AFRL AIR FORCE RESEARCH LABORATORY
Factsheet Knowledge Product: **Pharmacostability of Medications Exposed to Cold Environments**
Technical Directorate: RH – Human Effectiveness
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PHARMACOSTABILITY OF MEDICATIONS EXPOSED TO COLD ENVIRONMENTS

Objectives:

- **Describe the impact of extreme cold exposure on life-saving medications.**
- **Describe the impact of cold/hot temperature cycling on life-saving medications.**
- **Provide clinician confidence that deployed medications perform as expected.**
- **Provide evidence of which medications will degrade or suffer damage due to temperature extremes.**

Collaboration Partners: The Air Force Research Laboratory (AFRL), 711th Human Performance Wing, Human Effectiveness Directorate (RH), Air and Space Biosciences Division (RHB), Product Development Branch (RHBA), En Route Care Section (RHBAM), University of Cincinnati (UC) and Prompt Praxis Laboratories (PPL).

The knowledge generated by this collaborative effort has resulted in identifying medication damage and degradation to medications commonly used to treat combat casualties.

This study has revealed the need for research to evaluate alternative formulations, packaging, and environmental mitigation. Here are images and preliminary findings thus far.

WHAT IS IT? Caring for combat casualties requires medication administration to provide quality patient care and humanitarian efforts via air, sea, and ground. The potential for care in extreme cold environments is inevitable.

This research effort evaluates the potential impact of medically relevant operational environments on medications. The environments include a constant cold exposure (-60°F) and temperature cycling exposure from (-40°F to +68°F).

The experiments consist of 30-, 60-, and 90-day exposures at each condition compared to a controlled environment (based on manufacturer guidelines).

The first evaluation consists of assessing damage (broken, leaking, other physical damage) at each time point and, in all environments, described above. It is completed by a Doctor of Pharmacy (PharmD).

The second evaluation consists of concentration analysis by an accredited and approved laboratory.

This research provides crucial information for clinicians providing care in extremely cold or cyclic environments.

Epinephrine

- All vials showed cap separation by 30 days
- Two vials were broken by 30 days
- Intact vials did not show medication degradation

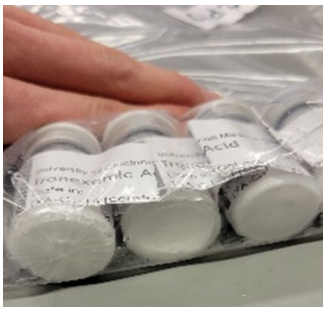
Propofol

- Emulsion visually disrupted by 30 days
- Fifty percent degradation by 30 days when cycled
- >10% degradation by 30 days at constant cold

Sodium bicarbonate

- All vials shattered by 30 days (both environments)

Tranexamic Acid (TXA)



- All vials shattered 30 days after cycling
- Most vials are shattered by 30 days of constant cold
- Intact vials did not show medication degradation.

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WHY IS THIS KNOWLEDGE IMPORTANT? Military clinicians must provide quality patient care in multi-domain, contested, degraded, and austere operational environments.

Understanding the impact of temperature on medication in austere environments is crucial to understanding the effect of these conditions on the storage units, stability, and effectiveness. As medications are often temperature-sensitive, understanding the impact of exposure to extremes of temperature is essential to ensure that patients receive the full therapeutic benefit of their medication.

Medications stored and utilized in this environment may interact differently compared to customary conditions, impacting the efficacy and safety of the drug and creating false confidence by the clinician that the administered medication is providing the intended outcome.

This knowledge also provides valuable information about the impact of cold environments on medications during military operations. Knowing which medications are and are not impacted by extremely cold temperatures is critical, as this information can help reduce logistical challenges, reduce the logistical footprint, and provide rapid deployment capabilities.

This study is designed to evaluate the following medications: amiodarone hydrochloride injection, calcium chloride injection, haloperidol injection, norepinephrine bitartrate injection, phenylephrine hydrochloride injection, propofol injection, sodium bicarbonate injection, atropine sulfate injection, dextrose injection, epinephrine injection, metoprolol tartrate injection, naloxone hydrochloride, Tranexamic Acid, Rocuronium, Succinylcholine, Dexamethasone, Ondansetron, Ketorolac,Phenergan,Diphenhydramine, and Ketamine.

Understanding the impact of the cold environment to optimize medication usability and adapting to the unique challenges of cold weather operations is essential for military success.

Disclosure Statements:

The study protocol was reviewed and approved by the University of Cincinnati Institute of Research Intuitional Animal Care and Use Committee (IACUC) and concurred with by AFMRA SGE-C. The experiments reported herein were conducted in compliance with the Animal Welfare Act and in accordance with the principles set forth in the "Guide for the Care and Use of Laboratory Animals," Institute of Laboratory Animal Research, National Research Council, National Academies Press, 2011.

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