Maximizing Human Performance Through Precision Health

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Presenter has no interest to disclose.

The views expressed are those of the author and do not necessarily reflect the official policy or position of the Air Force, the Department of Defense, or the U.S. Government.
At the conclusion of this activity, the participant will be able to:

1. Define Total Exposure Health as a bold and novel approach to healthcare services and programs.
2. Describe the precepts of TEH as a disruptive force in the delivery of healthcare, the practice of medicine, and the promotion of health.
3. Name the components of TEH and how they interact to create a holistic and comprehensive approach to prevention and improved health services.
Current State

The New York Times Magazine

By PORTIA SIMON

March 23, 2012

The soldiers burning garbage at a combat outpost outside Baghdad in December 2007

AP Photo/Mike Fizer/Associated Press

AT WAR

Veterans Go Back to Court Over Burn Pits. Do They Have a Chance?

The Department of Defense and the Department of Veterans Affairs say they have done all they can to address the health effects of burn pits. But veterans say they have been left out of the loop.

HIGHLIGHTS: Exposure to JP-8, JP-8, and Jet A Fuels occurs mainly in the workplace or from accidents or spills. Studies of military personnel suggest that exposure to JP-8, JP-8, and Jet A Fuels may affect the skin, kidneys, and the skin. Neither JP-8, nor Jet A Fuels are listed as carcinogens.

How might I be exposed to JP-8, JP-8, and Jet A Fuels?

Most people would not be exposed to JP-8, JP-8, or Jet A fuels unless they worked with these products or live very close to where they are used or may have been spilled.

Disposing air in an area where an accident or leak of these jet fuels has occurred.

Drinking water or touching soil contaminated with JP-8, JP-8, or Jet A. Swimming in waters where jet fuels have been spilled may also result in exposure.

Working refueling military or civilian aircraft or transporting jet fuels, particularly if protective clothing is not worn.

Living near a hazardous waste site where these jet fuels are disposed of.

How can JP-8, JP-8, and Jet A affect my health?

Little is known about the effects of JP-8, JP-8, and Jet A on people’s health. Results from a few studies of military personnel suggest that exposure to JP-8, JP-8, and Jet A Fuels may affect the nervous system. Some studies observed changes in reaction time and in other tests of neurological function.

People who accidentally ingested these chemicals, which are similar in composition to JP-8, JP-8, and Jet A Fuels, suffered hernia effects on the respiratory tract, gastrointestinal tract, and nervous system.

The New York Times Magazine
Genetics + ? = Precision Health

“Omics” + Exposome + Epigenetics + ?
TEH Overview
A New Tool in the Toolbox

Current State

Future State: Total Exposure Health

- Armed Forces Health Surveillance
- DOEHRs
- Biobank
- Personal Exposure Monitoring
- Deployment Surveys
- Comprehensive Surveillance
- Individual Longitudinal Exposure Record (ILER)
- "omics"

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TEH Program At-A-Glance

Mission

“The TEH program will enrich the clinical/patient experience allowing beneficiaries to take control of their own health.”

Vision

“TEH will achieve precision health through advances in medicine, sciences, technology and informatics using interactive and transparent precision health information platforms to improve health and well-being of all Air Force beneficiaries.”

Objectives

- Increase use of genomic research and knowledge
- Improve exposure monitoring through sensors and wearables
- Advance operational decisions using big data analytics
- Better understanding of the relationship between exposure and individual health outcomes

Impact

- Increased Readiness
  - Enhanced Human Performance
  - More lethal and fit force
- Population → Person-Centric healthcare delivery
- Trusted Care
Enhancing Lethality

Human Sensor/Weapon System

Lifestyle

Environment

Workplace

TIME

100%

50%

0%

High Stress & Exposures

Typical

TEH IOC

TEH FOC

Enhanced

IOC: Initial Operational Capability

FOC: Full Operational Capability

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Noise Induced Hearing Loss

- Why look at “total” noise?
  - CDC Study 2017
  - VA disability claims
  - Deployability

