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Telemedicine for Trauma and Emergency Management: an Overview

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Abstract
Purpose of Review This review focuses on the evolution of telemedicine programs on both national and international levels as it pertains to trauma and emergency medical care.
Recent Findings Advances in telemedicine have been shaped by increasing demands for meeting global health needs, as well as market-driven forces. Trauma and emergency medicine face significant barriers with regard to accessibility of care, expertise, and technology. Telemedicine serves to bridge these gaps on both a global and locoregional scale, making available the highest level of expertise and care to the most remote settings. Telehealth has served to advance patient care, surgical education, and inter-institutional collaboration through the use of modern technology.
Summary This review article highlights the evolution of telemedicine in trauma and emergency management and discusses recent examples and advances in technology and applications that can be used by a wide audience of health care providers to meet the needs of patients requiring trauma and emergency medical care.

Keywords Telemedicine · Trauma · Telehealth · Emergency medicine · Emergency telemedicine

This article is part of the Topical Collection on *Telemedicine and Innovative Remote Technologies for Trauma*

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Introduction

Injury represents a significant burden to the healthcare system worldwide, with approximately 10 % of worldwide deaths attributed to trauma [1]. Additionally, the impact upon public health measures such as disability, physical impairment, loss of work force, and quality of life remains significant [2]. While certain mechanisms of injury such as vehicular accidents have declined in incidence significantly over the last two decades in developed nations, the opposite trend has occurred in lower to middle income countries. The disparity in outcomes between socioeconomic classes is present not only on an international level but also on a locoregional level [3, 4]. The vast majority of specialized trauma centers and traumatologists are centered in urban settings. In the USA, patients in rural settings are at significantly greater risk of death from traumatic causes when compared to urban counterparts [5]. A significant number of such deaths can be prevented if timely access to specialized trauma centers and resources can be ensured [6].

The reasons for such discrepancy in access to trauma care remain largely unclear, although various contributing factors have been postulated. Rural health care facilities are often staffed with providers with limited expertise in traumatology which may lead to deviations from the "standards of care." Moreover, such facilities are limited in their ability to provide continuing medical education and skills training to their providers [7]. As a consequence, trauma patients in rural settings often lack access to timely care and interventions delivered by trauma subspecialists. This challenge is partially addressed through the nationwide implementation of trauma transfers; i.e., the physical transfer of a trauma patient from a referring rural facility to a definitive tertiary trauma center. The decision to initiate such transfers typically originates from the referring rural physician and is carried out via a telephone conversation

with the consulting and/or accepting traumatologist at the specialized receiving trauma center. Nonetheless, natural barriers to transportation, distance between referring and receiving institutions, the great cost of such transfers and the time-sensitive nature of traumatic injuries make the transfer system suboptimal. Therefore, it remains a significant challenge and important objective to bridge the gap between care delivered to rural trauma patients and their urban counterparts both on a national and international level.

A potential solution to bridge this gap may lie in developing telemedicine for trauma and emergency care ("teletrauma"). Advances in technology and demonstrated success in the applications of telemedicine on both national and international levels represent a significant opportunity in making the most advanced resources and highly trained personnel available to the most remote of settings in a timely fashion. The concept of "telepresence" involves providing access for smaller and more rural health care facilities to trauma surgeons at major trauma centers on an around-the-clock basis [8]. The implementation of such "telepresence" extends beyond mere video-teleconference (which remains a valuable component of collaborative and educational applications) but also includes expert evaluation of patients and processes which begins from the initial evaluation of the trauma patient and continues on to all aspects of care delivered for the patient. This review focuses on the evolution of telemedicine programs on both national and international levels as it pertains to trauma and emergency medical care.

