# NATIONAL ACADEMIES

# Emerging Science and Technology to Address Naval Undersea Medicine Needs: A Workshop

### THURSDAY, MARCH 21, 2024

9:00-9:25AM | SESSION 1 | The State of the Science, Then and Now

9:00-9:05AM (ET)	Welcome KENNETH W. KIZER, <i>Committee Chair</i> Stanford University School of Medicine
9:05-9:20AM	Stage Setting by the US Navy Office of Undersea Medicine MICHAEL LAFIANDRA, Division Director, Warfighter Protection and Applications SANDRA CHAPMAN, Program Officer, Undersea Medicine
9:20-9:25AM	<b>Program Overview</b> KENNETH W. KIZER, <i>Committee Chair</i> Stanford University School of Medicine

# 9:25AM-11:15AM | SESSION 2 | Dive Monitoring and Injury Prevention

### **Session Objectives:**

- Review key developments in dive physiology and submarine medicine in the years since the 2002 Underwater Hyperbaric Medical Society report, *An Assessment of a National Naval Need for Undersea Biomedical Research*.
- Review advances in understanding the pathophysiology of decompression sickness, and consider the implications for prevention and treatment research opportunities.
- Explore the approaches that can be taken to support diver safety and injury prevention through work at the intersection of dive physiology and dive equipment development.
- Discuss new approaches in neurophysiological monitoring to prevent the most common causes of military dive injury: hypoxia, hyperemia, and hypothermia.

9:25-9:40AM	FRAMING TALK: Key Advances in Undersea Medicine and Human Performance Since 2000
	SIMON MITCHELL, Diving Physician, Head of Dept of Anesthesiology, University of Auckland
9:41-9:51AM	FLASH TALK 1: Implications of High Within-Diver Variability in Bubbling Across Identical Dives for Research Opportunities in Decompression Sickness Prevention DAVID DOOLETTE, Research Physiologist, US Navy Experimental Diving Unit/NAVSEA
9:52-10:02AM	FLASH TALK 2: Preventing Leading Causes of Military Dive Casualties with Emerging Technologies in Rebreathers ARNE SIEBER, Co-founder/CEO of SEABEAR, Associate Professor for Biomedical Engineering, Chalmers University of Technology, Gothenburg, Sweden
10:03-10:13AM	FLASH TALK 3: Neurophysiological Monitoring for Dive Injury Status XAVIER VRIJDAG, Diving Medical Researcher, University of Auckland
	National Academies Privileged Proprietary Information DRAFT: DO NOT CITE, QUOTE, COPY, OR CIRCULATE

10:14-10:20AM	Break
	[10:20-11:15AM] Questions and Reflections between Presenters and Discussants
	The moderator and principal speakers of Session 2 (Mitchell, Doolette, Sieber, and Vrijdag) are joined by the discussants below. Each discussant below is afforded 10 min to: introduce themselves, describe how their expertise intersects with the session theme, offer reflections to the flash talks, and pose a top-line pressing question to the presenters for an immediate response. Additional questions the discussant may have will be deferred to the Q&A round at the end of the session.
10:20-10:30AM	<b>CAPT EVAN COLBERT, USN,</b> Deputy Director for Navy Diving, Office of Undersea Warfare (OPNAV N97)
10:31-10:41AM	<b>RICHARD E. MOON</b> , Professor of Anesthesiology and Hyperbaric Center Medical Director, Duke University Health System
10:42-10:52AM	<b>PETER LINDHOLM</b> , Professor & Gurnee Endowed Chair of Hyperbaric and Diving Medicine Research, University of California, San Diego
10:53-11:15AM	Q&A with Workshop Planning Committee and Audience

# 11:15-12:00PM | SESSION 3 | Women Operators

### Session Objectives:

- Discuss challenges and opportunities in understanding sex-specific physiological responses to diving and to the submarine environment, and how this translates to occupational injury risk for female operators.
- Explore how existing data archives can be mined for patterns and trends that inform safety and performance considerations for female divers and submariners.

11:15-11:20AM	Session Introduction and Framing Comments KAREN VAN HOESEN, Professor of Emergency Medicine, Co-Director of the San Diego Center of Excellence in Diving, Co-Director of the San Diego Center of Excellence in Diving, <i>Planning Member</i>
11:20-11:45AM	Discussion
	LINDA HUGHES, Statistician, Navy Submarine Medical Research Laboratory FRAUKE TILLMANS, Research Director, Divers Alert Network BRIAN MAGUIRE, Epidemiologist, Leidos
11:45AM-12:00PM	Q&A with Workshop Planning Committee and Audience
12:00-12:30PM	LUNCH

# 12:30PM-3:00PM | SESSION 4 | Monitoring Tools in Submarine Medicine

### **Session Objectives:**

- Explore the impact of changes in submarine operations since 2000 on submarine medicine research, focusing on gender integration and watch schedule adjustments as key drivers.
- Consider the importance of non-invasive monitoring to track cognitive performance affected by fatigue.

•	Examine human factors impacting extended manned submarine operations, addressing physical fitness,
	nutrition, and morale considerations.

