

Multi-Domain Operations in Urban Terrain and Implications for the Medical Line of Effort

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The urban battlespace has long been the bane of the military planner's existence. While high-intensity conflict, force-on-force scenarios have an almost scientific and analytical quality to them, the cannulating terrain, complicated human dimension (political, power, social, and cultural), and intricate infrastructure that needs to be maintained pose significant volatile, uncertain, complex, and ambiguous issues for urban operations. Therefore, it is no surprise that the initial efforts during the invasion of Iraq were to bypass population centers to the south, lest the main body gets bogged down. Gen. Mark Milley, first as chief of staff of the Army and more recently as chairman of the Joint Chiefs of Staff, has made it abundantly clear that there will be a need to fight in cities in the near future.¹ The likelihood of an urban conflict is only anticipated to grow in the coming decades.

Background on Urbanization


An urban area is defined as three hundred thousand or more people. In 1950, 30 percent of the world's population lived in urban areas. That figure rose to 55 percent in 2018, and over the course of the next thirty years, it is expected to again rise to 68 percent.² Deeper analysis shows that upper-middle-income countries have experienced the most explosive growth over the last century, growing from 22 percent residing in urban

areas in 1950 to an anticipated 83 percent by 2050.³ Poorer countries, those characterized by the United Nations as "lower-middle-income" or "lower-income," are expected to experience a 50 percent increase in urban population in just the next thirty years.⁴

Over 75 percent of the aforementioned low-middle- or low-income countries reside in Africa.⁵ Sub-Saharan Africa and the Sahel Steppes have long been a sanctuary for violent extremist organizations (VEO) such as al-Shabab. These fragile states have a dearth of economic opportunities for their populations, creating conditions

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in which VEOs can recruit and flourish. Additionally, Africa has the youngest population of all countries or regions around the globe.⁶

When these conditions are coupled with the youth booms in developing countries, the problem becomes readily apparent: there are too many young men without a way to provide.⁷ VEOs fill that need by offering young men desperate to feed their families an occupation and a sense of belonging. As migration toward urban areas becomes more common, radical ideologies may well travel with it. It is entirely feasible that today's second lieutenants and ensigns will find themselves in an urban fight before their retirement.

While urban battlespaces are hardly a new phenomenon, they are often heavily publicized and can have profound effects on the political will of nations. From the destruction of Carthage in the first century by Rome to the burning of Atlanta by Federal forces, urban areas have been a flashpoint for hostilities. The Germans' and Soviets' Battle of Stalingrad is one of the bloodiest examples from the past century. The United States' participation in the Battle of Hue in Vietnam, while operationally a success, had significant sway on U.S. public support for the war, with President Lyndon Johnson purportedly saying, "If I've lost Cronkite, I've lost middle America."⁸ Similarly, after the battle for Mogadishu in 1993, U.S. public opinion for withdrawal increased from 58 percent to 64 percent, with a nine-point increase on an "immediate withdrawal" timeline.⁹ It is easy for nations to get bogged down in an urban quagmire, winning the battle but losing the war at home.

Besides their unpopularity, urban battles are immensely costly in terms of blood and treasure. The complex airspace and supersurface, surface, and sub-surface architecture offer defenders an opportunity to engage attackers from a multitude of points, whenever and wherever they choose.¹⁰ Defenders can inflict casualties and then quickly blend back into the populace. In addition to surface streets, vertical structures offer the defender rich opportunities to strike while limiting exposure. The enemy can engage aircraft from the roof of a sixty-story residential structure (external supersurface) or from the fourteenth story window of a thirty-seven-story residential building (interior), negating defensive or counterfires. The enemy may position an improvised explosive device designed to crater a road in an electrical

tunnel (subsurface) and drop a convoy twenty-five feet into a crater for a deliberate secondary attack.

The financial impact of the maxim "if you break it, you buy it" introduces additional hurdles. In 2014, two divisions of Iraqi military withdrew from Mosul, gifting Iraq's second largest city to the Islamic State.¹¹ Three years later, the Iraqi military had to fight its way back in. The toll was staggering: twenty thousand commercial and governmental buildings were destroyed, thousands were killed, a million lives were uprooted and displaced, and the cost was \$400 million over the first six months just to turn the electricity back on.¹² In July 2019, two years after the victory, more than three hundred thousand residents remained displaced, living in rubble or refugee camps, with many waiting for reimbursement from the government.¹³

While strategists and leaders have mentioned much about megacities, the impact of fighting in a megacity as opposed to a smaller urban area is still subject to debate. A megacity is characterized by the United Nations as a city with over ten million people.¹⁴ However, wealth and population density are significant variables; Tokyo or New York look and behave significantly different than Karachi or Mumbai, all of which are characterized as megacities. The variables of wealth, technology, and culture influence the operational and cultural aspects of military operations. As of June 2020, there were thirty-five megacities, accounting for 8.4 percent of the earth's population.¹⁵ Proponents argue that the explosive population growth, poverty, and potential for social unrest make megacities more volatile.¹⁶ Meanwhile, critics state that megacities are just larger urban areas and are "likely to differ only in scale and density."¹⁷ Regardless, both camps agree that continued adaptation for urban operations is necessary. While multi-domain operations (MDO) may lead to enhanced U.S. capabilities, the rapidly evolving technological capabilities of near peers will ensure that the enemy still gets a vote.

