Treating Medicine as Ammunition

Enhancing Medical Logistics for Large-Scale Combat Operations

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U.S. Air Force special operations surgical teams (SOST) practice integration operations with a special operations partner force during a special tactics exercise at Hurlburt Field, Florida, on 16 October 2015. SOST members are military medical professionals selected to provide battlefield trauma and other surgical support in a special operations mission set and are often forward deployed to austere or hostile areas to perform lifesaving trauma surgery for special operators with little-to-no facility support. (Photo courtesy of the U.S. Air Force)

As the U.S. Army refocuses on sustainable preparedness for large-scale combat operations (LSCO), our force structure will evolve to ensure that we are manned, organized, and equipped to deter adversaries and win future fights.[1] However, the Department of Defense (DOD) maintains a disjointed and fragile supply chain and logistics system that does not ensure a posture of sustainable resilience internally, let alone with allied nations. The system lacks overall interoperability with the private sector, which forces the DOD healthcare enterprise to remain years behind private industry. Standardization, integration, and modernization require improvement to enhance efficiency and compatibility across the healthcare supply chain. Most Fortune 10 companies have operated with a supply chain designed for stable, peacetime economic conditions, which will become critically fragile during geopolitical disruption. Businesses must be prepared for significant vulnerabilities during potential conflict scenarios and embrace public-private partnerships to build the defense industrial base (DIB). Successful partnership development requires carefully structured economic incentives and predictability for government, industry, and allies alike.

The DOD must treat medicine as ammunition while adopting proven commercial healthcare best practices to address vulnerabilities in medical logistics. While this article highlights the risks of "just-in-time" models and pharmaceutical dependency on adversaries like China, it cautions against broad expansion of overbearing or compulsory additions to the Defense Production Act (DPA), which can disrupt supply chains and diverge from effective commercial approaches. Instead, leveraging voluntary partnerships and agreements under Title VII of the DPA, as well as standardized national frameworks, offers a more collaborative and flexible path forward. And yet, it is essential that the DOD remain the lead operational agent when it comes to national security as illustrated by Operation Warp Speed partnership (the public-private program initiated to develop and distribute the COVID-19 vaccine) and past efforts like the Manhattan Project. By focusing on voluntary, civilian-inspired strategies—such as predictive analytics and stockpiling, blockchain-enabled supply chain visibility, and robust public-private partnerships—the DOD must enhance medical readiness and resilience for future LSCO environments while maintaining strong industry relationships.

Reliable access to essential medical supplies and stable resupply near the point of need is as vital to military effectiveness and survival as a steady provision of munitions. Disruptions in the supply chain—whether from geopolitical conflict, natural disasters, or single-source dependencies—will quickly jeopardize readiness and force protection. The DOD's reliance on concentrated sources for items like the sole Food and Drug Administration (FDA)-approved Japanese encephalitis (JE) vaccine from Europe highlights the risks of limited suppliers and the cascading effects of any interruption.[2] By adopting a strategic approach to medical logistics—prioritizing redundancy, stockpiling, and resilient partnerships—the DOD will ensure that medicine remains as accessible and dependable as ammunition in any operational environment.

Geopolitical instability and supply chain fragility pose existential risks to medical readiness, even for substances with seemingly limited military relevance. While Suboxone—a critical opioid addiction treatment—faces only minor disruption risks from ongoing India-Pakistan tensions (production concentrated in nonborder regions), the JE vaccine exemplifies catastrophic single-source vulnerability. Valneva's IXIARO, the sole FDA-approved JE vaccine, is manufactured at a single German facility, creating a bottleneck that would require a *518 percent production surge* to vaccinate one million personnel during an outbreak.[3] Worse, ramping manufacturing in a regulatory permissive environment would, at minimum, take twelve to eighteen months to retool an existing facility for this type of surge. This mirrors artillery shell shortages in combat environments such as the war in Ukraine. Both scenarios force commanders into rationing decisions that degrade operational capacity, whether through unvaccinated troops or underequipped medics.

Prescription for Concern

In pharmaceutical production, key starting materials (KSMs) and active pharmaceutical ingredients (APIs) are critical components of drug manufacturing and typically have a longer shelf life than finished pharmaceuticals, also known as drug products.[4] KSMs are raw materials derived from chemicals or natural sources that undergo controlled chemical reactions,

Employees pack medicine at a pharmaceutical company 4 January 2023 in Xi'an, northwest China's Shaanxi Province. (Photo by Liu Xiao, Xinhua)

purification, and formulation to form the API. Para-aminophenol is an example of a KSM used to produce acetaminophen (Tylenol) in pain management, while penicillin G/6-aminopenicillanic acid (6-APA) is used in the antibiotic penicillin.[5] The API is the core component responsible for the drug's therapeutic effect, such as sedation in an IV medication.[6] The API is combined with nonactive ingredients like stabilizers, preservatives, or other important excipients to create the final drug product. The mixture is tested for safety, purity, and effectiveness before being sterilized and packaged into vials, tablets, combination products, IV bags, or other forms that facilitate effective use. This process ensures the final product is consistent, potent, and of sufficient quality to meet regulatory standards before reaching pharmacies, hospitals, and medical providers.

