

War is the Enemy of Health

Pulmonary, Critical Care, and Sleep Medicine in War-Torn Syria

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Abstract

The Syrian crisis, now in its fifth year, has created an unprecedented strain on health services and systems due to the protracted nature of the warfare, the targeting of medics and health care infrastructure, the exodus of physicians and nurses, the shortage of medical supplies and medications, and the disruption of medical education and training. Within a few short years, the life expectancy of resident Syrians has declined by 20 years. Over the first 4 years of the conflict, more than 75,000 civilians died from injuries incurred in the violence. More than twice as many civilians, including many women and children, have died prematurely of infectious and noninfectious chronic diseases for want of adequate health care. Doctors, local administrators, and nongovernmental organizations are struggling to manage the consequences of the conflict under substandard conditions, often using unorthodox

methods of health care delivery in field hospitals and remotely by telehealth communication. Much-needed medical supplies are channeled through dangerous routes across the borders from Lebanon, Jordan, and Turkey. Physicians in the United States and other western nations have helped Syrian physicians make the most of the situation by providing training on introducing innovations in technology and treatment. Portable ultrasound machines have been introduced and are being used extensively in the management of trauma and shock. This report, prepared by members of the Syrian American Medical Society, documents current needs for health care relief within Syria, focusing on pulmonary, critical care, and sleep medicine, and some of the efforts currently underway to meet those needs.

Keywords: disasters; crisis; chemical weapons; attacks on healthcare; Syrian crisis

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In the midst of war zones, civilian doctors, nurses, and health care administrators face major challenges that are not encountered in time of peace, including massive, often near-simultaneous influx of trauma victims; severe shortages of medical supplies and human resources; epidemics of infectious diseases; chemical weapon attacks; doctors and patients living under siege; and breaches of medical neutrality. Health care in the war-torn nation of Syria exemplifies these

challenges and illustrates contemporary approaches to overcoming some of the most pressing obstacles encountered by clinicians who endeavor to meet the medical needs of injured or sick civilians in active war zones.

The Syrian conflict started in March 2011 after peaceful demonstrations were transformed into a full civil uprising after brutal governmental responses. Officers and soldiers defected from the Syrian Armed Forces to form militarized

opposition groups known collectively as the Free Syrian Army. Islamic jihadist extremist groups exploited the resulting instability and assembled to form the Islamic State of Iraq and Syria (ISIS, also known as known as the Islamic State of Iraq and the Levant [ISIL] or Daesh). ISIS commenced ground attacks on both government forces and rebel factions and took control of large segments of northeastern Syria.



Figure 1. Dr. Abdel Aziz inspecting the aftermath of hospital that was damaged by bombing in Aleppo, Syria.

Before the onset of fighting, Syria's health care system was comparable with that of other middle-income countries. By 2015, the health care infrastructure was greatly diminished in all sectors of the country by destruction of hospitals and clinics, reductions in the numbers of health care providers, shortages of supplies, and pervasive fear.

This report has been prepared by several members of the Syrian American Medical Society (SAMS). We present available information on the status of health care in Syria with special attention to pulmonary, critical care, and sleep medicine, and we outline some of the

nongovernmental relief efforts currently underway to support health care delivery within the war-torn country.

The Humanitarian Impact of the Syrian Conflict

Displacement and Excess Mortality

Although global attention is focused on the 4.2 million refugees who have fled the country, roughly 7.6 million others are internally displaced inside Syria. Fully 80% of Syrians now live in poverty, and more than 12 million are dependent on humanitarian assistance (2).

In the period from March 18, 2011 to January 21, 2015 alone, there were 78,769 civilian violent deaths (1). Of these deaths, 77,646 were in areas controlled by non-state-armed groups (NSAGs) and 1,123 in government-controlled areas. Although the majority of those killed were men, nearly 25% of the Syrian civilians killed were women and children (1).

The war has reduced life expectancy by 20 years—from 75.9 years in 2010 to 55.7 years through the end of 2014 (2)—and led to massive economic losses estimated at more than \$200 billion (2).

Public Health

Since 2012, the conflict has become the leading cause of death in Syria (1). The deliberate destruction of the health infrastructure has led to a severe public health crisis (3). Vital services, including water, phone lines, sewage treatment, and garbage collection, were deliberately cut by the government and other armed groups to areas under siege. Health systems have been separated into areas controlled by the government and various, constantly shifting NSAGs. These areas differ vastly in terms of capacity for service delivery, the number of trained staff, and access to essential medicines (1).

