Editorial

Telemedicine and e-Health in Disaster Response

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Telemedicine over the past several decades has been used effectively and judiciously in the aftermath of disasters caused by both humans and natural occurring events. Natural disasters cannot be predicted precisely as to where and when they will occur, although significant technology available today provides some levels of awareness or an alert to pending tornadic activity, the destructive path of hurricanes, tsunamis, and earthquake fault zones. This awareness does little to prepare population centers other than to get as many people as possible to a safe location. This awareness capability differs significantly across the globe, and often parts of the developing world suffer larger loss of life and property as a result. Consider the recent earthquakes in Haiti, Japan, and Chile with respect to the destruction and devastation, and of course the needs of the population.

With respect to disasters caused by humans such as industrial, nuclear, biological, or chemical, these are often precipitated by some egregious acts of ineptness, war, or terrorism. In industrial settings there may be a response plan to an accident that can precipitate into a disaster, but the community may be unaware of the true danger. Consider the fertilizer plant in Texas that blew up in the summer of 2013 or the gas explosion in Bopal, India in 1984. A medical response to these kinds of events is also varied depending on the location, region of the world, and resources.

Telemedicine and e-health have been used both in preplanning and in post-disaster response. It can be a challenge to utilize telemedicine and e-health during or immediately following a disaster due to many factors, including telecommunications infrastructure and resource constraints. Over the past 20 years, this *Journal* has brought you several significant articles that have helped shape the discussion on telemedicine and e-health in disaster response. The knowledge from the work reported here comes from actual disaster response, the application of technology in disasters, or the manifestation of disease outbreak and how telemedicine has been of value.

In all disasters, there is significant disruption of services and in many cases significant trauma. In 2011, Dr. Ronald Weinstein reviewed a wonderful text from Dr. Rifat Latifi entitled *Telemedicine for Trauma Emergencies and Disaster Management*.[1] This review highlighted the importance of this text as a tool for teaching and implementing telemedicine in support of disaster response. In 2007, the American Telemedicine Association Special Interest Group (SIG) on Emergency Preparedness and Response also developed an inventory of what capabilities were available. A white paper, prepared by Dave Balch, reported on the SIG's efforts to develop a framework and infrastructure that could be used at the local, regional, and national levels in response to mass casualty events.[2]

One of the most significant applications of telemedicine in disaster response was summarized in 1998 by Doarn et al.[3] when they discussed the National Aeronautics and Space Administration's (NASA's) significant role in telemedicine and disasters in the 1980s in the Mexico City earthquake and the Spacebridge to Armenia. In 2011, two articles were published that looked back at the impact of this Spacebridge and the lessons learned and often forgotten. Doarn and Merrell[4] addressed the 20th anniversary of the Spacebridge to Armenia and its impact on the growth of telemedicine. Nicogossian and Doarn[5] further elucidated the lessons from this effort by presenting significant issues related to support in 1988–1989 and how those same issues are often minimized in today's response. They also provided some prerequisites as well as near- and long-term consequences for successful telemedicine implementation.

Although NASA's role has been significant, it is often the U.S. Military that is called into action for a humanitarian response. Consider recent history in Port au Prince, Haiti and the devastation there. The United States deployed assets to ensure communications, air traffic control, and a host of other capabilities and resources. To better understand what can be done by the U.S. Military in collaborative partnerships with nongovernmental organizations and other organizations, the U.S. Army's Telemedicine and Advanced Technology Research Center (TATRC) held a summit in 2010 to review the application of health technology in humanitarian response, specifically using deployed U.S. Military assets. The summit was summarized in a 2011 report for TATRC, and the executive summary was published in this journal.[6] Several early articles from U.S. Military personnel also provided strong evidence of the utility of telemedicine in disasters. In 1996, Gomez et al.[7] discussed tertiary telemedicine support during global military humanitarian missions; they reported on the use of satellite-based consultations of 240 cases between 12 remote sites and the facilities at Walter Reed Army Medical Center. Case presentations were both synchronous and asynchronous and were responded to within 24 h of receipt.[7] Military capabilities were further discussed by Meade and Lam[8] in 2007 in their article about deployable telemedicine capability in support of humanitarian operations; their focus was on operational initiatives of military assets, including a mobile army surgical hospital, in the European Regional Medical Command and Medical Command, Control, Communication and Telemedicine Special Medical Augmentation Team and the Army Knowledge Online Remote Consultation Program. These assets and capabilities were applied in Pakistan after an earthquake in Muzzaffarabad in 2005. In addition to the U.S. Military response, Gul et al.[9] reported in 2008 on their work using telemedicine and paraplegic rehabilitation at a hospital in Rawalpindi, Pakistan; the

