Journal Africain de Chirurgie Orthopédique et Traumatologique

African Journal of Orthopedics and Traumatologic Surgery

safoonline.org

ISSN 2519-9560

J Afr Chir Orthop Traumatol 2019; 4(1):2-60

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Editions Universitaires de Côte d'Ivoire

La Société Africaine de Chirurgie Orthopédique (**S.Af.O**) est une société conçue à Abidjan (Côte d'Ivoire) le 25 janvier 1995 et fondée à Casablanca (Maroc) en avril 1997.

Les buts de cette association sont de faire progresser la science et l'art de l'orthopédie, d'entretenir, de développer, de soutenir et d'encourager les échanges d'expérience professionnelle et de promouvoir également l'amitié parmi ses membres.

La SAfO regroupe tous les pays africains sans exclusion. Les langues officielles sont l'anglais et le français.

L'objectif général de son journal officiel est de **promouvoir** et **diffuser** la recherche en Orthopédie-Traumatologie en Afrique.

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- ***développer*** *les échanges scientifiques entre chercheurs Africains,*
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The African Orthopaedics Society (**Af.S.O**) is a scientific society initiated in Abidjan (Côte d'Ivoire) in January 25th, 1995 and officially founded in April 1997 in Casablanca (Morocco).

The goal of this society is to develop orthopaedics sciences and art in Africa by creating, promoting, helping and encouraging professional experiences shares and friendship between its members.

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Correspondant du journal | The Journal Correspondent
Prof. SIE Essoh Jean Baptiste
J Afr Chir Orthop Traumatol
UFR des Sciences Médicales d'Abidjan, Université Félix Houphouet Boigny
BP V 166 Abidjan - RCI
Mail: safojournal@gmail.com, (carbon copy) siessoh@yahoo.com

EDITION & DIFFUSION

Editions Universitaires de Côte d'Ivoire (EDUCI)
Université FHB Abidjan-Cocody BP V 34 Abidjan 01
educiabj@yahoo.fr

ISSN 2519-9560

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JACOT AJOT
Le Journal Officiel de la Société Africaine d'Orthopédie (SAFO)
The Official Journal of the African Society of Orthopaedics (AFSO)

Review Article [In English]

Pelvic pressure injuries

Escares pelviennes

AMOUZOU Komla Sena[1], MALONGA-LOUKOULA Elodie Lucrece Joyce[2]

[1] University of Lomé, Department of Surgery, Sylvanus Olympio teaching hospital, Lomé, Togo
[2] Hassan II University Casablanca, Department of Plastic and Reconstructive Surgery, Ibn Rochd Hospital, Casablanca, Morocco.

ASTRACT

Pressure injuries are defined as localised injuries to the skin and underlying soft tissue typically occurring over a bony prominence or under a medical implant and in response to external pressure or pressure in combination with shear. The pelvic area is most prone to developing pressure injuries. Spinal Cord injury, intensive care unit stay and all physical conditions that lead the patient to remain in bed or become bed/chair-bound are the core factors in the occurrence of pressure injuries. Diagnosis and care for pressure injuries have shown to be a substantial cause of burden to patients and significantly impact health-related quality of life thus a source of frustration for both patients and caregivers. Many terms were used to describe the condition but the NPUAP has harmonised the classification and definition. Therefore, only pressure injury and stages are used in the description of the disease. Intrinsic and extrinsic factors well known are associated with pressure injuries occurrence. Complications arise mostly as infection that can be local or systemic begging for urgent local or parenteral antibiotherapy. Prevention can be very successful but the complexity and intricacy of factors will inevitably lead some patients to develop pressure injury. Regular position change, use of a variety of support surfaces as pressure relieving surfaces and other nursing protocols are not always feasible. The curative treatment is often debridement, dressing and surgical coverage. All aspects of the reconstructive ladder are used from the simplest to the most complex procedure. Nevertheless, a high rate of recurrence characterizes pelvic pressure injuries with the highest rates encountered in the ischial pressure injuries.

Mots-Clés: Decubitus ulcers ■ National Pressure Ulcer Advisory Panel ■ Pressure injury ■ pelvic area ■ Pressure sore ■

RÉSUMÉ

Les escarres sont définies comme des lésions localisées de la peau et des tissus mous sous-jacents survenant typiquement sur une protubérance osseuse ou sous un implant médical et en réponse à une pression externe ou en combinaison avec des mécanismes de cisaillement. La région pelvienne est la plus prédisposée à développer des escarres. Les lésions de la moelle épinière, un long séjour en réanimation, et d'autres conditions qui conduisent le patient à garder le lit ou le fauteuil sont les facteurs principaux de la survenue des escarres. Le diagnostic et le traitement des escarres ont démontré être d'un important impact sur les patients avec un cout significatif sur qualité de vie ainsi qu'une source de frustration pour le personnel soignant. De nombreux termes ont été utilisés pour décrire l'affection, mais le NPUAP a harmonisé la classification et la définition. Par conséquent, différents stades sont utilisés dans la description de la maladie en rapport avec l'extension en profondeur. Des facteurs intrinsèques et extrinsèques bien connus sont associés à la survenue de escarres. Des complications surviennent principalement comme une infection qui peut être locale ou systémique requérant une antibiothérapie locale ou parentérale en urgence. Le traitement des escarres est catégorisé en mesures préventives et curatives. Le traitement chirurgical est fait de détersion chirurgicale, de pansements et de chirurgie de couverture. De nombreuses complications post-opératoires précoces et de récidive à long terme caractérisent la chirurgie des escarres. La prévention peut être réussie, mais la complexité des facteurs conduit inévitablement certains patients à développer des escarres. Le changement régulier de position, l'utilisation d'une variété de surfaces d'appui, et de soins infirmiers ne sont pas toujours réalisables. Le traitement curatif est souvent le débridement, le pansement, et la chirurgie de couverture. Tous les degrés de l'échelle dans l'arsenal de la chirurgie reconstructive sont utilisés de la plus simple à la plus complexe. Néanmoins, un taux élevé de récidive caractérise des escarres pelviennes, les escarres ischiatiques ayant le taux le plus fort.