The U.S. government has a history of stockpiling materials essential for national security. These materials provide strategic flexibility and agility, allowing for the storage of many years beyond the shelf life of the finished pharmaceutical products. The DOD submitted an interim pharmaceutical supply chain risk assessment to Congress in April 2024, analyzing 1,744 generic sequence numbers, which equated to 12,917 national drug codes, or about 10 percent of the U.S. pharmaceutical marketplace.[7] The assessment revealed that 54 percent of the DOD pharmaceutical supply chain is considered either high or very high risk due to dependency on non-Trade Agreements Act (TAA)-compliant suppliers, with significant sourcing from India (26 percent), China (5 percent), and 22 percent from unknown origins. Only 28 percent of APIs were sourced from North America, considered at least moderately secure.[8]

These numbers are based on the final drug product; however, some estimates contend that the numbers for APIs and KSMs are 80 percent originated in India and China.[9] The TAA requires the DOD, the Department of Veterans Affairs, and other federal agencies to procure "substantially transformed" pharmaceuticals containing API or KSM from TAA-compliant countries.[10] Both China and India have established themselves as global leaders in pharmaceutical manufacturing due to their cost efficiencies and extensive production capacities. However, given they are non-TAA compliant, this reliance creates vulnerabilities, including supply chain disruptions, geopolitical tensions, and potential quality control issues, and dramatically reduces the resilience of the U.S. health system.

The "substantial transformation test" is a regulatory criterion used to determine the country of origin for goods, including pharmaceuticals. Under this test, a product is deemed to originate from the country where it undergoes significant processing or alteration, even if its components (e.g., API or KSM) are sourced from noncompliant nations.[11] In 2022, 58 percent of drug manufacturers supplying the U.S. market were based overseas.[12] This exposes the drug supply chain to potential risks as federal regulators are unable to provide oversight in India, China, and other foreign countries. Although the 2025 National Defense Authorization Act proposes stricter rules requiring APIs and KSMs for DOD-procured generics to originate from TAA-complaint nations, the "substantial transformation" test allows APIs from non-TAA countries (e.g., China) to be used in U.S.-manufactured drugs.[13]

Over the last twenty years, pharmaceutical imports into the United States have increased significantly, making them the second-largest category of imported commodities. Pharmaceutical imports totaled $176 billion in 2021 and increased to $196 billion in 2022.[14] Currently, "90 to 95 percent of generic sterile injectable drugs used for critical acute care in the U.S. rely on [KSM] from China and India."[15] Additionally, China dominates the manufacturing of sodium—an essential pharmaceutical used in sedation and commonly in surgeries in the military and throughout the United States—and accounts for 57 percent of U.S. pharmaceutical imports by weight, followed by India and Mexico.[16] Moreover, China currently supplies 45 percent of KSM and 20 percent of the API for sixty critical medications including acetaminophen, a generic pain medication commonly used in the United States.[17] The recent 25 percent tariffs on Mexican imports are likely to shift trade patterns toward an increasing reliance on China, given its larger gross domestic product and manufacturing capacity.[18] Furthermore, China will be able to fill the gap left by reduced Mexican imports despite its own tariffs. The U.S. dependence on China for API and KSM remains a key concern for the geopolitical environment.

Tariffs represent one tool among many to incentivize supply chain diversification, but their impact must be weighed against systemic trade realities. Recent federal measures have introduced tariffs on imported medical devices, including a 10 percent baseline levy, as part of broader efforts to strengthen domestic production capabilities and address supply chain risks.[19] These actions respond to documented trade imbalances, including a $295 billion deficit in U.S.-China pharmaceutical trade in 2024, and align with regulatory adjustments such as streamlined FDA approvals for domestic facilities.[20] New fee structures now apply to foreign manufacturers, with proceeds directed toward enhanced overseas inspection programs, while interagency partnerships aim to accelerate permitting for critical medical infrastructure projects. Such approaches—focusing on diversified sourcing, modernized regulatory pathways, and strategic investment in domestic capacity—offer a framework for reducing reliance on concentrated foreign suppliers while maintaining global supply chain integration.