Historical Perspective

The origins of telemedicine in the setting of emergency management and trauma date back to military disaster exercises staged by R. Adams Cowley, M.D., who used satellite transmission to communicate images of burn victims to medical centers across the Washington DC area using now outdated technology [9]. Thereafter, several efforts have been made to expand upon this initial effort to both evaluate and treat trauma patients remotely. Mattox's group reported the successful remote evaluation of 17 trauma patients using real-time video observation combined with verbal interaction [10]. While this study was performed "in-house" with the remote evaluation occurring in a separate room within the confines of the hospital, it demonstrated that the trauma team leader does not necessarily need to be physically present during evaluation and initial resuscitation in order to attain good outcomes. The immediate physical availability of the traumatologist in this study provided not only a safety mechanism in case of equipment failure or potential inferiority of telemetric resuscitation but also allowed for the unbiased evaluation of remote evaluation and resuscitation in a setting where clear physical presence of the expert was readily available but not required. Subsequent studies extended this principle to truly remote locations of evaluation. Rogers et al. reported their experience with telemedicine for the management of trauma patients in rural Vermont [11]. Their study, which involved predominantly blunt trauma victims, demonstrated the utility of telemetric consultation in providing (1) identification of the need for, and expediting, transfer of complex trauma patients to a tertiary center, (2) recommendations for obtaining or forgoing diagnostic tests such as CT scans, and (3) recommendation for therapeutic interventions such as nasogastric tube and chest tube insertion. Lambrecht et al. reported in their study evaluating telemedicine consultation for the evaluation of extremity and pelvic injuries that 68 out of 100 patients evaluated were allowed to remain at the referring facility [12].

Much has changed in the field of telemedicine technologies. Initial experience with such communication ranged from the use of digital cameras to obtain and transmit pictures of radiographic studies of orthopedic injuries [13, 14] to closed circuit television and recording devices in the on-site evaluation, to provision of trauma care from the distance in real time. The simplicity of using smartphone technology to transmit images and recordings of patient wounds and radiographic images has been shown to be efficacious in more than one study [15, 16], although their ubiquitous use has not occurred due to Health Insurance Portability and Accountability Act (HIPAA) concerns and the security of patient data. Within the last decade, more advanced technologic programs were created and demonstrated to be highly functional. The use of bidirectional videoconferencing has been demonstrated in several settings of trauma and acute care to be an effective method for evaluation and teleconsultation [17, 18]. For example, the Southern Arizona Telemedicine and Telepresence (SATT) program initiated in 2004 used real-time transmission of video, audio, and vital signs on a secured, separate line, which was monitored around the clock by technical personnel, to link a major university medical center in Tucson, Arizona with a rural medical center over 100 miles away [19•].

Technological Modalities

While it is beyond the scope of this review to describe every type of network and its associated terminology, it is useful to include some of the common terms used in media and literature to describe networks [20]:

- Host, any device, such as a computer, connected to a network
- Local Area Network (LAN), interconnects hosts in a small area such as a building
- Small Office Home Office (SOHO) Network, same as a LAN, but usually very few hosts

- Metropolitan Area Network (MAN), interconnects multiple sites in a city area
- Wide Area Network (WAN), interconnects multiple sites over long distances
- Internet, network of networks that interconnects billions of hosts globally
- Public network, open or shared network infrastructure such as the Internet
- Private network, closed or restricted network such as a corporate network
- Virtual Private Network (VPN)[3], encrypted communications link over another network, such as the Internet
- Wired network, network transmissions via fiber or copper cabling
- Wireless network, network transmissions via radio waves

It is likely that a telemedicine provider will use many or all of the above classes or segments of networks to implement the connectivity that they need for their telemedicine operations. This chapter focuses on a discussion of the WAN, which is the network communications segment that handles the long distance communications between telemedicine providers and their patients. The WAN is often the network resource that is the most limited or scarce and also the most critical to the successful delivery of telemedicine services. WAN communication speeds are typically much lower, due to higher costs, than LAN communications. LAN communications speeds may reach gigabits per second at the core, and it is increasingly common for each host to connect to the network at 1 gigabit per second (Gbps). WAN communications circuits, by comparison, are typically sold in kilobits or megabits per second. Higher speed WAN communications such as 1 or 10 Gbps are possible, but often not necessary and also not affordable, particularly for small to mid-size healthcare providers and their patients.

