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C-CORE: Technological innovation for pressure ulcer prevention with a focus on sustainability

C-CORE: tecnologia para prevenção de lesão por pressão com enfoque em sustentabilidade

C-CORE: Tecnología para la prevención de úlceras por presión con enfoque en la sostenibilidad

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ABSTRACT

Objective: to analyze the scientific and sustainable advances offered by the C-CORE technology for pressure ulcer prevention. **Content:** pressure ulcers are a Public health problem with clinical, social and economic repercussions. Pressure redistribution and microclimate control are essential prevention measures. In the last few years, a number of innovations have been incorporated to the clinical practice. Developed from a tridimensional mesh made of polyethylene filaments, mattresses with C-CORE technology provide continuous ventilation, mechanical resilience and load redistribution. Health management requirements demand cost-effective, environmentally responsible and clinically safe solutions. Polyurethane foam faces technical challenges and high costs, whereas the C-CORE technology presents sustainable attributes, such as recyclability and greater durability, contributing to circular economy and to waste reduction. **Final considerations:** this is a support surface with the innovating C-CORE technology, representing an alternative for pressure ulcer prevention and contributing to sustainability. **Descriptors:** Products Technology; Technology Assessment, Biomedical; Device Approval; Diffusion of Innovation; Pressure Ulcer.

RESUMO

Objetivo: analisar os avanços científicos e sustentáveis da tecnologia C-CORE para a prevenção da lesão por pressão. **Conteúdo:** a lesão por pressão é um problema de saúde pública, com repercussões clínicas, sociais e econômicas. A redistribuição da pressão e controle do microclima são medidas essenciais de prevenção. Nos últimos anos, inovações vêm sendo incorporadas à prática clínica. Entre elas o colchão com tecnologia C-CORE, desenvolvido a partir de uma manta tridimensional de filamentos de polietileno proporciona ventilação contínua, resiliência mecânica e redistribuição de cargas. As demandas de gestão em saúde exigem soluções custo-efetivas, ambientalmente responsáveis e clinicamente seguras. A espuma de poliuretano enfrenta desafios técnicos e altos custos, enquanto a tecnologia C-CORE apresenta atributos sustentáveis, como reciclabilidade e maior durabilidade, contribuindo para economia circular e redução de resíduos. **Considerações finais:** trata-se de superfície de suporte com tecnologia inovadora C-CORE, consistindo em uma alternativa para prevenção de lesão por pressão, contribuindo com a sustentabilidade.
Descritores: Tecnologia de Produtos; Avaliação da Tecnologia Biomédica; Aprovação de Equipamentos; Difusão de Inovações; Lesão por Pressão.

RESUMEN

Objetivo: analizar los avances científicos y sostenibles de la tecnología C-CORE para la prevención de úlceras por presión. **Contenido:** las úlceras por presión son un problema de salud pública con repercusiones clínicas, sociales y económicas. La redistribución de la presión y el control del microclima son medidas preventivas esenciales. En los últimos años, se han incorporado innovaciones a la práctica clínica. Entre ellas, destaca el colchón con tecnología C-CORE, desarrollado a partir de una malla tridimensional de filamentos de polietileno, que proporciona ventilación continua, resiliencia mecánica y redistribución de la carga. Las exigencias de la gestión sanitaria requieren soluciones rentables, respetuosas con el medio ambiente y clínicamente seguras. La espuma de poliuretano se enfrenta a retos técnicos y a costes elevados, mientras que la tecnología C-CORE ofrece características sostenibles como la reciclabilidad y una mayor durabilidad, contribuyendo a la economía circular y a la reducción de residuos. **Consideraciones finales:** se trata de una superficie de apoyo con la innovadora tecnología C-CORE, que representa una alternativa para la prevención de úlceras por presión y contribuye a la sostenibilidad.
Descriptores: Tecnología de Productos; Evaluación de la Tecnología Biomédica; Aprobación de Recursos; Difusión de Innovaciones; Úlcera por Presión.