Keywords : Escarres ■ National Pressure Ulcer Advisory Panel ■ Région pelvienne ■ Ulcère de décubitus ■

Corresponding Author: Dr. Komla Sena Amouzou (alain.amouzou@gmail.com)

INTRODUCTION

Multiples factors impact the integrity of the skin including age, microclimate, medications, general condition of the body, and other medical conditions as diseases[1]. Among these factors, some will be responsible for prolonged bedrest, or lead the patient to become bed or chair-bound. Some others will be responsible for faecal or urine incontinence creating wet skin. Degradation of the general condition with malnutrition, anaemia, and weight loss impacts the patients' ability to control and maintain an upright position and normal mobility. Pressure injuries are part of the complications of local and systemic deterioration of the human system. Pressure on the skin and soft tissue trapped between bony prominences and the surface (bed, chair, medical or other devices), added to shearing forces are responsible for the capillary occlusion that can result in skin and soft tissue necrosis[2-10]. Pressures injuries are frequent complication in ICU patients and patients with spinal cord injury (tetraplegic or paraplegic)[2-10]. Less commonly, surgeries of long duration are also associated with pressure injury[12]. The overall incidence of pressure injuries across the globe ranges from 7% to 71.6%, and a prevalence of 8.8% to 53.2% with a geographic distribution[12-17]. Pelvic area (sacral, ischial, and trochanteric areas) is the body parts more regularly prone to develop pressure injuries[12,13,15,16]. The diagnosis of pressure injury is based on the American National Pressure Ulcer Advisory Panel (NPUAP) classification and is recognized worldwide with the most recent update of the classification in 2016[18]. The intricacy and complexity of factors associated with pressure injuries make the management not always standardised. This treatment is associated with early post-operative complications and a long-term high rate of recurrence increasing the hospital stay and cost of care. Recurrence rates up to 49% for ischial pressure injuries and 21% for sacral pressure injuries has been reported[19]. The considerable length of time to healing increases the morbidity and cost of treatment associated with pressure injuries. In the UK, Gerry *et al*. reported that pressure injuries were responsible for 4% of total national health system expenditure accounting for 1.4 to 2.1 billion British pounds annually[20]. Similarly, Filius *et al*. in Netherlands found that the direct cost related to the treatment of pressure injuries were high and depends on the site and the stage[21]. In the US, Wentworth *et al*. found an approximate cost of 2.2 to 3.6 billion United States Dollars (USD) added to an increase of morbidity, psychosocial, pain and reduction of mobility associated with pressure injuries[3]. Occurrence and care for pressure injuries are highly frustrating for both patients and caregivers. Therefore, diagnosis and care for pressure injuries have shown to be a substantial cause of burden to patients and significantly impact on health-related quality of life[22].There is a vast array of literature about all aspects of pressure injuries. Nevertheless, the great part of this literature is from western countries. African literature about pressure injuries is weak and data from many countries are still not reported. This publication based on a comprehensive literature aimed to provide a review and synthesis of knowledge concerning pressure injuries in a structured framework from definition, classification, risk factors, to the treatment.

1- DEFINITION

Pressure injuries are defined as localised injuries to the skin and underlying soft tissue, usually occurring over a bony prominence or under a medical or other device, in response to external pressure or pressure in combination with shear. Many terms have been used to name the disease. Along the literature, terms as pressure sore, pressure injury, decubitus ulcer, bed sore are encountered and used interchangeably[2,18]. In 2016, the NPUAP of the US has attended a consensus conference in which some modifications have been introduced in the definition of previously named pressure ulcers[18].Therefore, the term ulcer and sore has been abandoned and replaced by injury. This move has been justified by a better understanding of the pathophysiology of the condition. An ulcer literally means a necrosis that can be superficial or deep. Thus, it was determined that the term ulcer does not accurately describe the physical presentation especially in stage 1 and Deep Tissue Pressure Injuries [18]. Following this move of the NPUAP, the worldwide literature has started harmonising the definition in recent publications.

2- EPIDEMIOLOGY

2.1- Prevalence and incidence

Incidence of pressure injuries greatly vary across geographic positions. Approximately 412,000 individuals are diagnosed with pressure injuries annually in the UK with an incidence of new pressure injuries in long-term care ranging 12–13% annually, while a number of 2.5 million annually has been reported in the US with the incidence of 0.4 to 38%, and the prevalence was 10-18%3,20. In other Western countries, the prevalence ranges 0.3% in Czech Republic[23] to as high as 6.9% in France[24] and 25% in some settings in the UK[25]. In Africa the condition is generally under-reported. Higher than what is reported in Western countries the prevalence varies from one country to another and in the same country from one centre to another. In Nigeria, the incidence reported ranged from 13 to 22%[14,15,26] while Joseph reported a 50.3% incidence in spinal-injury patients in South Africa[7]. Ayodele Lyn *et al*. pointed that in the 20% incidence observed, 47.7% presented pressure injuries after admission[27]. One other contrast between the North and the South is the age of the patients with PI. While it has been reported that as many as 50% of patients presenting pressure injuries in the US were above 65-year-old, a similar condition is seen in other European countries where most of patients with pressure injuries are found in elderly homes and intensive care

unit[3,23,25]. In the other hand, in Africa and other low and middle-income countries, the age of patients is younger and patients involved were mostly victims of road traffic accidents and civil violence[7,14,15,26-29].