As a result of military blockades and government bureaucratic barriers over “cross-line” humanitarian and medical assistance, millions of Syrians are dependent on medical supplies and medications carried across the borders from Jordan, Lebanon, and Turkey. More than 500,000 Syrians in Ghouta and Homs Deir Alzour endure a complete siege by the Syrian military. In Deir Ezzor at least 200,000 people are besieged by ISIS (4).

Chemical Weapon Attacks

From December 2012 through late 2015, there have been a total of 152 documented attacks using toxic gases, including 8 using sarin, 92 with chlorine gas, 3 with mustard gas or a mustard-like agent, and 40 with other toxic agents (unpublished report by the SAMS). A total of 969 deaths reported in NSAG-controlled areas were caused by chemical weapons, compared with no deaths in government-controlled areas (1).

Sarin paralyzes the respiratory muscles, leading to death by suffocation. Chlorine reacts with water on the mucosal surfaces, producing hypochlorous and hydrochloric



Figure 2. Due to the shortage of electricity, surgeons working in Syria sometimes operate using flashlights or cell-phone lights instead of overhead surgical lights.

acid as it is inhaled, drowning victims in the dissolution of their own lungs. Mustard gas is directly toxic to the respiratory system. Unlike sarin and chlorine, the delayed toxicity of sulfur mustard gas peaks decades later in the form of chronic lung disease, late-onset blindness, and delayed death. Mustard gas is a known carcinogen, and the excess deaths due to lung cancer after prolonged exposure during World War I are well documented (23).

Availability of Health Care Professionals and Facilities

Since March 2011, Physicians for Human Rights has recorded 323 attacks on 225 medical facilities (Figure 1) and the deaths of 679 medical personnel. Government forces were responsible for more than 90% of those attacks, each of which constitutes a war crime. The attacks increased in frequency and intensity as the crisis continued. From March through August 2015, Physicians for Human Rights documented 74 attacks on medical facilities, the highest number in any 6-month period of the conflict (8).

In July 2012, the Syrian authorities declared it a criminal offense to provide medical care in areas controlled by opposition forces (6), in contravention of the Geneva Conventions. By 2013, 70% of the health workforce had left the country, according to Physicians for Human Rights. The number of physicians engaged in direct health care has dwindled further

since 2013. For example, before the current conflict, the population of Aleppo was 2.5 million people who were served by 6,000 physicians (6). Now, fewer than 70 doctors remain (7). The east of Aleppo in northwestern Syria is among the areas hit hardest by barrel bombs; however, as of late 2014, only two vascular surgeons and one plastic surgeon were available to care for trauma victims.

In Eastern Ghouta, an area under prolonged siege, up to 90% of medical staff members have left. The resulting lack of surgeons significantly worsens patient outcomes and puts further pressure on the few remaining overstretched health workers (4). The exodus of trained staff has left junior residents and medical students to work beyond their capabilities in increasingly difficult circumstances.

Medications and Electricity

Before the unrest started in March 2011, more than 90% of medicines in Syria were locally produced. The combined effects of economic sanctions, unavailability of hard currency, fuel shortages, and increases in operational costs have adversely affected the production of medicines and pharmaceutical products (2). In affected areas, there is a critical shortage of life-saving medicines, including for noncommunicable diseases. Routinely used items such as insulin, oxygen, nitrogen gas, anesthetic medications, and intravenous fluid are not available.

The loss of electricity is another complicating factor affecting health care delivery. No hospital or clinic can function without electricity. Most hospitals in the war zones of Syria now depend on diesel generators, an expensive commodity in war (5).

When diesel fuel supply lines are cut, even the generators cannot operate. Surgeons must operate under the light of flashlights (Figure 2) and cell-phone lights instead of surgical lights. Nurses use body heat to warm intravenous fluids before transfusing them to patients. Anesthesiologists rely on intravenous sedation for major surgeries and old-style, hand-operated bag valve masks for ventilation.

Impact on Pulmonary, Critical Care, and Sleep Medicine

Tuberculosis and Respiratory Tract Infections

In 2011, the prevalence of tuberculosis (TB) in Syria was 23 per 100,000. The conflict has interrupted drug supplies and treatment for patients, contributing to increased disease transmission, drug resistance, and relapse. The current prevalence of TB inside Syria is unknown; however, there has been a sharp increase in TB cases in neighboring countries. For example, in Lebanon, a 27% increased incidence of TB has been attributed to Syrian refugees (31).

