Plugging the wound: the development of haemostatics

REFERENCES

Bano L, Arshad M, Yasin T et al (2017) Chitosan: a potential biopolymer for wound management. International. *Journal of Biological Macromolecules* 102: 380–83

Bellamy RF (1984) Causes of death in conventional warfare. *Mil Med* 149: 55–62

Bergel S (1909) Über Wirkungen des Fibrins. *Deutsche Medizinische Wochenschrift* 35: 633 (German)

Kheirabadi SB, Pusateri E, Sondeen JL et al (2018) *Development of Hemostatic Dressings for Use in Military Operations.* Available at: https://www.sto.nato.int/publications/pages/results.aspx?k=Development%20of%20hemostatic%20dressings&s=Search%20All%20STO%20Reports (accessed 20.06.2018)

Landolin J (2014) *This Gel Can Make You Stop Bleeding Instantly.* https://www.ted.com/talks/joe_landolina_this_gel_can_make_you_stop_bleeding_instantly#t-287075 (accessed 20.06.2018)

Weller C (2017) *A 17-year-old Invented an Ingenious Way to Instantly Stop Bleeding.* Available at: https://www.independent.co.uk/news/science/a-17-year-old-invented-an-ingenious-way-to-instantly-stop-bleeding-a8002956.html (accessed 20.06.2018)

EDWARD WHITE
Freelance Medical Writer, British Columbia, Canada

Whilst the very semantics of 'wound care' might suggest a longer term management of what are typically chronic wounds, the management of acute wounds falls equally within the remit of the wound care specialist. Post-surgical or trauma related cavities and incisions have a dedicated procedure and class of dressings for their management, whilst burns have theirs.

As we move further toward an age of higher technological intervention in acute trauma and wound care, there arise real considerations for wound care specialists in how to deal with wounds closed by what might be innovative or unfamiliar technologies.

The use of human allografts or porcine xenografts is one such example, as is the focus of this article; haemostatics.

Battlefield exsanguination is an age-old dilemma which has precipitated fundamental developments in the history of medicine. Galen's use of ligatures in the 2nd century AD is one of the seminal advances in surgery, and Ambroise Paré's use of turpentine ointments to seal wounds, over the accepted method of cauterisation by boiling oil is famous in medical history. Paré may have dispensed with boiling oil cautery in the 16th century, yet haemostasis continues to be hugely problematic, particularly on the field of battle.

The application of pressure, tourniquets, ligatures and bandages primarily remain the go-to solutions, even in the present day (Kheirabadi et al, 2018). Haemorrhage from wounds is accountable for 50% of battlefield deaths according to Bellamy (1984), and indeed was responsible for 50% of combat deaths in the Vietnam War. The options currently being explored may seem far-fetched, yet appear to present legitimate biocompatible and biodegradable solutions.

The key has been to study the body's natural reaction to being wounded, and to extract and utilise the key elements necessary to expedite the healing process. The first phase of wound healing is of course haemostasis, wherein platelets plug breaches in blood vessels, before coagulation occurs, and strands of fibrin reinforce the platelets. Fibrin is the key element here, and its haemostatic qualities in acute wound treatment were first explored by Bergel, who employed it operationally in powdered form in 1909 (Bergel, 1909). WWI trauma surgeons Grey and Harvey developed 'pre-polymerized fibrin tampons and thin plaques to control bleeding in parenchymal organs' (Bellamy 1984), marking the first attempt to use a dry fibrin product for haemostatic purposes.

The development and use of fibrin sealant based products throughout WWII was hastily withdrawn due to their transmittance of hepatitis, as would occur again in 1977. Only relatively recent technologies have allowed for the preparation of fibrin products with reduced viral transmission risk, and fibrin sealant was only accepted by the FDA in 1998. The risk of using human donor plasma products of course begs the question of whether alternatives exist, and the ever-present need for haemostatics has led to the exploration of other areas for a viable solution.

With nearly 1.8M views at the time of writing, NYU graduate Joe Landolin's 2014 TED talk on his plant-derived haemostatic agent Veti-Gel shows the current extent of interest in this area. Whilst currently a vetinary solution, the proposed scenario for human use is that of battlefield trauma and rapid blood loss. The premise is that the gel's polymer grid adopts the structure of the local extracellular matrix (ECM) of whatever tissue it has been injected into, providing a scaffold for fibrin to work upon, thus accelerating the primary stage of wound healing.

Chitosan is another biomaterial used as a scaffold for tissue regeneration. Derived from chitin, a naturally occurring polysaccharide found in shellfish, chitosan dressings have promised vital characteristics for skin healing and regeneration in wounds and burns (Bano et al, 2017).

As with alginates, honey, silver, and cotton wool, the natural world may well have provided us with another solution to a problem which has faced us since prehistory. Could we finally be plugging the wound? WUK