INTRODUCTION

Pressure ulcers constitute a relevant Public Health problem with clinical, social and economic repercussions that affect patients, family members and health systems alike[1]. Their prevalence remains high in different care contexts, especially among critically-ill patients[2], aged individuals and people with chronic diseases[3]. Pressure ulcer genesis involves multiple factors, with pressure intensity and duration as the main ones. Shear forces, humidity, skin temperature, anatomical characteristics and individual clinical conditions interact with each other and worsen tissue vulnerability[4].

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National[5,6] and international[7] guidelines highlight the importance of pressure redistribution and of microclimate control as essential prevention measures, recommending high-specification mattresses for at-risk individuals[8,9]. In Brazil, the National Health Surveillance Agency (*Agência Nacional de Vigilância Sanitária*, ANVISA) recommends using special mattresses such as those made of viscoelastic foam for people at risk of developing pressure ulcers.

Selection of the support surface should meet the individual need for pressure redistribution based on each person's immobility and inactivity levels, size and weight, in addition to the number, severity and location of the existing pressure ulcers, without disregarding the risk of developing new lesions[6]. However, the recent knowledge reveals low certainties in the evidence regarding the comparative efficacy across different support surfaces, unveiling gaps that still challenge the clinical practice[10].

In the last few years, a number of innovations have been incorporated with the objective of overcoming these limitations. Developed from a tridimensional mesh made of polyethylene filaments, mattresses with the C-CORE technology stand out among them. Their structure provides continuous ventilation, mechanical resilience and load redistribution, characteristics that are associated with reduced pressure ulcer risks and with preserving the patients' comfort[11]. In addition to that, the technology presents sustainable attributes in line with the contemporary responsible consumption requirements and with the World Health Organization 2030 Agenda.

Given this panorama, the study objective was to analyze the scientific and sustainable advances offered by the C-CORE technology for pressure ulcer prevention.

CONTENT

The development of innovating technologies for pressure ulcer prevention has been driven by the need to reduce complications and costs associated with treatments. Originally developed in Japan, C-CORE technology mattresses represent one of these innovations[11]. They are tridimensional meshes made of polyethylene filaments, with approximately 80% air and 20% filaments, which provide good ventilation, resilience and low deformation levels (Figure 1)[12].

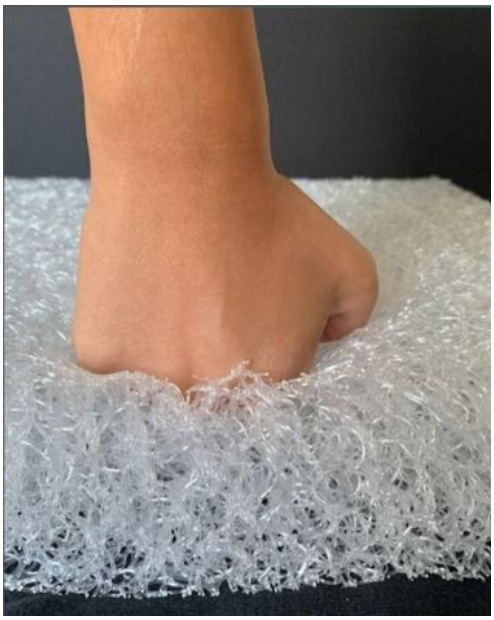

Figure 1: C-CORE technology mesh, made of ethylene-1-octene copolymers (elastomers). Belo Horizonte, MG, Brazil, 2024.

These characteristics differentiate them from traditional viscoelastic or polyurethane foam mattresses[13]. The action mechanism of the C-CORE technology links pressure redistribution (reducing critical points over bony prominences)[11] to microclimate regulation by means of efficient ventilation and low thermal conductivity. Diverse experimental evidence suggests that the ability to keep the surface cool can reduce the tissue damage risk, considering that the increase in local temperature is associated with higher chances of developing pressure ulcers[14].

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Available evidence

High-specification foam mattresses offer benefits in pressure ulcer prevention when compared to their standard hospital counterparts, but it is not certain which of different surfaces is superior[10].