Potential supply chain weaknesses, problems with quality control due to perceived lax regulatory monitoring by the FDA, and the possibility of shortages in essential pharmaceuticals all pose a threat to the United States.[21] Additionally, these factors have contributed to the decline of domestic manufacturing capacity and resulted in a significant pharmaceutical trade deficit that reached $96.2 billion in 2021.[22] The trade deficit was likely driven by macroeconomic factors like the reliance on imports to meet U.S. consumer demands. This imbalance was further worsened by offshoring to countries like China and India due to their lower manufacturing costs and ability to scale. In the pharmaceutical sector specifically, imports have surged due to rising healthcare spending and the dominance of foreign manufacturers in producing generic

A U.S. Air Force pararescueman from the 83rd Expeditionary Rescue Squadron prepares to move a simulated casualty during a personnel recovery exercise at an undisclosed location in Afghanistan on 6 March 2018. Army aircrews and Air Force Guardian Angel teams conducted the exercise to build teamwork and coordinate procedures as they provide joint personnel recovery capability, aiding in the delivery of decisive airpower for U.S. Central Command. (Photo by Tech Sgt. Gregory Brook, U.S. Air Force)

drugs and APIs that are critical for U.S. healthcare needs.[23] To protect the interests of national security and public health, the situation requires immediate attention and action.

The strategic similarities between ammunition and medicine extend beyond their battlefield importance to their shared supply chain challenges and critical material dependencies. The director of the Defense Logistics Agency (DLA), Army Lt. Gen. Mark Simerly, stated, "An agile and adaptable logistics system is critical, so we need to develop strategies to maintain supply chain integrity and operational readiness under adverse conditions."[24] This underscores the need for agile logistics systems that protect the supply of both ammunition and medical supplies throughout LSCO. For example, the 155 mm artillery round became a linchpin of Ukraine's defensive strategy, with its effectiveness underscored by glaring supply limitations. Ukrainian artillery crews frequently faced rationing that hampered operational tempo, with one battalion commander noting that promised monthly allocations barely covered a single unit's expenditure needs.[25] This challenge only intensified, even though the United States increased production by more than 50 percent and added new production lines. The United States was unable to maintain munition deliveries, forcing European allies to accelerate their production timelines. This exposed critical gaps in NATO's conventional ammunition stockpiles and manufacturing surge capacity.

The 155 mm artillery round's supply chain offers critical lessons for medical resilience. Each precision-guided variant relies on rare earth magnets sourced from China (95 percent global production), while its steel casing requires manganese and chromium—minerals increasingly subject to tariff-driven market shifts.[26] To mitigate this, the DOD has partnered with Australian firm Lynas Rare Earths to establish a second rare earth processing plant in Texas, bypassing Chinese refining dominance through a multiyear $258 million contract.[27] Concurrently, DLA now stockpiles tungsten (used in shell penetrators) under the National Defense Stockpile Program, a model applicable to pharmaceutical KSMs such as ketamine's cyclohexanone.[28] These measures recognize that component resilience—not just finished product stockpiling—determines wartime sustainability. For medical products, this is exacerbated because the location where the final product is produced and validated is even more essential due to assays that confirm quality, safety, and manage the benefit-risk for every individual who uses the product.

Just as Ukrainian forces depend on a steady supply of 155 mm artillery shells to sustain combat effectiveness, U.S. military medical units rely on ketamine as a critical pharmaceutical for pain management and anesthesia at the point of injury. During 2023, ketamine shortages—driven by supply chain disruptions, manufacturing delays, and reliance on KSMs often sourced from abroad—directly threatened the ability of medics to deliver timely care, much like artillery shortages have limited Ukrainian operational tempo. The production of ketamine requires specific chemical precursors and specialized manufacturing infrastructure, making its supply chain vulnerable to geopolitical

and logistical disruptions.[29] This parallel underscores that, for the warfighter, access to essential medicines like ketamine is as vital as access to ammunition, and both require resilient, diversified supply chains to ensure readiness in contested environments.[30]

DLA, Joint Medical Readiness, and Sustainable Stockpiling for National Security

The DLA is critical in supporting the U.S. military's wartime mission by providing end-to-end supply chain management for logistics and policy oversight. Unlike commercial entities, DLA focuses on combat effectiveness rather than efficiency, ensuring that combatant commands receive necessary commodities and services. DLA's expensive cost recovery model is evidence of this shortcoming of balanced effectiveness and efficiency. However, the DOD faces challenges in holistic supply chain management due to fragmented ownership across different organizations. This fragmentation complicates the provision of consistent demand signals to the industry, which requires predictability in investing in production capacity. The lack of clear requirements from combatant commands and services hinders the ability to inform the industrial base about potential crisis needs, leading to insufficient preparedness for protracted conflicts.

