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## **Supersaturated Oxygen Emulsion as a Novel Topical Treatment for Ocular Chemical Injury**

**Principal Investigator:** YIN, JIA

**Institution Receiving Award:** SCHEPENS EYE RESEARCH INSTITUTE

**Program:** VRP

**Proposal Number:** VR190039

**Award Number:** W81XWH-20-1-0869

**Funding Mechanism:** Investigator-Initiated Research Award - Funding Level 2

**Partnering Awards:**

**Award Amount:** \$860,831.00

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PUBLIC ABSTRACT

**Rationale:** Ocular trauma is a common injury on the battlefield, comprising 13% of all body injuries during recent conflicts. Chemical injury is one of the most common sources of eye injury and is an integral part of explosion injuries, which account for more than 70% of eye injuries on the battlefield. The costs of eye injuries in the military from 2000-2010 were in excess of \$2 billion per year. In civilian life, chemical injury to the eye occurs in nearly 50,000 Americans every year with an average of \$26.6 million per year in emergency departments' charges only. More important than the economic impact is the lost vision and quality of life. Unfortunately, chemical injuries often occur in both eyes, leaving otherwise able-bodied productive members of the military and society blind and disabled.

**Unmet Needs:** Chemical injury damages every part of the eye. Facial and eyelid skin deformity leads to poor eye closure and exposure of the eye. The cornea, the clear dome-shaped protective layer of the eye, is scarred and even melted when in contact with chemicals. Chemicals, particularly alkali, can seep to the inside of the eye and cause severe inflammation and tissue damage. Cataract, an otherwise incipient clouding of the lens in older population, can quickly form after chemical injury, requiring surgery to remove the cloudy lens. If deeper components of the eye including the retina (film layer of the eye) and optic nerve (sending signal from the eye to the brain) are damaged, these changes are often irreversible. When chemicals contact the eye, the eye must be flushed with large amounts of water, often requiring several liters to remove the chemicals completely. Other than flushing, there is no targeted treatment at time of injury. The situation is even worse on the battlefield with no access to proper irrigation. If there is delayed evacuation of Warfighters, chemicals can stay on the eye for days resulting in damage beyond treatment or repair. Therefore, an easy-to-use and effective therapy at time of injury will undoubtedly change the current standard of care for chemical injury.

**Research Idea:** Oxygen makes up roughly 21% of the air we breathe in and is vital to almost all living things. Oxygen therapy has been used to treat many diseases, ranging from oxygen mask for an asthma attack, to special chamber filled with high-concentration oxygen to treat diabetic skin ulcers. But these treatments are not practical in austere environments. We have developed an exciting technology using a biocompatible oxygen carrier perfluorodecalin, which has been used in humans as blood substitute due to its ability to bind and release oxygen. Our technology, Supersaturated Oxygen Emulsion (SSOE), harnesses and secures oxygen at very high concentration (>4 times of normal oxygen level in the air) in a canister, which can be directly sprayed onto injured tissues. We have done extensive testing of SSOE in human cells and live animals, demonstrating no toxicity. More importantly, we showed a single spray of SSOE to the surface of the eye after chemical burn reduces opacity by more than 60% and decreases the rate of cataract formation from 80% to less than 20%.

**Objectives:** In this proposal, we will fine tune the ingredients of SSOE for optimal oxygen delivery. We will test the product's toxicity and biocompatibility in human cells grown outside the body, and in live animals. We will mimic chemical injury in mice and apply SSOE to their eyes right after injury to determine how SSOE prevents tissue damage. In addition, we will give SSOE several hours to several days after burn to determine if it is effective when given at a later time. This is particularly relevant to battlefield care. When the proposal is completed, we will have a thoroughly tested SSOE product with clearly defined clinical guidelines to be used in the battlefield and healthcare facilities such as the emergency room.

**Impact and Military Application:** Our team is composed of vision and military scientists and eye physicians. Our proposed study will advance the field of ocular trauma research and explain the role of oxygen in chemical injury. Our research has direct translational value, aiming to deliver a

ready-to-use product capable of addressing chemical ocular trauma in a combat setting at the completion of this proposal. This is especially critical for our Warfighters when facing delayed medical evacuation following ocular trauma. We believe SSOE is an ideal treatment in such setting since (1) It has a 5-year shelf life when preserved, (2) it is packaged in a canister, which can be directly sprayed onto the injury site without the need for special tools or skills, and (3) it remains on/in the injured tissues and continues to release oxygen for hours, reducing the need for repeated application. Thus, SSOE stands to become a critical component of ocular trauma treatment protocol in both military and civilian settings.

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