

A Retrospective Cohort Study of Incidence, Progression and Management of Pressure Ulcers in Spinal Cord Injury Patients in a Tertiary Care Spinal Cord Injury Center

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Abstract

Study Design: Retrospective Cohort study.

Objectives: To analyze the incidence, prevalence, characteristics and treatment outcomes of pressure ulcers (PUs) in Spinal cord injury (SCI) patients.

Setting: A Tertiary care center in Western India dedicated to provide acute care and rehabilitation to Spinal cord injury patients.

Patients & Methods: Incidence and characteristics of PUs in 79 in-hospital adult patients aged between 16 – 55 years with SCI were studied through retrospective clinical records of admitted patients from 30 May 2018 to 26 Oct 2022 and prospectively thereafter till 27 Jun 2024. Ulcer characteristics were recorded on a daily basis throughout the hospitalization period. NPIAP guidelines for prevention and management of PUs were meticulously enforced. Appropriate wound care, antibiotic therapy, physiotherapy, NPWT and surgical interventions were carried out in an evidence-based manner. Only those in-hospital-spinal-cord- injured (SCI) patients were included in the study whose historical clinical records had been maintained by referring hospitals as per NPIAP guidelines. Patients admitted with spinal injuries without cord involvement & those whose clinical history had been recorded in an arbitrary fashion were excluded from the study. The collected data was Statistically analyzed.

Results: Patients with Neurological impairment of ASIA Grade A or B, or Quadriplegia tended to have already developed PUs by the time of admission and a greater number of PUs overall, they also showed a tendency to develop grade 3 or 4 PUs and to require Plastic surgical flap cover procedures. Patients who had already developed a grade 3 or 4 PU by the time of admission tended to develop another grade 3 or 4 PU after admission. Increasing lengths of in-hospital stay tended to increase the number of PUs. It was observed that significantly greater number of Grade 2 PUs occurred in the pre admission period as compared with Grade 1, Grade 3 or 4 PUs. After admission at this center significantly greater number of Grade 1 PUs were observed as compared with higher grades.

1. Introduction

Currently, the NPIAP (National pressure injury advisory panel) defines a pressure injury as localized damage to the skin and

underlying soft tissue, usually over a bony prominence or related to a medical or other device [1]. PUs are common among individuals with a spinal cord injury (SCI) due to varying degrees of sensory

and motor impairment. PUs occur when the external pressure exceeds the venous capillary closing pressure (8-12 mm Hg) & the capillary occlusion pressure (32 mmHg). While supine the sacrum, heel, and occiput bear pressures of 40-60 mm Hg. When prone, the chest and knees absorb about 50 mm Hg pressure. In the sitting position the ischial tuberosities bear pressures of up to 100 mm Hg. These locations are more prone to developing pressure sores [2–5].

Some Retrospective studies have reported the incidence of PUs among SCI in-patients as ranging up to 69.2% [6]. Other studies have reported an incidence ranging from 31.5 to 56% [3,7]. One prospective cohort study described a prevalence of 36.5% during the acute phase immediately after sustaining injury, and 39.4% during the initial rehabilitation [9]. The hip and buttock regions are known to account for up to 70% of all pressure injuries, with ischial tuberosity, trochanteric, and sacral locations being most common [10]. Muscle tissue is known to be especially susceptible to pressure injury [11]. The goal of our study was to study and statistically analyze PU characteristics in SCI patients right from the Date of injury, through the post operative period, on admission at this center and during the in-hospital post admission stay at this

center.

2. Patients and Methods

A total of 79 admitted patients were studied during the period from 26 Oct 2022 till 27 Jun 2024. 36 patients were studied retrospectively from 30 May 2018 onwards (date of injury of longest admitted patient). 43 patients in the studied population were admitted in the center after the start of the study. NPIAP guidelines were meticulously enforced for all admitted patients. Prior to admission all 79 patients had already undergone Neurosurgery for spinal stabilization at various tertiary care centers in India, this period was defined as Acute phase of injury (Pre hospital, Neurosurgery, emergency care). After admission at this center, they were deemed to be in the Rehabilitation phase. Only those in-hospital-SCI patients were included in the study whose historical clinical records had been meticulously maintained by referring hospitals as per NPIAP guidelines. Patients admitted with spinal injuries without cord involvement and those whose clinical history had been recorded in a sporadic fashion were excluded from the study. We used the Standardized pressure injury prevention protocol (SPIPP) checklist for our study.

