Research Report

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Readiness Implications of Coronavirus Infections on U.S. Navy Ships

In early 2020, a highly infectious respiratory disease, COVID-19, swept across the world. The disease affected nearly every aspect of human activity, specifically anything that required close contact with other people for a prolonged period. COVID-19 appeared to be most deadly for people who are older and/or have comorbidities. But even among young and healthy people, it sometimes took unexpected and fatal paths.

The active-duty U.S. Navy primarily comprises young and healthy people but, by its nature, requires crew members aboard its ships to be in close proximity over a period of weeks and months. Unsurprisingly, COVID-19 outbreaks have occurred on Navy ships. Although the Navy has generally refrained from releasing ship names, the most widespread and extensive outbreak was on USS *Theodore Roosevelt* (CVN 71) beginning in March 2020, one of the earliest months of the pandemic. The outbreak occurred while the ship was deployed in the Western Pacific and required a ten-week period pierside in Guam. A subsequent investigation by the Vice Chief of Naval Operations of the chain of command actions with regard to COVID-19 onboard the ship determined that the ineffective implementation of social distancing and premature release of sailors from quarantine were the primary causes of increased infection. This was attributed to the USS *Theodore Roosevelt* leadership not effectively implementing mitigation measures for the majority of their crew, allowing social gathering areas to remain open, and continuing to perform urinalysis testing for illegal substances that should have been considered nonessential during the outbreak. Additionally, the leadership prematurely released sailors from quarantine because conditions

KEY FINDINGS

- If the virus comes aboard a ship, the results can be devastating in terms of the ship's ability to complete its missions. The most immediate impact is on the ability to man watches in confined engineering spaces, but the cascading effect on training, maintenance, and repair can affect numerous readiness areas.
- The implications extend to other units that may have schedules disrupted. For instance, deployments could be extended because of the unavailability of the infected crew to meet commitments.
- Although the Navy clearly imposed mechanisms to control exposure, these mitigations affect other aspects of unit readiness, including schedule, maintenance, morale, retention, and mental health.
- The lessons of COVID-19 must be evaluated in terms of whether the Navy can successfully deal with an out-of-the-ordinary medical and/or mass-casualty event.

Most deaths and hospitalizations in the Navy occurred among civilian employees and contractors, with some indication that these more-severe cases largely occurred in shipyards and aviation maintenance facilities.

there were crowded, and they believed that the quarantine caused more sailors to become infected.[1] The way the outbreak was handled became a major embarrassment for the Navy and raised questions about its readiness to address a public health challenge.

Despite the high visibility outbreaks of COVID-19 on Navy ships, the overall infection, hospitalization, and death rates from the disease are comparable to, or lower than, the national average. Table 1 shows the infection and death rates from COVID-19 in the Navy as of March 7, 2021. It indicates that the actual sickness and mortality results for the Navy have not been dramatic.[2] Indeed, on the USS *Theodore Roosevelt*, about 60 percent of the infected crewmembers were asymptomatic. Among people who displayed symptoms, the vast majority did not experience symptoms severe enough to require hospitalization. The mostly young and healthy active-duty population of the Navy was not greatly affected by the outbreak in terms of direct and immediate health effects.

Most deaths and hospitalizations in the Navy occurred among civilian employees and contractors, with some indication that these more-severe cases largely occurred in shipyards and aviation maintenance facilities. The specifics of the individuals who died or were hospitalized were not reported. Generally, these populations are not screened for health issues or subject to the physical fitness and screening required of active-duty personnel.

The relative lack of severe consequences from COVID-19 should not, however, be taken as a conclusion that the outbreak was of no significance. There are reasons to be concerned about the potential for outbreaks in the crowded conditions of ships and reasons to examine medical response readiness overall. The outbreak of a highly contagious and potentially hazardous disease on a ship will likely affect readiness, with short-term consequences having longer-term implications.

Moreover, although it is unclear whether the virus had comparatively little impact on Navy ships because of mitigations or because, in reality, the

TABLE 1
Navy Infection and Death Rates from COVID-19 (Through March 7, 2021)

	Cases	Hospitalized	Recovered	Deaths	Cumulative Total COVID Cases[a]
Military	1,383	6	32,990	7	34,380
Civilian	665	19	12,951	57	13,673
Dependent	132	2	4,514	1	4,647
Contractor	216	11	4,449	26	4,691
TOTAL	2,396	38	54,904	91	57,391

SOURCE: U.S. Navy COVID-19 update, March 7, 2021.

[a] Cumulative = active cases + recovered + deaths.

health risk to the overall population on ships was relatively low, it is clear that the initial reaction to the COVID-19 outbreak was at best disorganized. For example, despite an apparent willingness to believe the outbreak on USS *Theodore Roosevelt* warranted a strong response, including large-scale evacuation and off-ship quarantine, it is not clear that the theater medical system was ready to respond effectively.

Although the virus is still very much a major public health issue as of the time this report is being written, a vaccine is being fielded and it is possible that within a year the outbreak will be substantially controlled in the U.S. population. However, some of the challenges resulting from this pandemic raise questions that may have broader implications for the Navy. In this report, we address the readiness implications.

The Navy and the Operational Environment

Although the primary purpose of this report is not to address medical approaches to COVID-19, it is important to recognize the magnitude of the challenge this virus presented. Its onset was sudden, and it spread quickly, sometimes overwhelming the intensive care facilities of public health systems. While the genetic structure of the virus was rapidly isolated, there were initially no known medicines that would combat the effects of the disease, making isolation, physical barriers, and frequent cleaning to remove the virus the only mechanisms for combatting the disease. Absent a vaccine or a treatment, the primary means for overcoming the disease was preventing its spread. This was challenging for the Navy, with its confined spaces and close quarters. Completely isolating the crew to itself became the only choice available.

It is also important to recognize that not all mitigations tried during the current pandemic or past other outbreaks will equally apply to future challenges. Each medical challenge is unique and should be dealt with via customized mitigations. Although the medical challenge was unique in the current pandemic, the operational environment was not. The 2018 National Defense Strategy does not specifically direct the Navy to maintain any particular presence level, but as a matter of practice, the Navy for decades has kept units on station in key areas of international competition to signal commitment. Since the outset of the pandemic, the Navy has continued to prepare its ships for deployment and carry out presence operations unabated, making schedule adjustments to meet requirements for presence missions as directed by the national command authority. We will examine later in this report how the Navy managed these operations in more detail, but the presence maintained was entirely at sea, with none of the usual port visits, in-port maintenance periods, or coalition exercises that normally characterize such deployments.

In addition to the requirements for peacetime presence, the Navy also attempts to maintain readiness for wartime operations. Wartime readiness means that the ship or other unit not only should be present, but also should be ready to carry out a range of combat operations on no notice—including the ability to respond to an event in which significant numbers of personnel become casualties. Wartime readiness extends beyond individual units and more broadly to the task forces and fleets to which individual units belong. The ability of the Navy's medical and logistics infrastructure to respond to the challenge of wartime operations is a key question in assessing the Navy's ability to respond to the direction of the National Defense Strategy. An initial assessment of the Navy's response to the USS *Theodore Roosevelt* outbreak could indicate reasons for concern.

Research Scope

In this report, we review medical research to lay a foundation for the challenges posed by the virus, but it is primarily about the Navy's response to these challenges. Thus, we first review what the broader medical community and the Navy in particular knew about the virus as it first became a threat on Navy ships and to Navy crews. We then examine the question of how the incidence of COVID-19 affects the readiness of particular Navy ships, and how the SARS-CoV-2 virus affected the Navy more

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broadly—spotlighting several areas where the Navy's strategic readiness is lacking.

Both the virus and the U.S. government's responses—at federal, state, and local levels—continue to evolve, and this report is not primarily about the best medical responses. It is specifically about how the Navy responded, the impact of its response, and what this might say about the Navy's readiness to respond to a major public health event generally. Viewed from the perspective of deaths and hospitalizations, COVID-19 did not significantly affect the Navy. Viewed from the perspective of impact on operations and readiness, and possible indications of insufficient resilience, the impacts may be significantly greater.