Multi-Domain Environment Impacts on Medical Care

First described in doctrine in 2018, MDO is "how Army forces fight across all domains, the electromagnetic spectrum, and the information environment and at echelon."¹⁸ The concept focuses on the synchronization of air, land, sea, cyber, and space power to defeat near-peer revisionist powers such as Russia and China.



Sgt. Marshall Medley, a crew chief attached to Company C, 3rd General Support Aviation Battalion, 25th Combat Aviation Brigade, looks down to the outskirts of Tokyo from an HH-60M Blackhawk helicopter 15 September 2017 while flying back to Camp Fuji, Japan, following medical evacuation training as part of exercise Orient Shield 2017. Urban battlespaces create difficult challenges for medical care. (Photo by Mass Communication Spc. 1st Class John Banfield, U.S. Navy)



A key principle of MDO is convergence. Convergence is needed to rapidly integrate all domains, overwhelm the enemy with complex problems, and get inside the enemy's observe, orient, decide, act (OODA) loop. The rapid and continuous integration of cyber, space, air, land, and sea is the key to successful convergence.¹⁹ Once friendly forces are able to create a gap in an enemy's defenses, speed will be needed to bring friendly forces to bear immediately. However, speed and mobility are characteristics foreign to large combat hospitals.

In recent years, U.S. Army Forces Command has reorganized the venerable combat support hospital (CSH) based on lessons from the past two decades, when split operations were a norm. The former CSH included 248 beds, with a forty-four bed early-entry capability (part of A Company) envisioned to be 100 percent mobile. The CSH comprised twenty-four intensive care beds, twenty intermediate care ward beds, and slices of the requisite supporting services such as operating rooms, emergency rooms, ancillary services, and medical supplies (Class VIII).²⁰ This forty-four-bed mobility came at a cost; for example, the 120-bed minimal care detachment had no mobility assets, and the overall

U.S. Marine Corps Lance Cpl. Avery Isabell, a cannoneer with 3rd Battalion, 12th Marine Regiment, 3rd Marine Division, demonstrates the proper procedures for Tactical Combat Casualty Care (TCCC) 26 August 2020 at Camp Hansen, Okinawa, Japan. TCCC aims to reduce combat deaths while allowing a unit to complete its mission and provide the best possible care for casualties on the battlefield. (Photo by Lance Cpl. Jackson Dukes, U.S. Marine Corps)

hospital was approximately 20 percent mobile, relying on external lift assets for mobility. CSHs would often be split within the theater, which was a viable option, as casualties never quite reached the threshold to occupy all 248 beds in a single location.

Based on the counterinsurgency fight at the time and past practices, doctrine was modified. Colonel-commanded CSHs were converted to 148-bed, lieutenant-colonel-commanded field hospitals (FH). The headquarters portion was divorced into a small hospital center (HC), designed to provide command and control to two field hospitals. In the original concept, half of the Army's ten CSHs were due to split into an HC and an FH, while the other five were envisioned to split into strictly FHs. That would leave the active-duty component

with five HCs to provide command and control to ten field hospitals, two FHs per HC. However, many of the ten CSHs were split into both HCs and FHs, in essence adding an additional layer of leadership. Regardless, no significant change in mobility was introduced. While the thirty-two bed initial entry section can be 100 percent

can make the movement of a hospital and its patients significantly more complex.

Battle with a near-peer adversary that possesses antiaccess/area-denial capabilities can have catastrophic effects on medical processes, especially MEDEVAC. In recent conflicts, from Desert Storm, Bosnia, and Kosovo



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mobile (similar to the old forty-four bed slice), the entire 240-bed hospital center (two thirty-two bed FHs, a twenty-four-bed surgical ward, a thirty-two-bed medical ward, and two sixty-bed intermediate care wards) with two field hospitals requires over one hundred trucks to transport forty-six C-17 lifts.²¹ Milley stated that with sensors everywhere, mobility will be the key to survival.²² This leaves the Role 3 (the first hospital in the evacuation chain with inpatient services) medical capabilities ill-prepared for a fluid conflict, let alone initial entry operations.