Unit	Standardized Pressure Injury Prevention Protocol Checklist (SPIPP-Adult) 2.0	Date
ITEM	Completed Yes/No	COMMENT
Assess risk factors for pressure injury to guide risk-based prevention		
Significant current or anticipated mobility problems		
Use a structured risk assessment approach (e.g., Braden or other validated risk tool) on admission		
Reassess risk q shift and with significant change in condition		
Patient/family informed of PI risk and prevention plan		
Additional risk factors considered: Previous PI __, Localized pain __, Diabetes __, Poor perfusion __, Vascular Dx __, Oxygenation deficits __, Increased Temp __, Advanced Age __, Spinal cord injury __, Neuropathy __, Surgery/procedure duration > 2 hrs __, Critical Illness __, Organ Failure __, Sepsis __, Mechanical vent __, Medical devices __, Sedation __, Dark skin tone		
Assess Skin/Tissue for signs of skin damage and pressure injury		
Assess skin (comprehensive, visual, palpation) upon admission and q shift for erythema, discoloration, edema, and temperature		Location(s):
Assess skin under medical devices q shift		Device(s):
Inspect heels q shift		
In people of color: Ensure adequate lighting and moisten/moisturize skin to augment visual inspection		
Consider enhanced skin assessment methods: thermography, SEM, skin color chart		
Preventative Skin Care - Manage moisture/Incontinence		
Avoid use of alkaline soaps/cleansers		
Consider urinary/fecal management systems for high-risk persons		
Single layer, breathable, high absorbency pads for incontinence		

Consider using low friction textiles		
Apply wicking material to skin folds when appropriate		
Redistribute Pressure		
Turn/reposition q 2-3 hours persons who do not have independent bed mobility and as required by individual needs and risk, unless contraindicated (Braden Activity/Mobility score ≤ 2)		
Use high specification reactive foam or reactive air mattress/overlay for immobile persons (Braden Activity/Mobility score ≤ 2)		
Use positioning aids that minimize friction/shear (pillows, wedges). Use turn/lift equipment if available.		
Proper side-lying position with upper leg over/in front of lower leg		
Keep head of bed as flat as possible		
Place silicone multilayer foam dressings on areas of high-risk (i.e., sacrum, lower buttocks, or heels) (Braden Activity/Mobility scores ≤ 2)		
Elevate heels off bed with pillows, heel devices or boots (Braden Sensory Perception score < 3)		
Use a 30 degree turn off the sacrum, ensuring that the sacrum is off-loaded. Position upper leg forward of lower leg and support it with pillow.		
Use slow, gradual, frequent, small body shifts when unstable		
Use pressure redistributing seat cushion for persons who cannot adequately reposition independently		
Reposition seated persons q 1 hour		
Consult Physical Therapy for mobilization program when appropriate (Braden Activity/Mobility scores < 2)		
Consider reminder systems, pressure mapping, motion sensors		
Implement early mobilization program		
Nutrition		
Screen for malnutrition using a validated tool on admission		
Consult dietitian for persons at or at risk of malnutrition, decreased nutrient intake, NPO > 48 hours or presence of stage 2 or greater PI (Braden Nutrition Score ≤ 2)		
Provide additional calories, protein, fluids, and additional nutrients (i.e. multi-vitamin, arginine, glutamine, HMB) per nutrition plan of care or as appropriate		
Continue to regularly reassess goals and consult dietitian as needed		

Patients were classified as having sustained a higher grade of injury if their neurological status was ASIA injury severity A or B. For the purpose of comparison and analysis subgroups were created based on neurologic deficit, Grades of PU and requirement of Plastic surgery. Comparison was carried out between and among the different subgroups using Pearson's and Spearman's correlation coefficient, T-test and ANOVA [12].

3. Observations & Analysis

Patient ages ranged from 16 to 55 years. There was only 1 female patient in the studied population, the rest were male. 63% (50) patients had sustained SCI due to Road Traffic accidents while 37% (29) sustained SCI due to fall from a height. There were 20 Quadriplegics and 59 Paraplegics in the studied population. 35 patients had ASIA neurology A/B and 44 had ASIA neurology

Grade C/D/E. 18% (14) patients had developed PUs within a week of SCI, 38% (30) before the end of the second week after SCI & 53% (42) by the end of the first month after injury. 47% (37) patients developed PUs later than 1 month after injury.

3.1. PUs on admission: All patients at the time of admission to this center had one or more PUs. 1% (1) patient had only one grade 1 PU. 56% (44) patients had grade 2 bed sores only. 32% (25) patients had only grade 3 or 4 bed sores. 14% (11) patients had both grade 1 & 2 PUs. 22% (17) patients had grade 1, 2, 3 and 4 PUs. 35% (79) of the PUs on admission were grade 1. 54% (123) were grade 2 and 11% (25) were grade 3 or 4. For Grade 3 or 4 PU, Gluteal and Sacral regions were the most common location - 92% (23). A total of 227 PUs were observed on admission.