2.2- Aetiology and pathophysiology

The term "pressure injury" suggests the primary cause to be a force over the skin and soft tissue producing damage ranging from skin redness to deep ulceration. In fact, immobility is the major cause of pressure injuries. Because of sensory loss in spinal injury patients and patients intubated in ICU, impaired mobility is related to impeding the reflex to change a resting position when tissues start lacking blood flow[2]. According to the NPUAP, pressure alone is not sufficient to define the pressure injury. It should be associated with a mechanism of shear and friction to be called a pressure injury[18]. The effect of ischemia produced by pressure is far more harmful to muscles and subcutaneous tissue than to the skin. In experimental studies conducted in domestic pigs, a pressure of 200 mmHg for 16h or 600 mmHg for 11h was required to produce a full thickness skin necrosis. In contrast, pressures of only 60-78 mm Hg for 1-2 h caused muscle fibres to degenerate[29,30]. Inter compartmental measures of pressure under bony prominences, such as the sacrum and greater trochanter, found pressure of 100-150 mm Hg in normal healthy subjects lying on a regular hospital mattress. In pathologic conditions, such pressures are sufficient to occlude capillaries thus, decreasing transcutaneous oxygen tension to nearly zero[30]. At this stage, no skin ulceration will be observed especially if the duration of the compression is short. Elderly subjects are characterized by thin and little subdermal fat. Therefore, the pressure and time required to develop pressure induced ischemia or pressure injury formation are quite reduced. Pressure shares its' detrimental effects along with shearing. Shearing forces are created in conditions such as when the head of the bed is elevated and the patients slides toward the lower part of the bed. The result is that the skin over the sacrum or ischium stay in the same plane as the bed while the subcutaneous tissues and underlying blood vessels are stretched and angulated creating an occlusion of these blood vessels. The same phenomenon can be observed in chair-bound elderly or paraplegic patients over the ischium. It has been reported that shearing forces in these patients were three times those of healthy young adults, and local blood flow was significantly reduced despite a contact pressure which remain the same. Increased friction to the skin result in the dissociation between the upper layer of the skin (epidermis) and the deeper layer (dermis). In addition, moisture increases the friction between the skin and the support surface. Moisture decreases or even inhibits the normal epidermal vapour loss. This results in maceration and breakdown of the superficial layer of the epidermis, rending the skin vulnerable to various noxious agents. It is worth noticing that a superficial pressure injury would not have a systematic linear evolution toward a deep injury. Nevertheless, superficial skin ulceration that are solely due to maceration without the involvement of pressure or shear should not be classified as pressure injuries.

3- CLASSIFICATIONS

The new NPUAP classification adopted in 2016 has gained international widespread acceptance. The classification was based on recent clinical knowledge on the pathophysiology and clinical presentation of pressure injuries which made the need for a new classification of pressure injuries clear. In the new NPUAP classification, stages replace the grade, and Arabic numbers are now associated with the stages[18]. **Table I** reports the different stages and their clinical characteristics.

A light has been shed on one typically underestimated cause of pressure injuries; medical devices applied for diagnostic or therapeutic purposes and other devices are clearly responsible for pressure injuries as well. Injuries related to medical-devices and other devices are staged using the same staging system. In order to perform an accurate visual assessment, pressure injury staging should take place only after the wound bed has been debrided[18]. Wounds with persistent eschar and undebrided slough making it difficult to assess the extent of the injury are classified as unstageable injuries. Mucosal membrane pressure injuries are not in the scope of this paper. Nevertheless, one should know that this staging system cannot be used to stage mucosal membrane pressure injuries.

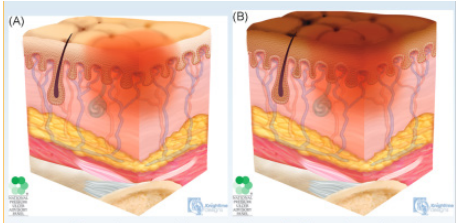
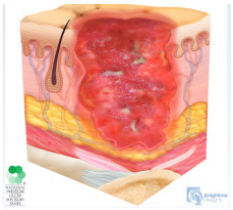
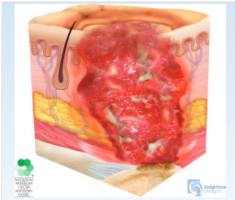
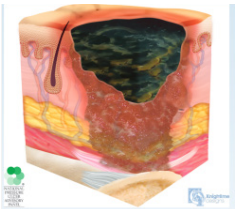
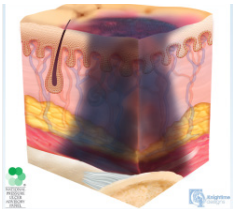
4- RISK FACTORS

4.1- Extrinsic factors

Pressure, shear, friction, and moisture are the body part of the extrinsic factors associated with pressure injuries. Pressure and shear are factors that define pressure injuries on the zones of bony prominence[2,3,18]. Friction and moisture are conditions that are usually factors that impede the skin intactness and the balanced repartition of pressure over the body of the bed or chair in bed and chair-bound patients. Duration and amount of pressure on the soft tissues over bony prominence result in different tissues injuries as earlier mentioned in the pathophysiology chapter. Muscle fibres, subcutaneous tissues, and dermis are damaged from a lower to a higher pressure. Shear force, are defined as force parallel to the skin surface. The superficial layer of the skin remains in the same plane as the supporting surface while the deep tissues glide on the direction of the gravity. Consequently, capillaries are stretched and get more prone to obstruction by constriction creating a deprivation of blood supply, nutrients and lack of evacuation of wastes of the normal metabolism. Friction may be responsible of local injuries to the skin on the areas of pressure over bony prominence. Moisture is a detrimental factor that potentiates the role of pressure, friction, and shear, and is associated with a higher rate of infection. Other risk

factors include medical devices and other devices used on the purpose of diagnosis or treatment[10]. Therefore, devices such as anti-embolism stockings and saturation probes[31] can be a cause of pressure injuries when the skin over a bony surface remains in prolonged contact with them.