The PRESSURE 2 study (the largest pragmatic clinical trial in the area) showed no significant difference between alternating pressure mattresses and low-technology viscoelastic foam ones, reinforcing the need to consider comfort, patient adherence and cost-effectiveness in choosing a device[15]. Other clinical trials reinforce that advanced technologies such as thermal control mattresses or alternating air systems can reduce pressure ulcer incidence and severity[16]; however, they frequently present limitations such as noise, discomfort, high costs or lower acceptance by the users[17]

According to their composition, the support surfaces have different action mechanisms for pressure redistribution. C-CORE technology mattresses have a networked and highly porous structure, increasing the contact area between the body and the surface. The profile of the filaments in C-CORE mattresses is extruded to confer high resilience to the mesh, which is one of the characteristics of this tridimensional product. The reduction in terms of pressure takes place when the support surface of the C-CORE technology exerts a reaction force that is lower than the patient's weight, assisting in pressure ulcer prevention. This action reduces pressure peaks over bony prominences (sacrum, calcaneus, trochanters) and, consequently, the pressure on deep tissues. In mechanical terms, multiple polymeric bonds from the tridimensional structure share the load and divert the force lines, preventing tensions from being concentrated in small spots. Pressure reduction allows decompressing skin capillaries, thus preserving blood irrigation[11].

Viscoelastic foam mattresses adapt to the body contour through immersion and enveloping, allowing body weight distribution over a large area. The mechanism favors increased contact between bony prominences and the surface, resulting in pressure redistribution. As it reduces pressure in specific areas (bony prominences), viscoelastic foam improves blood flow and tissue oxygenation, decreasing the risk of cutaneous lesions, especially in patients with prolonged immobility[13]. Maintaining blood flow is one of the main factors to prevent and reduce pressure ulcer incidence (Figure 2).

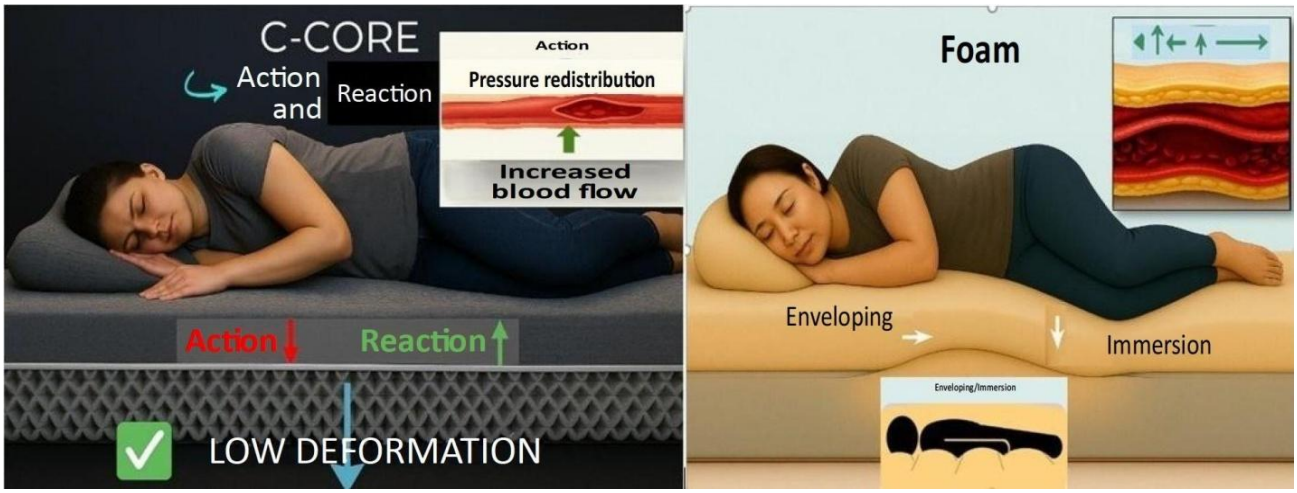

Figure 2: Mechanism for pressure redistribution and pressure ulcer prevention of the support surface in the C-CORE technology (action and reaction) and in the viscoelastic foam technology (immersion and enveloping).

