Evaluation of Wound Progression in Infected and Uninfected Directed Energy Injuries for Battlefield Wound Care

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Defense Health Agency
RESEARCH & DEVELOPMENT ®

Disclaimer/ Animal Statement

The views, opinions and/or findings contained in this presentation are those of the author and do not necessarily reflect the views of the Department of War and should not be construed as an official DoW/Army position, policy or decision unless so designated by other documentation. No official endorsement should be made. Reference herein to any specific commercial products, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the U.S. Government.

Research was conducted in compliance with the Animal Welfare Act, the implementing Animal Welfare regulations, and the principles of the Guide for the Care and Use of Laboratory Animals. The facility's Institutional Animal Care and Use Committee approved all research conducted in this study. The facility where this research was conducted is fully accredited by the AAALAC International. Prior to any injury, animals were anesthetized with Telazol and provided analgesia with buprenorphine SR.

Our Mission & Vision

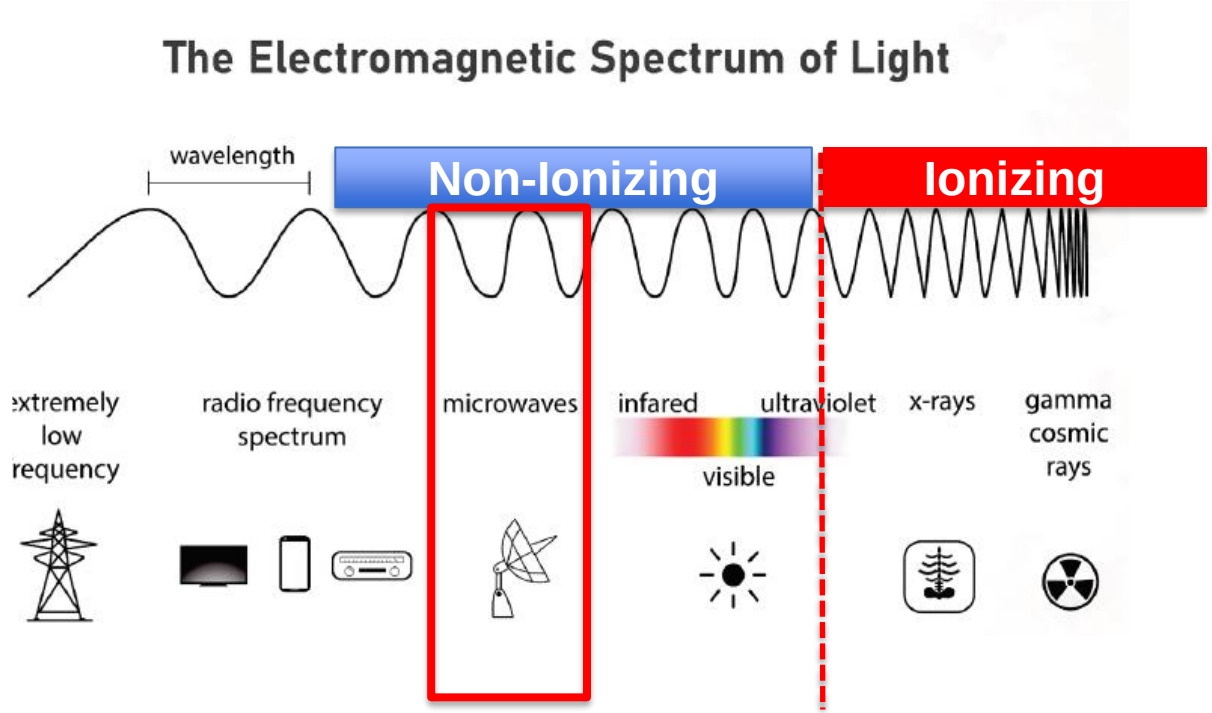
Mission

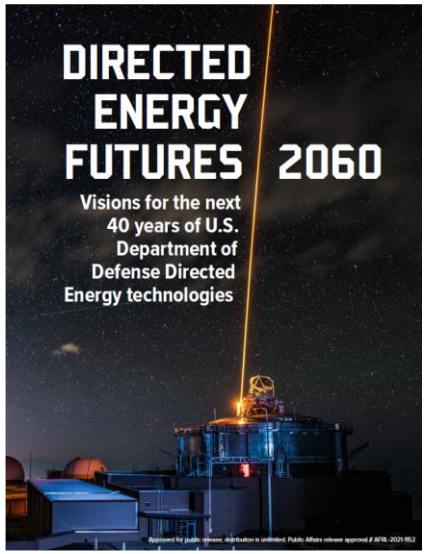
Responsively and responsibly create, develop, acquire and deliver medical capabilities for the warfighter.

Vision

Lead the advancement of military medicine.

What is Directed Energy (DE)?