Telemedicine Communications Modes

There are three major modes for conducting telemedicine operations: (1) store and forward or asynchronous, (2) real time or synchronous, and (3) a combination of both

Store-and-Forward Telemedicine Store-and-forward telemedicine refers to asynchronous transmission of medical information that can be accessed at a later date or time. This includes images, videos, documents, lectures, podcasts, or any form of digital information that can be transmitted from one computer to another. Sending an e-mail with an attachment or transmitting a computed tomography (CT) scan to a distant radiology provider's picture archiving and communication system (PACS) are examples of store-and-forward telemedicine. A major benefit of store-and-forward telemedicine is that information can be sent and accessed at ones earliest convenience from any location with access to the network. This means that medical images can be sent to experts around the world for analysis, Continuing Medical Education (CME), grand rounds, presentations can be accessed on demand, and electronic medical libraries can be available 24 h a day, 7 days a week. Some store-and-forward telemedicine transmissions, such as digital mammography studies, may have very large volumes of data that need to be transmitted over a very short period of time in order to allow medical service providers to meet service level agreements for the actual medical services being rendered. In this case, high bandwidth circuits will be needed. Store-and-forward applications are only as effective as the network being used to transmit the information, especially for high resolution images and video. If the network resources are not adequate or do not perform up to agreed-upon standards, then telemedicine service delivery will be negatively impacted. Network design should balance the data communications needs of the telemedicine applications, available budget, and the medical service provider service level agreements, if applicable. Store-and-forward may be the best and only means of reliable communication if the supporting network or networks are unreliable. Store-and-forward transmissions, due to their asynchronous nature, can be retried until successful, with little or no intervention or management by a person.

Real-Time Telemedicine Real-time telemedicine is the synchronous transfer of medical information between two or more parties. Real-time telemedicine applications predominantly consist of live video conferencing which allows medical personnel to be telepresent at distant locations; however, an increasing number of medical instruments have been digitized to allow interactive examination and live monitoring of patients. A primary benefit of real-time telemedicine is the instantaneous availability of medical information and the ability to provide expertise to a distant medical staff in real-time. This is especially important in trauma and emergencies where the condition of the patient can rapidly change.

Real-time telemedicine is relatively bandwidth intensive, especially during high resolution video conferencing. Real-time video conferencing requires solid network performance. Networks that have substantial delay in data transmission of greater than 150 ms, sustained packet loss, or substantial jitter (variance in network transit time for each packet of information) result in a poor video conferencing experience. The networking infrastructure must be reliable, free of errors and congestion, and preferably managed by QoS parameters that allocate sufficient network resources to video conferencing to support effective teleconsultations possible. It is also important to consider that the quality of real-time applications is as only as good as the weakest connection. For example, in a real-time teleconsultation between video systems connected

to the Internet with one system connecting through cable provider broadband and the other system connecting via a cellular third generation (3G) network connection, the quality of the conference will be limited by the 3G network connection as it can only support a limited bandwidth transmission in comparison to the cable connection. Private networks outfitted with QoS bandwidth management capability can offer the highest levels of performance for video conferencing. The Internet can also provide excellent performance, provided that all parties involved have adequate bandwidth available on their Internet connections and the Internet is not congested during the time frame that the video conference is in session.