Table I: Pressure injuries classification according to National Pressure Ulcer Advisory Panel[18] (Reproduced with permission)

	Description	Illustration
Stage 1	Intact skin with a localized area of non-blanchable erythema, which may appear differently in darkly pigmented skin. Not include purple or maroon discoloration	
Stage 2	Partial-thickness loss of skin with exposed dermis. The wound bed is viable, pink or red, moist, and may also present as an intact or ruptured serum-filled blister.	
Stage 3	Full-thickness skin loss, in which adipose (fat) is visible in the ulcer and granulation tissue and epibole (rolled wound edges), is often present. Slough and/or eschar may be visible	
Stage 4	Full-thickness skin and tissue loss with exposed or directly palpable fascia, muscle, tendon, ligament, cartilage, or bone in the ulcer. Slough and/or eschar may be visible. Epibole (rolled edges), undermining, and/or tunneling often occur	
Unstageable	Full-thickness skin and tissue loss in which the extent of tissue damage within the ulcer cannot be confirmed because it is obscured by slough or eschar.	
Deep tissue pressure injury	Intact or non-intact skin with localized area of persistent non blanchable deep red, maroon, purple discoloration, or epidermal separation revealing a dark wound bed or blood-filled blister.	

4.2- Intrinsic factors

These factors include immobility, urinary or faecal incontinence, malnutrition, hypoalbuminemia, dehydration, impaired circulation/underlying vascular disease, neurologic dysfunction, ICU stay, use of mechanical ventilation, advanced age, sepsis, hypotension, chronic or terminal illness, and previous history of pressure injuries. Any clinical condition that impairs the microcirculation places the patient at increased risk of developing pressure related injury. Malnutrition and hypoalbuminemia have been reported to be independent factors associated with PI[32,33]. However, it is more likely that some of these intrinsic risk factors represent factors that contribute to immobility and, therefore, in a combination of extrinsic factors, increase the risk of developing pressure injuries .

4.3- Risk assessment scales

Many assessment tools based on these risk factors have been developed to identify patients at risk of developing pressures injury and in need of vigorous surveillance and preventive care. The most verified to date include the Norton Scale, the Gosnell Scale, the Waterlow Scale, the Braden Scale, the Cubbin and Jackson Scale, and the Risk Assessment Pressure Sore Tool[34]. According to studies, the Braden scale has proven to have the highest sensitivity/specificity ratio followed by the Norton scale and the Waterlow scale, respectively[35-38]. In a meta-analysis study conducted by Pancorbo-Hidalgo *et al*.,the Braden scale has shown the optimal validation with a sensitivity/sensibility balance of 57.1%/67.5% respectively (odds ratio =4.08, CI 95%). The Norton Scale showed 46.8%/61.8%, 82.4%. The Waterlow scale showed a high sensitivity (82.4%) but a low specificity (27.4%)[35]. Many western centers have reported the difficulty for nurses to record accurately the risk assessment scales for all patients because of the important workload, fatigue and shortness of nurses in the hospitals[2]. There is a dearth of publication about this topic in African centres. Nevertheless, the well-known situation of scarcity of specialised-nurses, lack of interest of physicians for chronic wounds, and poorly recorded data may predict a high hindrance in patients' assessment for pressure injuries. No publication has evaluated the impact of using these scales in African patients. Nevertheless, Courtey *et al*. evaluated the Braden scale in black and Spanish ethnic groups in the US. These authors found that the Braden scale with a cut-off score of 18 was highly associated with predicting black elders aged 75 years and older who were at risk of developing PI (p--< .011) with a sensitivity of 81% and specificity of 100%[39]. The simple use of clinical judgement has proven to be the worst predictive tool[35,37]. Geographic adapted scales using modified Braden, Norton, Waterlow or combination of them have been developed, many of them have never crossed the gate of the hospitals where they are in use[34,36].

5- CLINICAL ASSESSMENT AND DIAGNOSIS

It is of paramount importance to obtain a complete medical history of the patient. The duration, prior treatment, and progression of the injury must be recorded. All potential risk factors that could lead to the formation of pressure injury or prevent proper healing of existing injuries must be recorded. An assessment scale must be used for every patient especially those in intensive care unit and those with spinal injuries. General condition of the patient must be assessed and recorded. Thus, anaemia, malnutrition, oedema, other pathologic conditions must be clearly and quantifiably documented.

A comprehensive skin examination should be performed on admission and daily. This should include a careful assessment for existing pressure injuries in addition to any findings that could suggest the patient is at risk of forming a pressure injuriy. The initial assessment is done during the admission. This assessment includes localized heat, oedema, discoloration, induration, erythema or skin becoming darker tone in pigmented skin population. All skin findings should be documented thoroughly in the patient's case sheet and be readily accessible to all care providers. Measure of the size of the ulcer is done by a linear measurement of the length and width. Use a paper tape for that purpose is helpful. The depth of the wound is gauged by a gloved finger. Avoid traumatic devices that can lead to bleeding especially in patients taking anticoagulators. Staging of pressure injuries are done according to the new NPUAP staging system (**Table I**)[18]. The staging is based on the extent of the tissue damage. An understanding of anatomy is essential when evaluating the type of tissue present in the wound (**Table I**). Signs of complications (warm, discoloration of surrounding skin, discharge, odour, fever) should prompt a local or systemic antibiotherapy. It is capital to confirm the presence of pressure and/or shear as a causative factor. Only pressure injuries should be staged with the NPUAP classification. Other ulcers or soft tissue injuries where the aetiology is not PI should not use the NPUAP classification. Finally, when labelling a PI, use correct anatomical terms to identify its location on the body and include describing anatomical sites: "sacral pressure injury stage 3" for instance.