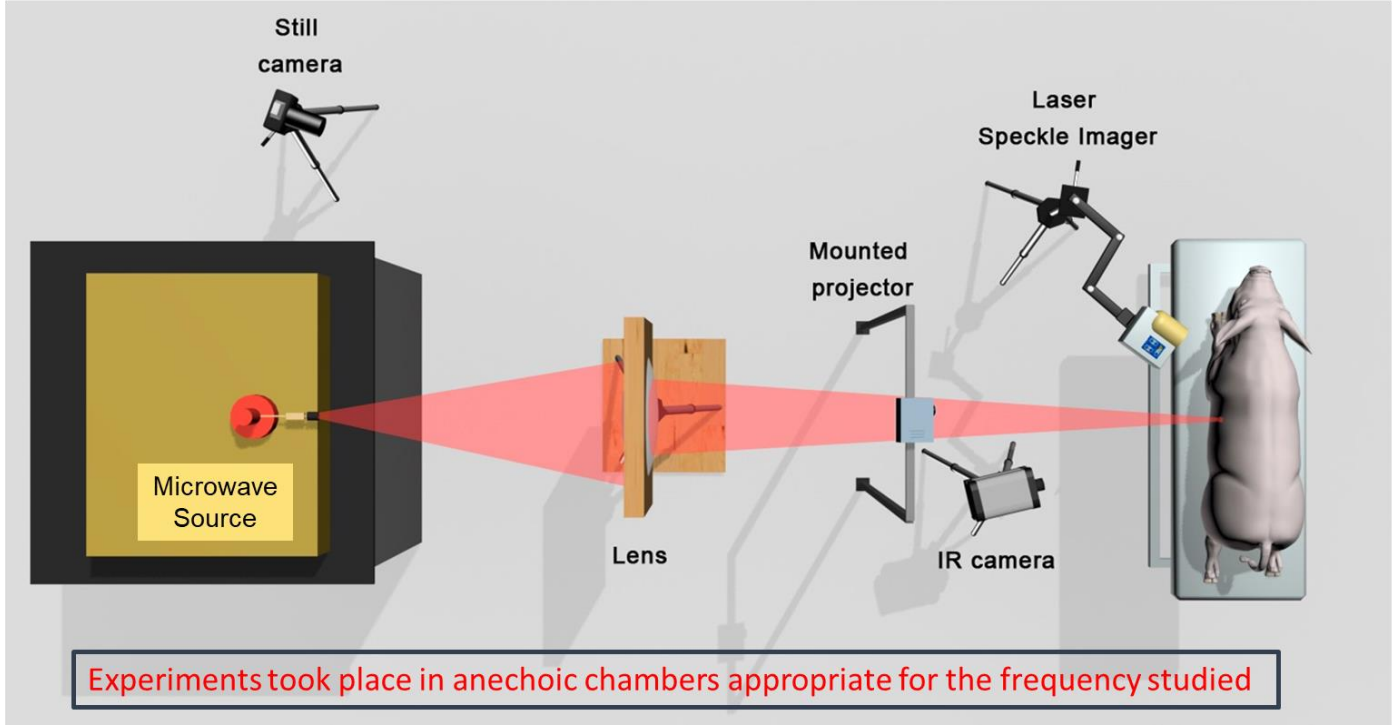




- » *Defined (for military applications) as* "the ability to project electromagnetic energy either broadly to provide information probing of the battlespace, or in a focused manner sufficient to produce a **defensive** or **offensive effect** at militarily relevant distances within the battlespace"
- » DoD is actively engaged in developing and employing Directed Energy (DE) technology for use in the global support of U.S. and allied forces

Collaboration with Air Force 711 HPW, Radio Frequency Bioeffects Branch

Lab Setup



Previous 711 HPW studies assessed:

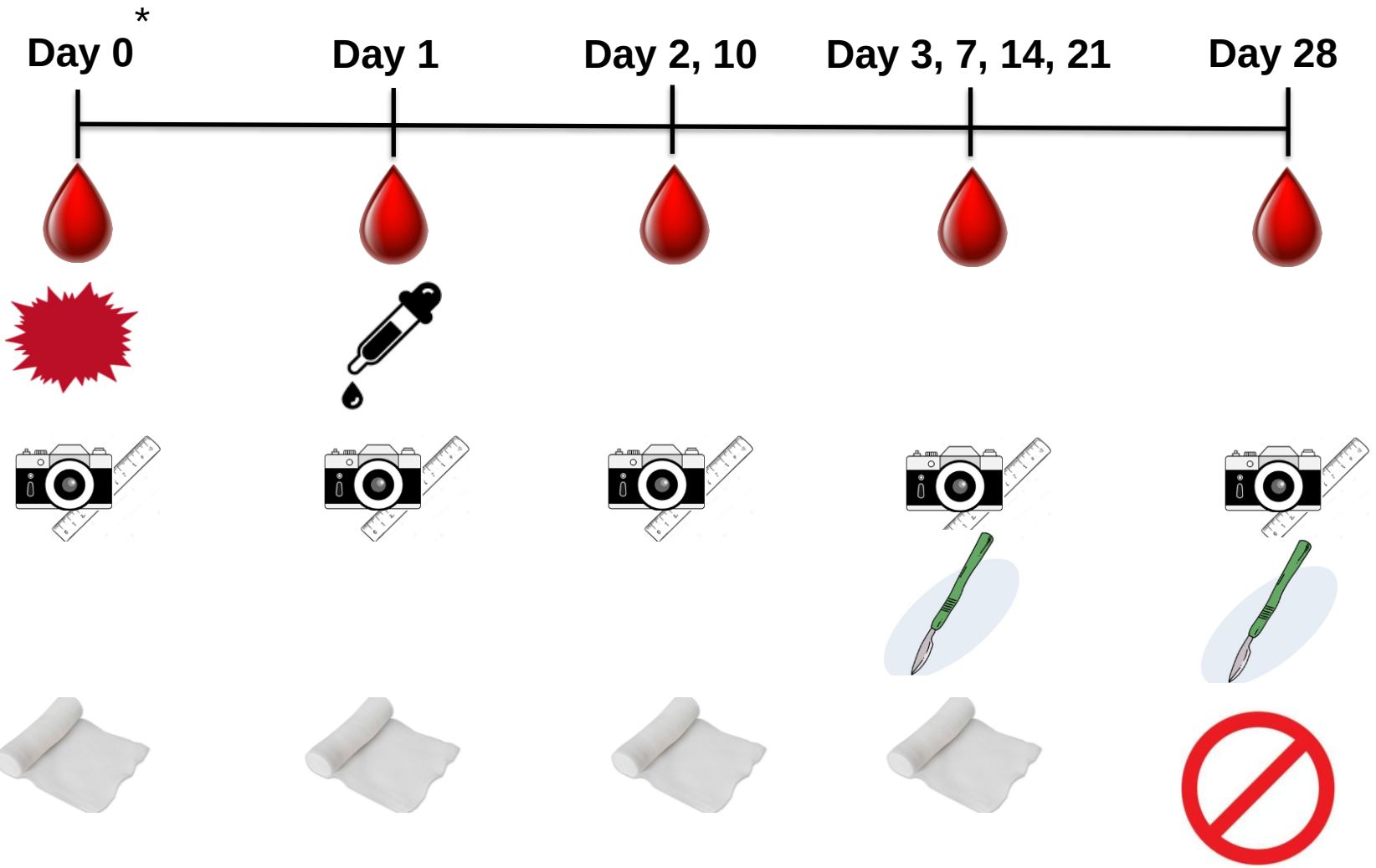
1. The effect of carrier frequency
2. The effect of dose
3. Compare Burn Depth of DE wounds to thermal contact burns
4. Efficacy of mathematical models

Objective and Hypothesis

Objective: Characterize the wound healing profile of uninfected and infected Directed Energy Wounds (8.2 GHz, 5 s, 15 W/cm^2 **or** 20 W/cm^2) in in comparison to deep partial thickness contact burns.