The support surfaces in the C-CORE and viscoelastic foam technologies have specific characteristics and different action mechanisms for pressure redistribution and pressure ulcer prevention (Figure 3).

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Parameters	C-CORE technology	Viscoelastic foam	Impact on clinical practice
Composition	Ethylene polymer with octene, >99% purity, tridimensional mesh	Polyurethane-derived foam with specific additives for shape memory	Both use polymers; C-CORE has total recycling potential, whereas viscoelastic foam presents greater initial adaptability to the body
Manufacturing process	Extrusion at high temperature, with no chemical additives; 100% recyclable	Production with chemical additives; difficult to recycle	C-CORE has a sustainability profile; viscoelastic foam is less sustainable
Comfort and resilience	High resilience, it recovers its shape quickly, low noise	High comfort by anatomical adaptation (shape memory), but less resilience (slow recovery)	Viscoelastic foam favors initial adaptation; C-CORE keeps support in position changes
Breathability and maintenance	Highly breathable, washable, low deformation throughout time	Low breathability, it retains heat and humidity, difficult to clean	C-CORE favors microclimate control; viscoelastic foam favors heat and humidity increases
Attrition coefficient	High coefficient, it allows overlapping layers without glue	Average, it tends to slip and requires gluing/mortising	C-CORE enables modular assembly; viscoelastic foam requires a fixed structure
Microclimate control	Structure with 80% air and 20% filaments; it keeps the surface cool even with a waterproof layer	It retains heat and humidity; the surface tends to get hot with prolonged use	C-CORE maintains a more stable temperature; viscoelastic foam can generate thermal discomfort
Pressure redistribution	Resilient structure that reduces the reaction force and allows capillary decompression	Excellent initial redistribution due to the foam adapting to the body contour	Both reduce pressure points; C-CORE maintains redistribution even with prolonged use, whereas viscoelastic foam can lose its efficiency when it gets hot/deformed

Figure 3: Comparative chart between C-CORE technology and viscoelastic foam mattresses, with emphasis on the impact for the clinical practice. Belo Horizonte, MG, Brazil, 2024.

Prospects and sustainability

Sustainability is currently an essential criterion to incorporate new technologies in health. Whereas recycling polyurethane foam mattresses faces technical challenges and high costs, the C-CORE technology (due to its structure) can be washed with no deformation or performance loss risks, is 100% recyclable and does not release dioxins when burned, contributing to circular economy and to waste reduction[18,19]. These characteristics render this technology compatible with contemporary health management requirements, which demand cost-effective, environmentally responsible and clinically safe solutions[18].

Sustainability and consistency with the World Health Organization 2030 Agenda are criteria increasingly central to incorporating technologies in health. It is recommendable to integrate Sustainable Development Goals (SDGs) such as Good Health and Well-being (SDG 3), Industry, Innovation and Infrastructure (SDG 9) and Responsible Consumption and Production (SDG 12). When choosing support surfaces for pressure ulcer prevention, not only clinical efficacy and immediate cost should be considered but the entire environmental chain, durability, reuse/recycling possibility and impact on how waste from health services is managed[18].

When comparing the usually employed technologies, viscoelastic foam offers clear advantages: good pressure redistribution, broad availability, comfort as perceived by the patients and relatively moderate initial costs in medium- to high-specification models. However, it presents important environmental and operational limitations: many foams contain additives and compounds that hinder recycling, undergo degradation with intensive cleaning and have a finite service life, which implies frequent disposal and generation of potentially problematic solid waste[20]. In terms of comfort and modeling, viscoelastic foam can promote heat retention (impairing the skin microclimate), a factor with the potential to favor pressure ulcers if not properly managed. These issues place foam in tension with the SDG 12 targets (reducing waste and increasing reuse/recycling).

Made of elastomers, the C-CORE technology presents a different set of trade-ins between benefits and limitations due to its exceptional properties, such as high elasticity, repeated processing ease and versatile performance[21]. From the technical point of view, its tridimensional structure maximizes ventilation and resilience, offering pressure redistribution with less permanent deformation and better microclimate control. Theoretically, these characteristics can reduce pressure ulcer risks and improve comfort and adherence.