Characteristics of COVID-19

COVID-19 has created a world-wide public health crisis of major proportions, which is still being addressed as of the conclusion of this research. It has had implications for the broader economy, for schools, for nursing homes and care facilities, for prisons, for essentially every aspect of life. The overall challenge presented by the virus provides context for the challenge the Navy must address.

Learning from the Last Pandemic

The 1918 influenza pandemic is the most directly comparable event to the COVID-19 pandemic. That deadly outbreak resulted in more than 40 million deaths, a number slightly higher than the total casualties from World War I.[3] The 1918 pandemic is estimated to have sickened 20 to 40 percent of U.S. Army and U.S. Navy personnel.[4] The military lost millions of workdays and tens of thousands of troops to the outbreak. Many soldiers and sailors were sickened in recruit camps and on ships on the way to the warfront. Training camps were hotspots, and an average of 25 percent of trainees in the camps were infected, with the number being as high as 50 percent in some camps.[5] Ships were returned to ports, and sailors were hospitalized. The pandemic hampered the war effort greatly.[6] Nearly all militaries, including those of the United Kingdom, Germany, and France, suffered similarly.[7]

The U.S. military had to choose between mobilizing forces to fight in Europe and taking protective measures to slow recruitment and limit troop ships' transatlantic crossings. Germany launched its spring offensive in 1918 to defeat the Allies before the United States could fully engage. In response, the United States wanted to increase its manpower on the battlefield as quickly as possible. The desire to continue mobilization to fight the war had a high cost. The spread of the virus affected readiness and imposed costs on the military that could have been better mitigated. Some service members failed to report for duty, or they performed poorly because they were sick. The sickest personnel required others to take care of them. The epidemic left hundreds of thousands of military personnel deployed to Europe ineffective for a period and consumed resources in caring for them.[8] The shipyards reported declines in productivity because of the pandemic.[9] The consequences for continuing to recruit, deploy, and operate were devastating.

Currently, the seasonal flu is generally kept at bay by widespread vaccine use. But if the annual vaccine is ineffective, military operations may suffer. In 1996, for example, a Navy cruiser was forced

to return to port because so many crew members became sick after receiving a vaccine that was a poor match for the virus circulating that year.[10] The influenza outbreaks show the potential for a virus to affect military operations, specifically on Navy ships where close contact is inevitable.

The lessons learned from the 1918 pandemic—effect of illness on mission, prioritization between crew health and continuing mission, and adverse effect on retention and recruitment—are directly applicable to the COVID-19 pandemic. Before we discuss these lessons in detail, we first discuss the spread of SARS-CoV-2 and susceptibility to the crew in a shipboard environment. We also discuss the measures taken to limit the spread of the virus on ships.

Virus Transmission

Infections with respiratory viruses are principally transmitted through three modes: contact, droplet, and airborne. Contact transmission is infection spread through direct contact with an infectious person or with an article or surface that is contaminated. The latter is also referred to as *fomite transmission*. *Droplet transmission* is infection spread through exposure to virus-containing respiratory droplets exhaled by an infectious person. Transmission is most likely to occur when someone is close to the infectious person, generally within about six feet. *Airborne transmission* is infection spread through exposure to virus-containing respiratory droplets made up of smaller droplets and particles that can remain suspended in the air over long distances and a long period of time.[11] These modes of transmission are not mutually exclusive.

Aerosol has been used both to define smaller respiratory droplets and particles and to describe the collection or cloud of these respiratory droplets in the air. Engineering controls are needed to prevent occupational transmission of infectious pathogens generated by aerosol-generating procedures that have potential to produce small droplets and particles. SARS-CoV-2 is one of the pathogens that require such engineering controls in health care or laboratory settings, where procedures can potentially generate aerosol.

Not all respiratory pathogens get transmitted efficiently via airborne transmission. Viruses, such as rubeola,[12] varicella-zoster,[13] and variola major and minor,[14] are transmitted very efficiently. Although these pathogens can be transmitted at close range, they are also efficiently and frequently transmitted over longer distances and over longer times. These viruses can infect people passing through an area in which an infectious person was present minutes to hours earlier and where they may have coughed, sneezed, talked, or otherwise created droplets or particles. Pathogens that readily infect via airborne transmission require special engineering controls to prevent spread.[15]

SARS CoV-2 Virus

The principal mode by which people are infected with SARS-CoV-2 is through exposure to respiratory droplets carrying infectious virus. Respiratory droplets are produced during such activities as breathing, speaking, singing, coughing, and sneezing. Respiratory droplets vary in size and fall into two categories based on how long they can remain suspended in the air. The larger droplets can be visible and fall out of the air rapidly within seconds to minutes, while the smaller droplets and particles can remain suspended for many minutes to hours and can travel on air currents far from the source. Particles are formed when small droplets dry very quickly in the airstream.

According to CDC, the epidemiology of SARS-CoV-2, the low attack rate, and slow spread across the world indicated that most infections are spread through close contact and not airborne transmission. CDC also reports that an estimated 40–45 percent of SARS-CoV-2 infections are asymptomatic, and that asymptomatic people can spread infection. CDC contends that if SARS-CoV-2 were to spread primarily through airborne transmission like measles does, experts would expect to have observed considerably more rapid global spread of infection in early 2020 and higher percentages of prior infection measured by serosurveys.

Based on available data, CDC concluded that the spread of SARS-CoV-2 follows the pattern of most other common respiratory viruses, primarily

through respiratory droplet transmission within a short range of less than six feet. CDC also maintains that there is no evidence of efficient spread to people at greater distances or who enter a space hours after an infectious person was present in the same space.

However, CDC also believes that airborne transmission of SARS-CoV-2 can occur under special circumstances, and, in several well-documented examples, SARS-CoV-2 seems to have been transmitted over long distances or times. These transmission events appear uncommon and have typically involved the presence of an infectious person producing respiratory droplets for an extended time—from half an hour to multiple hours—in an enclosed space. Under such circumstances, it is possible that enough virus was present in the space to cause infections in people who were more than six feet away or who passed through that space after the infectious person had left.

Thus, there are mainly three circumstances under which airborne transmission of SARS-CoV-2 appears to have occurred:

1. An infectious person either exposed susceptible people by being present in an enclosed space, or people were exposed shortly after the infectious person had left the enclosed space.
2. Susceptible people were exposed for a prolonged time to respiratory particles that were generated by expiratory exertion in an enclosed space. Examples of activities that increased the concentration of suspended respiratory droplets in the air include shouting, singing, and exercising.
3. Inadequate ventilation or air handling allowed a build-up of suspended small respiratory droplets and particles in the air.

It is conceivable that the airborne transmission of SARS-CoV-2 could occur on ships with many enclosed spaces and poor air circulation. At the beginning of the pandemic, at the same time as we started studying transmission modes, the prevention of spread should have been based on the assumption that airborne infection was a distinct possibility.

Existing interventions to prevent the spread of SARS-CoV-2 appear to be adequate to address transmission both through close contact and under the special circumstances resulting in potential airborne transmission. These interventions include social distancing, use of masks, handwashing, and surface cleaning. In addition, ventilation and avoidance of crowded indoor spaces are especially relevant for enclosed spaces, where circumstances can increase the concentration of suspended small droplets and particles carrying infectious virus.

The Shipboard Environment

Navy ships face periodic outbreaks of various diseases from viruses, such as norovirus, and influenza, and therefore have some experience managing the spread of such illnesses. The spread of illnesses caused by such known pathogens can be minimized by standard infection-control procedures. However, in the case of a novel pathogen, such as the SARS-CoV-2, the most effective procedures are initially not known.

SARS-CoV-2 is highly contagious and moves very rapidly through the crowded and, despite best efforts, often dirty environment of Navy ships. An actual berthing compartment configuration, shown in Figure 1, illustrates the crowded environment that typifies naval vessels. An infected person with mild or even no symptoms would pass infections through this berthing compartment very quickly. The ventilation systems on ships provide no special filtering, so it is not surprising that, when an infection strikes, it strikes big portions of the crew. Workspaces are equally crowded and prone to spread infections as well.