- Analyze lessons learned from analog contexts in lunar mission planning, focusing on contingency operations, emergency management, treatment, and risk mitigation.
- Consider how the issues above relate to and intersect with priority research questions and challenges in other subdomains of submarine medicine including gastroenterology, psychology, personnel development, and human factors engineering.
- Discuss how the above issues impact readiness and the ability of the submarine force to carry out their mission.

12:30-12:35PM	Session Introduction David Fothergill, Scientific Director, Navy Submarine Medical Research Laboratory <i>Planning Member</i>
12:36-12:46PM	FRAMING TALK: How Changes in Submarine Operations Since 2000 Have Shaped Submarine Medicine Research Enrique (Rick) Panlilio, Deputy Director for Plans, Policy, and International Engagement, Commander, Submarine Force Atlantic (COMSUBLANT)
12:47-12:57PM	FLASH TALK 1: Non-invasive Monitoring of Fatigue Jeffrey Bolkhovsky, Research Physiologist, Naval Submarine Medical Research Laboratory
12:58-1:08PM	<b>TALK 2: Human Factors for Extended Manned Submarine Operations</b> CAPT Michael Daigle, USN, Future Attack Submarine Requirements, Office of the Chief of Naval Operations (OPNAV)
1:09-1:19PM	FLASH TALK 3: Lessons Learned from Analog Contexts and Lunar Mission Planning Robert Sanders, Flight Surgeon, Program Medical Officer, Extravehicular Activity and Human Surface Mobility Program, National Aeronautics and Space Administration (NASA)
1:20-1:25PM	Break
	[1:25-2:45PM] Questions and Reflections between Presenters and Discussants
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# 2:55-4:20PM | SESSION 5 | Performance

#### **Session Objectives:**

- Provide insights into the importance of undersea medicine for operator needs, emphasizing the challenging conditions faced by Navy warfighters in undersea theater, and highlighting remaining challenges constrained by human factors.
- Highlight the need for neurocognitive research and technology development at depth in order to optimize readiness and maximize performance during and after dives.
- Emphasize the importance of research and technology development to neutralize the impact of ocean temperature on warfighter performance.
- Explore promising directions in CNS and pulmonary oxygen toxicity injury prevention, management, and treatment.

2:55-3:05PM	Session Introduction and Brief Remarks on Performance Medicine at the Navy Experimental Diving Unit
	JOHN FLORIAN, Scientific Director, Navy Experimental Diving Unit, Planning Member
3:06-3:16PM	FRAMING TALK: Perspectives on Undersea Medicine for Operator Performance Needs
	CAPT (ret.) DAVID REGIS, Supervisor of Diving and Salvage (SUPSALV), Program Manager, Deep Submergence Biomedical Development Program, NAVSEA
3:17-3:27PM	FLASH TALK 1: Neurocognitive Effects LCDR JENNIFER JEWELL, USN, Research Psychologist, Director of Biomedical Research, Preservation of Force and Family Cognitive Domain Lead, Naval Special Warfare Command
3:28-3:38PM	<b>FLASH TALK 2: Thermal Protection</b> DAVID HOSTLER, Director of the Center for Research and Education in Special Environments (CRESE) and the Emergency Responder Human Performance Lab, SUNY Buffalo
3:39-3:49PM	FLASH TALK 3: Pulmonary and CNS Oxygen Toxicity AARON HALL, Research Physiologist, Navy Medical Research Center
3:50-4:20PM	Q&A with Workshop Planning Committee and Audience

### 4:20-5:30PM | SESSION 6 | Closing Reflections

#### **Session Objectives:**

- Consider the question, "If you had to balance undersea medicine research needs and could only pick three research areas, what would they be?"
- Synthesize insights from the workshop's discussions to identify emergent themes in undersea medicine research and development.
- Highlight underexplored areas within undersea medicine that present opportunities for groundbreaking research and technological innovation.
- Reflect on the implications of the workshop's findings for enhancing diver and submariner health, safety, and performance in challenging undersea environments.
- Discuss the role of workforce development and interdisciplinary collaboration in advancing the field of undersea medicine, drawing on perspectives shared throughout the workshop.

4:20-5:25PM	Reflections on Promising Opportunities for Naval Undersea Medicine Moderated by Kenneth W. Kizer, <i>Workshop Chair</i>
	SANDRA CHAPMAN, Program Officer, Undersea Medicine, Office of Naval Research
	PETER WITUCKI, President, Undersea and Hyperbaric Medicine Society, Emergency Medicine Physician, University of California, San Diego; Diving Medical Officer, US Naval Reserves
	CAPT. EVAN COLBERT, Deputy Director of Navy Diving, OPNAV N97, USN
	CAPT TIMOTHY OLIVER (ret.), USN, Executive Director, Naval Submarine League
	VIRGINIE PAPADOPOULOU, Research Assistant Professor, University of North Carolina Chapel Hill
	JOHN MARSACK, Founder and Managing Partner, Legion Undersea Services, Chief Petty Officer (ret.), Special Operations (ret.), USN
	JIM BAGIAN, Professor of Engineering Practice; Co-Director, Center for Risk Analysis Informed Decision Engineering, University of Michigan
5:25-5:30PM	Close Out KENNETH W. KIZER, <i>Committee Chair</i> Stanford University School of Medicine