In Jordan, a collaborative effort between the United Nations High Commission for Refugees, the International Organization for Migration, the National TB Program, and the United States Centers for Disease Control has led to development of the Public Health Strategy for TB among Syrian Refugees (32). A screening survey sampling 10% of the refugee population in the first 6 months of 2014 showed a 40% increase in the prevalence of TB. The mass incarcerations during the late 1970s and 1980s accelerated the spread of TB in the prisons during that time. Tens of thousands of people currently imprisoned across the country are kept in conditions that offer a perfect breeding ground for drug-resistant TB. If TB becomes epidemic in Syria, containment will be extremely difficult to address, given the antibiotic shortages, the highly mobile population, the lack of staff and expertise,

and the intransigent nature of the disease itself (33).

Among Syrian refugees in Lebanon and Jordan, approximately 41% of consultations in primary health care are for respiratory tract infections (34). This likely reflects the harsh environmental and living conditions both inside and outside the refugee camps. There are no current data for the prevalence of respiratory infections inside Syria; however, the damaged health care system means that otherwise treatable conditions have become challenging. For example, there was an increase in the number of cases of bronchiolitis in Idleb, Hama, and Aleppo in 2014, with an associated increase in mortality (35). In December 2014 there were unverified but plausible reports of pneumonic plague in a prison camp in Damascus (33).

Chronic Noninfectious Diseases

There are few data about health care outcomes in public or private hospitals before the conflict in Syria due to a number

of factors, including lack of accountability, poor health information systems, and lack of trained staff to use existing information systems. The Syrian American Medical Society estimated that at least 200,000 Syrians have died since the crisis began in 2011 from chronic noninfectious conditions such as cancer, diabetes, hypertension, heart disease, and chronic lung diseases, due to diminishing access to medication and treatment.

This death toll is roughly double the number of civilians directly killed through military operations over the same time period (29). Research suggests that coronary heart disease accounted for more than half of all-cause mortality in Syria before 2011 (26, 27). More epidemiological data for noninfectious and chronic diseases among internally displaced people in Syria and refugees who have fled will be crucial to plan future humanitarian responses and to ensure that health service needs are met (28).

Before the crisis, Syria had the highest proportion of cigarette smokers in the

Arab Middle East, with 62% of men smoking (24) and prevalence of chronic obstructive pulmonary disease of up to 6.1% (25). There are no accurate data about the impact of the crisis on patients with chronic respiratory diseases. It is known, however, that many people who suffer from asthma or chronic obstructive pulmonary disease no longer have access to inhaled medications due to their high cost and the deteriorating economic condition. Those patients who rely on long-term supplemental oxygen have done without because of delivery interruptions or frequent electricity outages.

Few oncologists are left to provide care to patients with lung cancer. Travel to the remaining specialized cancer centers can take days due to unsafe roads and checkpoints, causing patients to miss vital treatments. Some cancer centers, such as Al-Kindi Medical Center in Aleppo, were destroyed early in the conflict (Figure 3). Of note, refugees with cancer have limited access to diagnosis and treatment in host countries, with the exception of Turkey, which provides free health care to roughly 2 million refugees (30).

Adult Critical Care Medicine

There are few data about the practice and outcome of critical care medicine in Syria before the crisis. Most of the critical care units in the country lacked custom design and structure or evidence-based protocols and equipment to assist staff and were without monitoring for quality control. Most critical care units were staffed by underqualified internal medicine physicians or anesthesiologists. Formal training in the fields of adult and pediatric intensive care did not exist. Similarly, nurses worked in intensive care units (ICUs) without any critical care training. One study reported a mortality rate of 51% for patients with severe H1N1 influenza infections admitted to the critical care units in 2009 compared with an Acute Physiology and Chronic Health Evaluation II–predicted mortality rate of 21%, resulting in a standardized mortality ratio of 2.4 (10).

Against this backdrop, the conflict has escalated the demand for critical care services due to the mass casualties and an unprecedented influx of war-related victims of trauma or nontraumatic injuries created by conventional and nonconventional weaponry. For example, according to the Aleppo Medical Council in its report in



Figure 3. The Al-Kindi Medical Center in Aleppo was completely destroyed by the detonation of two truck bombs on December 20, 2013.