Environmentally, its proposal of being 100% recyclable and washable is directly in line with the circular economy targets

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and with SDG 12, potentially reducing waste volumes and disposal-associated impacts. In addition, its durability and decontamination possibility contribute to reducing the need for frequent replacements, with positive implications on the total cost of ownership and emissions incorporated throughout its service life.

However, the environmental advantage of C-CORE is not exempt from reservations. Polymeric materials involve emissions and energy consumption in their manufacturing process. In addition to that, effective recyclability depends on the existence of local infrastructure for industrial collection and recycling. The assessment of risks related to the release of microplastics still needs to be researched. A number of assertions about absence of dioxins while burning or about recycling should be confirmed by life cycle analyses and standardized end-of-life tests in the actual conditions found in health services before constituting a single choice criterion[20].

Given the benefits and limitations presented by both technologies, it is recommended for the evaluations made when deciding which support surface for pressure ulcer prevention to buy to incorporate a clinical efficacy analysis, in addition to users' acceptability analyses (comfort, noise, mobility). These assessments are the ones closest to the Nursing study objects. However, the SDGs are explicit when stating the need for more in-depth studies that contemplate a full life cycle comparative analysis across technological options. Therefore, it is essential to include the total cost of ownership, which involves acquisition, maintenance, cleaning, replacement and disposal of the product, in addition to the local reprocessing and recycling logistics.

Finally, some knowledge gaps should be prioritized in research[22], aiming at formulating institutional policies in line with SDG 12. Conducting research in this knowledge area can favor technologies that show lower impacts when used for extended periods of time even when their initial cost is higher, as effective costs decrease when service life horizons and safe disposal are considered. In addition to comparative clinical trials that include economic and environmental outcomes, life cycle analysis applied to hospital mattresses are necessary, in addition to evaluating the microclimate, which contributes to reducing tissue tolerance and to increasing the pressure ulcer incidence risk. To elucidate certain hypotheses or when the topic involves population groups considered vulnerable (such as neonates), a possibility is to resort to realistic translational studies. The incorporation of new support surface technologies should be seen as promising, although dependent on local evaluation (cost, logistics and regulatory environment), and always complemented with multifactor strategies for pressure ulcer prevention[1,4].

Study limitations

The following study limitation is identified: the few publications found on mattresses with sustainable technologies for pressure ulcer prevention, mainly integrating Sustainable Development Goals (SDGs) such as Good Health and Well-being (SDG 3), Industry, Innovation and Infrastructure (SDG 9) and Responsible Consumption and Prevention (SDG 12).

FINAL CONSIDERATIONS

Pressure ulcer prevention requires multifactor strategies based on robust evidence. Although high-specification foam mattresses continue to be recommended as a minimum standard, it is necessary to search for innovating alternatives to bridge existing gaps.

C-CORE technology mattresses emerge as an innovation because they bring together pressure redistribution, microclimate control and environmental sustainability, representing a relevant alternative for at-risk patients. It is necessary to conduct more clinical studies to consolidate their comparative effectiveness and endorse their large scale incorporation in health services.

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Authors contributions

Conceptualization, E.L.B. and P.O.S.S.; methodology, E.L.B. and P.O.S.S.; formal analysis, E.L.B. and P.O.S.S.; investigation, E.L.B. and P.O.S.S.; resources, E.L.B.; manuscript writing, E.L.B., P.O.S.S. and J.A.O.S.; review and editing, E.L.B., P.O.S.S. and J.A.O.S.; visualization, E.L.B., P.O.S.S. and J.A.O.S.; supervision, E.L.B.; project administration, E.L.B.; financing acquisition, E.L.B. All authors read and agreed with the published version of the manuscript.

Use of artificial intelligence tools

Authors declare that no artificial intelligence tools were used in the composition of the manuscript "*C-CORE: Technological innovation for pressure ulcer prevention with a focus on sustainability*".