During the early days of Operation Iraqi Freedom, only 8 percent of the military's medical requirements were met from its existing stock, resulting in significant costs and inaccuracies in the requirements provided by the services.[31] To address this, DLA developed a system that efficiently sources supply from the U.S. commercial sector, transitioning to a prime vendor model and creating an electronic catalog for items that could not be converted. DLA provides global support to sustain warfighter readiness and serves as the executive agent for medical material.[32] The DLA system includes approximately three hundred vendors with six hundred different types of contracts, providing access to 1.4 million medical items in near real-time.[33] Prime vendors deliver within one day domestically and within five to seven days internationally. When required, these items are available on a vendor's dock within twenty-four hours, with subsequent batches ready every twenty-four hours thereafter.[34] However, these timelines do not account for a contested logistics environment and do not consider wartime planning factors, nor are they easy to replicate in peacetime.

COVID-19 exposed the Nation's reliance on fragile, often foreign, supply chains for essential pharmaceuticals and personal protective equipment; however, this vulnerability predates the pandemic. Put simply, chronic drug shortages and overseas manufacturing in adversarial nations represent an existential public health threat to our citizens, our warfighters, and our entire healthcare system.[35] Drug shortages—whether caused by geopolitical tensions, natural disasters, or manufacturing issues—disrupt access to critical medications, jeopardizing the health and well-being of the population and military personnel. Although it is not a new problem, it remains an expensive one to solve. Furthermore, the joint force requires a shift to start visualizing "medicine as ammunition" to save lives on the battlefield.[36] Avoiding complacency and developing a comprehensive maneuver concept with a decentralized/dispersed logistics model must remain a focus for the joint force.

Consequently, the DOD and DLA must employ commercial style "Sales and Operations Planning" (S&OP) systems for managing pharmaceutical supply chains, much like we did for limited supplies of COVID vaccines during Operation Warp Speed. Additionally, the joint staff needs to actively monitor working stocks of both the Joint Deployment Formulary and unit basic load items at the unit level (e.g., brigade combat team) and forward-positioned areas to ensure they are sustained above 80 percent and ready for the next conflict. A working stockage is not just an emergency planning tool; it also includes rotated stocks for use along with a rotated reserve that supports use across the whole of government, and it embraces both greater effectiveness and efficiency using modern S&OP planning tools.

Planning efforts alongside the private sector using S&OP tools need to be examined. Novel solutions involving vendor-managed inventory and a predictable rate of utilization would be welcomed by industry partners witnessing significant fluctuations in orders by different parts of the U.S. government, which has led to the government paying more for products while simultaneously increasing insecurity in pharmaceutical availability. However, corporate business will generally rely on an incentive model to participate, understanding

Medicine and medical supplies are stored in warehouses at undisclosed locations as part of the Strategic National Stockpile as a contingency for a mass outbreak or health crisis. (Photo courtesy of the Department of Health and Human Services Administration for Strategic Preparedness and Responses)

that such partnerships could lead to a more resilient medical supply and pharmaceutical industrial base.

The DLA Warstopper Program contributes approximately $20 million annually to a prime vendor for a medical logistics contract, providing a robust supply capability delivered to the warfighter starting on day thirty-one of a contingency.[37] This program buys access to medical supplies through a prime vendor with the DLA still responsible for the overall purchase of specific items in a contingency. Furthermore, the Joint Deployment Formulary and each service is responsible for medical supplies covering the first thirty days of a conflict. Although this does not compare to the planning factors the DOD will experience in LSCO for casualty estimates. At the same time, the DLA Warstopper Program ensures readiness and efficiency in supporting contingencies through a diverse network of medical supply companies through a single prime vendor, Cardinal Health.[38] Peacetime requirements prevent the Army from adequately testing this system in real-time with the vendors responsible for delivering at the time of need, given the time and distance factors necessary during a real-world contingency.

The Warstopper Program is a decent start, but it is not sufficient given that the focus of sustainable preparedness is contingency planning for an event that has not yet occurred. Thus, DLA needs clearer requirements for a contingency that are not based solely on recent past orders to be maximally effective for future contingencies while also being efficient with limited resources. DLA is working to address requirement gaps through the Supply Chain Risk Management System and by emphasizing the need for a whole-of-nation approach to logistics planning, including transparency with industry partners and a clear understanding

of the risks associated with inadequate supply chain resilience.[39] These efforts prioritize transparency with industry partners and risk assessments of supply chain vulnerabilities.