6- COMPLICATIONS

Infection is one major concern in the care of pressure injuries. Infection presents as local infection (skin and soft tissue infection, osteomyelitis), or distant leading to bacteraemia that can be associated with severe sepsis[2,12]. It is known that all pressure injuries stage 2, 3, and 4 are colonized with bacteria Gram-Negative, Gram-Positive, anaerobic, and yeast. Polymicrobial colonisation is often seen12. Local colonisation is not infection and should not require any specific action. Therefore, no local or systemic antibiotic is systematically required[2].

However, a critical colonisation can impede the wound healing. It has been reported that poorly healing wounds of PI indicates the presence of gram-negative bacilli (*pseudomonas, providencia* spices), and anaerobics (*Bacteroides* and *Clostridium* species)[12]. Swab cultures of pressure injury wounds can be misleading. Blood cultures, deep tissue biopsy, and needle aspirations give more accurate documentation of infection. Non-healing wounds can also be associated with osteomyelitis. Up to two third of stage 4 pressure injuries are associated with osteomyelitis[40].

Serial radiographs can reveal the bone infection. A specific triad for osteomyelitis includes elevated sedimentation rate, hyperleucocytosis, and abnormalities on the plain radiograph. Nevertheless, a bone biopsy is the key investigation to confirm osteomyelitis. CT scan, Tc99M and Gallium 67 scintigraphy have not shown a reliable specificity in detection of bone infection. The presence of fever, delirium, redness, induration, oedema of the peri-ulcer skin, warm, malodorous discharge that can be a frank pus, and hyperleucocytosis are signs of infection that should prompt a local or systemic antibiotherapy. In elderly patients, the absence of fever or other typical signs of infections can lead to a missing of the diagnosis of infection. In this population, a shift from the baseline physical status must prompt thorough investigation. Mortality rates from infections in pressure injury is up to 50%. Additionally, bacteraemia may lead to infective endocarditis, meningitis, or mycotic aneurysms. Probabilistic antibiotherapy followed by narrowed spectrum antibiotics after documentation of the infection is the rule. Finally, tunnelling, and neoplasm degeneration have been found in chronic non-healing pressure injuries wounds.

7- TREATMENT

Treatment of pressure injuries can be divided into two categories. The first category is for preventive management where all extrinsic and intrinsic risk factors have to be managed to avoid the occurrence of pressure injuries. The second category is for management with the aim to provide a wound healing and avoid complications when the condition has already developed.

Among wound healing strategies, there are the wound cleansing, the dressing, and the final coverage. Appropriate pain management is very important[2,12].

7.1- Prevention

Prevention should target the risk factors identified on each patient. A solution must be found for each of the risk factors.

7.1.1- Positioning

Positioning has been proven to be so successful in preventing pressure injuries that the US Medicare and Medicaid has included pressure injuries on the list of hospital-acquired conditions for which additional reimbursement is not provided[9,18,41]. Patients should change position preferably every 2 hours when in bed and every 15 min when they are in a chair[9,12,41]. Turning schedules include shifts to supine and oblique positions. The 30-degree left and right oblique positions are useful to prevent trochanteric injuries[18]. To minimize shear, the head of the bed should not be elevated above 30 degrees. An exception to this rule is time after meal.

7.1.2- Pressure relieving devices

The goal of pressure relieving devices are to lower the pressure exerted on the patient as low as 35 mmHg[12]. Standard hospital mattresses are not suitable for that purpose. Overlays, special mattress, and customized beds are used to achieve this requirement. Two types of support surfaces can be identified. These are the static devices and the dynamic ones. Mattress can be composed of gel, foam, air, or water. One must be careful about ring cushings that can be associated with venous congestion[41]. Support surfaces alone do not always prevent pressure injuries. Support surfaces must be associated with positioning and other measures such as wrinkleless drapes and use of under pads. Whenever possible, it is important to encourage ambulation and rehabilitation.

7.1.3- Skin care and moisture prevention

Regular inspection of skins over bony prominences of patients at high risk is an effective way to detect early changes in skin tone and address all aggravating factors. Deal with excessive moisture by regular cleaning with soap and lukewarm water and use of under pads and moisture barriers. Moisturizing cream should be applied on a dry skin. Nevertheless, massage should be avoided as it can lead to superficial skin ulceration[18]. Prophylactic use of polyurethane and hydrocolloid dressing has been described to be effective in preventing pressure injuries[42]. Preventive tools have proven to have drastic reduction in hospital-acquired pressure injuries[1,9]. With frequent repositioning, hygiene, dignity, and functional ability, some authors argue that pressure injuries could be totally preventable diseases[43]. Nevertheless, given the clinical complexities and constellation of comorbidities commonly encountered in today's healthcare environment, it is reasonable to state that not all pressure injuries are avoidable or preventable[1,18,44]. Some patients will inevitably develop pressure injuries that will need proper treatment.

7.2- Curative treatment of pressure injuries

7.2.1- Non-operative treatment

Nutrition

Numeral modes of nutritional support have not proven their efficiency in accelerating healing of pressure injuries. Adequate daily diet of 30-35 cal/Kg body weight/day is required including 1.25 to 1.5 g/Kg body weight of protein3,12,33. Supplementation with diverse minerals and vitamins (Vitamin C, Zinc) has given controversial results in patients without a prior deficiency[2,12,33].

Pain control

Patients especially those without neurologic impairment present a constant pain that need to be assessed using scales of pain evaluation (visual analog pain scale, or Wang-Bakers faces pain rating scale). In children and cognitively impaired elderly patients, pain may be difficult to assess. It is essential that analgesia be considered during dressing changes and particularly during bedside debridement, as well as during rehabilitation sessions. Use of occlusive dressings and proper positioning equally contribute to alleviate pain.

