Introducing New Diver Health Monitoring Technology

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Keeping Diving Relevant for the Future

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confidence under pressure
AGENDA

Health Monitoring in Diving

Existing Diver Health Monitoring Systems and their Limitations

Wearable Diver Health Monitoring Systems

Wearable Health Monitoring System Integration

Questions
The Importance of Health Monitoring in Diving
Saturation divers operate in remote, often harsh environments → maximising safety is **paramount**

Divers are susceptible to numerous medical conditions, including (but not limited to):
- Barotraumas (Pulmonary, Sinus), Hypo and Hyperthermia, Infections, Gas Embolisms, Decompression Illness, etc.

There is an increasing average age of Divers → Increases likelihood of conditions arising

Being able to react and help the Diver is vital

Intervention before an emergency occurs is ideal

**Requirement**
So how do we address this currently?

There are several health/medical monitoring and treatment systems commercially available for saturation divers.
Remote health monitoring system designed for Saturation Diving and Hyperbaric Treatment Chambers
→ Health data relayed to onshore medical staff
→ Blood pressure
→ Saturated Oxygen (SpO₂)
→ ECG
→ Core Body Temperature
→ + Additional Functions

Rated to 450msw

Satisfies DMAC 28 and OGP 411 recommendations

Typically only used once an incident has occurred
Assessment of diver decompression and likelihood of suffering from decompression illness

Uses Doppler ultrasound to count vascular bubbles and grades based on likelihood of DCI

Requires diver to have returned to surface
→ More suited to air or defence diving than saturation

Medical Emergency Systems

Other medical emergency equipment exists that is not directly related to health/medical monitoring
(not an exhaustive list)
Automated External Defibrillator (AED) Zoll Med

AEDs automatically diagnose life-threatening cardiac arrhythmias and attempt to return normal cardiac rhythm by delivering an electric shock.

Standard (unmodified) AEDs can be unreliable when stored and used inside hyperbaric chambers.

AEDs can be adapted for use in hyperbaric environments:
- AED unit can be stored outside chamber
- AED electrodes remain inside the chamber, connected to the unit through electrical penetrators.
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AEDs can also be contained in a 1atm housing and stored inside the chamber.

Other equipment includes: HERK, DMAC 015 kits, Hyperlite hyperbaric stretchers, confined space stretchers, bell survival kits, etc...
All current options are REACTIVE

An incident has to have already occurred or the diver presents it
Solution

Being able to monitor diver health **continuously** would facilitate earlier detection of incidents or medical emergencies

- Throughout an entire diving campaign: underwater, in chamber, and during hyperbaric evacuation
- Earlier detection would improve prognosis for the diver, and minimise job downtime
- Data logs would also help reduce chances of repeat incident

→ **WEARABLE HEALTH TECHNOLOGY**
Wearable technology or “wearables” would facilitate continuous diver health monitoring.

- Common wearables include: Apple Watch, Polar, GreenTEG CORE, AstroSkin.

Unfortunately, none are suitable for saturation diving.
So, we decided to create our own
Saturation Diver Health Monitoring System
Collaboration between JFD Fathom and the University of Strathclyde

Standalone prototype for assessing system feasibility
- ECG, PPG, Skin Temp, Blood Pressure, Heart Rate, Breath Rate
- Wireless (Bluetooth) and battery powered
- Watch based spot checks – initially for dry diving applications
- Completed successful hyperbaric testing and diver trials

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Next Steps

In development is the creation of a Health Monitoring Platform with additional and advanced functionality:

→ Core Body Temperature, SpO₂, Hydration Level, Depth

Platform will be common across several commercial and defence diving applications:

• Different solutions will then be created for both in-chamber/lifeboat (dry) and in water monitoring

Chamber/Lifeboat (Dry) Device
Will remain a watch based system. Basic continuous monitoring with periodic advanced spot checks

Underwater Device
Chest based to avoid hindering the diver. Continuous monitoring - no diver input

NOTE: Concept designs likely to change
System Integration
Saturation Dive Monitoring System (DMS)

**SAT Client**

- Watch based ‘spot checks’

**DIVE Client**

- Continuous in-water monitoring

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Concept implementation not indicative of end design
Air Dive Monitoring System (AirDMS)

Concept implementation not indicative of end design

Combining biometrics with Fathom HD Camera and DMS technology will provide state-of-the-art dive and diver monitoring

AirDMS Client

→ Continuous in-water monitoring
→ Chest based system – no input required from divers
Critical Systems Monitoring And Tracking System (CSMTS)

CSMTS is a standalone system consisting of a distributed array of sensors fitted to an SPHL that provides the information to ensure the SPHL is always operationally ready

→ Relays data to onshore personnel via the Iridium satellite network
→ IOGP 478 and IMCA D052 recommendation

→ Authorised onshore personnel can log in via online via dedicated CSMTS website and mobile applications
  → Current and historical data
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→ Authorised onshore personnel can log in via online via dedicated CSMTS website and mobile applications
   → Current and historical data
   → Operating mode
   → Diver information (name, SPHL)
Critical Systems Monitoring And Tracking System (CSMTS)

CSMTS is a standalone system consisting of a distributed array of sensors fitted to an SPHL that provides the information to ensure the SPHL is always operationally ready.

Extending CSMTS to also monitor diver health is the logical next step.

Watch-based health monitoring solution
→ Diver spot checks
→ Alarms on suspect data
→ Enables onshore personnel (inc. HRF) and medics to prepare for diver arrival.
Diver’s recommended changes for a better future **Table 10 – Step 3:**

“A trusted third-party **reporting and health-monitoring system for divers** should be created to eliminate the under-reporting problem and to obtain valuable health data that at present is being missed.”

DMS and CSMTS with health-monitoring technology is the answer

Post dive campaign monitoring could also be achieved by sending divers away with a health monitoring device and mobile logging app.
Thanks for your attention.

Questions?