The Supply Chain Risk Management System aligns with the DLA strategy to integrate supply chain security into its mission assurance portfolio and Enterprise Risk Management framework, ensuring proactive threat detection and mitigation.[40] DLA aims to enhance interoperability, eliminate redundancies, and secure critical supply chains through agency collaboration in both the government and private-industry sectors amid evolving threats such as geopolitical disruptions.[41] This comprehensive approach underscores DLA's commitment to enhancing supply chain resilience through innovation, cross-sector collaboration, and strategic risk management, positioning DLA to better navigate complex logistical challenges in LSCO.

Initial assumptions that supply chain disruptions were solely due to the COVID-19 pandemic have proven inaccurate, revealing deeper, systemic weaknesses within the U.S. DIB. Lt. Gen Philip Garrant, commander of the Space Systems Command, once stated, "Coming out of COVID, we thought a lot of these supply chain issues were COVID issues, what we're realizing is this is more than COVID; there are true industrial base concerns."[42] A heavy reliance on foreign suppliers, particularly China, for critical materials exacerbates this problem. Any conflict in the U.S. Indo-Pacific Command area of responsibility would then have a high likelihood of creating a situation where there would be contested logistics. Contested logistics will impact the supply and distribution of such pharmaceuticals, affecting DOD and civilian healthcare. Combating this requires better diversification and "friendshoring," a strategic trade approach that prioritizes manufacturing and sourcing goods from politically aligned countries.[43]

Unlike traditional offshoring, which primarily seeks cost reduction, friendshoring considers geopolitical stability, diplomatic relationships, and long-term strategic interests in supply chain decisions.[44] This integration not only ensures the availability and rapid deployment of critical medical supplies during emergencies but also promotes reciprocal learning and innovation between military and civilian healthcare sectors, ultimately strengthening national health security and assisting in rebuilding the DIB. To involve the private sector, DOD must find a way to incentivize partnerships. Likewise, the DOD must work with the FDA to establish relationships and methods that allow for the sharing of regulated medical products across countries, which is a significant challenge under current regulatory practices between sovereign countries, regardless of political alignment.

One key method to incentivize the industry would encompass bringing production of KSM and API back to the United States, while reducing the Environmental Protection Agency regulations that govern the mining of such critical minerals. For example, streamlining the National Environmental Policy Act review process for new mining operations could significantly accelerate the development of domestic critical mineral sources.[45] Every new mine in the United States must undergo a rigorous National Environmental Policy Act review that considers impacts on biodiversity and climate change. By focusing this process on critical risk-benefit areas, much like the FDA during emergencies, the government could encourage the rapid growth of domestic production. Cogent and data-driven risk-benefit evaluations could find the balance for critical mineral mining and use. Such Environmental Protection Agency regulations do not affect countries such as China and India, resulting in increased production and cheaper cost to the vendor and, ultimately, the consumer. Moreover, U.S.-based companies that produce KSM and API could also benefit from tax incentives to increase their annual profit margin.[46] Such incentivization would promote healthy competition amongst businesses and decrease reliance on sole-source vendors in the United States.

The DOD is responding with initiatives such as the Office of Strategic Capital, an organization established in 2022 to attract and scale private capital investments in technologies critical to U.S. national security.[47] Dependence on adversarial nations for drug manufacturing creates a vulnerability that could be exploited during times of conflict or political instability. These nations could restrict or completely cut off the supply of essential critical minerals such as KSM and API, crippling the healthcare system and impacting military readiness and future military operations. However, achieving a more self-reliant domestic supply chain requires breaking political gridlock, sustained funding, bipartisan cooperation, targeted incentives, and enduring trade policies.[48]

By prioritizing partnerships with allies like India and Vietnam—nations offering cost-competitive, ethical labor markets—the United States will diversify supply chains while advancing shared democratic values.[49] The bipartisan Promoting Resilient Supply Chains Act of 2025 further institutionalizes this strategy, mandating AI-driven mapping of critical industries and requiring federal agencies to source from "allies or key international partners."[50] This dual approach of punitive tariffs and strategic collaboration not only mitigates risks posed by China's 80 percent control over cobalt and copper mining in the Democratic Republic of Congo but also aligns with a broader vision to leverage trade policy as a tool for national security, economic growth, and technological leadership.[51]

Further, achieving the sustainable posture needed for biodefense also depends on the resilience commitment expressed at the 2023 NATO Summit in Vilnius, Lithuania, that each ally must ensure that "sufficient medical supplies are stocked and secure."[52] NATO leaders, including the United States, reiterated that resilience is essential for deterrence and defense.[53] In this context, resilient medical systems include pharmaceuticals and require strong cooperation between civil and military stakeholders across NATO nations. This deterrence by resilience approach necessitates the methods proposed here, including collaboration between nations and with industry.[54]