Figure 4. Field hospital in the basement of a deserted building in Northern Latakia.

2013, four small hospitals in eastern Aleppo city encountered 78,938 trauma cases, including 23,670 children, necessitating 12,449 major operations, with 779 critically ill patients requiring ICU care and more than 2,000 ventilator days.

Pediatric Critical Care and Neonatology

Pediatric intensive care and neonatology are two of the most challenging fields in Syria today. The toll of this conflict on civilian health is acutely evident in young children and infants, who are the most vulnerable to the effects of war—namely trauma, burns, chemical attacks, and infectious diseases, all of which are compounded by chronic malnutrition and comprehensive vitamin and micronutrient deficiency.

Children dehydrate more quickly, exsanguinate faster, and are more vulnerable to the effects of trauma and chemical agents. An analysis of 12,484 child deaths due to violent means in NSAG areas up to January 2015 revealed that 75% of deaths were caused by airstrikes or shelling, a figure consistent with the targeting of civilian homes and schools by government forces

(1). Barrel bombs, filled with a combination of trinitrotoluene and shrapnel, cause devastating damage to children—tearing off limbs and ripping apart torsos.

Although the critical demand for pediatric intensive care is evident and continues to escalate in parallel with the airstrikes, the complete lack of specialists means doctors from adult medical and surgical specialties are forced to take on this field. They tend to be unfamiliar with the aggressive resuscitation required in children, in particular the higher doses of fluids, inotropes, and other life-saving drugs relative to body mass. The concomitant lack of blood products and intravenous fluids compromise children further.

In Eastern Ghouta, besieged since November 2012 and where necessity is producing all manner of inventions, a local substitute for normal saline was developed for adults in 2014, but inexact osmolality means it is considered too dangerous for children. For those remaining units that have withstood the targeting, the danger posed to doctors and patients has led to the evolution of war standards: the criteria for

admission are extremely high, and for discharge they are extremely low.

The lack of specialists, units, equipment, drugs, and transport is painfully evident, not only in the high mortality rates, the excessive amputations, and scarring in survivors of trauma and burns but also in the fallout of human error. In September 2014, 17 infants died in Idleb when they were mistakenly injected with measles vaccine diluted with atracurium, a muscle relaxant used for major surgical operations, instead of sterile water. Had supportive therapy been available, they might have survived, as older children did who received a relatively smaller dose.

Neonatal skills and training are likewise in demand. In Eastern Ghouta alone about 700 babies are born each month in a population of about 400,000. Labor typically occurs at night—a universal phenomenon, but one that is incompatible with the insecurity and lack of transport for mothers and doctors alike, resulting in a rate of elective C-sections that ranges from 50 to 70%. The tendency toward preterm delivery due to “guesstimating” gestation exacerbates the extant problem of low birth weight and intrauterine growth retardation due to maternal malnutrition: 15% of neonates end up in incubators with immature lungs. During the winter of 2014 the average birth weight was just 1,800 g, with a rate of neonatal mortality up to 30%. Summer means more food and relatively heavier babies (average of 2,500 g), but the barrel bombs pose a year-round risk, slicing limbs and livers, even in utero, sometimes leading to stillbirth.

Sleep Medicine

Before the conflict, Syria resembled other middle-income countries in prevalence rates of obesity, hypertension, and cardiovascular disease. Sleep-disordered breathing was common, although there are no clear studies on its prevalence in Syria. In neighboring Turkey, 5,021 adults (including 2,598 women) screened with the Berlin questionnaire showed 13.7% of the screened population was at high risk for obstructive sleep apnea (36).

Prewar, there were few sleep diagnostic laboratories in Syria, and they were located only in major urban centers. Sleep treatment with continuous positive airway pressure was not well incorporated in



Figure 5. A tele-ICU in Aleppo hospital connected via satellite internet router and camera to volunteer physician consultant in the United States.

clinical practices due to expense, cultural barriers, and interrupted electricity even before the onset of conflict. The pervasive sense of insecurity, both financial and safety,

may lead many patients with chronic conditions to forego elective care. This may be particularly apparent in conditions that require specialized care, such as sleep-

disordered breathing, where access to diagnostic sleep facilities and positive airway pressure treatment is constrained by lack of safety and high cost.