Cyber and space capabilities can also have a significant impact on medical operations. Electronic health records transmit critical patient information on limited bandwidth. Any interruption in connectivity can deny critical information to medical providers further down the evacuation chain. Without that information, clinical staff will be missing data on everything from a patient's allergies and blood type to the amount of narcotics a patient received or the surgical procedure that was completed. That communication link is essential for managing intratheater and intertheater medical evacuation (MEDEVAC) as well. Loss of the Joint Capability Release (formerly Blue Force Tracker) system by electromagnetic pulse or active jamming systems may blind Role 2 and 3 facilities (see table, page 49) to casualty surges. Similarly, space enables medical operations to include evacuation of the wounded through GPS location. In March 2003, during the early days of the Iraq conflict, the 507th Maintenance Company got lost when its GPS malfunctioned.²³ A resulting wrong turn funneled the company into the urban maze of Nasiriyah, Iraq, where eleven were killed and several others wounded or captured. Loss of GPS capabilities

to the conflicts in Afghanistan and Iraq, air superiority has been a given. However, Russia and China possess a plethora of antiaccess/area-denial capabilities. There is much debate on whether the term "antiaccess" is setting the precedent of a *fait accompli* unnecessarily.²⁴ Regardless, contested airspace will have profound effects on evacuating casualties to advanced definitive surgical care in an urban environment within the Golden Hour. In a MDO battlespace complicated by urban terrain against a near-peer adversary, air superiority will be lost or contested at best. MEDEVAC aircraft will need to navigate between hundred-foot skyscrapers with a multitude of internal and external platforms that present a threat of attack with portable surface-to-air missiles or rocket-propelled grenades. It is fair to assume that there will be none to very limited aeromedical evacuation forward of Role 2, and perhaps to Role 3.

With MEDEVAC aircraft limited in utility, the next best option is to move casualties by ground. The restrictive urban terrain of bottlenecks and artificial canyons makes casualty evacuation with unarmored ground ambulances little more than potential cannon fodder, especially given the lack of top cover on many field litter ambulances. The possibility of subterranean explosions that collapse roads and the potential follow-on extrication from vehicles, coupled with gray-zone tactics of state-sponsored agitators leading riots to block roads, will significantly affect medical evacuation timelines and alter route selection daily.

The sea lines of communication will be constrained in MDO as well. Forty percent of the world live within sixty miles of the ocean, with megacities such as New

York, Los Angeles, and Tokyo on the coast.²⁵ The Navy will need the ability to put troops ashore (and withdraw casualties) in a contested littoral operating area. Establishing port operations in urban areas is a competency that has waned in the past decades. Ever since Korea, the United States has come ashore in friendly nations or with the help of host-nation allies, depending on existing infrastructure.²⁶ Further, lack of interoperability poses risks, with U.S. Army pilots not trained to land on hospital ships. Finally, the new LX(R) class of amphibious warfare ships has half the medical hold capacity of previous San Antonio class ships, reducing hold capacity to eight beds and one operating room.²⁷ All these ships afloat will be large targets for enemy hypersonic weapons, which can cover over a mile per second.

Broad Solutions

While there is a plethora of information regarding urban operations, medical considerations and efforts to save lives are often afterthoughts. In a recent 216-page RAND study commissioned to help the U.S. Army reexamine the urban battlespace of the future, the term “medic” was mentioned only a half dozen times in text and in stories related by interviewees.²⁸

There are potential solutions to address the aforementioned shortfalls, both in the high-tech and “low-tech, return to basics” categories. Medical personnel must return to brilliance in the basics in a contested environment to counter cyber and space threats. The ability to move using a pace count and azimuth will become critical if GPS is lost or if manual evacuation routes need to move underground. Medical staff should be prepared to chart with a pen and paper if information technology infrastructure becomes degraded. More high-tech solutions may include hourly burst transmissions to avoid triangulation of radio signals that could reveal the location of a hospital.

While communications may be tenuous, potential exists to leverage low bandwidth asynchronous telehealth to minimize the need to transport patients. Asynchronous telehealth showed a 65 percent decrease in the need to evacuate forward troops during Operation Inherent Resolve.²⁹ Well-established asynchronous platforms include the Pacific Asynchronous TeleHealth and the Health Experts onLine Portal. These tools use little bandwidth to access a secure website in a post-and-check-back fashion, allowing medical personnel to consult with

military experts worldwide, reducing the need to put limited MEDEVAC crews and patients at risk.