Prepositioned Predicament

Historically, current stockpile programs such as the Army Prepositioned Stocks (APS) and the Strategic National Stockpile (SNS) have remained insufficiently resourced for the next war with funding cuts continuing.[55] Funding cuts have impacted specific

U.S. Army ambulance vehicles assigned to the 64th Brigade Support Battalion, 3rd Armored Brigade Combat Team, 4th Infantry Division, advance toward a pickup point in a convoy as a part of joint multinational ambulance exchange point training during Defender 22 at Drawsko Pomorskie, Poland, 26 May 2022. (Photo by Sgt. Tara Fajardo Arteaga, U.S. Army National Guard)

DPA Title	Key Mechanisms	Purpose/Impact	Examples
Title III	Loans, purchase commitments, grants	Boost private-sector production of critical supplies during crises	Ventilators, personal protective equipment (COVID-19 pandemic)
Title VII	Public-private partnerships	Enhance supply chain coordination for emergencies	Strategic National Stockpile collaboration with drug manufacturers (antibiotics, anesthetics)

(Table from U.S. Department of Health and Human Services, *Strategic National Stockpile Report to Congress* [2022])

Table. Examples of Title III and Title VII of the Defense Production Act

APS, with priority funding going toward critical APS locations overseas. Moreover, modernization and near-term readiness for ground/air systems (e.g., Next-Generation Combat Vehicles) remain the priority effort over APS funding. Chronic underfunding has led to degraded equipment readiness and increased risk to casualty care in conflicts, resulting in a decreased fill rate for some of the APS medical inventories.[56] All APS locations receive a priority fill level based on geographic location and impact to the warfighter.[57] Globally, prepositioned stocks in Europe and the U.S. Indo-Pacific Command have been prioritized.[58]

The APS Program faces inherent risks even when stockpiling critical supplies, as demonstrated by Hurricane Helene's 2024 shutdown of Baxter International's North Cove IV fluid plant—a sole-source provider of 60 percent of U.S. medical-grade IV bags.[59] This single facility's closure triggered nationwide shortages, forcing hospitals and military medical units to ration supplies despite existing stockpiles. The incident revealed how centralized production can create volatility in medical logistics, mirroring ammunition stockpile vulnerabilities: prepositioned reserves alone cannot compensate for fragile supply chains. The FDA has responded to the IV fluid shortages by issuing temporary compounding guidance, adding IV fluids to the national drug shortage list, and encouraging alternative sourcing and conservation measures.[60] This approach mirrors ammunition's "warm base" industrial strategy, where component suppliers like Aerojet Rocketdyne maintain standby capacity through cost-sharing contracts.[61] Further, the DOD needs to remain close to the FDA and the Administration for Strategic Preparedness and Response for all medical shortages, military or civilian. Greater regulatory coordination, appropriate streamlining through data systems and international harmonization, and innovation could facilitate the availability of critical medical capabilities.

Despite the Army's efforts to adjust APS stock and programs for adequate funding through the program objective memorandum, reprioritizing modernization efforts over sustainment operations has resulted in a substantial 48 percent reduction from the planned expenditure over the past three years. Furthermore, Congress has directed the Army to operate with only 58 percent of the targeted APS spending.[62] Changing the National Defense Authorization Act is not the answer to the problem, as the DOD does not move the needle alone. This effort will require bipartisan support if the DOD expects to compete with near-peer adversaries. Furthermore, establishing strategic stockpiles for essential medicines, mainly those prone to shortages, such as sterile injectables, ensures a steady supply during unexpected disruptions, thus necessitating greater alignment with the SNS.[63] However, the need for antibiotics, sedation, and analgesic medications in LSCO to treat critically injured patients is of the utmost concern and alignment with the SNS and must ensure alignment of civil and military parts of the health system.

Defense Production Act

The Defense Production Act of 1950 authorizes the U.S. government to mobilize domestic industrial resources to address critical national security needs, including the stockpiling of essential medical supplies during crises (see table).[64]

The DPA also allows for the prioritization of contracts for materials such as vaccine components,

ensuring that production aligns with projected demand during biological threats.[65] Pharmaceuticals, vaccines, medical supplies, and equipment designed to supplement state and local resources during public health emergencies are maintained within the SNS and managed by the U.S. Department of Health and Human Services, ensuring the rapid deployment of critical resources to protect national health security.[66] Part of the problem is that "national health security" does not clearly involve the military and has pivoted to a civil health security implementation.