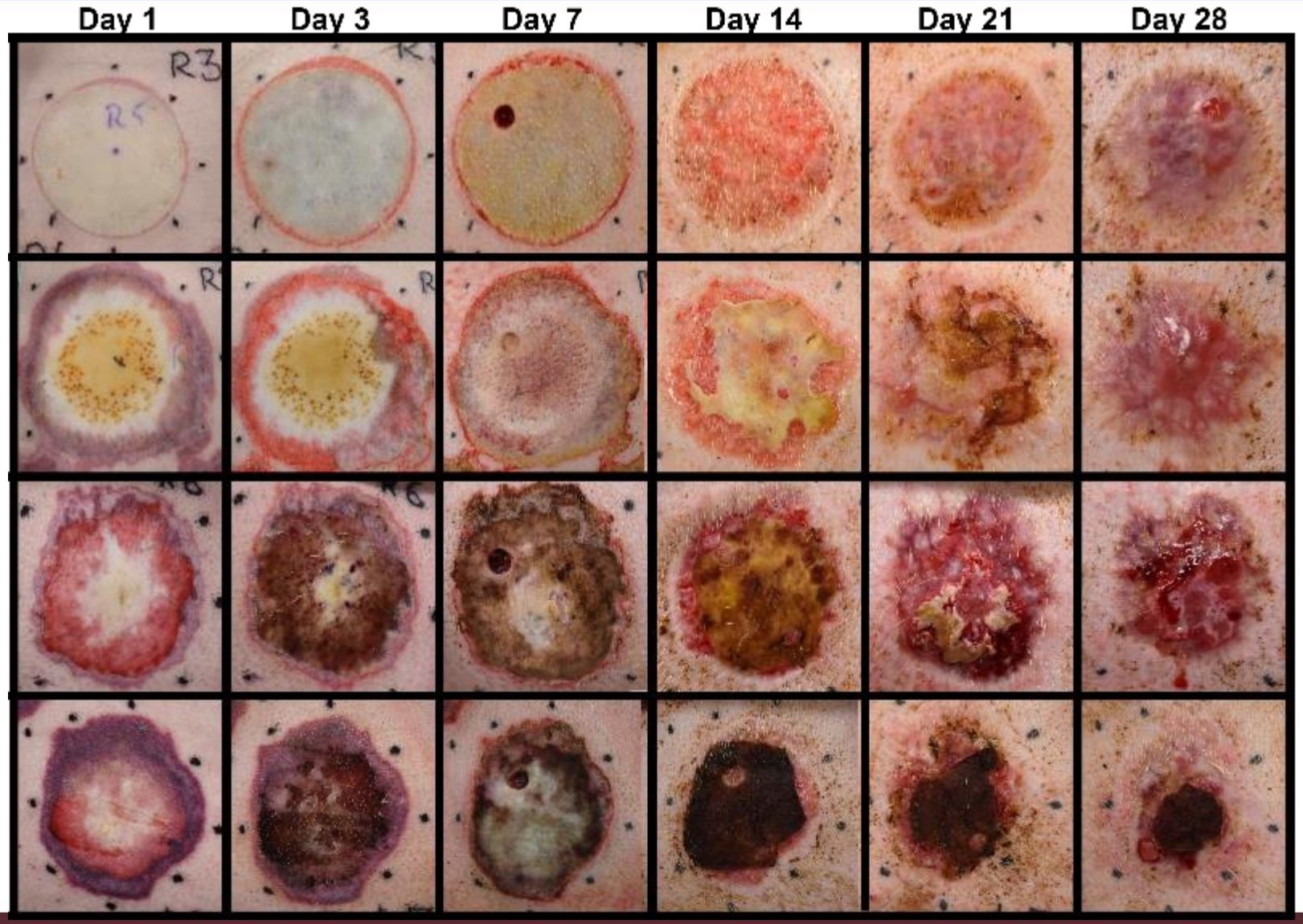
Hypothesis: Induced (8.2 GHz, 5 s, 15 W/cm^2 **or** 20 W/cm^2) partial-thickness burn injuries will heal (re-epithelialize; wound closure) at a rate consistent with contact burn injuries, in response to wound infection with Methicillin resistant staphylococcus aureus (MRSA) or Pseudomonas aeruginosa (PA).

Methods



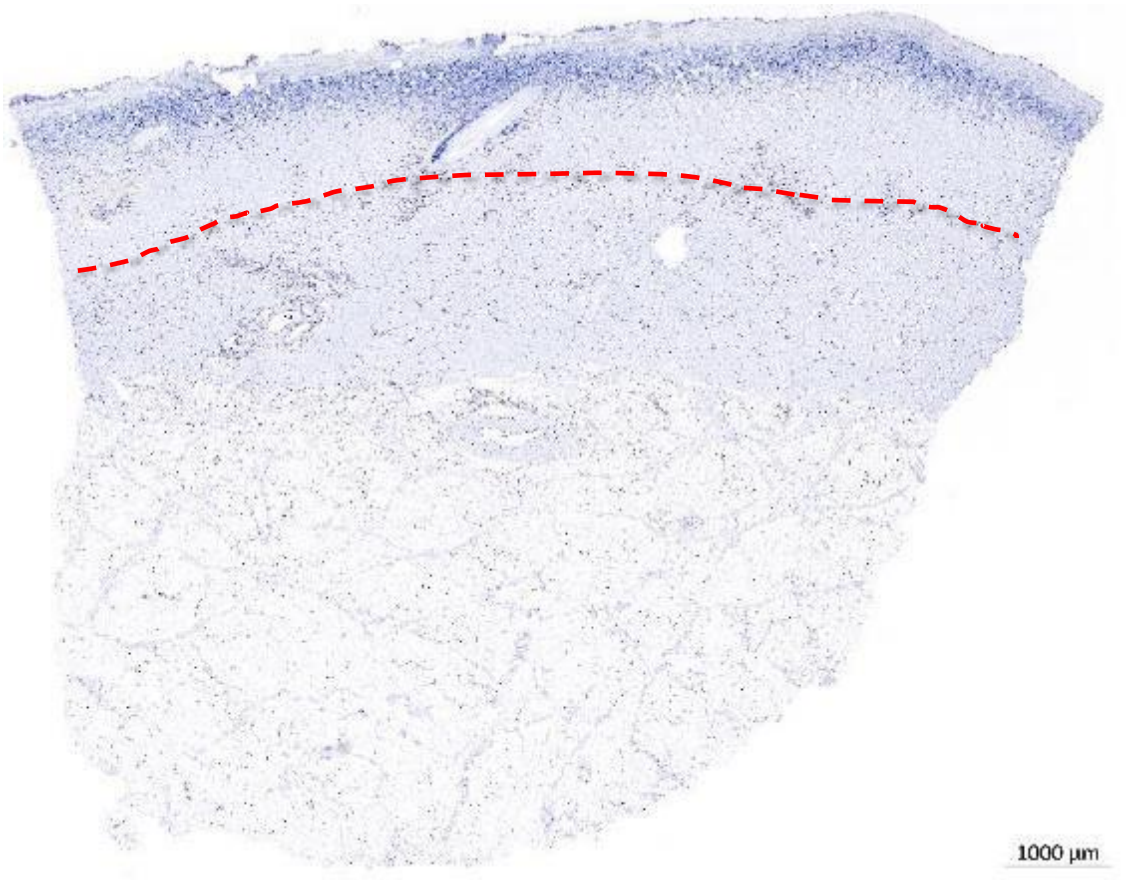
*Prior to injury, animals were anesthetized with Telazol and provided analgesia with buprenorphine SR.

