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Medical Supply Chain Impacts of Pandemic Preparedness and Response

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NPS NRP Executive Summary
Preparing for the Next Pandemic: How Can Navy Personal Protective Equipment Resupply Be Improved?
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NAVAL RESEARCH PROGRAM
NAVAL POSTGRADUATE SCHOOL
MONTEREY, CALIFORNIA

PREPARING FOR THE NEXT PANDEMIC: HOW CAN NAVY PERSONAL PROTECTIVE EQUIPMENT RESUPPLY BE IMPROVED?

EXECUTIVE SUMMARY

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Project Summary
Our efforts sought to address potential personal protective equipment (PPE) shortages to the fleet, the adverse effects to overall readiness, and the preservation of the Navy's greatest assets, its sailors. Two questions were posed as the study employed an exploratory sequential mixed method research design. The first phase of the research was designed to answer the research question– How can the Navy provide frontline subject matter experts (Independent Duty Corpsman [IDC]) the means to efficiently and accurately track PPEs during COVID-19-type pandemics? For this phase (qualitative), we adopted a case study design leveraging interviews with IDCs. This resulted in identifying policies related to the governing supply chain. Of equal importance was the identification of an area of deficiency within the IDC's training curriculum. This inquiry suggests the need for enhanced medical supply chain management training within the didactic level and possible fleet-based training solutions.

The second phase (quantitative) leveraged these findings to inform the stochastic re-order point (ROP) formula with variables to address the second research question– How can the Navy determine a reasonable onboard allowance for pandemic-related PPE given limits on shipboard storage and authorized medical allowance list (AMAL) composition and an empirically-sound prediction for the usage rate of each category of PPE during a pandemic? As some aspects of the qualitative phase yielded limited data, averages and assumptions were made to build and present the proposed stochastic ROP formula to determine a PPE (e.g., N95 masks) safety stock (reasonable onboard allowance) and an ROP. The prepositioned stock scenario resulted in a safety stock of 83 units and an ROP of 244 units. This result suggests a problematic on-hand AMAL requirement as the current guided missile destroyer (DDG) assemblage requirement is only 120 units yet represents an inventory level to sustain on-hand stocks to prevent future PPE stockouts.

Keywords: *COVID-19, pandemic, supply chain, optimization, pre-positioning, personal protective equipment, PPE, re-order point, ROP*

Background
We begin this research by explaining the demand and purpose for the current study by first presenting historical, comparative, and epidemiological pandemic data and the current impact of COVID-19 on the population's health and socioeconomic implications. We then narrow our scope focusing on subject matter experts (IDCs) within the Arleigh Burke-class DDG platform, concentrating on optimizing the PPE (N95) supply chain. We examined COVID-19 response at the ship and fleet levels by evaluating notional modifications to authorized medical shipboard allowances and medical supply chain processes and policies to increase resiliency for future pandemics. To accomplish this, policy data was gathered related to the required shipboard AMAL, including consumable supplies, which are presently tailored toward mass casualty situations and not pandemics. Guidance from the Office of the Chief of Naval Operations, Pacific Fleet, Fleet Forces, and Navy Medicine guidance regarding pandemic preparedness and response was also examined. The initial findings were then integrated with the AMAL review

processes. The data were brought together with Commander, Naval Surface Forces, Pacific Fleet After-Action Reports and lessons learned from the COVID-19 pandemic to understand likely usage rates and on-hand inventory.

The research sought to address potential PPE shortages to the fleet, the adverse effects to overall readiness, and the preservation of the Navy's greatest assets, its sailors. In addressing this, two questions were posed as the study employed an exploratory sequential mixed method research design. The first phase of the research method was designed to answer the first research question– How can the Navy provide frontline subject matter experts (IDCs) the means to efficiently and accurately track PPEs during COVID-19 type pandemics? This first phase (qualitative) adopted a case study design leveraging interviews with IDCs. The case study design used here is one of the most widely used research methods across academic realms (Yazan, 2015). Case studies focus on collecting data through inquiries or evaluations of programs, activities, processes or events (Creswell, 2014) over a period of time (Yin, 2012). This design selection is appropriate for the current study due to its qualitative component's inquiry into the IDCs' activities and processes as they maintain medical supply inventory.