Use of active protective systems was an important lesson the Israelis learned during their war with Gaza from 2009 to 2014.³⁰ While reactive armor has been common on tanks in the past, the importance of ensuring functioning “Iron Curtain” protection on soft-sided HMMWV ambulances running the concrete and steel gauntlet of a city will have lifesaving effects against rocket-propelled grenades.³¹ Further, as nascent microwave technology evolves, nonkinetic soft-kill solutions should be developed. As was seen in Mogadishu in 1993, an enemy blocking the intersections with debris can play havoc with pre-identified evacuation and transit routes. Engineer assets will be necessary to ensure route clearance but may be in high demand working to maintain existing infrastructure. Units should consider evacuating casualties in subsurface tunnels using a John Deere Gator or by subway, if available. Gators were used as early as March 2003 to transport up to three litter patients over brief distances.³²

Another lesson Israel learned was the need to reexamine its tunnel competencies.³³ In its latest conflict, Israel uncovered twenty-three tunnels with sixty-six access points.³⁴ With a well-established and extensive tunnel network throughout North Korea, the Army is already working on this competency.³⁵ These lessons also can be applied to the subterranean tunnel systems of large cities. Soldiers will need to brush up on skill sets such as azimuth and pace count to keep track of their location deep underground. Further, communications will be tenuous underground, with line-of-sight essential (above ground will similarly be degraded). The subsurface manmade tunnels of urban warfare (whether drainage, subway, or electrical conduit) will present complexities for medical planners and clinical personnel.

Implications for Roles of Care

Point-of-injury care will face significant challenges in a three-dimensional environment with a fluid forward line of troops. The aforementioned challenges for aeromedical evacuation forward of Role 2 is unlikely to change. (Roles of care are described in the table, page 49.) Besides man-portable surface-to-air missiles such as the SA-7, the close proximity of the enemy and its ability to blend into the surroundings and occupy elevated positions will increase the threat of small-arms fire to even

Table. Roles of Care

| Role of care | Characteristics |
|---------------|--|
| Role 1 | Unit-level medical care/battalion aid station <ul style="list-style-type: none"> • Focus on returning patients to duty or stabilizing them for evacuation (no medical hold) • Immediate lifesaving measures • Disease and nonbattle injury prevention • Combat and operational stress preventive measures • Patient location and acquisition (collection) • Medical evacuation from supported units • Treatment provided by designated combat medics or treatment squads |
| Role 2 | Treatment platoon in brigade or area support medical company <ul style="list-style-type: none"> • Increased capability to resuscitate trauma patients, 72-hour medical hold • Medical evacuation (MEDEVAC) from Role 1 medical treatment facilities (MTFs) • Damage control surgery (when augmented with a forward resuscitative surgical team) • Limited x-ray, clinical laboratory, and optometry services • Operational dental support • Physical therapy, blood support, and operational public health • Combat operational stress control |
| Role 3 | Field hospital <ul style="list-style-type: none"> • MTF staffed and equipped to provide care to all categories of patients as close to the supported units as the tactical situation allows • Trauma resuscitation • Damage control or initial wound surgery • Postoperative treatment and medical hold • Medical regulation/coordination of intra and intertheater MEDEVAC |
| Role 4 | Hospitals in the continental United States or robust overseas MTFs in safe havens <ul style="list-style-type: none"> • Represents the most definitive medical care available in the Army Health System |

(Table by authors; data from Field Manual 4-02, *Army Health System*, November 2020)

high-flying helicopters. The proximity and three-dimensional terrain will also be a problem on the ground. Forward of Role 1, battalion evacuation teams will have to move within close proximity of those in contact

to evacuate wounded personnel.³⁶ Unarmored evacuation platforms will expose medical personnel and casualties to small-arms fire from both the ground and elevated positions. This exposure will have the potential to create more casualties among the evacuation teams.

To those ends, the U.S. Army Institute of Surgical Research is working on the next generation of automated evacuation solutions. These include drone pods and robots that would be capable of lifting casualties and evacuating them from the battlefield.³⁷ The 2012 NATO Task Group HFM-184 study seeks to set safe ride standards for unmanned system casualty evacuation platforms, which is the first step in working toward an unmanned evacuation vehicle.³⁸ Further, artificial intelligence systems have demonstrated the ability to monitor and intervene in order to stabilize blood pressures in certain instances, and the Army is evaluating them for future use.³⁹ However, trauma management is far more complex with a multitude of variables at play, and full automation may be years away. This may dictate that the time-consuming evacuation route become the standard.