Reported Applications Within the USA

Table 1 summarizes relevant publications incorporating the use of telemedicine technologies and their use in the care of emergency and trauma care within the USA. The studies are classified by author and country of origin and list the title of the article as well as the journal of publication and include a brief summary and conclusion. Current technologies such as smartphones have been reported to be of significant value, particularly in the transmission of pictures taken of radiographic studies to specialists in tertiary care settings. Especially for neurologic and orthopedic injuries, assessment of imaging studies by traumatologists and specialists from a remote site can aid not only in establishing diagnoses and assisting in the initial management of patients but also in defining the indications for judicious transfer of such patients to specialized centers. Indeed, the transfer of critically ill patients suffering from trauma and other surgical emergencies can serve both as a life-saving measure and a significant burden upon patients, patient families, and the health care system. A number of the studies reviewed examining the use of telemedicine programs within the USA served to effectively reduce the rate of unnecessary transfers to tertiary care centers. It follows that the more widespread use of teletrauma may serve to more effectively use health care resources and provide timely care to patients in rural hospital settings when appropriate, while at the same time identifying the patients that truly warrant transfer to specialized centers and expediting the transfer process. The impact of telemedicine must be considered not only as it relates directly to patient care but also upon the recruitment and retention of the healthcare workforce. The management of critically injured patients can be challenging even in the most advanced health care settings with abundant resources. However, the lack of ancillary resources and ongoing skills training in rural health care settings presents a significant challenge to health care providers in such settings when caring for trauma and emergency medicine patients. In such settings, the availability of telemedicine was shown in at least one study (see Table 1) to enhance provider satisfaction with regard to the work environment and thus can be an invaluable tool to recruit and retain physicians for underserved areas. While prompt and accurate diagnosis and judicious use of the transfer mechanism is undoubtedly a tremendous benefit afforded by telemedicine, timely expert guided interventions have also been shown to be feasible in the setting of teletrauma [19•, 27•]. In one study, telemedicine was combined with video laryngoscopy to provide successful management of a difficult airway in life-saving fashion [27•]. In order to exert such a "telepresence" in all phases of patient evaluation, from pre-hospital care to initial diagnosis and management, availability of the consulting health care staff is paramount. In the Arizona experience, around-the-clock trauma and emergency management expertise were offered 24 h a day, 7 days a week for consultation to all trauma and emergency surgical patients at participating rural hospitals. The timeliness of assessment and intervention for the trauma and emergency medical/surgical patient is of utmost importance. As such, the extension of telemedicine to pre-hospital care is an important component of teletrauma which allows for earlier assessment, diagnosis and management. Initial studies reporting the transmission of data to detect falls in real-time hold significant promise in extending teletrauma to injury prevention and pre-hospital care (see Table 1).

Reported International Applications

Reported use of telemedicine modalities internationally range from the simple transmission of patient data via telephone and e-mail, to the complex wireless cellular data service, mobile wireless video conferencing devices, and multimedia messaging services (MMS) (see Table 2). Recent literature has demonstrated high sensitivity and specificity, simplicity, reliability as well as cost effectiveness for the use of telemedicine in the diagnosis and emergency response for both screening as well as teleconsultation in areas where previous obstacles such as armed conflict, geographic distance, and/or socioeconomic barriers would prohibit assess to specialty care. The French concept of a Mobile Neurosurgical Unit (MNSU) was recently described by Dulou, et al. Evaluation of the program provided details of the MNSU and its use in providing support to remote military medical surgical units deployed in Africa, South America, Central Europe, and Afghanistan [28]. As in the USA, telemedicine has also been employed internationally as an assessment tool allowing evaluation of imaging by specialists ranging from radiologists to trauma, orthopedic, neuro-, plastic, and burn surgeons from a remote site establishing diagnoses and assisting in required interventions. A study from Germany described the incorporation of telemedicine aiding the

Table 1 Summary of selected studies on the use of telemedicine for trauma and emergency medicine patients within the USA