Susceptibility of Infection Among Ship Crew Demographics

Ship's crews generally comprise young and healthy adults, and so the degree of susceptibility and severity is a matter of interest. In the early stages of the coronavirus pandemic, it was generally believed that young, healthy adults were less susceptible to SARS-CoV-2—that they remained asymptomatic or had milder symptoms after infection.[16] However, by summer 2020, studies showed that the younger

FIGURE 1

Enlisted Berthing Arrangements in the Navy

SOURCE: U.S. Navy photo by mass communication specialist Seaman Sandra A. Pimentel.

population had no differing susceptibility to the virus. A study of the age distribution of mortality data from three different countries and using a mathematical model suggested that there is no large difference of susceptibility by age.[17] However, once infected, the risk of hospitalization and death corelates with the age, as the ratios in Table 2 indicate.

A ship's crew ranges in ages 18 to 49 years,[18] and a large percentage of crew members fall on the lower end of this spectrum. For example, on the USS *Theodore Roosevelt*, approximately 69 percent of crew members are younger than 30 years old, and no crew member is older than 65 years.[19] Given these demographics, it is reasonable to expect a lower rate of hospitalization and lower risk of death among crew members. However, all the crew is equally susceptible to SARS-CoV-2 infection. Although most crewmembers will likely not require hospitalization, the infected crew will still have varying degrees of symptoms and severity of illness that renders them incapable of doing their jobs. Moreover, although a ship's crew is generally young, its key leaders are likely to be older and thus more susceptible to the most serious consequences of the disease. Thus, it is prudent to try and apply mitigation efforts to minimize the spread.

Limitations of Shipboard Medical Response

The ability of medical personnel to detect an uptick in symptoms or illnesses that may signal the beginning of an epidemic is extremely important in curbing the rapid spread of an infectious agent on a ship. Any shift in baseline symptoms or illnesses

TABLE 2

Rate Ratios Compared with 18–29 Year Olds

Age (Years)	Hospitalization	Death
0–4	4x lower	9x lower
5–17	9x lower	16x lower
18–29	Comparison group	Comparison group
30–39	2x higher	4x higher
40–49	3x higher	10x higher
50–64	4x higher	30x higher
65–74	5x higher	90x higher
75–84	8x higher	220x higher
85+	13x higher	630x higher

SOURCE: Centers for Disease Control and Prevention, "Risk for COVID-19 Infection, Hospitalization, and Death by Age Group," webpage, updated June 2021b.

may provide an early indication of a problem and an opportunity for proactive involvement of shore-based preventive medicine teams to assist in developing contact tracing and recommend quarantine measures.

However, a ship has limited organic medical capability and capacity, which must be augmented if an outbreak exceeds its ability to respond. Table 3 shows personnel in a typical medical department on a *Nimitz*-class aircraft carrier. As evident by the numbers and types of medical personnel, the organic capability and capacity on a carrier is not sufficient for a pandemic where a crew of more than 5,000 onboard is susceptible to infection.

Mitigations the Navy Has Attempted to Reduce the Spread

COVID-19 is a new, highly contagious disease, and all mitigation measures initially involved trying to erect new barriers and finding ways to isolate the crew. These measures had some significant effects on readiness that we will address in the next section. Additional mitigations that may have broader applicability to disease response could be considered by the Navy in the longer run, as the final section details.

Disinfecting and Maintaining Social Distance

At the most immediate level, the Navy put heavy emphasis on cleaning and disinfecting spaces. The Navy has historically put considerable emphasis on keeping ships clean, accepting as a given that the close quarters of Navy ships make cleanliness and sanitation paramount.[20] The conditions that aid COVID-19 spread are likely to persist, and the additional cleaning and distancing measures should likely be considered as permanent changes rather than a temporary measure. However, it is generally not the case that the disease is transmitted via contaminated surfaces, so surfaces may not in fact significantly affect the likelihood of disease transmission.

As a related pre-exposure protocol, the Navy has also imposed physical-distance regulations. Although maintaining distance in the general population has

TABLE 3
Medical Personnel by Types on a *Nimitz*-Class Aircraft Carrier

Medical Personnel	Numbers
Senior medical officer	1
General surgeon	1
Nurse anesthetist	1
Family medicine physician	1
Psychologist	1
Medical administration officer	1
Radiation health officer	1
Physical therapist	1
Physician assistant	1
Nurse	1
Flight surgeon	3–5
Dentist	5
Independent duty corpsman	1–2
Hospital corpsman	40–50

SOURCE: Surface Warfare Medical Institute, *Fleet Medicine Pocket Reference 2016*, San Diego, Calif., 2016; and Diego Vicente, Ryan Maves, Eric Elster, and Alfred Shwayhat, "U.S. Navy's Response to a Shipboard Coronavirus Outbreak: Considerations for a Medical Management Plan at Sea," *Military Medicine*, Vol. 186, Nos. 1–2, January 30, 2021.

proven effective at limiting spread, it is extremely challenging in the shipboard environment, where hundreds of sailors are brought onboard to work and live together in close quarters, breathing recycled air and sharing berthing spaces, silverware, exercise equipment, computers, and showers. Attempts to physically distance or limit virus transmission while living onboard are nearly impossible.

Isolating aboard the ship involves isolating exposed crew in a predesignated quarantine area with strict infection-control measures. This approach is challenging and resource-intensive. Limited resources are available to evaluate, manage, isolate, and transport infected personnel in or off the ship. There are also operational challenges and limited ambulatory space, lavatory areas, berthing spaces, supplies, medevac capabilities, and medical capacity on the ship.

Restrictions on Movement

The difficulty of keeping a ship clean enough or the crew separated enough has led to a policy that attempts to limit spread by quarantining the whole crew. We will talk in more detail about the effects on readiness of such mitigation efforts, but the mechanics are simple enough: A crew quarantines and isolates for 14 days prior and must have a 14-day before-period of COVID-negative tests before entering port. In the intervening period, the ship and crew simply stay underway without relief for the entire deployment period. The guidance below is from April 17, 2020, and has been in place with some modification since (emphasis added):

> Action taken by an operational commander to reduce risk of introducing a COVID-19 positive, asymptomatic **Service Member to a unit by instituting a 14-day ROM [restrictions on movement] period for the Service Members within the unit. This action may be taken for all personnel assigned to a unit prior to deploying, getting underway, or conducting operations.** A member of the unit or newly reported member of the unit who has traveled from or through an area where COVID-19 community transmission is widespread or is suspected of having been exposed to SARS-Cov-2 should be placed in Quarantine or Isolation and not Sequester.[21]

The requirement to stay underway meant that ships were staying not just out of homeport but underway without a port visit for months—a potentially lengthy period of time as illustrated by the record now held by USS *Stou*t with 215 days consecutively underway.[22] *Stout*, however, was no isolated occurrence. USS *Nimitz*, USS *Donald Cook*, USS *Eisenhower,* and USS *San Jacinto* have broken records for longest consecutive days underway. It is also important to note that operational requirements warranted waivers. On May 26, 2020, OPNAV issued NAVADMIN 155/20 which gave Fleet commanders the discretion to grant ROM waivers for operational requirements.[23]

Vaccinations

As this report was being written, the Navy was in the process of making vaccinations available to its members and was offering this as a means for relief from restrictions on movement.[24] The Navy had as of this writing not made vaccination mandatory—indeed cannot make pending Food and Drug Administration final approval—but the vaccination should help the Navy finally resolve the issues surrounding the COVID-19 outbreak. However, there are likely impacts from the pandemic that will remain, possibly for years, as we later discuss.

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Effect of COVID-19 on Unit Readiness

The Navy has standards of readiness for its ships and units that are reported in the Defense Readiness Reporting System (DRRS). The degree to which a unit can be assessed as ready depends on the degree to which it meets the criteria laid out in DRRS. Although there are other elements of readiness besides unit readiness, which we will consider in a separate section, some of the more immediate effects on readiness from the spread of a pandemic occur at the unit level. Put simply, readiness depends on a healthy and well-trained crew that is able to use operable equipment.