If so, additional training on nonlethal means should become standard practice for medical personnel, who operate by the principle, “first, do no harm.” When transiting evacuation routes, crowds of protestors or rioters may need to be dispersed. Consideration should be given to fielding of long-range acoustic devices. Deployed and used already in multi-

ple locations for antipiracy, and more recently, to disperse Portland protestors in June 2020, the long-range acoustic device emits a loud piercing sound designed to nauseate and encourage personnel to flee the emitted sonic cone.⁴⁰

There are alternatives to surface street evacuation. Following the MDO maxim, “What can be seen can be killed,” consideration should be given to establishing subsurface evacuation routes. These may include large sewer systems and dry aqueduct tunnels as well as subsurface electrical and information technology conduits.

the city and would likely subject the BAS to direct and indirect fires. Utilizing existing buildings would provide both cover and concealment. Access to evacuation routes to both Role 2 facilities and the company casualty collection points will be vital. This may be an opportunity to return to “tailgate medicine,” dropping the tailgate on a

“Battalion evacuation teams need an evacuation platform that provides protection from small-arms fire, and they must plan and rehearse the best routes from the battalion aid station to the company casualty collection points.”

If subways are operational, serious consideration should be given to utilize subway cars as casualty evacuation platforms. Control and electronic monitoring of all these potential corridors would need to be considered.

The immediate solution to address this threat is that all combatants must be well versed in the use of their individual first aid kits to give casualties a chance to survive potentially prolonged evacuation timelines. The training of combat medics and corpsmen must ensure they are capable of applying tactical combat casualty care and, when necessary, prolonged field care to sustain life forward of Role 1. Battalion evacuation teams need an evacuation platform that provides protection from small-arms fire, and they must plan and rehearse the best routes from the battalion aid station to the company casualty collection points. Lessons learned from the Joint Readiness Training Center show that battalions have difficulty planning how they will provide security for casualty movement.⁴¹ This oversight leads to long delays in casualty evacuation that are detrimental to casualty survival. This problem manifests between all roles of care but is most prevalent between the point of injury and Role 1.⁴² Since force protection requirements are very dependent on mission, enemy, time, terrain, troops available, and civilian considerations, how units will secure casualty movements, especially on short notice, must be planned in detail and rehearsed as a battle drill at the squad level prior to any operation.

Role 1. The increasing size of urban areas has implications for the Role 1 battalion aid station (BAS) as well. The requirement to maintain proximity to the forward line of troops would preclude staging the BAS outside

HMMWV and beginning to provide care without fully setting up. The inability to summon aeromedical evacuation to Role 1 care locations will require a reliance on ground evacuation to move casualties to Role 2 facilities. This decreased ability to evacuate casualties in a timely manner will require the ability to triage effectively, stabilize injuries, and then hold casualties at Role 1 until they can evacuate. Prolonged field care must be embraced, resourced, and trained at all roles of care. This is especially important at Role 1 because currently there is no doctrinal holding capability forward of Role 2. The ability to provide prolonged field care is a skill set that must be built from scratch, and leaders cannot assume that units will be able to surge this capability upon demand.

Role 1 is also where the first medical documentation occurs, excluding the Department of Defense Form 1380, *Tactical Combat Casualty Care (TCCC) Card*. Military medicine is currently tied to MC4 laptop computers as an enterprise solution. This an antiquated system that has not evolved in the last two decades and could be held at risk against a near-peer advisory such as China or Russia. Again, the U.S. Army Institute of Surgical Research is working on a viable solution, currently testing a persistent but temporary tattoo as a substitute.⁴³ Scanning the tattoo QR code would allow medical personnel to document and upload to a secure website and prevent loss of information when evacuating. The program was awarded \$1 million for development and testing in fiscal year 2020.⁴⁴

Role 2. The key component to survival of severely wounded combat casualties is time to reach surgical care. This makes location of forward surgical capability



essential to the planning of operations in large urban areas. Ideal locations would be buildings with ready access to power and water, which are traditional critical requirements for surgical support. The most forward surgical capability will be at the brigade support medical company provided it is augmented with a forward resuscitative surgical team (FRST). The Army should consider making damage control surgery capability organic to the brigade support medical company or as medical company-area support, which would align U.S. military doctrine with the Role 2 Light Manoeuvre in NATO doctrine.⁴⁵ Another consideration is that twenty-person FRSTs are incapable of providing security and performing life-saving surgery simultaneously. If the United States were to enter into a World War II scenario, the holding capability organic to Role 2 will become critical to both facilitate return to duty of disease nonbattlefield injuries and lightly wounded service members as well as hold critically wounded service members pending evacuation to Role 3.