Gross Image Assessment

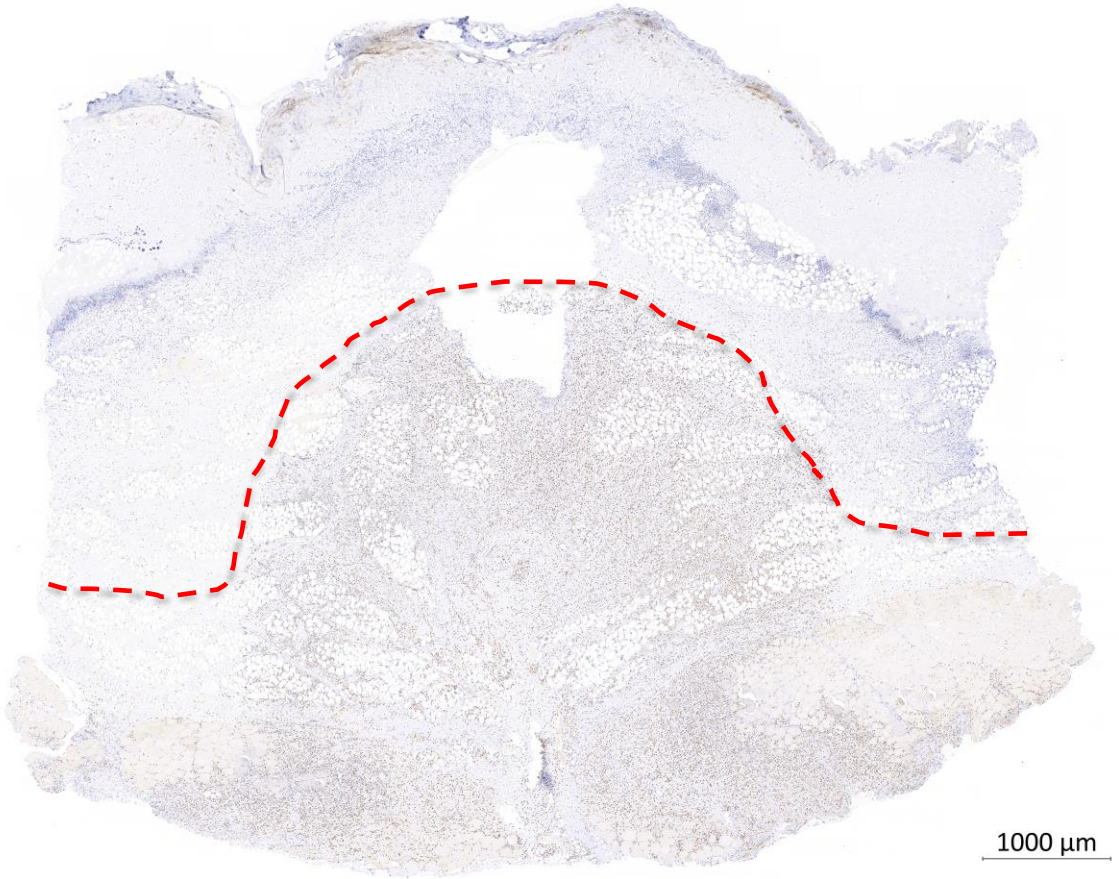


Histological Evaluation- Burn Depth

CB (100°C, 15 s)

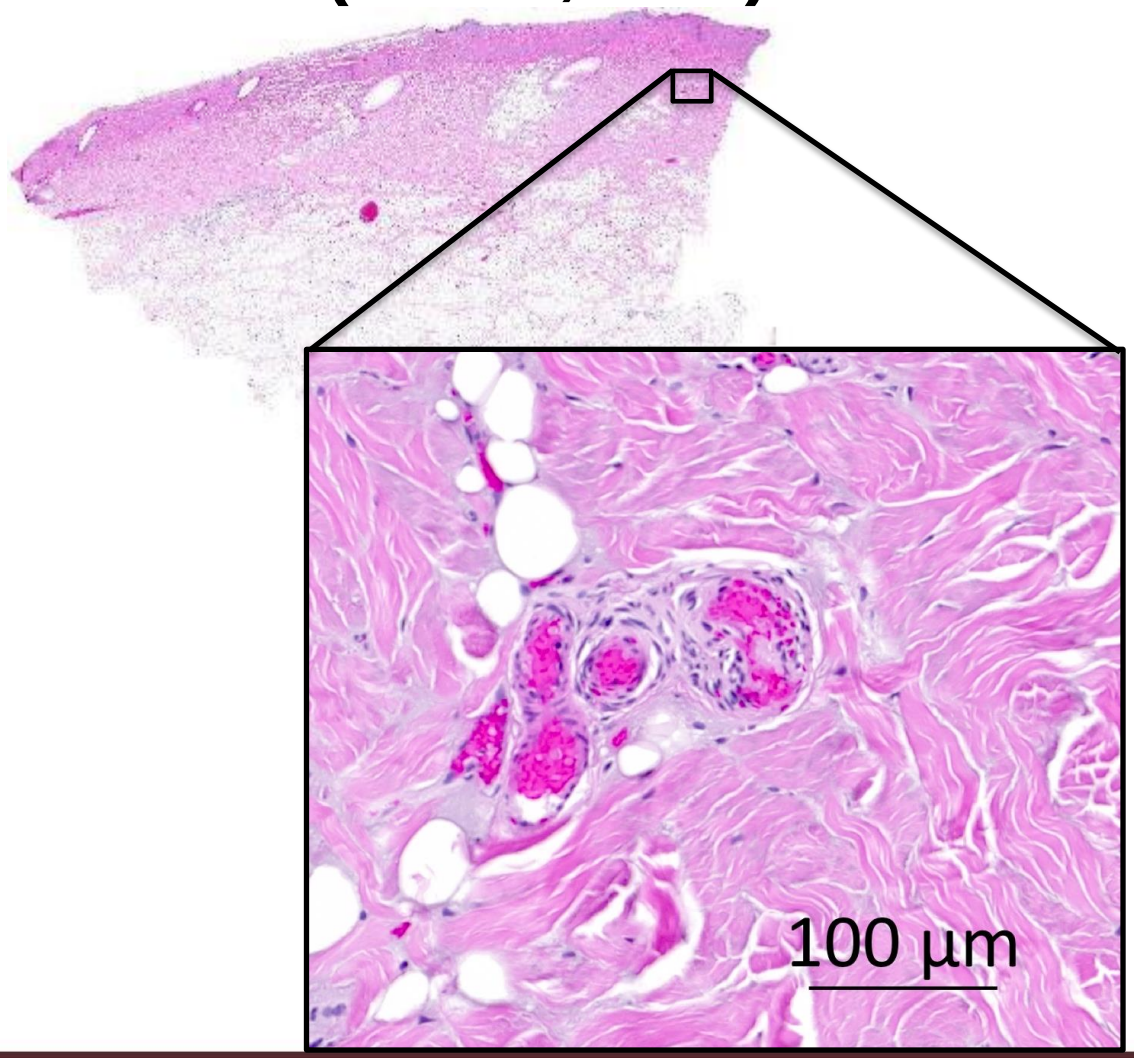


DE (8.2 GHz, 20 W/cm^2, 5 s)