- Air Force Coriell Study
  - Identified multiple genetic variants in multiple genes associated with Noise Induced Hearing Loss (NIHL) or related phenotypes
  - 17% may be at substantially increased risk of hearing threshold shift

Variation at rs7598759
In the USAF

17% may be at Substantially Increased Risk of Hearing Threshold Shift
Noise Exposure Demonstration Project (NEDP)

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**Funding:** Air Force Medical Support Agency (AFMSA)
**Study Recruitment, Technology, and Analysis:** AFMSA, United States Air Force School of Aerospace Medicine (USAFSAM), Air Force Research Laboratory (AFRL) & Intellisense
Noise Exposure Study: Overview

Aimed to collect and identify health exposure risk (noise) and derive actionable decisions and support related to NIHL. Focus of demonstration was exposures to noise on a 24-hour basis vs. traditional 8-hour occupational exposure basis.

- Study participants were asked to use their own cell phones for the study
- Cellphones were coupled with an external, wireless, bluetooth microphone (provided by the study) to be clipped to the collar or shoulder region
- Participants were asked to enter information on:
  - Noise event
  - Cause of noise
  - US Air Force workplace, and whether hearing protection was worn
- Participants’ ears were scanned to allow creation of custom-fitted earplugs
Noise Exposure Study: Descriptive Statistics

- **Study Location**: Moody Air Force Base, Valdosta, GA

- **Number of study participants successfully enrolled**: 19 people
  - 12 male, 7 female
  - 17 enlisted, 2 officers

- **Age range**: 19-41 years; average=28.9 years

- **Career fields included**: Aircraft Maintainers, Fleet Management, Military Working Dog Handler, EOD, Bioenvironmental Engineering, Weather, Security Forces, Medical Admin, CE Ops/Power Production

- **Number of days monitored, per participant**: range=7-13 days
Bulk of exposures occurred during traditional business hours/early evening. NEDP-53 (EOD) has high numbers of noise events late in the evening and overnight (unknown sources).
This was a Security Forces member. Highest noise events appear to be linked to his motorcycle, vehicle noise, slamming a car door, and use of a circular saw.

This was a CE Power Production member.
Noise Level & Duration by Location
Noise Exposure Study: Impacting Change

Did app heighten awareness of your exposure to potentially hazardous noise?

Based on the noise exposure information from this study, will you use hearing protection more frequently?
IEHRP Overview

Background: Individual Exposure Health Risk Profile (IEHRP)
Mathematical framework that considers individual health risks based on occupational, lifestyle, and environmental exposure factors, medical disposition, and genetic factors.

- Aims to integrate and provide exposure-related data to individuals, clinicians, and organizations to improve health-related decision-making
- Strengthen prevention, human performance, resilience, workforce, and readiness programs

Foundational IEHRP Framework

Individual Exposure Health Risk Indices (IEHRI) = (v_{1,1}) + (v_{1,2}) + (v_{1,3})

IEHR_{noise} = (v_{noise, measure}) + (v_{noise, genes}) + (v_{noise, history})

Individual Exposure Health Risk Profile (IEHRP) =
[(v_{1,1}) + (v_{1,2}) + (v_{1,3})], [(v_{2,1}) + (v_{2,2}) + (v_{2,3})], \ldots , (v_{n,j})

IEHRP = [(v_{noise, mea.}) + (v_{noise, gen.}) + (v_{noise, his.})], [(v_{radon, mea.}) + (v_{radon, gen.}) + (v_{radon, his.})], \ldots , (v_{i,j})
Way Ahead
TEH & DoD Exposure Monitoring Efforts

**Sensing**
- Personal
- Global
- Area
- Individual
- Location
- Exposures
- Date
- Other (DoD, VA, non-DoD)

**Storing**
- Data Security
- Data Encryption
- Server Access
- Cloud Access

**Seeing**
- Visualizations
- Reports
- GIS

**Utilizing**
- Clinical Decision Support
- Operational & Intelligence Decision Support
- Command & Control
- R&D
- Risk Profiling
- Predictive Analysis
- Situational Awareness
- Exposure Monitoring
- Performance Monitoring
- Public Health & Wellness Monitoring

**Guiding Questions**
- What type of data is collected (health, GIS, etc.)?
- How is data collected (wireless, dongle, etc.)?
- How is data protected and encrypted?
- Where is data stored and accessed?
- How is data visualized (applications)?
- Can reports be downloaded and manipulated?
- Does the visualization include GIS?
- What is the data used for (clinical, chemical/biological, risk profiling, etc.)?
- Who (stakeholders) utilize the data?
- How is data shared?