Wound cleansing

Normal saline and potable water have been identified by many authors as effective solution for wound cleansing[2,12,18,41]. Most of antiseptic agents (eg, Dakin's solution [ie, diluted sodium hypochlorite], acetic acid, povidone iodine, hydrogen peroxide, iodophor, neomycin sulfate, and chlorhexidine gluconate) despite there in-vitro bactericidal affect, are not recommended. They are cytotoxic to healthy tissue. These agents present possibility of developing skin allergy, and emergence of resistant germs in the wound[2,33]. However, use of antiseptics is recommended when there are debris in the wound, when there is a highly suspected infection, or when there is a documented infection[3]. Cleansing solution should be used with enough pressure to provide effective irrigation. The skin surrounding the wound must be cleaned accurately.

Dressings

The basic principle in wound dressing is to keep the wound bed moist and isolate the wound from ambient germs and other agents. Most of the internationally accepted dressings are based on the wound exudate and the nature of the wound bed[2,12,18,42,43]. For mild to moderately exudative wounds, hydrogels and moist saline dressings can be used; for wounds with heavy exudates and possible maceration of normal skin around the wound, foams, alginates, and saline-impregnated gauze are recommended. **Table II** presents a list of most used dressings. All so-called modern dressings are based on the principle of occlusive dressing. In fact, occlusion influences both epidermal resurfacing and dermal repair. Exposing wound to ambient air is taking the risk of inflammation, pain, itching, scabs' formation, infection, altogether factors of wound healing delay. Packing of wound intend to obliterate dead space and prevent abscess formation[4]. Another tool for wound dressing is the application of negative pressure wound therapy. Despite the attraction provided by this tool in modern wound care era, on the basis of a systematic assessment of controlled trials, negative pressure therapy has not proven to be more effective than various control intervention. Nevertheless, negative pressure therapy in our experience was effective for wound bed preparation before flaps or free skin grafts.

Infection control

As aforementioned, bacterial colonisation does not necessarily need any special measures.

The National Institute of Clinical Excellence (NICE) of the UK does not recommend the routine use of topical antimicrobials or antiseptics. Use of systemic antibiotics are justified in the presence of documented infection, but not to treat a positive wound culture if signs of infection are absent[18]. If present however, an infection needs to be documented and treated accurately, timely, and thoroughly. Signs of infection include erythema, edema, foul odor, purulent discharge, fever, and deterioration of the general condition. Up to 2 weeks of topical use of antibiotics (Silver sulfadiazine, gentamicin) is necessary to control local infections. Suspected or documented bacteremia should prompt systemic antibiotherapy. In addition to all measures, health care staff must use universal hand cleaning protocols that comprise hand washing with soap and hand sanitisers. Use of sterile instruments and gloves for debridement is important as well.

Adjunctive therapy

Several therapies that have been used but are, as of yet, unproven in benefit for the treatment of pressure injuries include topical application of gold, phenytoin, aloe vera gel, growth factors, and other agents; use of systemic agents (eg, vasodilators, fibrinolytic agents, growth hormone); hyperbaric oxygen therapy; and infrared, ultraviolet and low-energy laser treatment. Of these proposed adjunctive therapies, only electrotherapy of wounds has shown any benefit but is associated with an increase of cost of care for the pressure injury patient[3,41].

7.2.2- Operative treatment

Debridement

Debridement is the removal of necrotic tissue and foreign bodies in the wound to promote the formation of granulation tissue. Several methods of debridement are available, as such the approach should be tailored to the patient's condition and amount of necrotic tissue present. **Table III** illustrates different types of debridement, and their mechanism. Although there are no data to support the practice of debridement for pressure injuries, it is widely admitted that epidermal growth and wound resurfacing happen on a clean wound surface. However, based on studies conducted on other types of wounds, most clinical guidelines support debriding necrotic, devitalized tissue in wound beds of PI wounds[18,41].

Coverage

Superficial wounds will be covered by spontaneous epidermal cell growth and migration. Most deeper wounds will need a surgical assistance for closure. Reconstruction of the pressure injury wound follows the reconstructive ladder. Surgical reconstruction ranges from the simplest procedure to the most complex one; direct suture, split skin graft, and a variety of flaps. Flaps often used comprise of local cutaneous flaps, fasciocutaneous flaps, local musculocutaneous flaps, regional flaps, and free flaps depending on the extent and location of the injury.

Table II: Types of debridement, description and indication

Type of debridement	Description	Indication
Sharp surgical	Use of blades of other devices to remove necrotic tissue from the wound bed and provide a stimulus for healthy tissue growth.	cellulitis, stage 3 or 4 with slough or necrotic tissue
Mechanical	Removes both necrotic and healthy tissue with the dressing. This include wet-to-dry dressing, ultrasound debridement, hydro dissection.	Delayed debridement in fragile patients for whom surgery is not an option
Enzymatic	Application of topical proteolytic/fibrinolytic enzymes (streptokinase, streptodornase, trypsin, or similar enzymes) that selectively target necrotic tissue by dissolving necrotic debris	Debridement where surgery is not an option and where these products are available
Autolytic	Capitalises on the body's own healing process by using occlusive dressings that create an optimal environment for breakdown of necrotic tissue	Slow debridement in fragile patients in non-infected wounds where surgery is not an option
Bio surgery, Maggot	Application of larvae (L Sericata) (which produce proteolytic enzymes) to the wound bed in addition to the secretion of proteolytic digestive enzymes that dissolve necrotic tissue, Secretion of various cytokines and tissue growth factors that increase local tissue oxygenation.	Delayed debridement in fragile patients where surgery is not an option Infected wounds with resistant bacteria
Deep tissue pressure injury	Intact or non-intact skin with localized area of persistent non blanchable deep red, maroon, purple discoloration, or epidermal separation revealing a dark wound bed or blood-filled blister.	