Authors	Journal/title	Methods	Summary	Comment
Waran et al. (2008) [21]	Journal of Trauma	Case series describing patients with acute neurosurgical problems for whom imaging studies were photographed and transmitted to a tertiary care setting	In all patients studied, diagnoses could accurately be made based on the images transferred	Even simple user friendly technology such as smartphones can be used to accurately make diagnoses and meaningful decisions for consulting physicians from remote locations
Duchesne et al. (2008) [22]	Journal of Trauma	Case series analyzing outcomes before and after implementation of telemedicine in treating trauma patients in rural emergency departments	The use of telemedicine resulted in a significant decrease in the transfers of trauma patients to a major trauma center, thereby decreasing health care costs	The reduction in unnecessary transfers is an equally important benefit of telepresence in trauma and emergency care
Saffle et al. (2009) [23]	Journal of Trauma	Case report and commentary highlighting the benefits of, and need for telemedicine	The use of telemedicine reduced unnecessary transfers of burn patients	Telemedicine can be accurate in identifying the need for transfer of burn patients to specialized centers
Marcin et al. (2004) [24]	Pediatric Critical Care Medicine	Prospective cohort study investigating utility of a pilot telemedicine program to provide remote pediatric critical care consultations for acutely injured children in an adult intensive care unit	Young severely injured children received effective remote critical care consultations with high scores on provider and parental satisfaction surveys	Telemedicine consultations to a remote intensive care unit are feasible and provide a high level of user and patient satisfaction
Latifi et al. (2007) [19•]	American Journal of Surgery	Retrospective review of telemedicine consultations connecting rural hospitals with a tertiary trauma center	Teletrauma consults resulted in both lifesaving measures undertaken at the referring facilities as well as judicious patient transfers	Around-the-clock telepresence of consulting trauma surgeons can result in evaluation, diagnosis, management, and transfer of trauma patients
Potter et al. (2014) [25•]	Rural Remote Health	Survey analysis of physician attitudes towards work environments in rural areas where telemedicine is available	Access to telemedicine increases the likelihood of physicians entering and remaining in rural emergency medicine practice	The recruitment and retention of physicians in rural settings can be strengthened by providing access to specialty centers via telemedicine
Sposaro and Tyson (2009) [16]	Institute of Electrical and Electronics Engineers Conference Proceedings	Presentation of a developed smartphone alert system for fall detection and activation of emergency response	A smartphone application is effective in identifying falls based on movements and alerting appropriate emergency responses	Applications of technology can be used not only for managing patients remotely but also to detect injuries as and when they occur
Boissy et al. (2007) [26]	Telemedicine Journal and e-Health	Evaluation of a user based motion sensing device to detect falls in the elderly	The technology and algorithm were able to detect fall events in simulated fall conditions with a high success rate	Automated detection of falls is a promising entrée of telemedicine into the area of injury prevention
Sakles JC et al. (2011) [27•]	Telemedicine Journal and e-Health	Case report of telemedicine assistance provided to a rural provider to successfully perform endotracheal intubation	Videolaryngoscopy combined with a telemedicine network can provide life-saving remote assistance with the management of difficult airways	Telehealth consultation in the setting of emergency medicine/trauma can aid not only in diagnosis and transfer but also delivery of therapeutic measures

Table 2 Summary of selected studies on the use of telemedicine for trauma and emergency medicine patients internationally