Elements of Unit Readiness

Units are called on to carry out several different operations, from very intense and complicated to normal peacetime presence missions. These operations vary widely in the amount of preparation that might be required or available. When there is time to build up and prepare for major theater war, preparation may be extensive. Other times, contingencies may arise that demand that units arrive without all the resources they would prefer for preparation.

Individual units operate in several different ways, both independently and in company with other naval units in strike groups or surface action groups. For purposes of response in major contingencies, it is safe to assume that these ships will be operating in company and the ability to do so is a component of overall readiness.

The most challenging scenarios may be those that start as a limited engagement and then escalate. Part of the service's challenge is to anticipate where such escalation is likely to occur and ensure that the transition to a different conflict level is manageable. Services must make choices between making units ready for likely missions—and which may indeed involve significant risk and thus need to be performed at a high level of proficiency—and making them ready for a wide range of missions.

Even without COVID-19, for several years, the Navy has had difficulty meeting basic readiness requirements in many areas of its force. Submarines have had difficulty finishing maintenance periods on time, mostly because of lack of capacity in public shipyards performing work on nuclear propulsion plants. Aircraft carriers have experienced delays finishing maintenance periods because of discovery of extensive corrosion on external hulls.[25] Inability to get ships out of repair periods—which applies across all ship classes—had a cascading effect, with deployments routinely stretching to eight months or greater and then returning in poor material condition, which would likely cause their availabilities to become prolonged.

Surface ship readiness has been particularly troubling, not just in delays in completing maintenance periods but in difficulty in maintaining basic levels of seamanship and tactical proficiency, a trend that goes back years. As recently as 2017, in response to a series of mishaps, the Navy conducted a "comprehensive review" and a "strategic review,"[26] which indicated that the surface fleet had encountered a serious mismatch between the demands for presence and routine operations and its ability to meet the demand with ready forces.

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Ships were routinely facing manning shortages, particularly shortages of personnel with critical skills. In turn, maintenance periods were routinely going over budget and past their scheduled completions. This created a cycle of delayed training, prolonged deployments, additional maintenance delays, and deteriorating material condition. Although the Navy has tried to approach the problem in different ways, the fleet has been under strain for years. In a very real sense, the Navy has been operating near the readiness edge, even without the effects of COVID-19. The loss of these individuals to severe illness or death may create a leadership gap that is detrimental to training, readiness, and mission continuity for the ship.

Infection of a watch team, unit, or division, for example, can potentially render the whole team incapable of carrying out its mission, adversely affecting the ship's operations, as discussed in more detail in a later section.

Effects of the Pandemic on Unit Readiness

The Navy typically measures readiness across seven elements, with each element containing multiple components. Table 4 lists some of the elements.

Not all these dimensions apply as we assess the Navy's response to the disease outbreak. Ordnance, networks, and infrastructure, for example, are only indirectly affected or affect the response to the disease outbreak. We consider the most relevant readiness elements.

TABLE 4
Navy Readiness Assessment Metrics

Readiness Elements	Components	Performance Metrics
Personnel	Billets	Required versus filled billets
	Specialty codes	Required versus assigned specialty codes
Equipment	Readiness	Equipment operability
	Maintenance status	Status of required maintenance
Supply	Parts	Availability of critical parts
	Fuel	7 to 10 days
	Logistics	Adequate contract suppliers
Training	Individual	Individual experience/proficiency not measured
	Unit	Unite complete in optimized fleet response plan
	Group/task force	Group deployers complete
Ordnance	Fill	Deployers have complete inventory
	Resupply capability	No ability to conduct underway
	Resupply inventory	Worldwide inventory
Networks	Availability	Full range of targeting and data links
	Readiness	Deployers have completely operable networks
Infrastructure	Capacity	Sufficient piers, base infrastructure
	Readiness	Base operating support funded to 80 percent requirement/installations

SOURCE: Bradley Martin, Michael Linick, Laura Fraade-Blanar, Jacqueline Burns, Christy Foran, Krista Romita Grocholski, Katherine C. Hastings, Sydney Litterer, Kristin F. Lynch, and Jared Mondschein, *Measuring Strategic Readiness: Identifying Metrics for Core Dimensions*, Santa Monica, Calif.: RAND Corporation, RR-A453-1, 2021.

The overall population of the Navy is young and generally healthy, so the death rate from SARS-CoV-2 infection is low. But the consequences for crew readiness may be severe.

Personnel Readiness

As discussed previously, the overall population of the Navy is young and generally healthy, so the death rate from SARS-CoV-2 infection is low. But the consequences for crew readiness may be severe. Some individuals will be too sick to stand a watch or perform other shipboard duties. Ships are generally manned to perform the missions discussed in in the Standard Organization and Regulations of the Navy (SORN),[27] and even in cases in which watch stations are reduced to require fewer personnel, large numbers of personnel unable to stand watch has an immediate impact. In nuclear power plants, the watch station qualifications are rigorous and the effect of individuals being unable to perform watches might be enough to preclude propulsion plant operation.

In the case of the USS *Theodore Roosevelt*, 1,271 personnel were infected with the virus—about one-quarter of the crew.[28] A significant number of the infected personnel were in engineering spaces. A study conducted by the Navy reported the following:

> Those working in tighter spaces (e.g., reactor, engineering, supply, and weapons departments) appeared more likely to have confirmed or suspected COVID-19 than those working in a combination of open-air and confined conditions (e.g., air and deck crew).[29]

In the absence of qualified engineering watchstanders, the ship cannot get underway or even operate its generators at the pier. These watchstanders must, however, perform their duties in conditions that are particularly susceptible to virus spread. In the case of the *Theodore Roosevelt*, we have not found specific evidence that engineering or reactor watchstations were affected to the point that the ship could not operate. However, we have evidence that watchstanders in these areas were particularly vulnerable to the spread.

Experience and Age

The Navy's study on the *Theodore Roosevelt* notes that the hospitalization rate was low among the young and mostly healthy crew. There was one death, a 41-year-old aviation ordnanceman chief. The report notes that preexisting conditions were present even among the mostly healthy crew:

> Although cases of serious illness occur in younger persons, they are less frequent and typically less severe than those in older persons. In the case of the U.S.S. *Theodore Roosevelt*, few crew members were hospitalized. Certain coexisting conditions, such as hypertension, obesity, and diabetes, are associated with higher mortality. In our findings, we noted a number of coexisting conditions among hospitalized crew members, including uncomplicated, mild, and medically managed asthma, lung disease (e.g., bronchitis), hypertension, and liver disease–related conditions.[30]

To the extent that these coexisting conditions are associated with age, a COVID-19 outbreak could have a disproportionate effect on crewmembers who have longer service and serve in supervisory positions or in positions requiring higher levels of experience and training. This would put additional burdens on more-junior personnel and, in some cases, might result in a gap that could not be easily remedied. For example, an engineering officer of the watch on most ships is either a junior officer, generally in the less-vulnerable demographic, or a senior enlisted person,

who might be young by overall population standards but would be closer to the age likely to develop the conditions that create a greater risk if infected with SARS-CoV-2.

Responding to Emergencies

The SORN specifies that ships will be manned for battle stations, not just routine operations. This means the whole crew must be able to man repair lockers, primary and secondary ship control stations, weapons control stations, and emergency medical care. Although ships generally are not manned at general quarters for more than a few hours at a time, manning for Condition III wartime steaming stations is expected to be manned for days at a time. If one-third or more of the crew is sick, they cannot man these stations, and thus the ship will not be ready to operate in a wartime environment. With an outbreak on the order of the *Theodore Roosevelt*, the ship can do no more than stay underway rather than be underway *and* perform missions.

Indirect Effects: Training and Equipment Maintenance

Although the most immediate effects are likely to be on manning, a major disease outbreak affects the readiness elements that require time and personnel to achieve, specifically training and equipment readiness.