Table III: Commonly used dressings, principles and indications

	Compound and Principles	Indications
Hydrogel	A gel base of 90 % water in suspension Assists in providing the appropriate amount of moisture to assist the wound with healing	Autolytic debridement Promotion of granulation and eventually full healing of non-infected ulcers.
Hydrocolloids	Gelatin of sodium carboxymethylcellulose held within an adhesive compound, which is laminated in place on a foam or film, generally made of polyurethane. Absorbent, flexible wafer waterproof and self-adhering highly absorptive, maintain a moist environ for the wound.	Uninfected partial or full thickness skin loss (stage 2 and 3). Low to moderate drainage wounds. Granular and necrotic wounds Autolytic debridement.
Alginates	Made of sodium and calcium fibers derived from seaweed. Alginates are able to absorb up to 20 times their own weight.	Infected wounds of stage 2, 3 and 4. Wounds with tendency to bleed. Heavy drainage wounds.
Transparent films	Made up of Transparent film waterproof and impermeable to bacteria and contaminants, provide a moist, healing environment that promote autolytic debridement.	Partial-thickness wounds (Stage 2) with no or minimal drainage. Protection for intact skin, Debridement of eschar (Stage 3). Secure another dressing.
Foams	Semipermeable polyurethane foam Non-adherent and non-linting Hydrophobic or waterproof outer layer Provides moist wound environment Permeable to water vapor but blocks entry of bacteria and contaminants	Stage 2 or 3 as primary or secondary dressing wounds with minimal to heavy drainage. Granulating and epithelialising wounds.

	Compound and Principles	Indications
Hydrofibers	Non-woven pad or ribbon dressing composed of sodium carboxymethylcellulose. Creates a moist wound environment. Promotes absorption and retention. Protects peri-wound skin and reduces maceration. Balances the inflammatory response. Minimizes pain during wear and at dressing change. Provides a long-period wear time	Stage 2, 3 or 4, Heavy drainage infected wounds. Wounds with sinus and important cavity.
Paraffin gauze	Low-adherent polyethyleneglycol or paraffin impregnated tulle incorporating an antiseptic (e.g.: chlorhexidinegluconate, iodine) in some presentations.	Granulating or epithelization wounds
Sugar and honey dressings	Sugar or honey (sterilized honey), reducing edema, lowering wound pH, and debriding slough and eschar.	Stage 2, 3, 4 infected wounds with slough and necrotic tissue for which surgery is not an option.
Wet gauze	Soaking gauze or cotton in saline that is placed on the wound. As the sponge dries, it will dry out the wound around it as well, helping to debride it (Mechanical debridement).	Stage 3 or 4, Wounds with slough and necrotic tissue in absence of other solution for mechanical non-selective debridement.
Negative pressure wound therapy	Use of foams or gauze, in closed wound dressing sealed by transparent film, under negative atmospheric pressure to promote wound granulating and healing	Stage 3 or 4 non-infected wounds with low to moderate drainage. Granulating and epithelization wounds.

Pre-preparation for surgery of coverage

Surgery of pressure injuries may be doomed to failure if underlying initiating factors are not addressed before the procedure. The patients and his/her attendants have to be educated in position changing, nutrition, control of fecal or urine incontinence. The psychologic status of the patient has to be assessed and managed. The expectations of the patient are paramount to consider as well.

7.3- Indications

Most of the procedures described for pressure ulcer surgical coverage has been done in young patients[12]. Nevertheless, age is not an absolute contraindication to surgery for pressure injuries. The possibility for the patient to observe pre and post-operative requirements for surgery, the benefits and risks of surgery, as well as the patient's life expectancy, comorbidities, and expectations should be considered. Stages 1 and stage 2 usually heal without the need for a surgical reconstructive procedure while stage 3 or 4 are more likely to require a surgical coverage[8,16,18,46]. Numerous other indications for surgical treatment include persistent wound infection, osteomyelitis, systemic sepsis or bacteremia, very large surface of ulceration, recurrent discharge from sinus or fistula, excessive fluid or protein loss through the wound, malignant degeneration, and development of amyloidosis[47].

Surgical reconstruction should only be considered after an adequate preparation of the wound bed (cleansing and debridement). The final reconstruction method should obliterate all dead space and achieve a tension free closure using well vascularized tissue in accordance with basic reconstructive surgical principles. In addition, suture lines should be kept as much as possible away from zone that could be future pressure points.

Choice of flaps

- Sacral stage 3 and stage 4 injuries, gluteus maximus muscle-based musculocutaneous V-Y advancement flap and gluteal artery perforator-based fasciocutaneous V-Y advancement or rotation are the first line reconstruction methods[16,48-50]. **Figure 1** represents a sacral pressure injuries stage 4 covered after debridement with a bilateral V-Y advancement gluteal fasciocutanous flaps.

- Ischial stage 3 and stage 4 pressure injuries are primarily closed with a gracilis muscle-based musculocutaneous rotational flap, posterior thigh V-Y advancement flap, and gluteal artery perforator-based fasciocutaneous V-Y advancement or rotation flaps[16,46,51,52].

- Trochanteric stage 3 and 4 pressure injuries are more likely closed with a muscle-based musculocutaneous V-Y advancement or rotation flap of tensor fascia lata[16,46,47]. **Figure 2** shows a trochanteric pressure injury stage 4 debrided and covered with a rotational musculocutaneous tensor fascia lata flap.