3.2. PUs after admission: All except 3% (2) patients developed new onset PUs after admission. 47% (37) patients developed only grade 1 PUs. 25% (20) patients developed both grade 1 & 2 PUs. 24% (19) patients had grade 1, 2, 3 and 4 PUs. A total of 380 new onset PUs were observed after admission, of which 66% (249) were grade 1, 29% (112) were grade 2 and 5% (19) were grade 3 or 4. The Ischial regions were most commonly involved with Grade 3 or 4 PUs – 63% (12), followed by the Sacral region – 37% (7).

3.2. Treatment modalities: 94% (573) of a total of 607 PUs healed with conservative management (NSAIDs, antibiotics, daily dressing). 30% (24) patients required Reconstructive flap cover surgery. 43% (34) patients needed Vacuum assisted closure techniques for healing of PUs

3.3. Correlation Analysis (Table 1): -

Factors that correlated positively with the tendency to have already developed PUs and specifically Grade 3 or 4 PUs by the time of admission; a greater number of PUs overall and the tendency to

require Plastic surgical procedures: -

- Patients with ASIA neurology of A/B
- Patients with quadriplegia
- Factors that correlated positively with the tendency to develop PUs after admission: -
- Patients with ASIA neurology of A/B
- Patients with quadriplegia
- Increasing lengths of in-hospital stay
- Factors that correlated positively with the tendency to develop a grade 3 or 4 PU after admission: -
- History of presence of a grade 3 or 4 PU at the time of admission
- Patients with ASIA neurology of A/B

There was almost no correlation between the time from injury to onset of first bed sore & presence of Grade 3 or 4 PU on admission. Similarly, the presence of quadriplegia and the tendency to develop a grade 3 or 4 PU after admission did not show significant association.

ANOVA comparing number of Pre admission Grade 1 (G1), 2 (G2) & Grade 3 or 4 (G3,4) PUs		
Tuckey HSD Comparisons	HSD _{.05} = 0.3899	Q _{.05} = 3.3357
G1: G2	0.56	Q = 4.77 (p = .00253)
G1: G3, 4	0.68	Q = 5.85 (p = .00015)
G2: G3, 4	1.24	Q = 10.61 (p = .00000)
f-ratio value was 28.254, p-value was < .00001 & the result was significant at p < .05.		
ANOVA comparing number of Post admission Grade 1 (G1), 2 (G2) & Grade 3 or 4 (G3,4) PUs		
Tuckey HSD Comparisons	HSD _{.05} = 0.5918	Q _{.05} = 3.3357
G1: G2	1.73	Q = 9.78 (p = .00000)
G1: G3, 4	2.91	Q = 16.41 (p = .00000)
G2: G3, 4	1.18	Q = 6.64 (p = .00001)
f-ratio value was 68.149, p-value was < .00001 & the result was significant at p < .05.		

ANOVA Analysis (Table 2):

Significantly greater number of Grade 2 PUs occurred in the Acute phase as compared with Grade 1, Grade 3 and Grade 4 PUs. Significantly more Grade 1 PUs were observed when compared with grade 3 or 4 PUs before admission. After admission in the center significantly greater number of Grade 1 PUs were observed as compared with higher grades. Significantly greater number

Grade 2 PUs were observed as compared to Grade 3 or 4 PUs in the rehabilitation phase.

T Test Analysis: Significantly greater number of PUs occurred after patients got admitted in the center than before admission. The t-value was 4.33. The p-value was .000013. The result was significant at p < .05



Figure 2: Grades of PU



Figure 3: VY Gluteal flap for Sacral PU

PEARSON CORRELATION COEFFICIENT AT $p < 0.05$			
R value	R ² value	P value	Interpretation
Higher ASIA grading correlated with No of PUs			
0.6708	0.45	< .00001	Strong positive correlation
Higher ASIA grading correlated with No of PUs before admission			
0.68	0.46	< .00001	Strong positive correlation
Higher ASIA grading correlated with No of PUs after admission			
0.52	0.27	< .00001	Moderate positive correlation
Higher ASIA grading correlated with requirement of flap surgery			

0.74	0.55	< .00001	Strong positive correlation
Quadriplegia correlated with No of pressure sores			
0.33	0.11	.003	Weak positive relationship
Quadriplegia correlated with No of pressure sores before admission			
0.31	0.095	.006	Weak positive relationship
Quadriplegia correlated with No of pressure sores after admission			
0.28	0.08	.013	Weak positive relationship
Quadriplegia correlated with requirement of flap surgery			
0.25	0.06	.027	Weak positive relationship
Days since admission correlated with No of bedsore after admission			
0.64	0.41	< .00001	Moderate positive correlation
Correlation between the time from injury to onset of first PU & presence of Grade 3 or 4 PU on admission			
-0.002	0	.986043	Very weak negative correlation.
Correlation between ASIA grading and presence of Grade 3 or 4 PU on admission			
0.76	0.58	< .00001	Strong positive correlation
Correlation between Quadriplegia and presence of Grade 3 or 4 PU on admission			
0.23	0.05	.04	Weak positive correlation
SPEARMAN CORRELATION COEFFICIENT AT p<0.05			
Rho value	P value (2-tailed)	Interpretation	
Correlation between ASIA grading and presence of Grade 3 or 4 Bedsore on admission			
0.76	0	Positive correlation	
Correlation between Quadriplegia and presence of Grade 3 or 4 Bedsore on admission			
0.23	0.041	Positive correlation.	
Correlation between ASIA grading and presence of Grade 3 or 4 Bedsore after admission			
0.63	0	Positive correlation	
Correlation between Quadriplegia and presence of Grade 3 or 4 Bedsore after admission			
0.22	0.054	No significant association	
Correlation between presence of a Grade 3 or 4 PU at the time of admission & developing another Grade 3 or 4 PU after admission			
0.699	0	Positive correlation	