Training

Training has individual, classroom, unit, and task group components, all of which take time and individual effort to complete. Prolonged time away from a workstation because of illness or the need to quarantine reduces availability for training and is thus detrimental to readiness.

The most significant effects of a disease outbreak on training may occur as ships pass through the phases of Optimized Fleet Response Plan (OFRP) cycle. This cycle is intended to bring carrier strike group units through their basic phase, which is focused on the basics of seamanship, damage control, engineering plant operations, medical response, and several other activities related to the simple ability to carry out operations. Ships must pass through the required certifications before they can advance to more-advanced training events.

An outbreak during this phase would essentially preclude the training being conducted at all. Every department of the ship participates in this training, and not being able to carry out this type of training could delay deployment preparations by at least weeks and possibly months. This delay would thus affect the ability to carry out advanced training required prior to a ship's deployment as part of a strike group or to conduct independent operations.

The essential complication is that when units lack people and time for a significant period and, in the process, create scheduling delays, it affects other units. The tenuous position that the Navy already faces in aligning demand with the supply of ready units, as explained at the outset of this section, gets worse.

Maintenance and Equipment Readiness

Shipboard maintenance and repair take time and trained personnel, so the same kinds of effects that would be felt in training would also apply to these areas. Routine maintenance checks, known as the Planned Maintenance System, require personnel to be at a certain proficiency level. A significant

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portion of the crew's time is spent performing planned maintenance, and all these actions would be difficult to complete with a significant proportion of the crew out of action because of illness. Data on the exact level of deferred maintenance are not yet available. However, in a ship the size of the USS *Theodore Roosevelt*, deferring one-quarter of planned maintenance would involve thousands of man-hours either lost or rescheduled.

The more immediate readiness effects might be on the civilian shipyards that conduct more-extensive repairs and maintenance periods. As discussed earlier, inability to complete maintenance periods on time has had a major cascading effect on the Navy's ability to meet readiness commitments.[31] COVID-19 outbreaks among shipyard personnel affected maintenance schedules early in the pandemic and may continue to even as mitigations are put into place. VADM William Galinis spoke in 2020 about the pandemic's effects on the shipyards:

> The Navy currently has 47 chief of naval operations maintenance availabilities throughout the private shipyards, according to Galinis, who noted that three are submarines undergoing maintenance at Newport News Shipbuilding and the rest are scattered throughout various yards across the world.
>
> "About half of those are tracking to the schedule and to the plan that we established for those availabilities," Galinis said. "The other half—quite frankly — are challenged, some more than others, either by schedule pressures, cost pressures, resource loading, or a combination of those. So that's the work going on in the private sector."
>
> One concern Galinis has is the potential for a team performing a "critical path job" having one member become infected, who then spreads COVID-19 to the rest of the team, a scenario that he said could throw the entire maintenance availability schedule out of whack despite only several individuals becoming sick.[32]

Galinis is specifically referring to the effect of the virus on the public shipyard workforce at the facilities that perform work on nuclear-powered aircraft carriers and submarines, but the observations also apply to the private-sector providers who work on surface ships. When workers performing "critical path jobs" are unable to complete these tasks, the maintenance periods drag on, and, as they drag on, the schedule for the remainder of the OFRP process also drags on. An already-difficult schedule becomes even more so.

Effects of Mitigations on Readiness

The Navy had little choice but to put mitigations in place and deal with the reality that, once the virus infected someone in a crew, it was likely to spread widely enough to prevent the ship from accomplishing its missions.[33] This meant that effective mitigation required isolation of the crew, testing, and then sequestering of crew members for 14 days before they were allowed to join the crew once underway. These mitigations further required personnel actions, including delays in normal permanent change-of-stations transfers, holiday leave, and attendance at service schools.

All these created inconveniences, but the mitigation that may have most significantly effected

The Navy had little choice but to put mitigations in place and deal with the reality that, once the virus infected someone in a crew, it was likely to spread widely enough to prevent the ship from accomplishing its missions.

readiness has been the requirement that ships stay underway while on deployment. The two-week quarantine requirement prior to departure and two weeks after return meant that ships were adding a month of separation to what was already an eight-month time out of homeport.

The effect these extended periods will have on ship readiness, morale, and crew retention is not yet known, but underway periods of this length are extraordinary. It is difficult to imagine that this will be inaugurated as a new normal, but it seems obvious that deployments and underway periods within a deployment of this length are bound to have an effect. This might be significantly greater were it accompanied by a deployment extension caused by the inability of another ship to conclude its maintenance periods. Extended deployments are more likely for ships with limited numbers, such as aircraft carriers, than with more numerous small combatants, but the mitigation requirements stretch what is already a strained force to an even more extreme level.

The potential effect on the mental health of Navy personnel is difficult to assess but impossible to ignore. Being kept in a confined environment for months is an expected part of Navy life, but the separations, deployment lengths, and an inability to engage in port calls are unprecedented. Reactions to stress vary greatly between individuals, but it would be hard to dismiss the fact that the COVID-19 mitigations impose stressors beyond the normal demands of shipboard life.

Implications for Broader Fleet Readiness

In the previous chapter, we concentrated on the immediate effects of the coronavirus on unit readiness. However, some of the larger implications might be at the commands. Apart from the fact that larger units are made from smaller ones whose lack of readiness affects the whole, fleet readiness also requires coordination above the unit level—up through squadrons, strike groups, and fleets. The COVID-19 outbreak response showed some

Being kept in a confined environment for months is an expected part of Navy life, but the separations, deployment lengths, and an inability to engage in port calls are unprecedented.

significant fissures in this structure that require correction, which we address in the final section.

Components of Strategic Readiness

Since 2016, the RAND Corporation has worked with the Office of the Secretary of Defense to explore a more expansive approach to readiness assessments: one that looks beyond the narrow lens of operational readiness more typical of readiness systems in use in the department today.[34] These readiness dimensions include:

1. *Military effectiveness*: The quality, skill, integration, and responsiveness of military forces vis-à-vis a competitor. It requires the performance of similar military activities better than an opponent and is applicable across all warfare domains.
2. *Operational readiness*: The status of major force elements—that is, whether they have the resources and training right now to undertake the mission for which they were organized and designed.
3. *Force posture*: The global organization, distribution, and employment of military forces in furtherance of military strategy.

4. *Structural readiness*: The speed at which DoD can bring existing forces that are not operationally ready at the beginning of military operations to an employable and deployable state in required time.
5. *Mobilization readiness*: The swift and deliberate structural expansion of military forces to close the gap between the supply of or demand for actual capability needed now and potential capability needed later.
6. *Sustainment readiness*: How well the United States and its industrial base are able to meet the continual demand signal for ready forces, equipment, materiel, and munitions until the conclusion of operations.
7. *Resilience*: The ability of military forces, military infrastructure, and critical national infrastructure to absorb, withstand, and, when necessary, rapidly recover from the full force of enemy attack in all warfighting domains.

These readiness dimensions are interrelated, and it is generally not possible to have readiness in any one dimension without support from others. However, taken together, this more-expansive view of readiness provides a guide for what DoD and the joint force need to be ready for missions as described in the National Defense Strategy.

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When this framework is applied to the Navy's response to the COVID-19 outbreak, the Navy falls short in multiple dimensions. Not all apply. The outbreak did not directly diminish force-wide military and operational readiness. The Navy maintained required presence and could have generated the forces required to respond at least initially to wartime requirements. However, its overall readiness to respond to National Defense Strategy requirements was doubtful. In particular, the Navy did not have enough ready and available forces to deal with an unexpected occurrence and had a difficult time reconciling different chain of command perspectives.

As detailed in the unit readiness discussion, where the Navy succeeded, it did so largely by making extraordinary demands on its crews. But the Navy also failed in several key areas, particularly in structural, mobilization, and sustainment readiness, resulting in an obvious loss of resilience. If the COVID-19 outbreak had been more severe—if, for example, it had been more like the 1918 pandemic in terms of mortality for a younger age group or if there had been a more urgent need to care for sick or injured patients—the response would likely have been inadequate.