The effect of the current crisis on sleep health may be substantial and long lasting. Sleep is among the first things affected during violent conflicts, especially protracted civil wars that are fought mostly in civilian areas. One study assessed the level of exposure to war-related trauma during the Iraqi occupation and the first Gulf war. The authors found that exposure to war-related events during childhood was associated with post-traumatic stress, poor sleep quality, high body mass index, and poor self-reported health in adulthood. It is possible that the long-term health effects of sleep deficiency for Syrians may unfold for years ahead.

In-Country Adaptations and Transnational Relief Efforts

Health care providers working within Syria have adapted to extraordinary working conditions by using approaches developed previously in other war-torn areas and novel approaches befitting the unique challenges generated by the current crisis. Several international relief organizations are actively engaged in the preservation of health care for resident Syrians and Syrian refugees. The World Health Organization and the United Nations have partnered with several nongovernmental organizations (NGOs) to promote health care for Syrian refugees residing in neighboring countries (37). Several Syrian-led and Syrian diaspora-led NGOs, including the SAMS, work to preserve health care capacity and deliver aid to medical personnel working inside Syria (38, 39). Some of the approaches applied by these groups are outlined below.

Underground Hospital System

Early in the crisis, published reports from Human Rights Watch and other human rights organizations documented the Syrian security forces' arrests, and sometimes torture, of doctors and patients inside public hospitals. Public hospitals were thus deemed unsafe, and a parallel network of underground field hospitals was developed, initially to provide basic trauma care and damage control surgery but later to provide comprehensive medical care (9).

Field hospitals (Figure 4) have been established in basements, farmhouses,



Figure 6. An intraosseous (IO) needle inserted by a Syrian health provider in support of a trauma victim at a medical facility in Aleppo, Syria.

deserted buildings, mosques, churches, factories, and even natural caves. The underground system has provided much-needed surgical and medical care to hundreds of thousands of civilians. It also provides emergency rooms, multispecialty clinics, rehabilitation centers, and even birth centers for the local population deprived from health care access due to destruction of local hospitals and outpatient clinics and unsafe transportation due to the siege and military operations.

Telemedicine

In disaster zones, telecommunication is essential for the provision of emergent yet unavailable services (15, 16). Innovative tools for diagnosis and management are required to deliver patient care in hospitals and underserved clinics in war zones and cities under siege. Telemedicine is one such tool (16). The U.S. Department of Defense

used telemedicine to augment medical support to army units on peacekeeping operations in Macedonia in 1993 (17) and in war zones such as Bosnia (18) and Iraq. Bringing in external expertise through online consultation and the use of remote monitoring in areas of high demand is valid and of proven benefit (19).

Although the concept of telehealth has been widely accepted, cultural and technical obstacles have prevented widespread uptake and success in Syria (20). American diaspora medical organizations introduced electronic-ICU during the crisis. The Syrian American Medical Society now provides remote online coverage to nine major ICUs in besieged or hard-to-access cities in Syria via video cameras, Skype, and satellite Internet connections. The program includes direct supervision of patient care and constant communications between treating staff in Syria and supervising

specialists in the United States (21) (Figure 5). The impact of these programs on short- and long-term outcomes needs to be validated.

Distance Learning

To address the shortage of qualified critical care specialists, Syrian medical diaspora organizations implemented a two-pronged strategy based on training the trainer and using technology to reach hard-to-reach hospitals. Board-certified critical care specialists residing in the United States provide structured courses on war trauma and disaster medicine and adult and pediatric critical care to hundreds of trainees.

Between August 2012 and October 2015, hands-on practical courses using simulators, manikins, airway management kits, and ventilators have been held in Turkey and Jordan. Those courses were attended by 577 trainees of different disciplines working in emergency rooms and ICUs in the remaining public, makeshift, and field hospitals inside Syria. Training sessions include emergent use of intraosseous infusion needles for patients with difficult vascular access (Figure 6), nasotracheal intubation for transport and long-term care of neonatal and pediatric patients, and use of tranexamic acid transfusions in patients with massive bleeding (5). After training in Focused Assessment of Sonography in Trauma, trainees received portable ultrasound devices to use at field hospitals and emergency rooms.

