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Epidemic Protection and the Underwater Domain: A Mechanism in Common and an Opportunity for Technology Transfer

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While we are trained to deal with physically focused and time-sensitive natural disasters, the coronavirus disease 2019 (COVID-19) pandemic global disaster challenged us and forced the creation of quick solutions in a state of uncertainty.

Diving, hyperbaric conditions, and the COVID-19 pandemic are extreme settings with limited breathing capabilities, restricted mobility and visibility, and disrupted communication that demand personal protective equipment, breathing options, monitoring and supervision, communication, transportation, autonomous support, and adaptive pressurized spaces. The similarities among the 3 may serve as inspiration for innovative ideas and technology transfer, enabling future disasters to be handled faster and more effectively, such as:

(1) The comfortable, soft, and flexible diving suits allowing unrestricted physical activity may inspire the design of comfortable epidemic protective gear.[1,2]
(2) Modification of divers' transparent full facemasks or hoods may enable longer and safer stays in contaminated areas,[3] but require connection to compressed gas sources. Moreover, a microphone installed in the mask or hood for communication and a closed-circuit video camera on the mask may overcome physical distance restrictions between health-care providers and patients in contaminated situations.
(3) Operating portable units like hyperbaric monoplace chambers used for the transfer of diving casualties to hyperbaric centers[4,5] may inspire transportation facilities for contaminated patients in aircraft or ambulances.
(4) Controlling the fatigue, contamination load, and stress of staff in isolated and polluted areas can be aided by principles of diver monitoring devices that monitor dive duration, location, and physiological data.
(5) The concepts of unmanned underwater robotic systems and remotely operated vehicles used in deep sea missions will assist in building autonomous equipment for the treatment and care of isolated patients without risking the staff.
(6) Designing complexes of rooms with negative and positive pressure in hospitals based on marine engineering principles will assist in quick adaptive solutions for patients requiring isolation.

Based on such analogies, we suggest the following:

(1) Develop reusable personal protective equipment, inspired by diving gear, including a suit of soft and comfortable fabrics with zippers and a transparent full-face mask or a hood comfortably fitted to the head, connected to a portable small elastic source of a breathing gas placed inside the protective uniform, allowing safer and longer work in contaminated spaces, with good visibility and clear communication.
(2) Expand use of autonomous, remotely operated robotic platforms at hospitals and patients' residences for patient monitoring, communication, treatment, and patient care, that have both flying and walking abilities.
(3) Plan hospitals with infrastructure for negative- and positive-pressure inflatable units operated on demand, allowing a differential increase in oxygen pressure in individual rooms and an option for connection to portable personal capsules for safe patient transfer.
(4) Compose an "epidemic meter" for health-care workers, similar to diver's decompression computer, calculating viral load and safe exposure time depending on personal risk factors for caregivers (age, comorbidities).

Using the analogy to diving for inspiration and technology transfer will help to face subsequent epidemics and climate change disasters. As the father of nanotechnology, the Nobel laureate Richard Feynman said, "There is plenty of room at the bottom."

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