Operational Readiness: The Navy Did Not Follow Its Policies and Procedures for Dealing with Large Numbers of Casualties and Widespread Contamination

Although COVID-19 was unprecedented in its rapid onset and wide effects, the Navy was nevertheless aware that large-scale medical emergencies can occur and has policies and procedures in place to cover such events. Ships have mass-casualty drills and are required to exercise these in the unit training cycle. The Navy also requires units to plan for and demonstrate proficiency in responding to chemical, biological, and radiological contamination.[35] To quote the *Fleet Pocket Medical Guide* for surface force units, *mass casualties* have the following characteristics and expected responses:

> DEFINITION: Any large number of casualties produced in a relatively short period of time, usually as the result of a single incident such as a military aircraft accident, hurricane, flood, earthquake or armed attack that exceeds local logistical support capabilities. In laymen's terms [if] you and your team are overwhelmed by this volume of patients, you are in a Mass Casualty.
>
> During a mass casualty situation, the goal is the disposition/triage of as many patients as possible to other MTFs [military treatment facilities] either within or outside of the area of operations.
>
> A patient overload situation exists when the capability of any echelon of care is overwhelmed beyond the point where it can no longer receive additional casualties. Patient overload situations require prompt and aggressive action so that normal treatment capability of the affected facility can be restored.
>
> Factors which may lead to a patient overload situation include a surgical backlog, high census, manpower shortages directly due to casualties or indirectly due to the staff being fatigued, depletion of stores and lack of available equipment and/or blood or component products.[36]

So, at the unit and up to fleet level, the Navy's procedures for dealing with large-scale medical incidences of casualties and outbreaks of contamination should have provided at least some basis for COVID-19 response.

The recent outbreak had some characteristics of a mass casualty event, although it turned out to be not as deadly as feared. The outbreak also resembled a chemical, biological, and radiological contamination, in the sense that a biological agent causing illness passed throughout the ship. However, the response to the COVID outbreak suggested that existing procedures are either not understood, not tested, or are possibly ineffective. When faced with an emergency that involved large numbers of sick people requiring quarantine, with some requiring intensive care, the Navy stumbled. If the epidemic had been more deadly for the demographic represented on Navy ships, the response would not have been adequate.

Structural Readiness: Theater-Level Response to the COVID Outbreak Was Poorly Executed

Structural readiness refers to the ability of the joint force to generate responses to contingencies using existing resources. In the context of medical readiness, this implies that the system can face a challenging situation and react to it effectively. In the case of COVID-19, the Navy first faced a major outbreak on a ship aboard the USS *Theodore Roosevelt*. This became a politically fraught episode and a public-relations debacle for the Navy. But here we consider the point of whether the Navy, above the individual unit level, was positioned to deal with a health emergency. Despite best efforts, the answer is clearly no.

The Navy's command investigation into the *Theodore Roosevelt* episode emphasized missteps by the command.[37] We intend not to assess relative culpability for shortfalls but to point out that the collective response appeared to be insufficient. Among the report's conclusions:

> C7F's [the 7th Fleet's] early focus on the Okinawa option over the Guam hotel option resulted in the TR [*Theodore Roosevelt]* Strike Group key Captains (CSG-9 COS [carrier strike group–9], former TR CO [commanding

If the epidemic had been more deadly for the demographic represented on Navy ships, the response would not have been adequate.

> officer], TR XO [executive officer], TR SMO [senior medical officer] and CVW-11 CAG [Carrier Air Wing 11 commander]) believing that C7F did not feel their same sense of urgency for providing proper long term quarantine and isolation quarters. This led these Captains to distrust the C7F staff and hampered their ability to deal with the crisis with the resources that were available, or develop alternate courses of action other than the request for 4,000 CDC compliant rooms, which at the time was the most constrained and least likely COA.[38]

Fleet staffs convened crisis-action teams and worked to find solutions. But what appears to have happened is a near-constant request for information from the ship without clear direction to the ship as to what it should do. Had this resulted in an efficient evacuation of infected personnel, the apparent churn would have been excusable, but after the determination was made to provide off-ship quarantine, there were insufficient resources across the theater to either house or transport the crew. The execution of the evacuation and quarantine took weeks, ultimately with 1,800 crew members coming off the ship, primarily in Guam. Commands and staffs in the region were challenged to find sufficient berthing to allow for the quarantine of this number of individuals. Communications with personnel ashore were spotty; personnel accountability was complicated and marginally effective. The ship's chain of command felt confused and concerned that not enough was being done to address the needs of the crew.[39]

The Navy's command investigation lays this confusion largely on the ship's command and medical team. We interpret that there was a systemic breakdown in which the theater response appeared inadequate to the ship's commanding officer, who felt the need to request assistance across many different commands. Although this could plausibly be impatience and poor judgment on the part of the commanding officer, it also bespeaks his concerns that not enough was being done to deal with the outbreak at echelons above him.

In a different review of the Navy's overall response, the DoD Inspector General found, among other things, that four of the five Navy component commands that operationally support a geographic combatant commander did not conduct biennial pandemic influenza and infectious disease exercises in accordance with OPNAV Instruction 3500.41A.[40]

> However, the Navy had not fully implemented measures intended to reduce the risk of the spread of infectious diseases. Prior to the COVID-19 pandemic, we found that four out of five Navy Component Commands did not conduct a biennial Pandemic Influenza & Infectious Disease exercise in accordance with the Office of the Chief of Naval Operations (OPNAV) requirements.[41]

Given this lack of prior preparation and training, it is hardly surprising that the Navy stumbled when faced with an actual outbreak.

Although every fleet commander has a fleet surgeon who is responsible to the commander for advice and coordination of medical issues affecting the fleet, there is also a relationship with type commander surgeons and the Navy surgeon general structure.

Mobilization Readiness: Poor Coordination Between Medical and Operational Chains of Command

Although every fleet commander has a fleet surgeon who is responsible to the commander for advice and coordination of medical issues affecting the fleet, there is also a relationship with type commander surgeons and the Navy surgeon general structure. In general, this is harmless and sometimes helpful in that details about medical practice or risk abatement are in some cases purely matters of medical professional judgment. However, mobilization readiness implies a readiness to switch between peacetime and wartime considerations. The focus in wartime shifts from the health and well-being of individuals to the need for a ready force.

In the case of the COVID-19 outbreak, however, advice came from the medical chain, while direction about operational employment came from the operational chain. Some of the confusion apparently facing the commanding officer of the *Theodore Roosevelt* can be traced back to medical personnel urging greatest caution and rapid evacuation and an operational chain trying to mitigate a variety of effects. Different Navy entities gave advice. Indeed, the advice was generally not complementary and was at times contradictory. The Navy's command investigation criticized the ship's medical officer for the number of addressees in emails but did not seem to address why the senior medical officer or, for that matter, the commanding officer, felt the need to include so many commands and individuals. The Navy's command investigation included this finding of fact (emphasis added):

> The TR SMO [*Theodore Roosevelt* senior medical officer] also sent a letter off the ship on March 31st, outlining areas of concern of the medical staff aboard, and a threat to release the letter to the media if immediate actions were not taken. This letter did not outline specific requests but did relay a sense of urgency. It calculated that at least 50 Sailors would die from COVID-19 based on data received and analysis conducted on the potential mortality rate. The SMO emailed the medical letter to eight people initially, addressed to the Surgeon General of the Navy and copying seven others. **The SMO then emailed the letter to over 160 additional email addresses, primarily individuals within the Navy Medical community and outside his operational and administrative chains of command**.[42]

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This finding of fact prompted the following opinion:

> When asked to sign a letter that contained a flawed, worst-case crew casualty narrative as well as an ultimatum concerning an intent to submit the letter to the public, the TR SMO missed a leadership opportunity to correct subordinates. Instead, he signed the letter, and transmitted it outside the chain of command, essentially endorsing the effort to undermine Navy leadership. [43]

Again, we are not attempting to assess the specific merits of the *Theodore Roosevelt*'s chain of command or the Navy's report. But this opinion is as much an expression of concern about undermining Navy leadership as it is an assessment about why the senior medical officer found the perceived lack of action troubling.