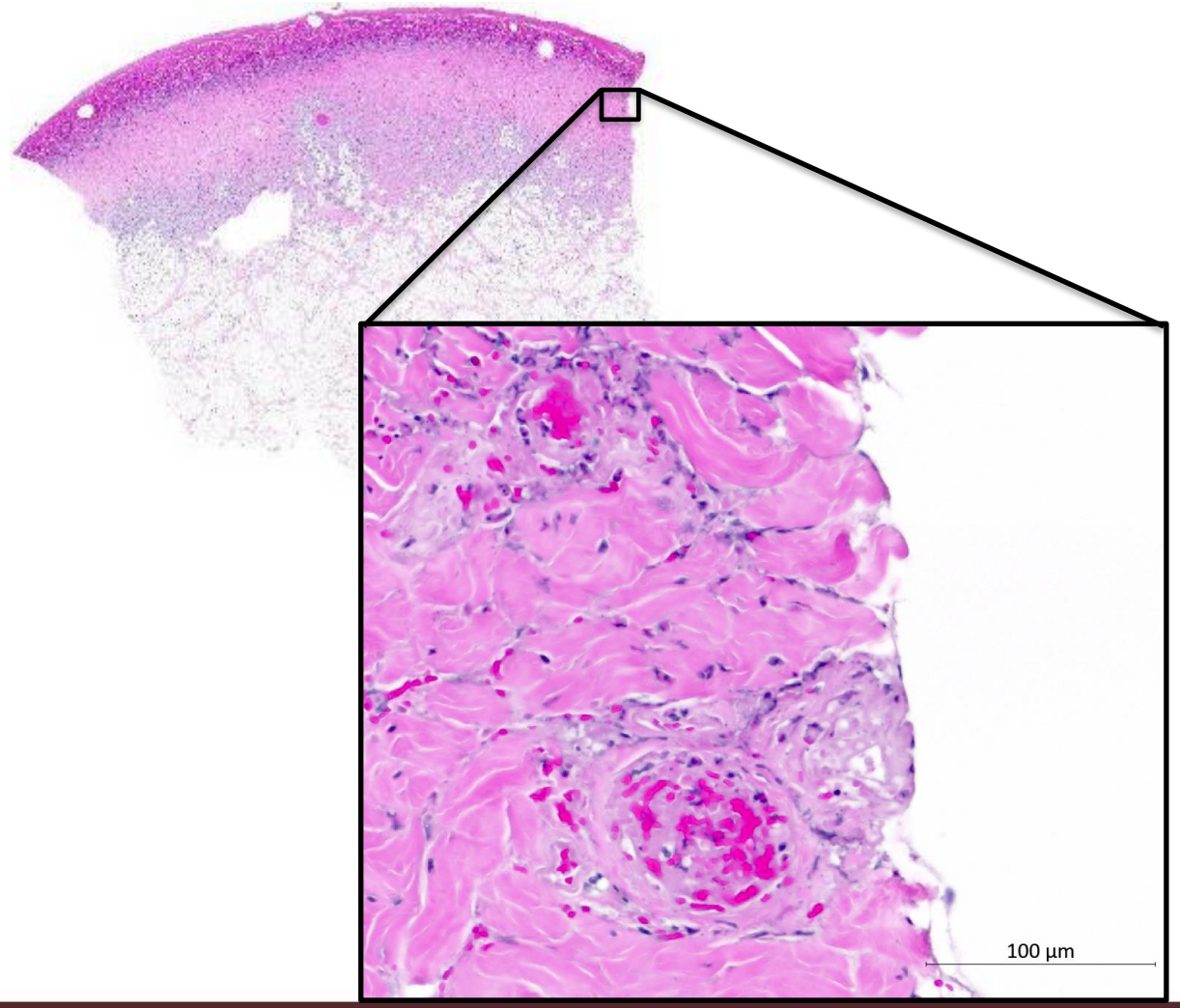


Histological Evaluation- Vascular Occlusion

CB (100°C, 15 s)



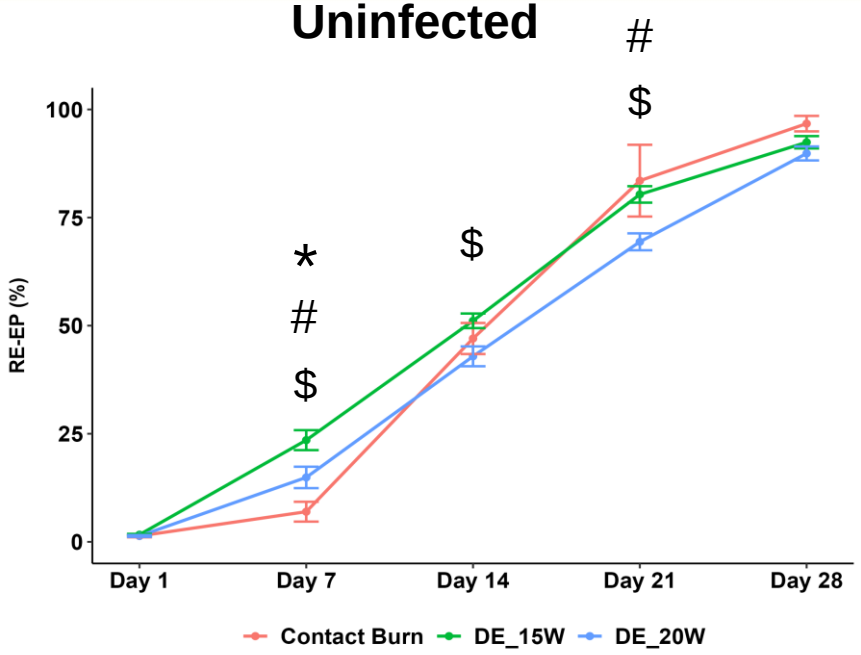
DE (8.2 GHz, 20 W/cm^2, 5 s)