Fig:1 : 1A=Stage 4 Sacral pressure; **1B**:=Negative pressure wound therapy, **1C=**presentation after the negative pressure wound therapy; **1D**=Coverage with a double VY advancement fasciocutaneous gluteal flaps

Fig:2 : 2A=Stage 4 trochanteric pressure injury; **2B**=Intra-operative tensor fascia lata rotational flap; **2C**=Early post-operative aspect; **2D=**Follow-up after six months.

Some authors advocate for the need of preserving reconstructive options for future surgeries in case of recurrence. Therefore, these authors successfully used the distal part of the gluteus maximus muscle for the treatment of ischial pressure injuries[53,54]. However, in our experience, the gluteus maximus flap may fall short in larger ischial ulcers. Perforators flaps are believed to be the future for the reconstruction surgery of pelvic PI for their minimal donor site morbidity, their versatility, and their reliability. Therefore, a pedicled anterolateral thigh flap have been reported for the coverage of a trochanteric pressure injury[55]. The gluteal based perforator flaps have been reported with low rate of post-operative complications and low recurrence rate in sacral and ischial pressure injuries[13,46,56]. Table IV shows the commonly used flaps for sacral, trochanteric and ischial pressure injuries.

Table IV: Indication of flaps toward different sites of pressure injury

Site of pressure injury	Flap options
Sacral	Inferiorly based cutaneous rotation flaps VY advancement or rotation cutaneous, fasciocutaneous flaps Pedicled superior gluteal artery perforator fasciocutaneous flaps Gluteus maximus musculocutaneous V-Y advancement flap
Ischial	Direct suture Posterior thigh flaps with or without harmstring Gluteal thigh flap Inferior gluteal muscular or musculocutaneous flaps Tensor fascia latafasciocutaneous flap Gracilis musculocutaneous rotational flap, Gluteal artery perforator-based fasciocutaneous V-Y advancement or rotation flaps
Trochanteric	Tensor fascia lata musculocutaneous VY advancement of rotation flap Vastus lateralis muscular or musculocutaneous flap Inferior gluteous maximus musculocutaneous flap Anterior thigh flap Antero-lateral thigh flap

Use of the underlying muscle

Whether the underlying muscle should be used in stage 3 and stage 4 PI is still a matter of debate. Filip *et al.* in a comparative study of fasciocutaneous and musculocutaneous flaps reported no significant differences in early complications, no statistical differences in PI recurrence. In addition, the type of flap used was not associated with postoperative morbidity or recurrence in the univariate and multivariate analyses[57]. Yuhei *et al.*[19] however, found that the group of the pressure injuries reconstructed with the fasciocutaneous flap demonstrated significantly or marginally significantly better results in the percent survival (total of ischial and sacral, $p = 0.0155$; ischial, $p = 0.0555$) compared to pressure injuries reconstructed with myocutaneous or muscle flaps. They concluded that the fasciocutaneous flaps provide better post-operative results than myocuatenous flaps. In further support of fasciocutaneous flaps, Diaz *et al.* recommended not to use the muscle in ambulating patients[8].

Care for the exposed bone

What to do for the exposed bone is controversial as well. Some authors argued that bone excision removes bony prominences and prevents recurrences[47,58]. However, in our experience, bony debridement is useful only in the presence of clinical or laboratory evidence of infection. In the setting of joint infection, though, especially with septic hips related to trochanteric injuries, require joint resection and amputation[5,51].

Schedule and plan for surgery

Patients with multiple sites classically may require several stage surgeries. Nevertheless, a one stage approach has been reported in patients with more than 2 sites of pressure injury with good post-operative results59. However, such procedure requires rigorous nursing in the post-operative setting.

7.4- Post-operative care

Postoperatively, a pressure-free environment and adequate rehabilitation is essential for success in the treatment. Ambulation should be encouraged and pressure releasing devices used in patients with spinal cord injury. It is critical that patients avoid lying on the site of the reconstruction before the wound is stable, a period that can take up to 15 days in our experience. Repositioning and all preventive tools are necessary to avoid recurrence on new sites. Dressing changes are done according to the clinical evaluation. Pain control during this period remains very important and should not be minimized. Antibiotics are used only in case of evident systemic infection.

7.5- Results and outcome

Surgery of pressure injuries is associated with a high rate of complications and recurrence that depend mainly on the site of the injury, the patients' condition, a body mass index lower than 18.5, active smoking, and diabetes[13,60]. Early complications include suture line dehiscence, hematoma, seroma, infection, and early flap necrosis. Among all pelvic pressure injuries, ischial pressure injuries have the highest rate of recurrence ranging from 8 to 64% in the literature[51]. Recurrence of other pressure injuries present as recurrence up to 21% for the same site, and up to 31% for different site[58].

CONCLUSION

Pressure injuries are the result of pressure and shear over bony prominences in prolonged immobilized patients. Spinal cord injury, intensive care unit stay, and many other intrinsic and extrinsic factors are associated with the occurrence of the morbid condition. The new classification system of NPUAP has been based on evidence and replaces all existing denomination and staging for pressure injuries. The patient conditions and all extrinsic factors have to be evaluated to prevent pressure injuries or avoid aggravating an existing pressure injury. Among all predictive tools, the Braden scale has been granted of the best sensibility/specificity. Therefore, this tool has to be used in all settings dealing with patient dwelling in beds or chairs. Preventive tools include position changing, pressure relief tools and skin care and are to be used concurrently. The treatment consists of non-surgical and surgical methods. Surgery for pressure injuries is associated with early complications and an appreciable long-term recurrence rate, the highest for ischial pressure injuries. The current healthcare environment has become complex and pressure injuries, despite use of all preventive measures, cannot be prevented in all patients. Nevertheless, prevention has to be the main preoccupation of the healthcare team in front of all patient at risk. . ■

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