The command investigation emphasized that the senior medical officer and commanding officer were undermining Navy leadership, but the more pertinent and fundamental issue was that the

medical chain of command was focused on how best to treat an outbreak, with maximum emphasis on *minimizing risk to patients*, while the operational chain of command was focusing on how best to *mitigate risk to mission*. And there did not appear to be a clear answer or clear course of action emanating from either chain.

The *Theodore Roosevelt* episode was early in the COVID-19 outbreak and, as a result, there was some understandable confusion as to approach. This was a problem occurring at every level of government, not just in the Navy. The Navy subsequently issued guidance intended to balance health and operational risk. But in assessing the Navy's ability to deal with a large, complicated, and new medical problem, the result was a patchwork of responses, and the institutional answer appears to be criticism of officers who professed to be confused.

Sustainment Readiness: Expertise in Public Health and Epidemiology Is Poorly Distributed

Even on large and well-equipped ships, such as the *Theodore Roosevelt*, medical personnel on ships are oriented toward first aid, immediate trauma response, routine medical care, and overall caring for a young and healthy patient population. The Navy has personnel within its force structure who are trained to deal with epidemics and control of infectious diseases, but they are typically not assigned to operational units or even major operational staffs. The result is mutual lack of familiarity between individuals who understand the shipboard environment and those who understand infectious diseases. Earlier in this report, we reviewed the complement of an aircraft carrier medical department and noted that although this is a large and robust capability, it is not—indeed *was not*—well positioned to deal with an infectious disease outbreak.

Overall Response to the COVID-19 Demonstrated Poor Resilience

The Navy's response to the COVID-19 outbreak was characterized by chaos and drama and, in the case of the *Theodore Roosevelt*, resulted in high-level removals of officials up to the Secretary of the Navy. Even given the unprecedented nature of the outbreak and the degree of confusion about the course and effects of the disease, the Navy lost operational days with the *Theodore Roosevelt* episode, kept presence with other platforms largely by making extraordinary demands on crews and their families, and presented to adversaries some obvious vulnerabilities in the Navy's medical responses. Its institutional reaction, unfortunately, appears largely oriented toward showing that, in the case of the *Theodore Roosevelt*, the commanding officer and senior medical officer made mistakes and/or undermined efforts of senior staffs to assist them. This might be true—we make no assessment of relative culpability—but the outcome does not suggest strategic resilience.

Outcomes and Ways Ahead

If the metric of success is number of deaths and hospitalizations, the Navy largely avoided serious issues. If the metric is continued presence at

The Navy's response to the COVID-19 outbreak was characterized by chaos and drama and, in the case of the Theodore Roosevelt, resulted in high-level removals of officials up to the Secretary of the Navy.

combatant command requested levels, the Navy also achieved this, with the notable exception of the period in which *Theodore Roosevelt* was not available. However, when the overall consequences of the outbreak are considered, along with the mitigations, there are good reasons to worry about the Navy's ability to respond to a similarly large medical event, such as a mass-casualty situation.

There is no doubt that the Navy was not prepared to deal with SARS-CoV-2 outbreak, and although it avoided hospitalizations and widespread loss of life, it did so at a cost to morale and readiness. This may have been, to an extent, unavoidable, but it seems prudent to discuss whether other options might have been available and/or should be made available if such pandemic or other major medical events occur in the future. Many of these mitigations involve investing in people or capabilities and thus should be evaluated relative to the potential improvements in readiness and force posture.

Summary Implications for Unit and Strategic Readiness

We approached this problem first from the unit level, looking at how ships and other units might be affected by both an outbreak of COVID-19 and the mitigation measures put in place to contain it. We then looked at higher-level strategic readiness. There are a few key takeaways:

- If the virus comes aboard the ship, the results can be devastating in terms of the ship's ability to complete its missions. The most immediate effect is on the ability to man watches in confined engineering spaces, but the cascading effect on training, maintenance, and repair can affect numerous readiness areas.
- The implications extend to other units that may have schedules disrupted, including deployments extended because of the unavailability of the infected crew to meet commitments.
- An outbreak among shipyard repair personnel can delay the completion of maintenance periods, with cascading effects on schedule and readiness for the affected ships and ships affected by schedule changes.
- Although the Navy clearly had to impose mechanisms to control exposure, these mitigations affect other aspects of unit readiness, including schedule, maintenance, morale, retention, and mental health. This history is still being written, so we do not yet know the full effects. It seems imprudent to assume that these extraordinary measures can be adopted as a matter of routine. Consecutive underway periods of over seven months in deployments lasting nine months or more cannot help but have an effect on some readiness areas.
- The lessons of COVID-19 must be evaluated in terms of whether the Navy can successfully deal with an out-of-the-ordinary medical and/or mass-casualty event. This requires not just that procedures exist in writing but that they be tested above the unit level in training exercises. It also implies a degree of coherence between operational and medical priorities, which was clearly not present in the initial phases of the outbreak.

Given these apparent shortfalls, we offer several potential remediations. Any of these are subject to

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an assessment of policy and operational priorities. For example, we recommend a review of criteria for operational essentiality, but we offer no opinion about whether the Navy's judgments of essentiality have been correct.

Critically Evaluate Operational Priorities: Is the Commitment Essential?

Among the apparent misunderstandings between the *Theodore Roosevelt*'s commanding officer and the chain of command was a sense that attempting to operate in a COVID-19 environment was unnecessary given that the United States is not at war. CAPT Brett Crozier's specific words included: "We are not at war. Sailors do not need to die. If we do not act now, we are failing to properly take care of our most trusted asset—our Sailors."[44] The commanding officer's specific words and the method in which these words made their way into public discourse has received criticism. Indeed, most of the disagreement between the commanding officer and his superiors seems to have centered not on whether the *Theodore Roosevelt* should have remained operational but on the best means of controlling infection. But the commanding officer's specific question related to the priority between operational risk and health risk.

The Navy subsequently implemented policies that kept deployment schedules on track by isolating the crews before, during, and after the underway periods. This starts with the assumption that the deployments and/or commitments are essential, which is then managed by minimizing exposure of the known healthy crew.[45] Missing from implementation of these policies is an assessment about whether these commitments are essential.

If, for example, quarantine time is added to the overall calculation of operational tempo, resulting in shorter time on station, the overall effect to Navy presence might be a month gap in presence. If a ship has an outbreak onboard, the options could simply include not continuing the mission and returning to port, with no expectation that a relief will be assigned. The assessment is essentially whether the ship's mission is at a particular point so essential that it must either continue with some number of people ill or be replaced by another ship (or potentially another crew on the same ship).

Use Engineering and Personnel Controls to Minimize Spread

If the Navy determines that a ship must be underway to support a mission and cannot be replaced, the next step is to keep the crew healthy and minimize spread to the extent possible. We have already discussed the Navy's policy of restricting movements and more recently administering voluntary vaccinations. The Navy is also already mandating social distance and enhanced cleaning and disinfection to reduce the chances of outbreak. Expeditious removal of infected personnel, even those who are asymptomatic, may help to minimize spread, although the larger the number of people removed, the more challenging it is for the ship to maintain readiness.

There also may be ways to isolate particular watch teams such that they only minimally interact with the rest of the crew, to the point of sharing messing and berthing arrangements. This would imply that, instead of officers, senior enlisted, and junior enlisted residing in berthing based on rank, they would be berthed and eat together based on watch station. Under this arrangement, if a watch team becomes exposed, the whole team could be removed from the ship and replaced in block. This arrangement would likely affect overall crew cohesion and does not account for times when special evolutions require a cross-section of watch teams.

It does, however, allow localization, containment, and management of outbreaks. If the ship simply cannot evacuate personnel, either because of location or mission, the ship's berthing and health care arrangements could be modified to allow for limited quarantine. However, the close quarters and installed ventilation of Navy ships make this challenging. As a longer-term possibility, better filtration of ship ventilation might help reduce the spread of viruses. Ventilation modifications exist to allow ships to function in a chemical, biological, and radiological environment, and these modifications should be explored. But this generally does not include protection against viruses originating from sick people in a space.