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authors discussed 194 patients from the epicenter region using the telemedicine training capabilities in Rawalpindi for rehabilitation.

Recent news reports present a significant epidemiological problem with an Ebola virus outbreak in Guinea and Liberia in West Africa. Although an outbreak may be contained, the determinants of health in one part of the world may affect other parts—even microscopically. Although telemedicine was not applied in this case, it was used in relation to a cholera outbreak in Makakumbh Mela, India during a large gathering of people. A telemedicine capability was deployed to support this large gathering. Through microbial swabs and examination, *Vibrio cholerae* was isolated. This prompted health officials to respond accordingly and reduced the severity of diarrheal cases and averted an epidemic disaster.[10]

Research has also been conducted in support large gatherings where any kind of disaster may impact the public. During the 2003 Super Bowl (XXXVII) in San Diego, CA, several of our colleagues conducted a series of experiments in and around the stadium to determine readiness and utility of telemedicine in large events.[11] This project, known as Shadow Bowl, demonstrated the value of telemedicine when infrastructure is impeded in some way (i.e., overtaxed, overloaded, etc.). It also highlighted several key attributes that must be addressed in responding adequately.

Over the past 20 years the U.S. government through NASA, the Department of Health and Human Services' Office for the Advancement of Telehealth (OAT), and the National Institutes of Health's National Center for Research Resources (NCRR) has held several seminars and conferences that have discussed telemedicine and telehealth as tools for responding to disasters. NASA held two such conferences in 1991 and 1994.[3] In 2009, a gathering of subject matter experts by NCRR in Bethesda, MD produced a large number of articles as outcomes from its conference on "The Future of Telehealth: Essential Tools and Technologies for Clinical Research and Care." Alverson et al.[12] prepared a summary report on telehealth tools for public health, emergency, or disaster preparedness and responses. A year earlier, in 2008, OAT funded its Midwest Alliance for Telehealth & Technology Resource Center to conduct an invitation-only conference to develop a roadmap to propel telemedicine to its next stage. One of the breakout sessions was on applying telehealth in natural and anthropogenic disasters. Simmons et al.[13] provided a compelling piece with recommendations and a roadmap that can be used to guide us forward.

Most recently, telemedicine and telehealth have been used in the aftermath of Hurricanes Katrina and Ike. The authors of these articles, Kim et al.[14] and Vo et al.,[15] highlighted post-recovery on the Gulf Coast and how these tools were used in South East Texas after Hurricane Ike. Often medical services must rapidly transition from nominal or normal operations to that of a disaster mode. With your editors, you may recall the rapidly changing needs of all medical services along the Eastern Seaboard on that dreadful morning of September 11, 2001. Reynolds et al.[16] set a wonderful stage in their article on the tele-intensive care unit during a disaster and seamless transition.

In 2005, we published an editorial entitled "Disasters—How Can Telemedicine Help?"[17] This was nearly 10 years ago. The last paragraph was a sort of call to arms. We have seen since that time 11 articles published. Of the 17 highlighted here, that is 65% of the work. Clearly, disasters will continue to happen. Recent news reports from Washington indicate climate change is real, and that will result in all kinds of problems that impact our health. Telemedicine may not prevent these events, but it will surely be a significant tool in responding for the public good. Whether it is through seeing patients in an earthquake zone using national or international systems, the utilization of information technology and communications will provide the necessary foundation and structure to move forward.

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