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Saving Lives on the Battlefield

GEOFFREY DOBSON

Treatments that stem blood loss after a catastrophic injury in the battlefield can damage the brain. However, a new drug strategy aims to stabilise both in the first crucial 10 minutes.

In the Iraq and Afghanistan wars, around 87% of combat deaths occurred in the first 30 minutes before the casuality could reach a treatment facility. In a study carried out by the US military, nearly one-quarter of these deaths, almost 1000 combatants, were classified as having potentially survivable wounds. The "Golden Hour", a term used in emergency retrieval medicine to denote the highest likelihood that prompt medical treatment will prevent death, is a meaningless concept in these far-forward military environments. The "Platinum 10 minutes" is the new window of opportunity.

Saving lives in this fast-closing window is not an easy problem. Ninety per cent of early battlefield deaths suffer catastrophic haemorrhage and 50% have traumatic brain injuries. Having both injuries is a double-edged sword because existing treatments may be good for the body but are bad for the brain, and vice versa. No drug therapy currently exists to rescue both and stabilise the combatant or victim for delayed evacuation. Buying time is the key to improving the survivability of soldiers in the first few moments after a catastrophic injury.

In the Heart, Trauma and Sepsis Laboratory at James Cook University, research associate Hayley Letson and I are collaborating with the US military to develop a one-two drug strategy to rescue the heart and dial-up the right pressure to protect the brain – but not too high to dislodge the blood clot that has newly formed. If one aims too high, the casualty will bleed to death by "popping-the-clot", but if it's too low the brain and body will become starved of oxygen and be irreversibly damaged. If we can kick-start the heart and dial-up the right blood pressure it will be a world first, and has the potential to save many lives on the battlefield and pre-hospital civilian settings, including hemorrhaging and stroke victims.

In the first few minutes after injury, the dying soldier enters a state of shock from low blood volume and low blood pressure. The heart tries desperately to pump what little blood remains to

keep the body alive with oxygen. However, the heart also succumbs to a lack of oxygen, and death is imminent.

Shock is what 19th century American surgeon John Collins Warren aptly called "a momentary pause in the act of death". We are developing a new way to solve the problem.

Our drug therapy comprises adenosine, lidocaine and magnesium (ALM), which came from my prior invention to hibernate and stop the heart for cardiac surgery. Around 17 years ago I asked whether the human heart could be pharmacologically tricked to operate more like the heart of a natural hibernating animal. Hibernators such as the tiny hummingbird can lower their heart and body's energy demands by more than 98% during overnight torpor. In 2008, when cardiac surgeons showed me how strongly the heart resuscitated after very complex and long operations by simply dialling down the ALM concentration, I began thinking about its wider applications for resuscitating the heart after different trauma states.

The new low-volume ALM drug therapy will be administered as a shot or bolus into a vein, or into the bone marrow if intravenous access isn't possible. Both methods have equivalent efficacy in distributing drug therapies in the body.

The first shot will rescue the heart and circulation, and place the body in a low-pressure, hypotensive, hibernating-like state. The blood pressure will then increase into a region of restorative optimisation. The high salt content of the first shot will prevent the brain from swelling and reduce secondary damage, and the ALM will further protect the body by lowering energy demand and thus help the brain to regulate organ functions.

Despite losing litres of blood, the volume added to the body will only be a therapeutic100 mL, and perhaps as low as 20 mL, which has important implications for early survival. Larger volumes must be avoided to prevent high blood pressures and equally so as not to dilute the blood's clotting factors or other survival responses.

A major problem in past wars, notably the Vietnam war, was when medics used many litres of saline-based fluids. The result was blood thinning and an acute lung injury known as "shock lung" or "Da-Nang lung". This standard-of-care treatment in many cases caused more injury, multiple organ failure and possibly death.

Unfortunately, many of the current fluids today have a negative impact on the outcome by shocking the body a second time. Our new "rescue shot" resuscitation is designed to nurture the heart and body slowly back to health.

The second shot of our therapy will be a very slow saline drip containing ALM to allow the casualty to stabilise and prepare for safe MEDEVAC retrieval. The goal is to reduce secondary complications arising from the initial trauma by improving oxygen-based metabolism, correcting coagulopathy, blunting the inflammatory response and reducing the possibility of immunosuppression and hence the risk of infection. According to a 2011 US Joint Theatre Trauma Registry and Infectious Diseases Outcome Study: "About 25% of casualties were found to develop infections, and this rate approached 50% in patients requiring intensive care unit admission". In pre-clinical studies this one–two therapy has been protective against hemorrhagic shock, cardiac arrest, infection and sepsis.

Secondary complications result in major mortality and morbidity both in military and civilian pre-hospital trauma settings following trauma. Thus our work has major implications for pre-hospital medicine in urban areas as well as rural and remote Australia.

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Military environments share many features with rural and remote regions, such as unforgiving geographies, variable climates, inaccessibility, long retrieval delays and limited resources. Our treatment therefore has the potential to improve trauma care in rural clinics in preparation for aeromedical rapid response by rescue teams such as the Flying Doctor or CareFlight services in the case of car accidents, rescuing and stabilising the critically ill or treating post-partum haemorrhage – the largest killer of woman around the world.

In addition, our one-two therapy would be useful in mass casualty incidents such as 2005 Bali bombings, disaster management and biosecurity preparedness, and for humanitarian and relief operations in the Asia–Pacific, the Torres Strait Islands and Pacific Oceania. Time will tell if we have raised the bar high enough to meet these urgent unmet needs in battlefield and civilian pre-hospital medicine.

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