Improve Shipboard Capability for Coping with Infectious Disease Outbreaks

We have already noted that shipboard medical departments, even on very capable platforms—such as carriers or big deck amphibious ships—are generally oriented toward care of young people who might get injured, not toward containing widespread infection. This shortfall might be met with improved training for ship's medical officers and independent duty corpsmen. It might also be improved by assigning enlisted personnel with specific infectious disease training on ships.

We have already discussed possible changes in berthing and health care arrangements to improve a ship's ability to care for sick individuals requiring quarantine. These are specific engineering modifications that require specific care.

The ship's medical capability could also be augmented by flyaway teams with a variety of required specialties to help handle outbreaks. The specialties, depending on the type of infectious agent, might include surgeon, intensive care unit nurses, nurse anesthetist, physician's assistant, respiratory therapist, microbiologist, medical technologist, infectious diseases doctor, infection control nurse, psychologist, medical laboratory technician, respiratory technician, radiology technician, and hospital corpsman. It may take some time to assemble such a team and fly it out to the ship. In addition, this approach also risks putting additional people in danger of exposure. But it does use existing capacity to meet an emerging demand.

Improved telemedicine is another way to augment the medical capability without putting additional personnel on the ship and risking their health. But the use of telemedicine would have to be balanced against the needs of other users competing for limited bandwidth. Telemedicine has limitations, and in-person medical personnel will still be needed to carry out specific medical functions. One potential use of telemedicine could be to help connect different medical teams or personnel in various parts of the ship. The establishment of telemedicine links between medical teams and isolation berthing

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This set of issues was particularly apparent during the Theodore Roosevelt episode, but it appears in other ways throughout the COVID-19 pandemic.

spaces, for example, could allow medical personnel to consult with one another and conduct routine checks on crew in a more remote fashion.

Improve Communications Between Medical and Operational Chains of Command

Medical and operational chains of command have different priorities, different criteria for evaluating costs and benefits, and generally do a poor job of communicating a common purpose. Medical professionals as a group are devoted to the idea of saving lives and preserving health; operationally focused officers are focused on the mission and are, in general, looking for ways to meet mission requirements. Both are pursuing worthwhile goals but are to a large degree talking past one another.

This set of issues was particularly apparent during the *Theodore Roosevelt* episode, but it appears in other ways throughout the COVID-19 pandemic. Restrictions of movement, for example, reflect an aggressive effort to ensure that crews are isolated from infection, but when coupled with a desire to maintain presence requirements, the result is likely beyond what either community would have sought as an outcome. Ships met commitment, and no major outbreaks occurred, but there may have been lasting damage to longer-term readiness, including to retention. A better discussion of the actual health risks involved with some portion of the crew getting sick might have resulted in a different decision, possibly less onerous for individual service members and better oriented toward long-term outcomes.

Reconciling points of view will take more than a formal process for consultation. It will take actual effort to consolidate different viewpoints and to do it in a way that accurately captures the risks and priorities of each group. Medical advice should contain a description of how best to contain the disease and reduce severity or to deal with any large-scale medical event involving significant numbers of casualties and medical resources. Operational considerations should match the medical advice against the operational environment and need. The resulting decisions need to be communicated across all chains of command, without the consultative channels that appear in this case to have resulted in different—and uncontextualized—advice affecting different parts of decisionmaking.

Improve Theater Medical Evacuation and Coordination Plans

The most disturbing parts of the Navy's response to the COVID-19 outbreak might be the seeming chaos. Everyone acknowledged that the virus was new and incompletely understood and that the national response was troubled. But as far as the Navy is concerned, if the medical conditions had been more dire—and included a need for large-scale evacuation and/or trauma care—it is unclear whether either the Navy or the combatant commander had adequate means or a plan for meeting this challenge in the early stages. In the *Theodore Roosevelt* case, care aboard the ship was not sufficient, theater facilities were not available, and transportation to appropriate care locations was not immediately available.

Since the initial response, the Navy has responded to the challenges with aggressive isolation and, more recently, with vaccination, but we did not find any indication that the lessons from the earlier stages of the response have been assimilated. The Navy has initiated and published thorough reviews of the *Theodore Roosevelt* case, but these are largely oriented toward improving specific shipboard isolation procedures and/or finding indications that

the *Theodore Roosevelt*'s commanding officer and senior medical officer did not perform their duties satisfactorily. The reviews do not answer—nor really even pose—the broader questions of readiness to respond to a large-scale medical or mass-casualty event.

Readiness to deal with medical situations, such as a pandemic or infectious disease outbreak or large-scale trauma care, requires substantial planning and resource support. The apparent fact that the Navy could not successfully isolate or readily transport patients from the *Theodore Roosevelt* and that the expertise for infectious disease does not appear to reside on ships or even fleet staffs, should be of some concern. These are not necessarily cultural problems but possible resource and personnel shortfalls. The COVID-19 episode should be a warning that shortfalls may exist in the Navy's ability to respond to taskings in the National Defense Strategy. COVID-19 has not been as significant an event as feared, partly because it does not affect the Navy's dominant age group and partly because of the Navy's mitigation efforts. The Navy should not, however, overlook the shortfalls revealed by this event and their applicability beyond the end of this pandemic.

Notes

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[11] *Airborne* can be used to describe any size particle capable of travel through the air. For respiratory droplets, that can include droplets that are close to the source and those that have moved farther away. The term *airborne*, in the context of *airborne transmission*, is used to describe infections capable of being transmitted through exposure to infectious, pathogen-containing small droplets and particles suspended in the air over long distances and that persist in the air for long periods of times. See Centers for Disease Control and Prevention, "Science Brief: SARS-CoV-2 and Potential Airborne Transmission," webpage, October 5, 2020a.

[12] Rubeola causes measles; it is very infectious virus transmitted through direct contact or droplets and is a vaccine-preventable disease. See Centers for Disease Control and Prevention (CDC), "Measles (Rubeola)," webpage, last reviewed November 5, 2020b.

[13] Varicella-zoster virus is a highly contagious virus and causes chickenpox. The virus spreads easily from people with chickenpox to others who have never had the disease or never been vaccinated. The virus spreads mainly through close contact. See CDC, "Chickenpox (Varicella)," webpage, last reviewed April 28, 2021a.

[14] Variola major and minor cause smallpox. It is extremely contagious, can be contracted by contact and droplets, and is a vaccine-preventable disease. See CDC, "Smallpox," webpage, last reviewed July 12, 2017.

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About This Report

Like the rest of the world, the U.S. Navy scrambled to react to the sweeping effects of the early months of the coronavirus pandemic and take steps to mitigate longer-term effects even as the service continued to meet its mission requirements. The early outbreak on the USS *Theodore Roosevelt* and how that situation was handled received a great deal of public attention. It illuminated fissures in the Navy's readiness to respond to major medical events. The shortfalls highlighted and discussed in this report apply not only to the spread of infectious disease aboard a ship but also to a mass-casualty event or large-scale trauma care—circumstances that may be a more likely outcome in future warfare than has been experienced in the recent past. Drawing from the challenges presented by COVID-19 and the Navy's response, we examine broader implications for readiness in the Navy in this report.

RAND National Security Research Division

This research was sponsored by the Office of the Secretary of Defense and conducted within the Navy and Marine Forces Center of the RAND National Security Research Division (NSRD), which operates the RAND National Defense Research Institute (NDRI), a federally funded research and development center (FFRDC) sponsored by the Office of the Secretary of Defense, the Joint Staff, the Unified Combatant Commands, the Navy, the Marine Corps, the defense agencies, and the defense intelligence enterprise. For more information on the RAND Navy and Marine Forces Center, see www.rand.org/nsrd/ndri/centers/nmf or contact the director (contact information is provided on the webpage).

The research reported here was completed in March 2021 and underwent security review with the sponsor and the Defense Office of Prepublication and Security Review before public release.

For more information on this publication, visit www.rand.org/t/RRA468-1

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RR-A468-1