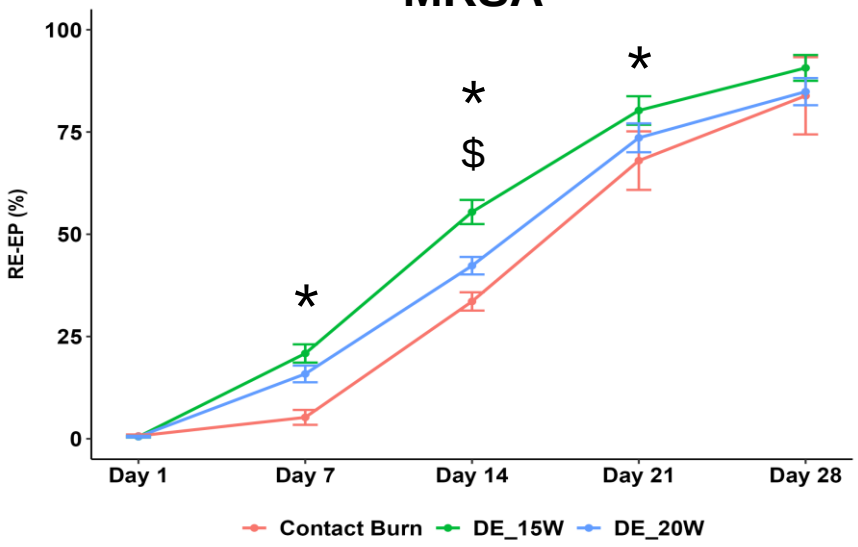
Wound Closure

* = CB diff than DE_15W
# = CB diff than DE_20W
$ = DE_15W diff than DE_20W

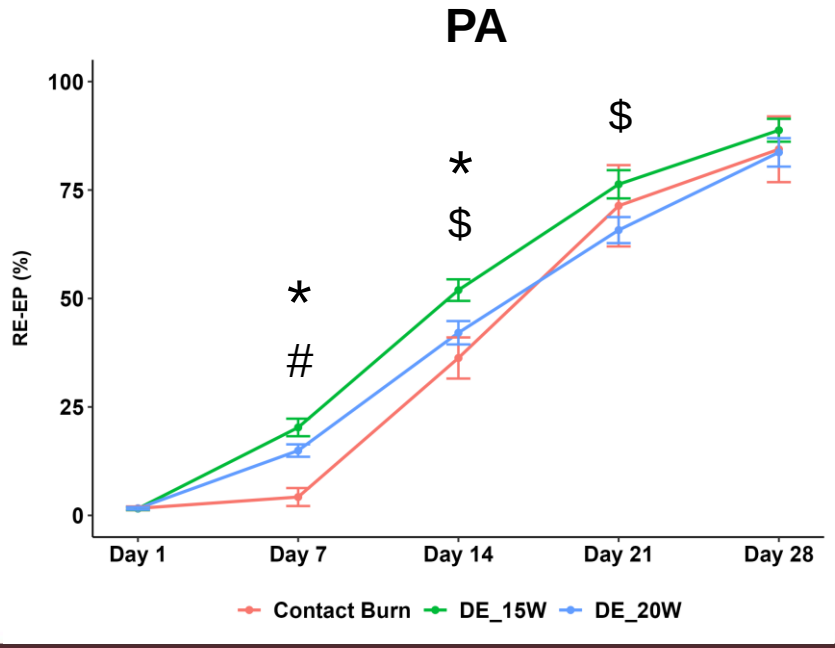
Uninfected



MRSA



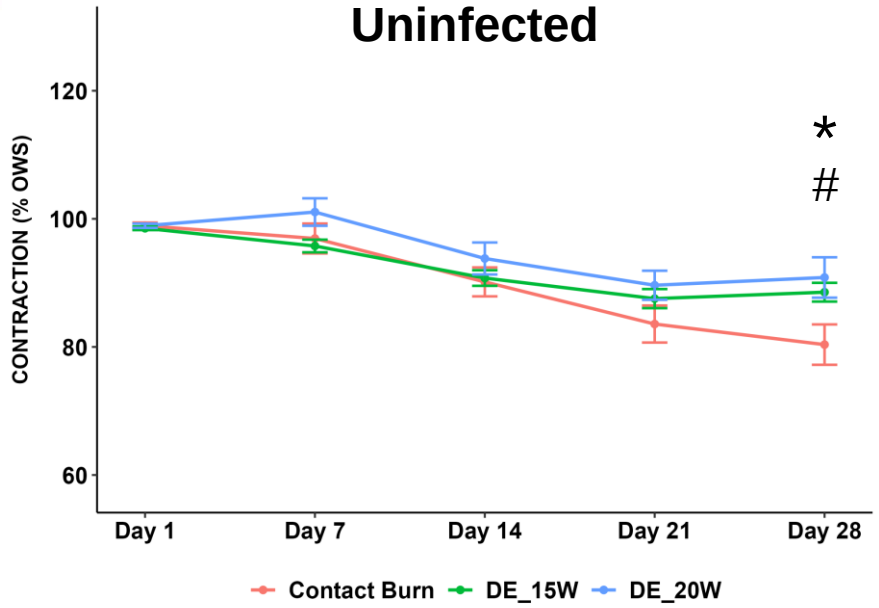
PA



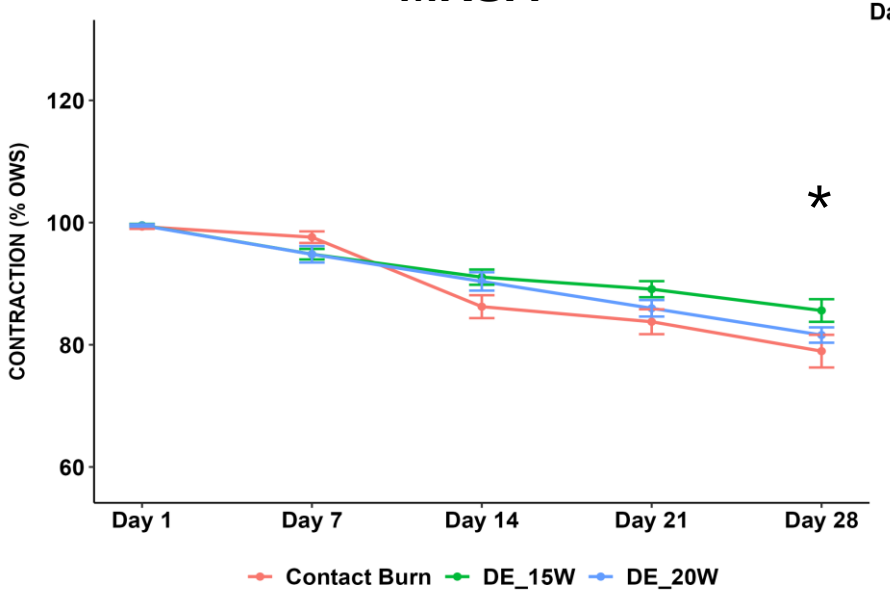
Wound Contraction

* = CB diff than DE_15W
# = CB diff than DE_20W
$ = DE_15W diff than DE_20W

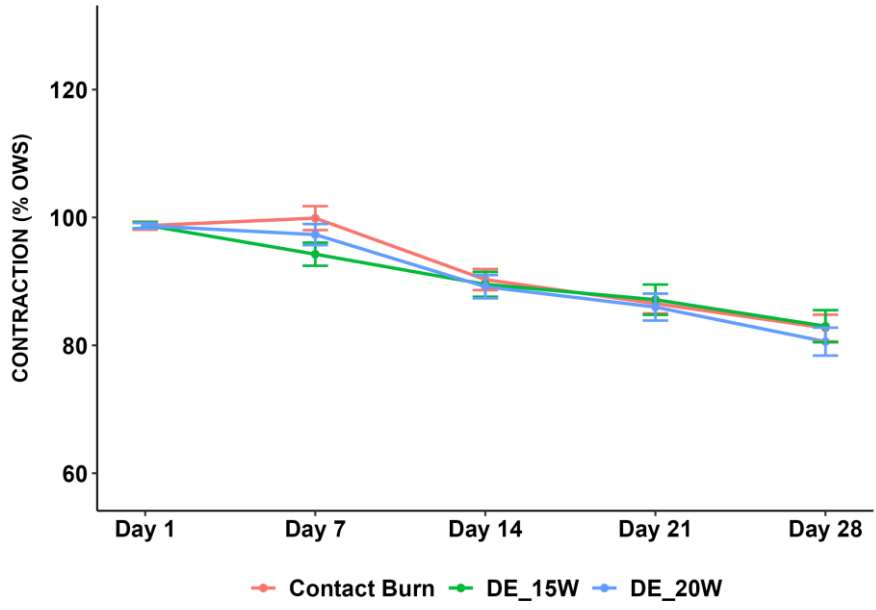
