies have cited a lower

Table 2
Device related pressure ulcers.

Medical Device	Insitu (n = 146)	Total Number of Pressure Ulcers per medical device	Percentage of MDRPU per medical device (%)
NG Tube	81	10/81	12.3
Temperature probe	34	2/34	5.9
ET Tube	42	3/42	7.1
A-Line	71	1/71	1.4
Identity Bands	121	2/121	1.7
Cervical Collar	12	0/12	0.0
DVT Pump	64	4/64	6.3
Pressure Stockings	6.0	0/6	0.0
B.P Cuff	80	3/80	3.8
NIV Mask	15	3/15	20.0
TT Fixation Band	18	1/18	5.6
Foot Splint	3.0	0/3	0.0
Fecal Containment Device	1.0	0/1	0.0
Nasal Prongs	23	2/23	8.7
Condom Catheter	27	2/27	7.4

NG Tube- Nasogastric tube,ET-Endotracheal tube, A Line-Arterial Line, DVT-Deep Venous Thrombosis, B.P-Blood Pressure Cuff, TT-Tracheostomy tube, NIV-Non Invasive Ventilation.

prevalence.

Wille et al. [12] reported a frequency of 5% of pressure ulcers related to the use of pulse oximeter in a surgical ICU. In 2009 Van Gilder et al. reported a prevalence of device related ulcers of 9.1% in a huge acute care database of 86,932 patients [13].

Black et al., in 2010, found medical devices to account for 34.5% of PUs among 2079 hospitalized patients [3]. Hanonu S et al., in 2016 who conducted a prospective study in MDRPU in an adult ICU. Out of 175 patients, 70 patients developed MDRPU (40%) and it was found to be most commonly associated with ETT [14]. In a latest prospective study from Australia Baraket Johnson et al. reported an overall prevalence of MDRPU of 27.9% among hospitalized patients. MDRPUs occurred most frequently behind ears, and on the mouth due to oxygen tubings and ETT respectively [15]. Hobison et al., in 2017 reported prevalence of graduated compression stockings (GCS) associated injuries in surgical ICU's [16]. About 22% of patients were found to have MDRPU related to GCS that accounted for about 74% of all MDRPUs.

Majority of the studies regarding MDRPU have been conducted in pediatric population. There have not been many studies conducted exclusively in adult ICU settings.

Curley in a prospective study had found an overall incidence of ulceration with medical devices to be 27% in pediatric ICU more common with oxygen saturation probe, bi-level mask and ETT [17] Ayer et al., in 2011 studied the prevalence of MDRPU over 11 months in a long term acute healthcare setting. MDRPU was found to account for 44% of all hospital acquired PUs [18], especially in pediatric population. The next most extensive work was published by Apol and Rudrych in 2012. They conducted the study in pediatric age group in a hospital in Minnesota. Nearly a third of serious PUs were due to medical devices. Majority of them were related to the use of cervical collars, oxygen tubings, and NGT. Significant proportion also occurred on the foot secondary to use of immobilizers and support stockings, etc. [19]. Visscher et al., 2014 in their neonatal ICU showed the numbers of PUs secondary to medical devices was 80% overall [20].

We did not have any cervical collar related pressure injury because of only few patients were using it. In 1995,Davis et al. however reported an incidence of cervical collar related pressure ulcers of 33% approximately [21].

Apart from these prevalence studies there has been research on preventive strategies as well.

Correct positioning of endotracheal tubes with regular assessment of underlying skin was found to be effective in reducing MDRPU by Aplod and Rudrych in 2012 and Boesch et al., in 2012 [19,22]. Many investigators have found use of thin hydrocolloids, or film dressings to be effective in reducing the moisture, friction and shear underneath the device, thereby decreasing MDRPUs [23,24]. Large et al., in 2011 found use of pressure reducing dermal gel pads effective in reducing MDRPUs [25].

Long Beach memorial miller children's and women's hospital, CA developed a pressure ulcer prevention model in 2013. They were able to reduce the incidence of MDRPUs in neonatal and pediatric ICU's. A reduction of 0.6% to zero of stage III MDRPU per 1000 patient days occurred in pediatric age group. In adult the incidence decreased from 0.28% to zero [4].

In 2013,Visscher et al. [26] found reduction in MDRPUs through the use of a team in pediatric ICU's. Similarly in 2015 Coyer et al. [27] reported that regular skin assessment and other preventive measures helped in preventing pressure injuries in ICU settings.

Recently Karadag et al. published their data on nursing staff perceptions and interventions to prevent device related injuries. Twenty percent of nurses were unaware of the fact that medical devices could also lead to ulcer formation. Most common interventions used by nurses were loosening devices at least once in every shift and checking their correct positioning. Clearly there was a need for a structured in house training program [28]. Jaul et al., in 2011 found that increasing level of awareness of MDRPUs among the nursing staff helped in taking better care of patients [29].

4.1. Implications for practice

Since we found a significantly high prevalence of MDRPU in our set up, we need to take effective preventive steps. Formalizing a MDPRU Bundle and regular staff training may be an effective step in this regard.

Regular teaching sessions for nursing staff regarding MDRPUs should be adopted as the standard of care. Regular assessment of underlying skin, padding under the devices and proper positioning of devices over injured skin should be emphasized. Their compliance needs to be regularly audited. Collaboration between all health care providers is essential to develop a solution to this pressing issue. We also need to identify, if there is a risk between any particular device, its frequency and depth of underlying tissue involved. Medical devices are used for patients benefit, and all effort should be made to minimize any harm associated with them.

4.2. Study limitations

Since ours was a point prevalence study, it had some limitations linked to its very design. We could not prospectively follow up the patients. The exact date of onset of MDRPU could not be captured, we did not gather information on the incidence of MDRPU. We also did not record whether postural ulcers were acquired before or after ICU admission. We had two members of investigating team involved in actually capturing the data clinically, this may also be regarded as a limitation as we did not record the inter rater reliability data.

The data from this study needs to be validated in a larger multi centric study as it was a single center study. There is a need to conduct research on preventive strategies as well.

5. Conclusion

This study reaffirms that MDRPU is a significant iatrogenic problem in healthcare settings. There is a need to explore specific devices in relation to their unique risk. Future research is required to illuminate the duration for which a device can be safely placed, before it is moved or removed to examine the underlying skin. There is a need for frequent assessments and timely observations. Education and training of nursing staff remain essential to its successful prevention and early detection.

Newer, better and less damaging materials used either in manufacturing or securing these medical devices need to be invented. Implementation of preventive strategies and their regular adherence are of utmost importance in tackling this clinical problem.

Competing interest

The authors declare that they have no competing interest in the completion of the study.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jtv.2018.12.002.

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