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Wheelchair Seating — Part 14: Vocabulary and Concepts related to managing external forces to maintain tissue integrity

DTS stage

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Foreword

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This document was prepared by Technical Committee ISO/TC 173, *Assistive products*, Subcommittee SC ~~01~~ 1, *Wheelchairs*~~, Working Group 11, Wheelchair Seating~~.

A list of all parts in the ISO 16840 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html~~.~~.

Introduction

The influence of pressure on the health of skin tissues has been acknowledged for some time: what used to be called "bed sores" or "decubitus ulcers" became renamed "pressure ulcers" in Europe and "pressure injuries" in much of the rest of the world. However, in recent years, greater awareness of other extrinsic factors affecting the health of skin tissues has led to increased reference to the more general term of tissue integrity. The current pressure injury definition from the 2019 International Guideline Prevention and Treatment of Pressure Ulcers/Injuries[1] highlights this new understanding. Pressure injury is referred to in this documentReference [1] as "localized damage to the skin and/or underlying tissue, as a result of pressure or pressure in combination with shear." "The tissue damage occurs as the result of intense and/or prolonged exposure to sustained deformations in compression (perpendicular to the tissue surface), tension or shear (parallel to the tissue surface), or a combination of these loading modes. The tolerance of soft tissue for sustained deformations differs by tissue type and may also be affected by microclimate, perfusion, age, health status (either chronic or acute), comorbidities, and conditions of the soft tissues".

The current NPIAP/EPUAP/PPPIA Guidelines [1] note the changing views on pressure injury staging. Stages 1 and 2 are described as "partial-thickness tissue loss" and having the strongest connections to superficial microclimate (temperature, humidity, altered pH due to incontinence), shear, and friction effects. Stage 1 and 2 pressure injuries are also described as 'outside in' skin damage [2]. Stages 3 and 4, Unstageable, and Suspected Deep Tissue Pressure Injury are categorized in the Guidelines as "full-thickness skin and tissue loss". Deep tissue injury is an 'inside out' skin damage, which usually originates in deep soft tissues subjected to external pressure and shear forces and subsequent deformations around the bony prominences [2]. Suspected deep tissue injury is one of the most challenging pressure injuries for accurate identification: it can present as an intact non-blanchable red, maroon, or purple discolouration that maycan quickly evolve to reveal a full tissue loss [3]. Current guidelines advise clinicians not to think of the numbered stages as linear progression of the wound towards improvement/healing or worsening, but rather use the stage descriptions to note the maximum depth of a wound at a single point in time [3].

While the characteristics of an ideal microclimate (skin temperature and humidity) are still being researched, it is recognized that there are strong connections between microclimate and friction, and hence surface and internal tissue loads. This is relevant for all pressure injuries, not just the superficial ones [1].

It is the materials closest to the skin, be they clothing, continence products, and/or the materials in the cover of the support surface that the person is sitting or lying on that often have the most impact on microclimate, friction, and shear effects on the surface of the skin.

Stage 3 and 4, Unstageable and Suspected Deep Tissue, Pressure Injuries affect the deeper layers of the skin and around bony tissues and are currently thought to derive from the effects of external pressure, external shear forces, and the resulting internal shear stresses and strains.

Both short-term high pressure and long-term moderate pressures maycan be harmful for soft tissues. Internal muscular, adipose, and dermal tissue deformations are linked to multitude of damaging effects: partial or total occlusions of microvascular and lymphatic network, tissue ischemia, direct cell deformations with cytoskeleton distortions and breakdown, cellular DNA damage, tissue inflammation and necrosis, pH changes in interstitial fluids, altered orientation of collagen fibres, and subepidermal separation [2,][4,][5,][6].

Combined effects of shear and pressure ~~may~~can be more damaging than effects of pressure and gravity forces alone. These effects can be ameliorated or exacerbated by the materials and construction of support surfaces.

The accompanying effects of shear strain alongside the pressures introduced by the effects of gravity creating areas of pressure on the body, have a more damaging effect on the tissues themselves, than pressure alone.

Frequently the terms discussed in this document are misused or confused in general usage. This document has been created to aid in understanding the differences between the defined extrinsic elements and their respective effects on human tissues.

Wheelchair Seating – Part 14: ~~Vocabulary and~~ Concepts related to managing external forces to maintain tissue integrity

1 Scope

This document describes common terms related to forces and their effects as experienced by human bodies and their support surfaces. It provides further information on concepts around how these forces affect the human body's response to postural support systems, and particularly highlights the impact of the interface between tissues and postural support devices (PSD) on the maintenance of tissue integrity. It provides a general introduction to biomechanical concepts, phenomena, and vocabulary. This will facilitate effective understanding and sharing of information between a range of disciplines/stakeholders involved in providing equipment to manage tissue integrity.

Representative stakeholders include people with a disability, occupational therapists, physical therapists, biomedical engineers, nurses, medical and para medical personnel, device manufacturers, and other professionals facilitating development, provision, and access to seating and mobility equipment.

This document does not provide detailed information that is currently available in physiological text books or scientific literature.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 7176-26, *Wheelchairs — Part 26: Vocabulary*

ISO 16840~~-~~1, *Wheelchair seating — Part 1: Vocabulary, reference axis convention and measures for body segments, posture and postural support surfaces*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7176-26 and ISO 16840-1 and the following apply.

ISO and IEC maintain ~~terminological~~terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
perpendicular force
force occurring at 90° to an element's surface

Field Code Changed

Note 1 to entry: It is measured in newtons (N) .).

3.2
shear force
F_s
force occurring parallel with an element's surface

Note 1 to entry: It is measured in newtons [(N].).

3.3
pressure
p
force per unit area in a direction perpendicular to the surface

$$p = X / A \quad (1)$$

where

~~***p*** is the pressure [MPa]~~

~~X is the perpendicular force (N)~~

~~*A* is the area [mm²]~~

~~1 MPa = 1000 kPa~~

- p is the pressure (MPa);
- X is the perpendicular force (N);
- A is the area (mm²);
- 1 MPa = 1 000 kPa.

Note 1 to entry: It is measured in pascals [(Pa]) or equivalent units.

3.4
shear stress
~~τ~~
~~**the** τ~~
shear force divided by the area of the element's surface to which the shear force is applied, parallel with the slope or plane in which it lies

$$\tau = F_s / A \quad (2)$$

where

~~τ is the shear stress [MPa]~~

~~F_s is the shear force (N)~~

~~*A* is the area [mm²]~~

~~1 MPa = 1000 kPa~~

- τ is the shear stress (MPa);

- F_s is the shear force (N);
- A is the area (mm²);
- 1 MPa = 1 000 kPa.

Note 1 to entry: It is measured in pascals [(Pa)] or equivalent units.

3.5
axial strain
normal strain

~~σ~~
ε

change of dimension due to the action of pressure

Note 1 to entry: Axial strain is dimensionless.

EXAMPLE Compressive effects from pressure are illustrated in Figure 1.

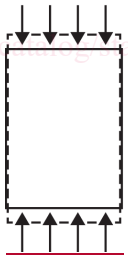

Figure 1 — Axial strain effects from the compressive effect of pressure

3.6
shear strain

~~γ~~
γ

change in the shape of an element due to the action of shear stress

Note 1 to entry: Shear strain is dimensionless.

Note 2 to entry: See Figure 2.