Uninfected



MRSA



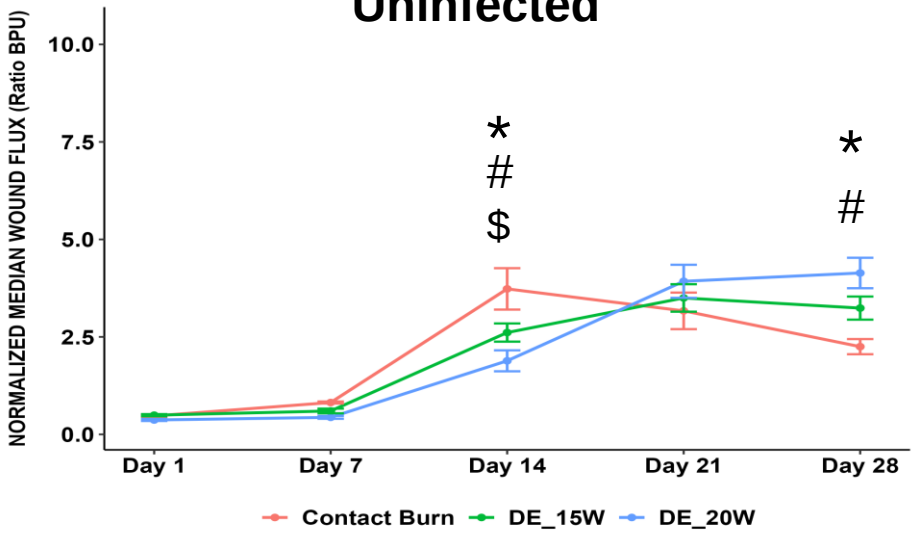
PA

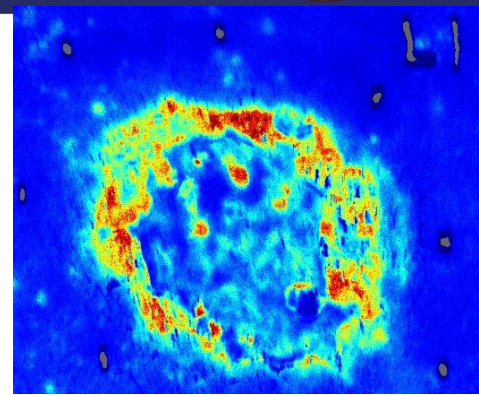


Wound Perfusion

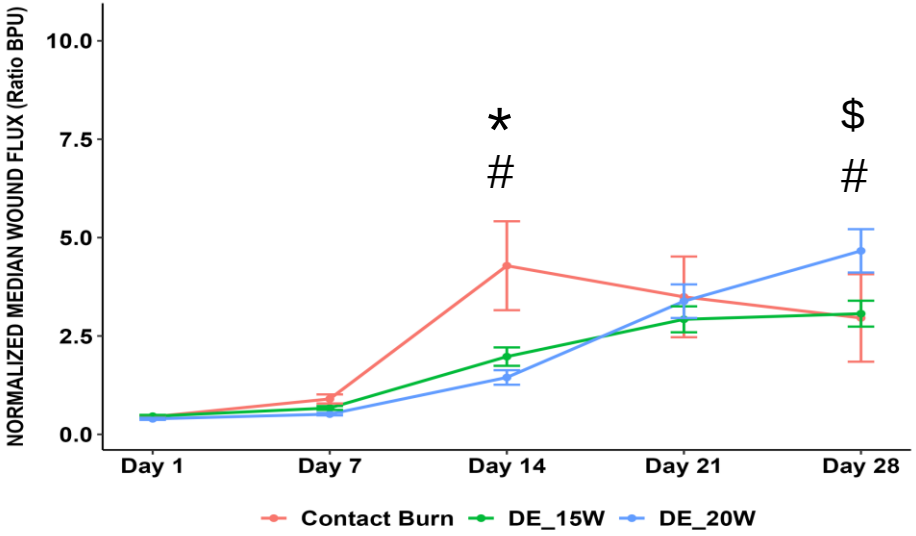
* = CB diff than DE_15W
# = CB diff than DE_20W
$ = DE_15W diff than DE_20W

Uninfected





MRSA



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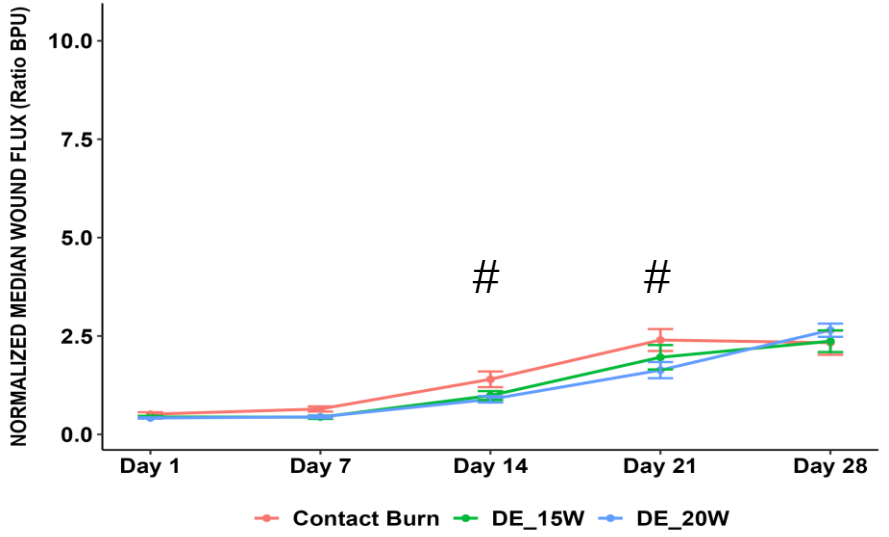
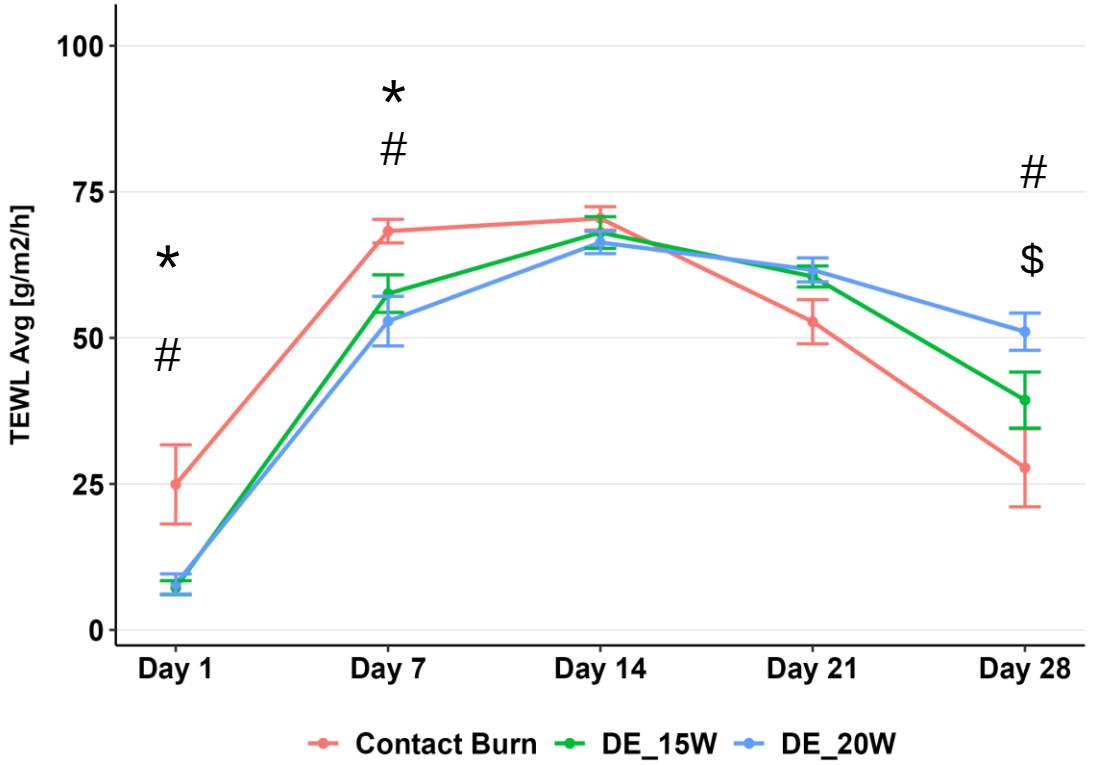