Retrospective analysis using post-training surveys has confirmed that a significant percentage of trainees incorporated the new skills in their management paradigms and daily practices (unpublished data). Despite being a relatively new tool for trauma assessment, Focused Assessment of Sonography in Trauma has become a preferred screening tool in acute trauma management (11–14) due to the ease of learning and nature of portable ultrasound devices—hand-held, highly portably battery-operated devices—especially because almost all field hospitals lack computed tomography scanners. Using a simple algorithm adopted by the course trainers, trainees have learned to use point-of-care ultrasonography to do a quick differential diagnosis and assessment of traumatic

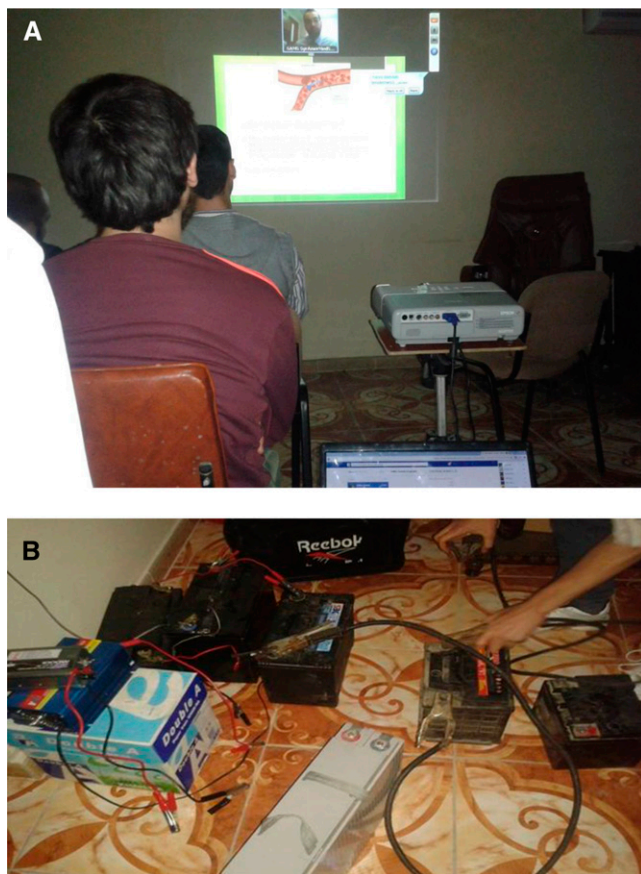


Figure 7. (A) An online webinar lecture delivered to medical students in besieged east Damascus. The lecturer was speaking in Illinois. (B) The internet connection, computer, and peripheral hardware used to project the 90-minute webinar were powered by four car batteries.



Video 1. Portable ultrasound device used to perform a Focused Assessment of Sonography in Trauma examination on a victim of a bombing attack at M-10 Hospital in Aleppo, Syria.

and nontraumatic patients in shock (Video 1).

During the peak of chemical weapon use in Syria from April through September 2013, nationwide courses were provided in the Medical Management of Chemical and Biological Casualties. Decontamination centers were established in 100 different locations. Personal protective equipment, antidotes, and other medications were distributed.

Tele-education offers another alternative to conventional medical education for students and trainees whose education was interrupted due to the war, siege, or unsafe travel (22). SAMS and other NGOs have organized educational webinars in key medical fields and specialties to provide continued medical education to trapped trainees and medical practitioners who have limited access to educational opportunities (Figure 7).

Conclusions

The Syrian conflict has led to the disintegration of the public health care system within the country and scattered refugees to camps in neighboring countries and beyond, where provision for health care is limited. This has affected all aspects of health care for Syrians. Demands on critical care have increased significantly due to trauma-related war injuries and subsequent respiratory problems at a time when intensivists are scarce inside Syria. Patients with chronic respiratory conditions do not have access to routine care and potentially life-saving treatments. Diaspora medical organizations have pioneered innovative solutions and technologies to bridge some of the gaps created by the loss of health workers and material resources; however, more can be done to support remaining health workers.

International medical organizations and societies should advocate on behalf of their Syrian colleagues and champion an end to violations of international humanitarian law and respect for medical neutrality. Educational opportunities to support Syrian health care professionals, including scholarships for medical students, would help to build the health staff that is essential for rebuilding the Syrian health system. More resources should be directed to research the impact of conflicts on health care and the use of technology and other innovative solutions to mitigate the harms. Consensus should be achieved and acted on by the international community on the urgent need to protect civilians from the airstrikes and chemical attacks and to apply pressure on the Syrian government to stop targeting the remaining health care staff and hospitals. ■

Author disclosures are available with the text of this article at www.atsjournals.org.

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