# Rebekah Wang

* STEM Research Area

When people think about the technology behind the Navy and Marine Corps, they might think of submarines or satellite communication. But what about undersea medicine? Undersea medicine is not something most people first consider to be contributive to naval operations; however, it is just as important. Undersea medicine helps to prevent, treat, and diagnose diving-related conditions and ensure the safety of military divers.

Divers are an essential part of the Navy and Marine Corps. They complete routine tasks such as ship/system maintenance and item recovery but also put themselves at risk to perform more dangerous jobs such as explosives disposal and direct combat. Some might argue that undersea medicine would be mostly inessential in the future as robots replace divers. While robots are extremely useful tools, humans still have many important abilities—such as creative problem-solving and adaptability—that robots don't have, which is why undersea medicine is always essential.

Undersea medicine is a medical field that helps these important divers do their job by relieving some problems they might face. Diving involves placing divers in conditions their body is not normally used to, resulting in a host of challenges. Divers need to breathe underwater, endure extreme temperatures, withstand immense pressure, and undergo the risk of various medical conditions—such as decompression sickness, nitrogen narcosis, and oxygen toxicity. Aspects of undersea medicine that alleviate these problems include hyperbaric medicine and oxygen therapy to treat diving-related illnesses and diving technology that enables divers to spend longer and more comfortable periods of time underwater. Clearly, undersea medicine is of utmost importance to the Navy as it helps prevent and mitigate some of their divers' setbacks, allowing them to do their jobs safely.

It is for that same reason undersea medicine provokes such inspiration in me: by breaking the limits of human capability. From a young age, I loved visiting the local aquarium and reading about space. I wondered what it would be like to swim in ocean depths like fish or look at the Earth from the moon. To this day, I remain fascinated by ocean and space exploration because they let us indulge in our innate human curiosity and learn more about environments beyond our natural habitat. I was always curious about what it looked like down in the ocean or on the moon, and I even dreamed about going to these places myself. Hence, subjects such as undersea medicine, which allow humans to break their boundaries and be able to explore extreme environments, are something I, personally, find quite inspirational. Researching and creating technological innovations to allow humans to surpass what is natural and unravel the mysteries of vast, enigmatic places such as the ocean would have been completely unimaginable years ago.

* People

Dr. Sandra Chapman, a scientist and the Program Officer of the Navy's Undersea Medicine Program, has made many impactful contributions to undersea medicine. She has developed extensive technology—such as augmented reality visual displays and hydrolysis masks—to ensure the safety of military divers, but what makes her especially inspiring to me is her unique approach to undersea medicine.

Dr. Chapman wants to make the transition from land to water smoother by improving the human body rather than technology. For example, researchers in her program are investigating what allows sea nomads to be so adapted to water. Others are using marine mammals as models for their research due to their metabolic similarity to humans. She is also working on bioengineering bacteria to generate or release heat depending on surrounding temperatures.

Dr. Chapman's goal of guiding humans away from being dependent on technology and instead utilizing biology to improve the human body's water adaptability truly inspires me. Her work pushes the limits of discovery and diving research, as most aspects of undersea medicine are focused on advancing technology rather than the human body. As I mentioned earlier, "pushing limits" is very inspiring to me. Part of my goals for the future is to go above and beyond what I think I am capable of, whether it be breaking boundaries of thought and research to make innovative discoveries, or quite literally, making it easier for humans to go where they cannot. I want to challenge myself to achieve my study and career goals. Regardless if I go into undersea medicine, her way of revolutionizing how humans search for solutions is something I hope to be guided by in the future.

I also hope to bring her energy into my current interests. I believe that technology is becoming more and more relevant in our lives. So as an aspiring computer science student interested in artificial intelligence (AI), I aim to make technology a more cohesive part of the average person's life and reduce some of the possible downsides of a technology-centered society. Precisely, I want to make humans and technology more compatible and ensure that AI is safe and trustworthy. For example, the human-in-the-loop model balances artificial and human intelligence. Even though Dr. Chapman focuses on leaving technology behind, and my future goals might involve making technology a more natural part of modern life, her pioneering philosophy of redefining the status quo will steer me as I navigate opportunities and obstacles to come.

* Future

A new advancement in deep-sea diving that could realistically occur in the next 15 to 20 years is underwater treatment centers. Closer treatment centers for diving-related illnesses would allow Navy and Marine Corps divers to receive faster treatment and make recovery easier for divers with diving-related illnesses. Such treatment centers would have general medical equipment along with other equipment that specializes in treating diving-related illnesses, such as hyperbaric chambers. Possible new technologies to treat diving-related conditions could leverage artificial intelligence (AI) and

quantum computing to efficiently analyze patient data and create patient-specific treatment plans. Novel AI algorithms could be developed to intelligently and accurately analyze data, while quantum computers would run these algorithms unprecedentedly fast. Using these computer systems would also help general doctors diagnose patients more easily, benefitting the lives of all patients, not just divers. Finally, these centers could be stationary or on ships such as submarines that could move where they were needed, and could also be used for a wide range of people, such as those who are injured in the ocean.

While underwater treatment centers help treat diving-related illnesses, other technology could be used to prevent these complications from arising in the first place. Simulations are a more extensive training option for divers and are used to train many people, including pilots. A technological advancement of these simulations could utilize AI to provide a more randomized and realistic simulation of unexpected situations that could arise in the sea. This technology could also be used to train people in different occupations, such as doctors, not just those in the Navy or Marine Corps.

The technologies mentioned above were on the more realistic side and could be developed in even less than 15 to 20 years. However, more advanced technology could also be developed with more time—specifically, masks that convert exhaled carbon dioxide into oxygen for re-inhalation. This mask could also be used in other places with little oxygen, giving it a wider range of use. Another feature of these masks could take free carbon dioxide in seawater and convert it to oxygen. The copious amount of carbon dioxide in the ocean causes detrimental ocean acidification, so this mask would help divers breathe without the bulk of oxygen tanks and positively affect the environment. However, the mask's low conversion efficiency might not sustain a diver. In this case, adapting the human body would be useful.

Relating to such adaptations, researchers have already begun drawing inspiration from marine mammals and other humans who have adapted to life in the water. As Dr. Chapman explained, sea nomads have enlarged spleens, which might help them hold their breath better, as spleens are a reservoir of red blood cells that carry oxygen to cells. Thus, in the future, technology that identifies genes that cause helpful adaptations could be developed, and gene-editing technology could be used to alter those genes. Gene editing has already been experimented with across the world—e.g., CRISPR—so it is very likely that such advancements could happen in the future.

Technology offers many effective and realistic solutions for problems humans face, but as Dr. Chapman said, biological solutions would be the most valuable as they allow humans to be independent of sometimes fallible technology. Since completely abandoning technology might not be feasible in the next 15 to 20 years, I think that there will be a gradual integration of biological advancements. Such integration of biology and technology would also give divers more options and allow them to customize their treatment. Furthermore, to incorporate Dr. Chapman's methods, undersea medicine technology might contain more biological and human-friendly aspects in the future. Since the purpose of undersea

medicine is to maximize the safety and comfort of divers, I believe combining technology and biology would be realistic while also leaving room for future innovation.