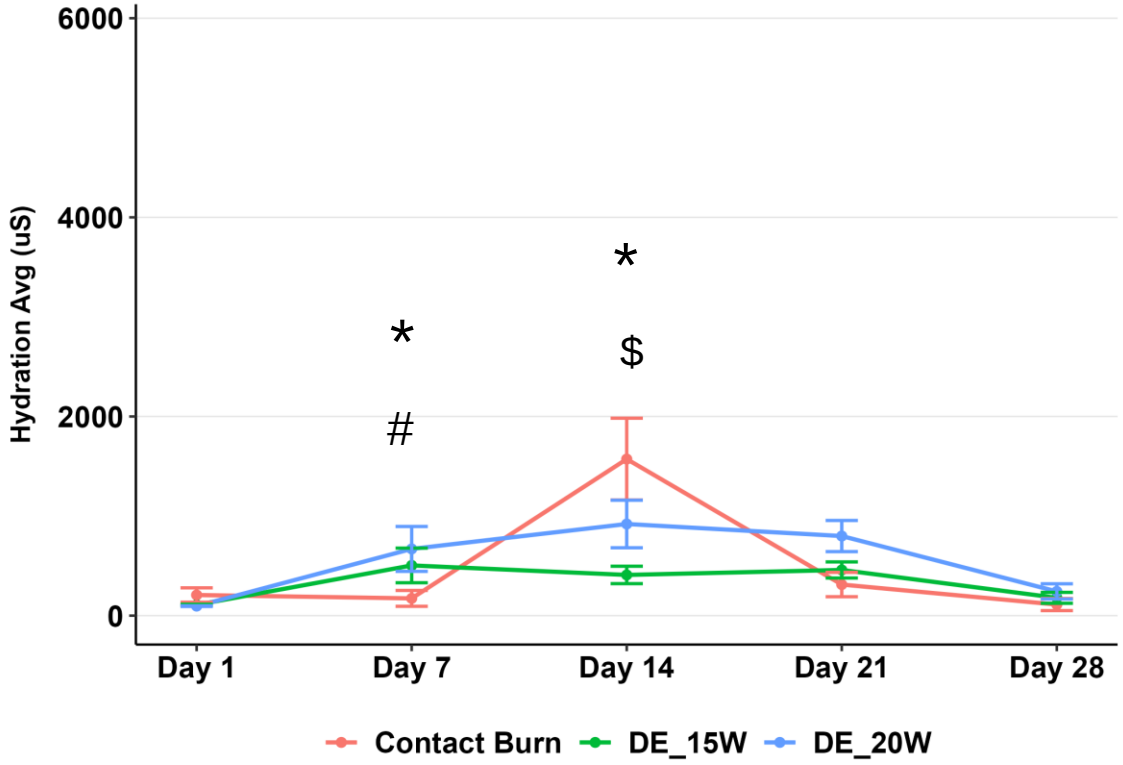
Skin Functional Assessments

* = CB diff than DE_15W
# = CB diff than DE_20W
$ = DE_15W diff than DE_20W

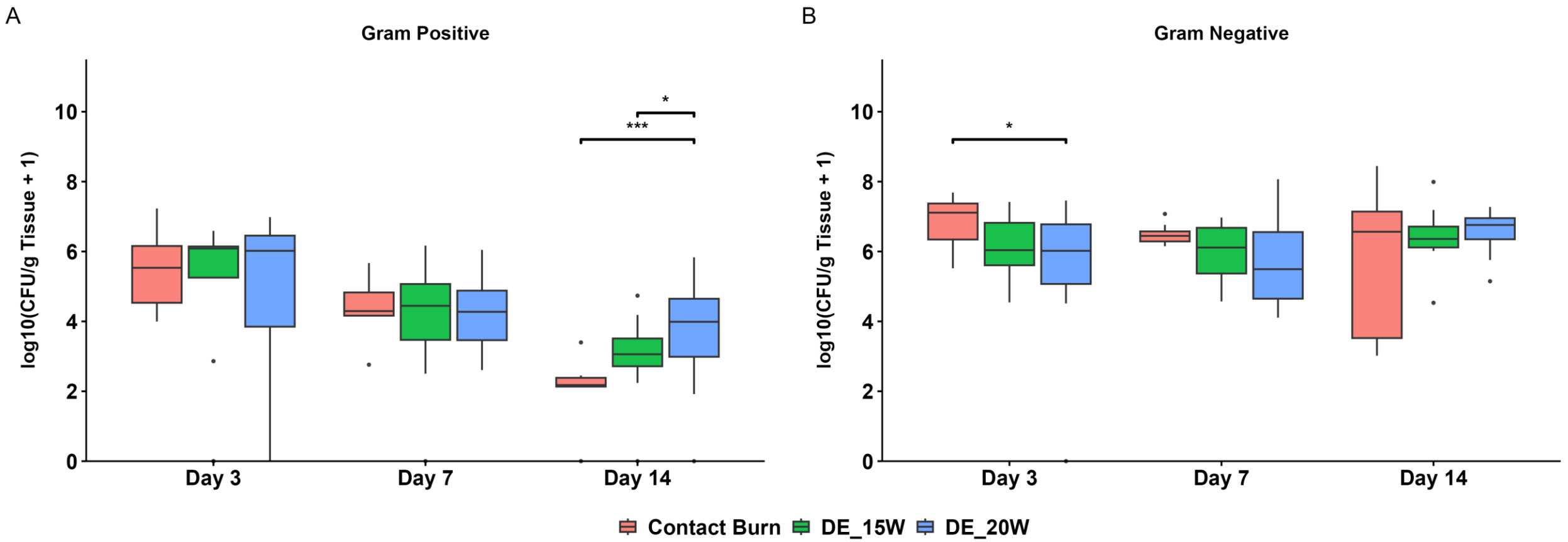
TEWL



HYDRATION



Bacterial Enumeration



Conclusions and Future Work

Conclusions:

- *Deep partial-thickness DE burn injuries, through different modes of energy transfer, produce similar tissue necrosis and vascular dysfunction to that of contact burns of the same severity.*
- *Ultimately, wound healing (re-epithelialization) progresses on a similar timescale as contact burns of the same severity.*
- *Similar to contact burns, DE injuries display an increased susceptibility to infection.*

Future Work:

- *Evaluation of current battlefield clinical practice guidelines to manage DE burn injuries, with and without infections.*

Acknowledgements

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Questions

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