EXPLORING THE IMPACT OF 3D PRINTING ON MEDICAL LOGISTICS IN OPERATIONAL ENVIRONMENTS

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Abstract

The study answers the research questions, does 3D printing have the potential to positively affect medical logistics operations for operational and distributed maritime operations (DMO) environments, and if so, which Class VIII(a) consumable medical supplies show high potential. The qualitative cases analysis investigates the challenges of medical logistics in austere, deployed environments, particularly in mass casualty scenarios, and the implications of additive manufacturing (AM) to medical logistics operations for selected Class VIII(a) consumable items in one simulated distributed maritime operations (DMO) environment. The analysis and findings suggest that some Class VIII(a) medical supplies are not good candidates for 3D printing. However, interviews with subject matter experts revealed other potential Class VIII(a) consumable medical supplies that meet characteristic requirements to be 3D printed in operational environments. The study results in initial insights, propositions, and recommendations on how to proceed with 3D printing to support medical logistics operations for operational and distributed maritime operations (DMO) environments.

Driver	Outcome
Providing intensive care beyond 72 hours. More time and intensive care than facility was intended to provide; Afghan facility were not capable to care for patients.	Caused personnel to go through supply quickly. Medical conditions required more rapid use of flushes, which depleted supply of flushes. Personnel required to improvise flushes.
Facility and supplies are not designed for highly contagious patients, with an open ward and limited PPE.	Personnel forced to break infection control protocol because of rapid depletion of PPE and secondary resources.
Supplies not adequate for types of procedures.	Facility ran out of surgical items forced to request from other facilities delaying patient's surgery and discharge.

Critical events during a 9-month period provided insight into burn rates during mass casualties

Methods

2-Phase Qualitative Analysis

Phase 1:

- contextApproach: Case analysis of mass casualty events at NATA Role 3 MMU
- Data sources: Interviews and documents
- Output: Identify and describe critical incidents and process failures

Phase 2:

- Approach: Exploratory investigation of early 3D printing adoptions
- Data sources: Interviews of subject matter experts
- Output: Identify and describe feasible uses in medical supply/logistics

I collected and analyzed data in two phases. In phase one, to develop the case, I interviewed deployed medical professionals from NATO Role 3 MMU. I also used my field notes and Department Head Turnover Guide. In phase two, I interviewed 3D printing subject matter experts and collected documents and articles relating to medical logistics and 3D printing. I also collected reports of research on 3D printing of medical supplies.

The seven rights of logistics framework guided my analysis. I analyzed the case data to develop an understanding of the challenges of medical logistics in operational environments. I drew on my initial findings and the seven rights of logistics framework and analyzed the 3D printing data to develop an understanding of current state of 3D printing related to medical supplies. I integrated these analyses to answer my research questions.

Results

Interviews with medical professionals identified six Class VIII(a) medical supplies rapidly depleted during mass casualty events: **syringes, IV tubing, cranial kits, implants, suction valves, and canisters.**

Key Shortages	Low	Moderate	High
Syringes		X	
IV Tubing	X		
Cranial Kits	X		
Implants			X
Suction Valves		X	
Suction Canister		X	

Key Characteristics	Interview Participants
Internal/External	"An implant is printed with materials sustainable within a patient, approved by FDA"
Material and Use	"It's not just being in the patient, it's the material of the object that matters."
Watertight	Watertight integrity critical for patient use
Flexibility	"Material/objects that are rigid are easier to print than flexible materials"
Technology Requirements	"3D printing watertight objects requires specific printing technologies; concerns of leaching"

Potential to 3D print and printing characteristics

Interviews with subject matter experts revealed other potential Class VIII(a) consumable medical supplies that meet characteristic requirements to be 3D printed in operational or distributed maritime operations (DMO) environments such as **antibiotic bandages** that leach antibiotics over hours to days, supplement as a splint and have potential to increase survivability during the **golden hour**.

The greatest value of 3D printing on-site comes from relieving the time an ordered Class VIII(a) consumable item is in transit from PV to operational environments.

This is also relevant to a DMO environment where fleets are far removed from logistical shore-based hubs where resupply is warehoused.

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