Some parts of the DPA assist civil and military authorities alike. By leveraging these authorities, the DPA mitigates vulnerabilities in medical supply chains. Section 708 of Title VII enables the president to collaborate with various industry representatives to form voluntary agreements aimed at bolstering national defense, particularly under circumstances that threaten preparedness programs.[67] A notable initiative under this section is the Federal Emergency Management Agency's "Voluntary Agreement of the DPA for the Manufacture and Distribution of Critical Healthcare Resources Necessary to Respond to a Pandemic." Established in August 2020, this agreement addresses needs arising from the COVID-19 pandemic, focusing on personal protective equipment, diagnostics, pharmaceuticals, and medical devices.[68] While section 708 of the DPA enables critical public-private collaboration, reliance on voluntary agreements risks unreliable participation from industry partners, particularly when profit incentives conflict with national priorities. For example, during COVID-19, some manufacturers hesitated to join Federal Emergency Management Agency's voluntary agreement due to concerns about antitrust liability, production costs, or unclear long-term commitments.[69] These challenges highlight the need for medical logistics systems capable of responding to a contested logistics environment in LSCO. The United States risks significant vulnerabilities in responding to the next crisis without robust modernization efforts and strategic public-private partnerships. It is equally important to note that while most focus on the coercive portions of the DPA, our focus here is on the voluntary agreements portions of the DPA. While not historically an industry best practice, we argue that this is a clear target for enhanced public-private partnerships that maximize the use of industry best practices.

Civilian Industry Practices (CVS Health)

CVS Health utilizes eighteen distribution centers (DC) across the continental United States, providing retail and pharmaceutical supplies to over nine thousand retail store locations and one thousand MinuteClinics (primary care clinics) supporting over five million daily customers. At each DC, a three-tier level of stockage anticipates the demand of each retail store location across the United States, enabling daily shipments of critical supplies. Each DC utilizes a deep reserve, forward reserve, and pick-line concept to anticipate the demand and ensure adequate supplies are rendered.

The "deep reserve" encompasses items that are not immediately needed but are stored in the rear of the warehouse to ensure ready access based on demand.[70] The "forward reserve" encompasses items with a daily need from each DC while supporting shipments to ensure shelves remain stocked with the highest-demand supplies. The items on the "pick line" are the final stop before packaging. A frontline distribution point, where workers manually package crates based on an integrated technology system called "pick-to-voice," telling each worker which retail items or medications are needed in each crate. CVS Health DCs receive over sixty shipments of supplies daily and account for more than two hundred thousand line items across the retail storefront and pharmacy lines.[71]

Automation remains at the forefront of operations within each DC, with interoperability and machine learning as key components; these are all elements of effective S&OP systems. Similar systems, if utilized in the DOD, would enable increased predictability while ensuring the warfighter is equipped with the right medical supplies at the right time during LSCO, resulting in less lead times and rapid supply deployment.

Contested Logistics

The DOD needs to become comfortable with being uncomfortable and recognize the tyranny of distance for the medical logistics problem-set. The United States must begin manufacturing reliable and high-quality KSM and API to win future wars and provide our service members, and that of the American public, with

the tools needed to compete and fight in the next war. To reduce dependency on China and India for critical minerals, the United States must prioritize stockpiling essential pharmaceutical ingredients and proactively predict the demand now rather than wait for the next contingency. Strengthening domestic production capabilities and diversifying supply chains are essential strategies for reducing the United States' reliance on foreign sources of KSM and API.

Diversifying supply chains involves identifying and partnering with a broader range of reliable suppliers, both domestically and internationally, to reduce the risks associated with overreliance on any single country. For example, the Strategic Minerals Act, reintroduced by Sens. John Hickenlooper, Todd Young, Chris Coons, and John Cornyn, aims to strengthen America's critical minerals supply chain by expanding trade with international partners.[72] Encouraging partnerships with nations that share similar regulatory standards and geopolitical stability secures the supply of essential materials.

To enhance supply chain resilience and reduce dependence on China and India, the United States must pursue strategic coproduction agreements with Australia by developing joint rare earth mining and processing projects, U.S.-backed plants would maintain supply chain control over specific reserves and mining ventures, while ensuring the United States priority access to mineral deposits in those partner countries.[73] Lastly, the likelihood of contested logistics is extremely high, especially for medical systems; thus, the U.S. government needs to invest in innovation that supports delivering essential medicines close to their point of need. Investing in drug or biologics "in a box" at a small but functional scale will maximally diversify the supply chain. This will challenge regulatory systems, but it will also maximize the current data revolution involving artificial intelligence and require the positive control proposed for managing KSMs. By integrating tiered stockpiles, allied coproduction frameworks, advanced supply chain analytics, and innovation that maximizes operational utility, the United States will reinforce critical supply lines against geopolitical disruptions while transitioning away from the fragile "just-in-time" logistics model currently employed by the DOD, thereby ensuring the long-term security and medical readiness of the force.