Authors	Title/journal	Methods	Summary	Conclusion
Modi, et al. (Canada) [15]	iPhone-based teleradiology for the diagnosis of acute cervicodorsal spine trauma *Can J Neurol Sci* 2010	Retrospective study of 74 cases of suspected cervicodorsal spine fracture	High sensitivity and accuracy of detecting vertebral body fractures (80 and 97 %) and posterior element fractures (75 and 80 %)	This system is accurate in diagnosis of cervicodorsal trauma and allows rapid, remote, and secure visualization of medical imaging without storing patient data
Dulou, et al. (France) [28]	The French mobile neurosurgical unit *Neurosurg Focus* 2010	Descriptive program evaluation of the French Mobile Neurosurgical Unit (MNSU) to support remote military medicosurgical units	From 2001 to 2009, 15 Mobile Neurosurgical Unit (MNSU) missions were performed for 16 patients. Injuries included 2 craniocerebral wounds, 7 closed head trauma cases, 5 cases of spinal trauma, and 2 spontaneous intracranial hemorrhage cases. In 5 of the 16 cases, neurosurgical intervention was provided on site	The MNSU can be deployed for timely treatment when a short delay time in neurosurgical management is acceptable
Knobloch, et al. (Germany) [29]	Cell-phone-based multimedia messaging service (MMS) and burn injuries *Burns* 2009	Case report evaluating telemedicine to transfer images of patients to the consultant physician	A cell-phone-based multimedia messaging service is feasible and accurate in transferring a comprehensive impression to consultant	The use of cell-phone-based MMS photo and video transmission facilitates immediate decision making irrespective of geographical location of the consultant
Keane (United Kingdom) [30]	A review of the role of telemedicine in the accident and emergency department *J Telemed Telecare* 2009	Literature review of articles on the role of telemedicine in accident and emergency care	Review of 39 articles using telemedicine in emergency medicine. Communication equipment included radio links, telephone, e-mail, and mobile wireless video conferencing devices	All devices were found to transfer information effectively but success was at times limited to technical failure of the technology and staff confidence using the technology
Juhra, et al. (Germany) [31]	Telematics in acute trauma care *Stud Health Technol Inform* 2009	Description of a pilot project integrating telemedicine into a trauma network	Description of program framework	Pilot project for telemedicine framework in trauma network in Germany
Di Paolo, et al. (Italy) [32]	Emergency radiology without the radiologist: The forensic perspective *Radiol Med* 2009	Case review of 2 mortality cases due to failure to obtain accurate radiologic diagnosis	Review of 2 cases with unfavorable outcomes related to failure to activate a teleradiology system	There is a risk for adverse outcomes when teleradiology is excluded from the management of patients in an emergency setting
Kreutzer, et al. (Germany) [33]	Teleradiology in neurosurgery: Experience in 1024 cases *J Telemed Telecare* 2008	Retrospective case review of an analog image transfer system for CT and MRI images from 7 referring hospitals in Germany	1024 neurosurgical cases (945 patients) between 1995 and 2000. Analysis showed 67 % of cases did not require transport and admission to a neurosurgical center and the associated potential cost savings	A teleradiology system enables rapid and reliable TC in neurosurgery patients with trauma, stroke, and intracerebral hematoma at low cost
Dyer, et al. (Canada) [34]	The clinical and technical evaluation of a remote telementored telesonography system during the acute resuscitation and transfer of the injured patient	Case series evaluating the use of telesonography protocols during trauma resuscitations	3 normal volunteers and 20 acute clinical examinations were performed using an existing internet link to direct or observe EFAST	Remote real-time guidance or observation of an EFAST using telesonography appeared feasible. Technical challenges included initiating US audio and video communications,

Table 2 (continued)

Authors	Title/journal	Methods	Summary	Conclusion
	J Trauma 2008			image freeze and US transmission delays
Tsai, et al. (Taiwan) [18]	The effectiveness of video-telemedicine for screening of patients requesting emergency air medical transport (EAMT) *J Trauma* 2007	Cross-sectional study evaluating the effectiveness of video-telemedicine for preflight screening of patients for air medical transport	822 transfers included, 36.2 % reduction of EAMT after instituting preflight physician screening using telemedicine and cost savings of USD $448,986	Physician-assisted preflight screening using video-telemedicine reduced the frequency of unnecessary EAMT and consequently led to reduced costs
Ashkenazi, et al. (Israel) [35]	Effect of teleradiology upon pattern of transfer of head injured patients from a rural general hospital to a neurosurgical referral center *Emerg Med J* 2007	Prospective cohort study to assess the effect of teleradiology on the need for transfer of head injured patients from a rural level 2 trauma center.	209 trauma patients with head injury and neurosurgical pathology were evaluated using telemedical technology resulting in 126 (60.2 %) transfers and 83 (39.7 %) remaining at the level 2 institution.	With the availability of teleradiology and neurosurgical consultation, selective head injured patients may be safely managed at level 2 trauma centers.
Latifi, et al. (Albania) [36••]	Access to specialized care through telemedicine in limited resource country: initial 1065 teleconsultations in Albania Journal of Telemedicine and e-Health, 2016, *in press*	Retrospective review of prospectively collected data from teleconsultations in Albania delivered synchronously, asynchronously, or both	Teleconsults for radiology, neurotrauma, and stroke utilized synchronous and asynchronous technology and resulted in transfer of only about 20 % of patients studied	A well-structured telehealth system in Albania is effective in providing care to regional hospitals and limiting unnecessary transfers