The second phase (quantitative) took elements from the first phase's interview results to inform the stochastic ROP formula with variables to address the second research question– How can the Navy determine a reasonable onboard allowance for pandemic-related PPE given limits on shipboard storage and AMAL composition and an empirically-sound prediction for the usage rate of each category of PPE during a pandemic? As some aspects of the qualitative phase yielded limited data, averages and assumptions were made to build and present the proposed stochastic ROP formula to determine a PPE safety stock (reasonable onboard allowance), and a re-order point. The model of the ROP, where variable (random and unknown) expenditure rates and lead times are accounted for, unlike a standard deterministic model, reflect known and constant expenditure rates and lead times (Maiti et al., 2009).

Findings and Conclusions

The IDC interviews resulted in identifying positive attributes of base knowledge of understanding available sources of policies related to supply chain. Of equal importance was the identification of an area of deficiency within the IDC's training curriculum. This implication elicited the recommendation of enhanced medical supply chain management training within the didactic level and possible fleet-based training solutions.

The prepositioned stock scenario resulted in a safety stock of 82.46 units and an ROP of 243.46 units. This result suggests a problematic on-hand AMAL requirement as the current DDG assemblage requirement is only 120 units. The second scenario, cross-level support, resulted in a safety stock of 80.39 units and an ROP of 87.29 units. Although this scenario resulted in a feasible outcome, this replenishment option is not ideal and should only be executed in contingent or emergent situations. This phase addressed the study's second research question and offered reasonable onboard allowances in two different scenarios.

The proposed safety stocks resulting from the stochastic ROP formula may provide DDGs an inventory level to sustain on-hand stocks while preventing PPE stockouts in future pandemics.

As a result of the mixed-method exploratory sequential design, the recommendations we offer include the establishment of accurate PPE tracking standards, employment of an automated ROP model, sustainment of the AMAL periodic review process, and the enhancement of supply chain training solutions for IDCs.

Recommendations for Further Research

Future research should be considered to build upon the results from the current study and enhance the Navy's resilience in potential pandemics. With a continued focus on medical supply chain, studies pertaining to other ship classes such as landing helicopter attacks (LHAs), landing helicopter docks (LHDs), and nuclear-powered aircraft carriers (CVNs), and submarines should be considered. A vital accessory to platform-specific studies are studies that focus on personal protective equipment (PPE) supply procurement. More specifically, studies that aim to determine optimal stockpiling and pre-positioning schemes should be considered to emphasize assured access and prompt replenishment to underway fleet assets. Studies such as these could be further complemented with research aimed at leveraging technological innovations involving forecasting methods to optimize PPE assemblage requirements that inform notional authorized medical allowance lists (AMALs).

Another relevant area of study to consider may be the potential price gouging of PPEs, as their use proliferated in the COVID-19 era. An area to consider would be how to establish dedicated stocks impervious to national or international stock shortages and regulation of prices while securing procurement solutions economically beneficial to the Department of Defense.

Lastly, as vaccine data is gathered, there may be high demands for studies identifying obstacles and leveraging solutions for efficient means of distribution across the fleet. Such studies might take into consideration the effects of vaccine stock and efficacy as COVID-19 variants arise. Contingency supply chain planning should still be emphasized across the fleet to ensure readiness across the fleet and perhaps even extend to all branches of the military. Current processes involve Naval Medical Logistics Command and content managers such as the Commander-Fleet Forces, Command Surgeon, and the Type Commander Surgeon, who offer annual reviews of AMAL composition across the fleet where subject matter experts participate in an annual November time frame conference to discuss changes (allowance change requests). Discussions are based on thoughtful insight from subject matter expert experience and scholarship regarding medical care and how to leverage the supply chain. Theoretically grounded automated innovations might aid in a more standardized method of forecasting individual needs of commands and platforms.

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Acronyms

AMAL	authorized medical allowance list
COVID-19	Corona virus disease
CVN	nuclear-powered aircraft carrier
DDG	guided missile destroyer
IDC	independent duty corpsman
LHA	landing helicopter attack
LHD	landing helicopter dock
PPE	personal protective equipment
ROP	re-order point