Revolutionizing the Understanding of How Pressure Ulcers Actually Form: How Biomechanics makes the Fundamental Difference

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Our research work, which spans over nearly two decades, has identified sustained tissue deformations as the primary cause of pressure ulcers/injuries - both at the skin and in deeper tissues. The sustained exposure to tissue deformations has multi-dimensional and multi-factorial influence on tissue status and cell viability and function, importantly including direct damage to cell structures, e.g. localized, gradual failures of the cytoskeleton and plasma membrane. From a biomechanical engineering perspective, cells are structures that require energy to support loads and to repair themselves, hence, when loads are delivered for a period exceeding a critical threshold, or when the energy supply for cells is low (e.g. due to ischemia or hypoxia), cells gradually fail structurally, and lose their homeostasis. As our research work evolved, we have developed a variety of living and *in silico* model systems, including cell cultures, animal models, tissue-engineered constructs, medical imaging of humans and anatomically-realistic finite element models of relevant body parts. Considered together, these different model systems, revealed that the fundamentals for achieving effective pressure ulcer prevention are to minimize exposures to sustained tissue deformations. In addition, our work demonstrates that minimization of tissue deformations applies to the entire layered structure of soft tissues, from superficial to deep. In other words, any device, consumable or equipment that claims pressure ulcer prevention, or a device that contacts the skin and may cause a pressure ulcer, should be designed to not only protect the skin but also, alleviate subcutaneous tissue distortions. In practical terms, there are different approaches for achieving minimization of exposure to tissue deformations (both cutaneous and subcutaneous), such as to maximize immersion and envelopment of the body by a supporting surface (e.g. by molding or conforming to the body contours), as well as by matching stiffness properties of devices to contacting tissues and absorbance of mechanical deformation energy. Microclimate management couples with these considerations. The aforementioned approaches and relevant device concepts will be discussed in the aetiological context. Ultimately, devices aimed at alleviating tissue deformations should be combined with sensor technology to assess tissue status and early-diagnose deterioration in viability, as early as when the first cell deaths occur.