Role 3. Role 3 medical treatment facilities are much larger and require more space to set up, making site selection critical and difficult. They should be positioned outside the urban area and/or at a securable location

A patient gets transferred to an operating room for an emergency assessment and evaluation 13 March 2019 during a mass casualty exercise as part of Operation Forlorn Reaper at Rodriguez Live Fire Complex in Korea. The 121st Combat Support Hospital established a thirty-two-bed field hospital to support the exercise and validate its expeditionary capabilities. The combat support hospital was later converted into two field hospitals. (Photo courtesy of the U.S. Army)

in close proximity to a landing strip capable of accommodating strategic MEDEVAC aircraft to facilitate evacuation out of theater. Consideration should be given to large convention centers, if they can be secured. As COVID lessons have showed us, this is a viable venue for makeshift hospitals and provides ready access to power and water. At the other end of the spectrum, over the years, medical professionals have found ways to innovate and adapt. The Malinta Tunnel on the island of Corregidor in the Philippines housed a one thousand-bed hospital during World War II.⁴⁶

The biggest problem confronting Role 3 facilities will be the ability to arrive in a theater in time to be relevant. Role 3 medical facilities are usually last on the

time-phased force and deployment data and draw from prepositioned stock when they arrive to theater. As stated earlier, the lack of inter- and intratheater mobility in the current field hospital design jeopardizes their relevance early in a conflict. In the future, the Army needs to find ways to make the “early entry” portion of the field hospitals smaller and more mobile. This could start with reintroducing the medium and large general purpose tents, which are easy to set up as well as easy to break down and move, and they require no power. Trading 3:1 and 2:1 isolation shelters for general purpose mediums would be one way to decrease weight and cube without sacrificing capability. While lack of sterility is an unsettling concern for operative procedures, the experience of FRSTs and austere surgical teams operating in warehouses and open desert air areas over the past two decades shows there are ways to mitigate that risk. That sterility factor needs to balance with survivability, the ability to remain mobile and relevant.

Increased mobility is also necessary if there are casualties present in a hospital. If hospitals have to move with the front of large-scale combat operations, as they did in World War II, they have to be prepared to move with casualties. Not since North Africa and Italy have hospitals had to deal with the logistical challenges of moving a hospital while simultaneously caring for and transporting dozens of casualties in the back of light medium tactical vehicles.

Urban areas near the coast may require a joint solution of a hospital ship or amphibious assault ship off the

coast until an Army field hospital can be established in the area of operations. Army aeromedical evacuation pilots should be required to train to land on Navy ships now; this certification is too imperative to be delayed until a conflict breaks out.

Lastly, U.S. forces should not occupy or take host-nation hospitals to establish their Role 3 medical treatment facilities. Combat operations in an urban area will result in an increased need for medical care to civilians. Civilian medical capability must be maintained to prevent civilians from overwhelming the military facilities and avoid placing commanders in the position of having to turn away civilians with no alternative to receive care. Doing so will have two primary detrimental and long-lasting effects. First, it could create an overreliance on U.S. medical capabilities. Second, turning away civilian casualties when there are no host-nation facilities available to care for them will certainly have a detrimental impact on opinion of U.S. forces and could stoke the flames of insurgency.

Conclusion

Urban environments present complex challenges for medical operations. An overreliance on modern technology will exacerbate any threats associated with medical evacuation and treatment in future MDO battlespaces against a near-peer adversary. In order to avoid those snares, the medical community needs to be cognizant of gaps in security and develop applicable skills and concepts to mitigate the potential pitfalls. Failure to do so will have catastrophic consequences. ■

Notes

1. Matthew Cox, “Chief: Army Will Need Smaller Units for Megacity Combat,” *Military News*, 21 March 2017, accessed 6 May 2021, <https://www.military.com/daily-news/2017/03/21/chief-army-will-need-smaller-units-for-megacity-combat.html>; “Joint Chiefs of Staff Chair Confirmation Hearing,” C-SPAN, 11 July 2019, accessed 6 May 2021, <https://www.c-span.org/video/?462250-1/joint-chiefs-staff-chair-nominee-general-mark-milley-testifies-confirmation-hearing>.

2. United Nations, Department of Economic and Social Affairs, Population Division, *World Urbanization Prospects: The 2018 Revision*, ST/ESA/SER.A/420 (New York: United Nations, 2019), xix, accessed 6 May 2021, <https://population.un.org/wup/Publications/Files/WUP2018-Report.pdf>.

3. Ibid.

4. Ibid.

5. Ibid., xviii.

6. United Nations, Department of Economic and Social Affairs, Population Division, *World Population Prospects: The 2017 Revision*,

Key Findings and Advance Tables, ESA/P/WP/248 (New York: United Nations, 2017), 17, accessed 6 May 2021, https://population.un.org/wup/Publications/Files/WPP2017_KeyFindings.pdf.