assessment of burn injury and microsurgical free flaps [29]. Utilization of telemedicine has also been applied to a variety of settings from acute emergencies in Emergency departments to medical advice for paramedics in the pre-hospital setting (see Table 2). Specialty guided assistance has also been shown internationally in the setting of teletrauma. Dyer et al. evaluated the use of telesonography protocols during acute trauma resuscitation (EFAST) [34]. Additionally, several international studies have described the use of telemedical technology when evaluating the appropriate utilization of health care resources and transferring patients between rural hospitals and specialty centers. For example, Tsai et al. evaluated the effectiveness of a video-telemedical preflight evaluation for air medical transportation requests in Taiwan and demonstrated a 36 % reduction of emergency air medical transport applications after the preflight evaluation [18]. One of the most organized systems to date is the telemedicine program in Albania where telehealth consultations across a variety of disciplines, most frequently radiology and neurotrauma/stroke, have resulted in effective care provided to regional hospitals while limiting unnecessary transfers [36••].

Table 2 presents several publications incorporating the use of telemedicine and teletechnologies and their use in the care of emergency and trauma care internationally. The studies are classified by author and country of origin and list the title of the article as well as the journal of publication and include a brief summary and conclusion.

Network Management and Technical Personnel

One important consideration to addressing the activities and needs for any telemedicine program, but particularly for a network that supports teletrauma, is to identify the network managers and technical personnel who will support the network and any equipment housed on it. One of the biggest misconceptions in telemedicine is the idea that one simply hooks up to the Internet and can begin using telemedicine applications. The reality is that there is a lot of behind the scenes configuration, programming, and installation that goes into making a telemedicine network operable, especially with VPN's. It is essential to have a network administrator as a consultant or part of the program to ensure that the connections are setup correctly and there is a clear link between consulting parties. Additionally, Health Insurance Portability and Accountability Act (HIPAA) regulations require stringent encryption and data protection which an administrator would be best at implementing.

Network monitoring is extremely important, especially if you are consulting with multiple sites. Administrators deploy monitoring packages that can pinpoint any trouble in the network from servers, switches, routers, hubs, and computers. Monitoring allows the network managers to proactively respond to network and system problems and to notify users of outages vs. waiting for users to report problems before troubleshooting is initiated. Finally, a network administrator would be able to help you determine the best way to connect to your sites and the technology and resources needed to accomplish it.

Technical personnel will help support the operations of the telemedicine program on a day-to-day basis. This staff will ensure the equipment is running correctly, users are trained properly, and that the networking connectivity is established and maintained. End user training is an underestimated aspect to the success of any telemedicine effort. Continuous training and support should always be available to doctors, nurses, and other medical personnel since these individuals will be the ones interacting with and using the technology. Maintaining a high awareness of the technology ensures that communication and consultation can be conducted quickly during a trauma or disaster.

Conclusions

Although the majority of development and utilization of telemedicine has occurred in high income areas and countries throughout the world, its use has offered specialty care to resource poor settings on a global level. With the utilization of remote and Internet-based systems, telemedicine has emerged as a bridge between pre-hospital, community based and tertiary care allowing specialty care previously outside the scope of local healthcare. From initial treatment of orthopedic and neurosurgical injuries to tube thoracostomies and EFAST assessment, telemedicine has the capability to provide expert guided mentoring of timely life-saving procedures as well application in pre-hospital assessment and triage. While barriers exist limiting wider adoption in resource poor areas, continued advances in technology may be the key to breach the barriers and observe the full health benefits telemedicine has to offer.

Compliance with Ethical standards

Conflict of Interest Drs. Prabhakaran, Lombardo, and Latifi declare no conflicts of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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