**Impact**
- Enhanced Lethal Force
- Better Health
- Improved Readiness
- Better Care
- Lower Costs

- Increased Readiness
- Better Care
- Better Health
- Lower Costs

- How does the solution enhance exposure monitoring?
- How does the solution protect the health of the Force?

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Joint Health Risk Management (JHRM) Enhanced Capability Demonstration (ECD)

Objective

(U) Left of the Boom

Impact

Saved Rounds

- A Population at Risk
  - Find Gaps and Vulnerabilities not normally evaluated in readiness programs
  - Change Reactive into Pre-habilitative
    - Forecast Risk and Energize Healthy Behavior
    - Maximize Survivability and Optimize Force Availability.
  - Fuse Areas of Collaboration to Maximize Positive Effect
  - Increase knowledge/research in holistic surveillance, innovative biotechnology, and prehabilitative programming
- Now or Never:
  - Drive change to personalized, precision medicine for the Tip of the Spear
  - Move to 21st Century Readiness with 21st Century Capability
  - Be the model of readiness for DOD Personnel
Enhancing Lethality Through Human Performance

**Sensing & Collecting Data:**
- High Performance training and rehab
- Genomics and biomarkers
- Interpersonal functions
- Cognitive / physiological functioning
- Neurological functioning

**Storing & Utilizing:**
Push data to a cloud platform (SPEAR, AAG) that will interact / push data to MHS GENESIS

**Impact: Prehabilitative**
- Optimized wellness
- Optimal or sustained performance
- Early intervention
- Rapid return to duty
- Enhanced unit and individual readiness

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**Sensing & Collecting Data:**
Collect individual genomic biomarker data

**Storing & Utilizing:**
- TEH analytics can store **individual data** on a cloud that could interact / push data to MHS GENESIS
- TS SADA can store **area data** on a cloud that could interact / push data to MHS GENESIS

**Impact:**
- Increased Readiness
- Enhanced Human Performance
- More lethal and fit force
- Population → Person-Centric healthcare delivery
- Trusted Care
Future TEH Exposure Studies

Screening:
- Potential SME support provided by Air Force Precision Medicine program

Sensing:
- Individual & Area Sensors, possibly including:
  - Silicone Wristbands: captures all exposures
  - Noise Dosimeters: A subset of sequenced cohort will receive NEDP noise application notifications → behavioral change

Intervening:
- NEDP noise application notifications
- Genetic Counseling

Storing:
- Risk Management Framework (RMF) - approved platform
- Ultimately intended to integrate into MHS GENESIS

Analyzing & Visualizing:
- Analysis of participant genetics, exposures (silicone wristband & noise exposure), and behavioral change survey results
- Visualization
- IEHRP

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Making a Difference Together

Pacific Northwest National Laboratory

Total Exposure Health 2018 Conference: Bridging Human Exposure & Precision Medicine

DARPA

The National Academies of Sciences Engineering Medicine

U.S. Department of Veterans Affairs

Battelle

It can be done

American Public Health Association

Integrity - Service - Excellence
### Key Ongoing Questions

- Bioethics
- Screening used for decision-making
- Privacy - PHI & PII Information
- Compliance with technology (wearables, etc.)
- Staffing & Resources (Genetic Counselors, screening tests, etc.)

### Opportunities

- Joint TEH DoTMLPF-P Change Recommendation (DCR)
- Enhanced collaboration with DHA, Health Affairs, AFMS Precision Medicine & Human Performance Branches, and new/ existing external
- 24/7 Exposure Study
- Total Exposure Health Conference
Questions?

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