7. Kristen M. Lord, “The Pentagon’s Next Terrorism Threat (and Solution): Kids,” *Defense One*, 13 December 2017, accessed 6 May 2021, <https://www.defenseone.com/ideas/2017/12/pentagons-next-terrorism-threat-and-solution-kids/144513/?oref=d-river>.

8. Associated Press, “Legendary CBS Anchor Walter Cronkite Dies at 92,” *MPR News*, 18 July 2009, accessed 6 May 2021, <https://www.mprnews.org/story/2009/07/17/legendary-cbs-anchor-walter-cronkite-dies-at-92>.

9. Eric Larson and Bogdan Savych, *American Public Support for U.S. Military Operations from Mogadishu to Baghdad* (Santa Monica, CA: RAND Corporation, 2005), accessed 6 May 2021, <https://www.rand.org/pubs/monographs/MG231.html>.

10. Joint Publication 3-06, *Joint Urban Operations* (Washington, DC: U.S. Government Publishing Office [GPO], 20 November 2013),

IL-10, accessed 12 May 2021, https://www.jcs.mil/Portals/36/Documents/Doctrine/pubs/jp3_06.pdf.

11. Martin Chulov, Fazel Hawramy, and Spencer Ackerman, "Iraq Army Capitulates to ISIS Militants in Four Cities," *The Guardian* (website), 11 June 2014, accessed 6 May 2021, <https://www.theguardian.com/world/2014/jun/11/mosul-isis-gunmen-middle-east-states>.

12. Margaret Coker, "After Fall of ISIS, Iraq's Second-Largest City Picks up the Pieces," *New York Times* (website), 10 December 2017, accessed 6 May 2021, <https://www.nytimes.com/2017/12/10/world/middleeast/iraq-isis-mosul.html>.

13. "In Pictures: Mosul Two Years after ISIL's Defeat," Al Jazeera, 10 July 2019, accessed 6 May 2021, <https://www.aljazeera.com/indepth/pictures/pictures-mosul-years-isis-defeat-190710082834633.html>.

14. United Nations, *World Urbanization Prospects*, 77.

15. "Demographia World Urban Areas: 16th Annual Edition," Demographia, 25 June 2020, 8–9, accessed 6 May 2021, <http://demographia.com/db-worldua.pdf>.

16. Kevin Felix and Fredrick Wong, "The Case for Megacities," *Parameters* 45, no. 1 (Spring 2015): 22–23, accessed 6 May 2021, <https://press.armywarcollege.edu/cgi/viewcontent.cgi?article=2798&context=parameters>.

17. Michael Evans, "The Case against Megacities," *Parameters* 45, no. 1 (Spring 2015): 38, accessed 6 May 2021, <https://press.armywarcollege.edu/cgi/viewcontent.cgi?article=2800&context=parameters>.

18. U.S. Army Training and Doctrine Command (TRADOC) Pamphlet 525-3-1, *The U.S. Army in Multi-Domain Operations 2028* (Fort Monroe, VA: TRADOC, 2018), 5, accessed 6 May 2021, <https://admnpubs.tradoc.army.mil/pamphlets/TP525-3-1.pdf>.

19. Ibid, vii.

20. Army Techniques Publication 4-02.5, *Casualty Care* (Washington, DC: U.S. GPO, May 2013), 3-11, accessed 6 May 2021, https://armypubs.army.mil/epubs/DR_pubs/DR_a/pdf/web/atp4_02x5.pdf.

21. *Army Health System Doctrine Smart Book* (Washington, DC: U.S. Army Medical Center of Excellence, 16 March 2021), 8, accessed 20 May 2021, <https://www.milsuite.mil/book/docs/DOC-609342>.

22. C. Todd Lopez, "Milley: Army on Cusp of Profound, Fundamental Change," *Army.mil*, 7 October 2016, accessed 6 May 2021, https://www.army.mil/article/176231/milley_army_on_cusp_of_profound_fundamental_change.

23. Diana Washington Valdez, "Battle Heroes of Fort Bliss Maintenance Company Remembered," *Stars and Stripes* (website), 23 March 2013, accessed 6 May 2021, <https://www.stripes.com/news/army/battle-heroes-of-fort-bliss-maintenance-company-remembered-1.213200>.

24. Luis Simon, "Demystifying the A2/AD Buzz," *War on the Rocks*, 4 January 2017, accessed 6 May 2021, <https://warontherocks.com/2017/01/demystifying-the-a2ad-buzz/>.

25. United Nations, *Factsheet: People and Oceans* (The Ocean Conference, United Nations, New York, 5–9 June 2017), accessed 6 May 2021, <https://www.un.org/sustainabledevelopment/wp-content/uploads/2017/05/Ocean-fact-sheet-package.pdf>.