Incentivize Industry

The U.S. government needs to incentivize industry investment in critical mineral production through targeted policies and financial support. Immediate action could include expanding DPA Title III authorities to mandate 50 percent cost-sharing for domestic API facilities, as demonstrated in IperionX's $47.1M titanium agreement, which would reduce reliance on Chinese KSMs.[74] The DOD contract award to IperionX reduces reliance on foreign suppliers of titanium while expediting the Titan Critical Minerals Project in Tennessee, a new domestic mining source of the critical mineral.[75] The U.S. government must fully utilize Title VII to establish voluntary agreements, amplifying their impact across both military and civilian health systems. An example includes companies such as the Virginia-based Phlow Corporation, a public-benefit company specifically focused on bringing API manufacturing onshore through native production and secure facilities. Likewise, the Missouri-based API Innovation Center is a 501(c)3 nonprofit that unites government, industry, and academia to advance technology and optimize underutilized manufacturing facilities to make the pharmaceutical supply chain more resilient, often using cutting edge data-oriented methods. Investment was previously initiated but has recently fallen off—the approach needs to be refocused to maximize outcomes for essential medicines and the DOD.

If the DOD contracted with private industry to support the U.S. DIB, it would need to take the same approach to supporting pharmaceutical resiliency. Legislative action must impose 30 percent domestic sourcing quotas for DOD-procured antibiotics by 2030 and reform the "substantial transformation test" to ban Chinese API in "Made in USA" pharmaceuticals.[76] Additionally, the U.S. government needs to mandate domestic sourcing quotas, create strategic mineral stockpiles, streamline permitting processes, establish tiered tax incentives, and modernize workforce and cyber infrastructure.[77] The Bureau of Land Management has recently introduced a "pre-plan coordination" approach to streamline the permitting process for mineral projects on public lands, aiming to reduce review timelines while maintaining robust environmental and public engagement standards.[78] These efforts align with the need to address the United States' staggering twenty-nine-year average lead time for bringing

Several tons of container delivery system supplies are loaded onto a U.S. Air Force C-17 Globemaster III during the 25th Infantry Division's Joint Pacific Multinational Readiness Center 25-01 rotation on 9 October 2024 at Joint Base Pearl Harbor-Hickam, Hawaii. (Photo by Sgt. Jared Simmons, U.S. Army)

mines online, which is the world's second-longest.[79] Furthermore, expanding DIB funding through targeted allocation of Inflation Reduction Act funds could subsidize domestic API/KSM production facilities, with a goal of reducing reliance on Chinese-sourced pharmaceutical inputs by 2030.[80] By adopting these strategies and forging new collaborations, the DOD, and that of the U.S. healthcare enterprise, will significantly enhance its medical readiness and resilience for future large-scale conflicts.

Conclusion

The DOD must continue to address critical vulnerabilities throughout the medical logistics enterprise in preparation for LSCO. Recommendations include transitioning from a "just-in-time" logistics model to civilian-inspired predictive stockpiling, employing S&OP methods, mandating cross-governmental interaction and collaboration, expanding DPA authorities like voluntary agreements to incentivize domestic API and KSM production, and leveraging technologies such as blockchain-enabled tracking systems for real-time supply chain visibility. China's monopoly on certain critical minerals enables it to dominate the strategic supply chain of pharmaceuticals and medications. Focusing on allies with shared values enhances supply chain resilience, reduces dependence on geopolitical rivals, and strengthens economic partnerships. The DOD must foster strategic partnerships with allies through coproduction agreements while diversifying supply chains

and reducing reliance on foreign nations like China and India while building logistical resilience.

These reforms, coupled with strategic investments in domestic manufacturing and streamlined regulatory processes, will enable the DOD to transition from a fragile "just-in-time" logistics model to a robust, decentralized system capable of sustaining LSCO medical readiness. With 80 percent of Americans supporting increased defense spending, there is an opportunity to address these challenges in military medical logistics.[81] Unfortunately, military medicine does not drive this industry, so it must involve collaboration with the civilian health systems in the United States and internationally. By treating medicine as ammunition and implementing centrally coordinated, regionally aligned unit basic load war reserve materiel with guaranteed funding, the DOD will optimize inventory management, reduce expiration losses, and enhance overall supply chain resilience, ensuring warfighter survivability and maintaining national security in an era of contested logistics and geopolitical uncertainty. ■

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