Engineering the future of pressure care

LEIGH FLEMING
Senior Lecturer, EPSRC Centre for Innovative Manufacture in Advanced Metrology, University of Huddersfield, Huddersfield

When the development and prevention of pressure ulcers are being discussed, pressure, friction, and shear are frequently referred to as the key factors involved.

Pressure, friction, and shear are fundamental engineering concepts that are studied and modelled in great detail in many industrial applications. There is a whole branch of engineering known as tribology, which is focussed on understanding the way in which surfaces interact, the way in which lubricants change and optimise systems and what effect those systems may have on the wear of or failure of components.

Engineers have been instrumental in improving the performance, efficiency, and longevity of vehicle engines. Some of the challenges faced by engineers in the design and optimisation of a car engine have similarities with those challenges faced in providing pressure care. If a piston were to start up in an engine block with no lubrication, there would be a high amount of friction, wear would occur and the parts would quickly wear out. Through developing specific surfaces and lubricants to enable friction reduction, the engines can last a lot longer and suffer far less from wear.

There have been a great deal of resources spent on the development and testing of orthopaedic implants. Surgeons and engineers have worked together to develop prostheses, instrumentation, and operating practices to optimise patient outcomes. By studying the effects of friction and lubrication in orthopaedic implants, much progress has been made on reducing the amount of wear from the bearing surface.

When we talk about wear of a surface, essentially we are talking about the breakdown of integrity in that surface; when that surface has altered through frictional wear, or heat, the system has changed and the surface may be at greater risk of damage.

As engineers, we often talk about systems; these can be as elaborate as a nuclear power station or the internal combustion engine, or as simple as a fixing bolt in a plate of metal.

UNDERSTANDING THE SYSTEM

When discussing the development of pressure ulcers, there is often debate about which is most important: pressure, friction or shear? Which should we aim to eliminate to eradicate avoidable pressure ulcers and which device will reduce pressure the most?

From an engineering perspective, all of the elements in the system which contribute to the development of pressure ulcers need to be addressed and investigated to provide a reliable and robust solution in pressure care. Engineers and clinicians need to work together to establish what the 'system' is? Often thought of as the patient's skin and the mattress, the system is far more complex than that and requires thorough evaluation. The system will, at the very least, comprise of:

- The musculoskeletal system.
- Tissue.
- Skin.
- Clothing.
- Bed linen.
- Mattress.
- Pressure relieving devices.

Without a proper appreciation of that system, a correct evaluation of product performance and efficacy will be restricted to case study evaluations and circumstantial evidence, in order to determine whether the cost and benefits marry up.

A SYSTEMIC APPROACH

In engineering systems, there are very few disciplines, if any, in which such methods would be adopted to determine the function and performance of a product or component. For instance, in the automotive industry, theoretical modelling using sophisticated computational methods, such as finite element analysis, are employed to determine potential performance. All variables in the system are carefully evaluated and modelled in order to predict the outcome of changes or developments to a system. This takes great resources in terms of time and money, however, the alternative is to see a component fail to perform. If it were the case of the brakes

"The engineer and clinician ... can collaborate to promote a bench-to-bed ethos through research, development, and study."

of a car failing to perform, the outcome could be catastrophic.

There are many devices and methods for pressure reduction or pressure redistribution which are available for use by clinicians. These devices have a variety of functions. During a study on pressure ulcer prevention across one health authority, Guy et al (2013) noted that, although some evidence showed that patients on alternating pressure relieving mattresses are less likely to develop pressure ulcers than those on standard foam, there are patients that still do and, therefore, repositioning of the patient is still required. It may be that more accurate predictions could be made about who and when would develop problems using a pressure relieving device if more were known about the whole system of patient, device, and environment by applying fundamental engineering knowledge along with clinical expertise based on real life situations.

A systematic approach to the prevention of pressure ulcers is not revolutionary; the use of care bundles, as reported in a study by Downie et al (2013), looks at the whole system of care and ensures that all elements of that system come together to prevent the development of pressure ulcers. Engineers can take that systematic approach one level further by looking at how those interventions change fundamentally depending upon the patient's skin type, the devices in place and even possibly the type of bed linen being used. This could give clinicians greater knowledge and power in deciding on the best practice for pressure ulcer prevention.

Dr Michael Clark has noted that one of the key research gaps in the treatment of pressure ulcers was a need for well-designed, soundly-executed controlled trials of interventions used – and an assessment of beds and mattresses (Smith & Nephew Foundation, 2008).

Established engineering design techniques could be partially implemented before the products were even trialled, providing all variables in the system were better understood.

CONCLUSION

There are many things that engineers can offer the area of pressure ulcer prevention and, indeed, tissue viability in general, such as:

- Education about what pressure, friction, and shear actually consist of so that clinicians can better understand how to reduce them.
- The accurate measurement and modelling of the surfaces of skin and devices to see how they interact so that more could be understood about the system as a whole.
- Collaboration with clinicians to develop real solutions with evidence of measured improvements in care.

As noted in the title of an article by Geraghty (2013) 'Industry and clinician: collaboration is key', the same is true for the engineer and clinician, who can collaborate to promote a bench-to-bed ethos through research, development, and study. Engineering the future of pressure care means engineering a stop to pressure ulcers. WUK

REFERENCES

Downie F, Perrin A, Kiernan M (2013) Implementing a pressure ulcer prevention bundle into practice. *Br J Nurs* 22(15): 4–10

Geraghty J (2013) Industry and clinician: collaboration is key. *Br J Nurs* 22(12): 3

Guy H, McIntyre L, Peters J (2013) Pressure ulcer prevention: making a difference across a health authority? *Br J Nurs* 22(12 Suppl): S4–13

Smith & Nephew Foundation (2008) *Skin Breakdown – The Silent Epidemic*. Smith & Nephew Foundation, Hull

RETRACTION

Johnstone A, McGown K (2013) Innovations in the reduction of pressure ulceration and pain in critical care. *Wounds UK* 9(3): 76–80

The authors retract the article cited above. The conclusions drawn in the article were based on incorrect and incomplete data. The authors and publisher apologise for any confusion that may have been caused.