26. Brian Molloy, "Frustrated Cargo: The U.S. Army's Limitations from Projecting Ship to Shore in an A2/AD Environment," *Joint Force Quarterly* 96 (1st Quarter, January 2020): 91–92, accessed 13 May 2021, <https://ndupress.ndu.edu/Media/News/News-Article-View/Article/2076632/frustrated-cargo-the-us-armys-limitations-in-projecting-force-from-ship-to-shor/>.

27. Sam LaGrone, "What the Navy's Next Generation Amphibious Ship Could Look Like," *USNI News*, 21 November 2014, accessed 6 May 2021, <https://news.usni.org/2014/11/21/navys-next-generation-amphibious-ship-look-like>.

28. Gian Gentile et al., *Reimagining the Character of Urban Operations for the U.S. Army* (Santa Monica, CA: RAND Corporation, 2017), accessed 6 May 2021, https://www.rand.org/pubs/research_reports/RR1602.html.

29. Charles Nguyen, Jennifer Mbutia, and Craig P. Dobson, "Reduction in Medical Evacuations from Iraq and Syria Following Introduction of an Asynchronous Telehealth System," *Military Medicine* 185, no. 9-10 (September/October 2020): e1693–99, <https://doi.org/10.1093/milmed/usaa091>.

30. Raphael Cohen et al., *Lessons from Israel's Wars in Gaza*, (Santa Monica, CA: RAND Corporation, 2017), 9, accessed 6 May 2021, https://www.rand.org/pubs/research_briefs/RB9975.html.

31. Kyle Mizokami, "The Army Is Testing a Missile-Proof 'Iron Curtain,'" *Popular Mechanics* (website), 14 May 2018, accessed 10 May 2021, <https://www.popularmechanics.com/military/weapons/a20685338/the-army-is-testing-a-missile-proof-iron-curtain/>.

32. Brad Tibbetts, in discussion with author Michael Wissemann, 2020.

33. Cohen et al., *Lessons from Israel's Wars in Gaza*, 11.

34. "Getting from Gaza to Israel, by Underground Tunnels," *New York Times* (website), 22 July 2014, accessed 6 May 2021, <https://www.nytimes.com/2014/07/23/world/middleeast/gaza-israel-hamas-tunnels.html>.

35. Tom Bowman, "As North Korea Tensions Rise, U.S. Army Trains Soldiers to Fight in Tunnels," NPR, 9 January 2018, accessed 6 May 2021, <https://www.npr.org/2018/01/09/576542410/as-north-korea-tensions-rise-u-s-army-trains-soldiers-to-fight-in-tunnels>.

36. Williams Skiles, "Urban Combat Casualty Evacuation," *Marine Corps Gazette* 92, no. 1 (January 2008): 46–50.

37. Jose Salinas, "The Need for Automation Technology in the Next Battlefield: The Medical Assistive Support Technologies Program (MAST)" (PowerPoint presentation, Department of Defense Joint Trauma Conference, Fort Sam Houston, TX, 6 August 2020).

38. NATO Science and Technology Organization, *Safe Ride Standards for Casualty Evacuation Using Unmanned Aerial Vehicles*, AC/323(HFM-184)TP/475 (Brussels: NATO Science and Technology Organization, December 2012), accessed 6 May 2021, <https://www.sto.nato.int/publications/STO%20Technical%20Reports/RTO-TR-HFM-184/SSTR-HFM-184-ALL.pdf>.

39. Salinas, "The Need for Automation Technology in the Next Battlefield."

40. William Bruton, "Standoff," *Dockwalk*, February 2017, 52, accessed 6 May 2021, <http://viewer.zmags.com/publication/bc289e2b/bc289e2b/55>; GlobalData Thematic Research, "Directed Energy Weapons: Defense and Technology Trends," *Army Technology*, 3 August 2020, accessed 6 May 2021, <https://www.army-technology.com/comment/directed-energy-weapons-trends/>.

41. Tibbetts, discussion.

42. Ibid.

43. Salinas, "The Need for Automation Technology in the Next Battlefield."

44. Ibid.

45. Allied Joint Publication 4.10(A), *Allied Joint Medical Support Doctrine* (Brussels: NATO, 30 May 2006), 1-10, accessed 6 May 2021, [https://shape.nato.int/resources/site6362/medica-secure/publications/ajp-4.10\(a\).pdf](https://shape.nato.int/resources/site6362/medica-secure/publications/ajp-4.10(a).pdf).

46. Wikipedia, s.v. "Malinta Tunnel," last modified 11 March 2021, 23:32, accessed 6 May 2021, https://en.wikipedia.org/wiki/Malinta_Tunnel.