

KEYNOTE



Plain language summary

Canadian Institute for Military and Veteran Health Research Forum 2024: Keynote Speaker Dr. Jaque Reifman

AI IN THE MILITARY: SAVING LIVES AND IMPROVING PERFORMANCE

OVERVIEW

The rapid growth of artificial intelligence (AI) applications in healthcare is leading to advances in the use of predictive analytics for military medicine. Dr. Jaques Reifman, Senior Research Scientist at the U.S. Army Medical Research and Development Command, leads a team that is exploring questions such as:

- What if a mobile phone could assess a military service member's fatigue level every time they interact with the phone and sound an alarm—based on analysis of facial features—when a dangerous level is reached?
- What if we could train AI systems to learn the 72 clinical practice guidelines—and with that, develop a clinical decision support system to help combat medics address complex cases on the battlefield?

Dr. Reifman's keynote address explored these questions and detailed the types of AI he has developed for military medicine, AI's limitations, and exciting opportunities ahead.

WHY IT MATTERS

Dr. Reifman's mission has focused on saving lives, preventing injuries, and improving Warfighter performance. His team has developed solutions to optimize and enhance military performance, supporting soldiers at war and helping to prevent, diagnose, and treat military injury and disease. Saving lives starts with predicting, intervening early, and avoiding undesirable outcomes.

AI offers promising opportunities to achieve these objectives. Dr. Reifman's team created a personalized prediction model that reduces the risk of non-battle injuries and enhances Warfighter performance. His innovations have led to numerous patents and will prove critical in caring for casualties in global geopolitical conflicts.

The Canadian Institute for Military and Veteran Health Research (CIMVHR) works to engage academic and government researchers, facilitate new research, increase research capacity, and foster knowledge translation. CIMVHR hosts an annual Forum that brings together thought leaders to present new research, exchange ideas, share insights, learn, and collaborate with the shared objective of serving military and Veteran health needs.

KEYNOTE

EVOLUTION OF AI

The use of AI in a health context began in the 1970s with expert systems designed to address a narrow problem, such as diagnosing infectious diseases. As AI has evolved, so too have the opportunities to advance military medicine.

1980s: Artificial neural networks and machine learning

Artificial neural networks were initially developed and popularized to address a specific problem, with knowledge obtained by learning from data (known as machine learning). Machine learning uses algorithms that learn from data and make predictions.

In a military context, machine learning can be used to train an artificial neural network to predict the likelihood of hemorrhage in trauma casualties based on vital signs. Once trained, it can be used to determine, in less than a second, whether the patient is likely to be bleeding or not.

2010s: Deep neural networks

The development of deep neural networks advanced AI by using thousands of layers and nodes to allow deeper learning at multiple levels of a problem. This added complexity to AI models, allowing them to better understand and provide solutions to complex problems. The work during this period ultimately led to generative AI solutions.

2024 and beyond: Generative AI

New opportunities in military medicine are emerging with generative AI and transformer architecture. Both have led to exponential growth in the development of large language models that connect words to context.



LIMITATIONS IN MILITARY MEDICINE

Machine learning requires data. In military medicine, data are limited, leading to challenges in:

- **Quality:** Data used to train software must be curated. Completing the task manually is time-consuming and challenging and can lead to inaccuracies. Automated algorithms can allow for the tagging of certain data segments, so they are not used to train AI systems.
- **Quantity:** There is a limitation to the size and amount of data available to develop AI systems. Researchers often conduct studies with 20 subjects; however, much larger numbers are needed to train networks.

Potential solutions

While scientists can conduct large clinical studies, they are costly and take years to complete. One alternative is to generate synthetic data using physiology-based models. Synthetic data mimics the data needed, which is then used to train AI algorithms. Another option is to collect real-time data through AI wearables, such as a smartwatch, and train AI algorithms in real time.

AI IN ACTION

In military operational settings, AI predictions can prevent injury and illness, help triage and diagnose injuries and diseases, and optimize patient care and resources. Dr. Reifman and team continue to innovate with a common goal across all AI solutions: To make accurate, real-time predictions at the individual level for improved health and performance. Their AI innovations address important military operational and health needs:

Triaging combat casualties for hemorrhage risk

- Problem: Approximately 90% of combat casualties die of uncontrolled bleeding on the battlefield before they reach a medical treatment facility.
- AI solution: The APPRAISE-HRI (Hemorrhage Risk Index) analyzes vital signs and predicts which trauma casualties are at the greatest risk for hemorrhage. It prioritizes care and can help save lives.
- How it works: APPRAISE is a decision support system that helps combat medics triage casualties for hemorrhage at the point of injury using software in their smartphones.

Preventing heat illness

- Problem: Every year, the U.S. military sees about 2,000 cases of heat illness, including 500 heat strokes. The majority occur during training in the U.S. and are potentially avoidable.
- AI solution: 2B-Cool provides real-time personalized predictions of core body temperature. It offers an early warning sign of body temperature to help take action and prevent heat illness.
- How it works: The user wears a smartwatch that monitors heart rate and skin temperature. These data are transmitted to a smartphone, where the AI algorithm resides.

Optimizing mental acuity from sleep deprivation

- Problem: About 40% of U.S. military service members are chronically sleep deprived (less than 5 hours per night), yet they are expected to perform at peak alertness.
- AI solution: 2B-Alert provides personalized predictors of alertness and caffeine consumption, telling users how much caffeine to take and when.
- How it works: The user enters sleep history, caffeine consumption, and performs alertness tests (about 2 per day for 2 weeks) using a smartphone and the algorithm automatically “learns” how the user responds to sleep loss.

KEYNOTE

Optimizing resources and trauma care

- Problem: As global conflicts grow in size and intensity, future wars may involve mass casualties without sufficient resources to support them. AI can be used to optimize the use of resources for prolonged medical care.
- AI solution: 2B-Treated forecasts treatment outcomes and selects the treatments that minimize the use of resources. This allows large numbers of casualties to be treated using the least number of resources.
- How it works: The AI algorithm “learns” the physiology of a trauma casualty, including the response to different treatment options to restore vital signs to a healthy state. It then selects the treatment option that leads to a positive clinical outcome while minimizing the use of medical resources, such as blood.

RESEARCHERS

- Generative AI offers the promise of exciting new opportunities in military medicine. For example, AI can automate and accelerate the annotation of clinical data, allowing medical personnel to quickly analyze records and determine ICD-10 codes (to classify diseases and medical conditions).
- AI can accurately predict outcomes on the battlefield in real time. The algorithms can help triage, diagnose, and prevent injury and illness while optimizing resources.
- AI can help address the problem of limited data in military medicine. AI applications can be used to generate synthetic data to train AI systems.
- AI can save lives. AI can serve as a clinical decision support to aid combat medics in identifying trauma casualties at high risk for uncontrolled bleeding (the no. 1 cause of death on the battlefield).



This is a plain language summary of the plenary session, “AI Applications to Enhance Military Medical Readiness,” at the Canadian Institute for Military and Veteran Health Research (CIMVHR) Forum on October 22, 2024, in Winnipeg, Manitoba.

Speaker: Jaques Reifman, Ph.D., Senior Research Scientist, U.S. Army Medical Research and Development Command, Fort Detrick, MD

See the video: <https://youtu.be/gOsw2ImOLDM?si=BVXQZqgrho2DKC0I>