Table 1

ANOVA comparing number of Pre admission Grade 1 (G1), 2 (G2) & Grade 3 or 4 (G3,4) PUs		
Tuckey HSD Comparisons	HSD _{.05} = 0.3899	Q _{.05} = 3.3357
G1: G2	0.56	Q = 4.77 (p = .00253)
G1: G3, 4	0.68	Q = 5.85 (p = .00015)
G2: G3, 4	1.24	Q = 10.61 (p = .00000)
f-ratio value was 28.254, p-value was < .00001 & the result was significant at p < .05.		
ANOVA comparing number of Post admission Grade 1 (G1), 2 (G2) & Grade 3 or 4 (G3,4) PUs		
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G1: G2	1.73	Q = 9.78 (p = .00000)
G1: G3, 4	2.91	Q = 16.41 (p = .00000)
G2: G3, 4	1.18	Q = 6.64 (p = .00001)
f-ratio value was 68.149, p-value was < .00001 & the result was significant at p < .05.		

Table 2

4. Discussion

In the present study it was observed that all 79 (100%) patients developed at least 1 PU in the Acute post injury phase (Pre-hospital, neurosurgical, emergency care setting) & 77 (97%) of 79 patients developed at least 1 PU after hospitalization at this tertiary care center. This is in contrast to other studies which have reported a PU incidence of up to 69.2%, 47% in the acute phase and 34% - 38% in the acute and rehabilitation phase [13-15]. This discrepancy may have resulted from strictness in documenting even the smallest grade 1 or grade 2 PUs. 37% of the total PUs observed during this study occurred during the acute stage and 63% occurred during the post admission rehabilitation phase. This is in contrast to some studies which reported a greater incidence of PUs in the acute phase than in the rehabilitation phase [15,16]. This may be attributed to the present study spanning 7 years retrospectively. 11% of the PUs observed during the acute phase were grade 3 or 4 (most commonly gluteal and sacral), as compared with 5% during the rehabilitation phase (most commonly ischial followed by sacral). 66% PUs developed in the rehabilitation phase were Grade 1. About 94% of all PUs observed in the present study healed well with conservative methods.

Like in other studies, patients with ASIA A/B neurological impairment were found to have a propensity for developing Higher number of PUs & progression to higher grades of PU, both in the acute and rehabilitation phases. Higher Neurological impairment grades – ASIA A/B and quadriplegia tended to be associated with higher grades of PUs which required NPWT and plastic surgical interventions for complete healing [17-19]. All patients in the present study belonged to the young and middle age group and there was only one female in the studied group, therefore the correlation of PUs with advanced age or gender was not conducted. In this regard other studies have reported an increase in PU occurrence with increasing age and male gender [20-21]. Female gender was found to be positively correlated with developing PUs by one study [22]. In the present study increasing lengths of in-hospital-stay tended to increase the occurrence of PUs. Similar findings have been reported by other studies [23]. It was observed during the present study that patients who had developed Grade 3 or 4 PUs during acute phase, tended to develop grade 3 or 4 PUs again in the rehabilitation period too.

5. Conclusion

This study showed that all patients of SCI tend to develop at least 1 PU in the early and rehabilitation phases. 94% of PUs in this study healed well with offloading strategies & conservative measures. Higher grades of Neurological impairment (ASIA A/B, Quadriplegia) tended to be associated with Grade 3 or 4 PUs which tended to require NPWT and Plastic surgical flap surgery. ASIA A/B neurology and Quadriplegia were associated with a greater number of PUs overall. SCI patients who developed grade 3 or 4 PUs in the Acute phase, tended to develop grade 3 or 4 PUs in the rehabilitation phase as well. Patients admitted for prolonged periods of time tended to develop more PUs. The results of this study highlighted the importance of careful Observation & meticulous documentation of occurrence, progression and

management of PUs and showed that adherence to NPIAP guidelines for PU prevention increases the chance of diagnosing and addressing early PUs, which may otherwise go unnoticed.

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