CRITICAL CARE TELEMEDICINE

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Abstract

Critical Care Units that are well-staffed with board-certified intensivists who provide proactive, one-on-one care to their patients tend to have the lowest morbidity and mortality rates, but due to cost and staffing shortages, many hospitals are not able to provide this level of care. Critical Care Telemedicine is a rapidly emerging alternative that uses technology to provide virtual hourly rounds, 24/7 patient monitoring, and continual availability for collaboration with on-site medical professionals to assess and treat patients. Although critical care telemedicine is not without challenges, it represents a modern approach to traditional medicine and offers significant benefits to patients, staff, and facilities.
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This educational activity is credited for 4 hours. Nurses may only claim credit commensurate with the credit awarded for completion of this course activity.

Statement of Learning Need
More acute care facilities with limited health services and medical specialists available to treat patients in a critical health condition rely on telemedicine. Telemedicine both addresses gaps in local or regional care and challenges health teams unfamiliar with its many aspects and use.
Course Purpose
To provide nursing professionals with knowledge of the growing area of telemedicine and future trends in critical care and emergency medical delivery.

Target Audience
Advanced Practice Registered Nurses and Registered Nurses
(Interdisciplinary Health Team Members, including Vocational Nurses and Medical Assistants may obtain a Certificate of Completion)

Course Author & Planning Team Conflict of Interest Disclosures
Jassin M. Jouria, MD, William S. Cook, PhD, Douglas Lawrence, MA, Susan DePasquale, MSN, FPMHNP-BC – all have no disclosures

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There is no commercial support for this course.

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Please take time to complete a self-assessment of knowledge, on page 4, sample questions before reading the article.

Opportunity to complete a self-assessment of knowledge learned will be provided at the end of the course.
1. The term “telemedicine” is used broadly to describe medical services:
   a. delivered over distances using communication technologies.
   b. that utilize computer systems.
   c. that utilize audiovisual communication.
   d. that utilize data storage.

2. TRUE or FALSE: Recent technological advances have enabled trauma centers to provide care to regions with limited medical resources.
   a. True
   b. False

3. The medical record in telemedicine must include:
   a. copies of all relevant patient-related electronic communications.
   b. relevant patient-physician e-mails.
   c. prescriptions, laboratory and test results.
   d. All of the above.

4. One of the primary cost benefits of telemedicine is:
   a. the remote evaluation of patients.
   b. the accuracy of clinical data that may be recorded.
   c. that it promotes early transfer when indicated.
   d. the availability of expert trauma care to patients medical facilities without advanced trauma systems.

5. TRUE OR FALSE. Telepresence extends support to remote hospitals from a central location, such as that of a trauma surgeon.
   a. True
   b. False
**Introduction**

Critical Care Telemedicine is a rapidly emerging alternative that uses technology to provide virtual hourly rounds, 24/7 patient monitoring, and continual availability for collaboration with on-site medical professionals to assess and treat patients. Although critical care telemedicine is not without challenges, it represents a modern approach to traditional medicine and offers significant benefits to patients, staff, and facilities. When Critical Care Units (CCUs) or Intensive Care Units (ICUs) and Emergency Departments (EDs) are well staffed with board-certified intensivists and/or ED/trauma board-certified physicians trained to provide proactive, one-on-one care, their patients tend to have the lowest morbidity and mortality rates. However, due to cost and staffing shortages, many hospitals are not able to provide this level of care. This course highlights the multiple aspects of telemedicine, benefits and challenges, to improved healthcare delivery in the CCU or ICU and ED setting.

**Emergency Care And Telemedicine**

Emergency situations require fast, definitive and precise care as well as major resources and continuous expertise. Without these, the consequences can be devastating. The major trauma centers and trauma specialists around the world are concentrated mainly in urban settings. Subsequently, “most of the population of the USA, and the world for that matter, is not covered by specialized trauma systems. Although only 23–25% of the population in the USA lives in rural America, 56.9% of deaths caused by motor vehicle crashes (MVC) occur in this population. Furthermore, only 15 states in the USA have state wide 911 or enhanced 911 systems. As a result, rural patients
are at greater risk of traumatic death than their urban counterparts. In fact, patients involved in motor vehicle crashes in rural America have twice the rate of mortality when compared with those in an urban setting with the same injury severity score.”¹

Approximately six hundred people die or sustain long-term disability from traumatic injuries each day. Up to “40% of the deaths could be prevented if access to a well organized system of trauma care was uniform throughout the country.”² Residents of small rural communities are almost 600 times more likely to die following an automobile crash than residents of a major metropolitan city.³ Although it is not entirely clear why there is such a discrepancy in trauma care between rural and urban America, a few factors have been identified. First, emergency room personnel in low volume trauma care “centers” often have limited experience with major traumas, which may lead to management errors and departures from the standard of care. In addition, “many rural emergency rooms are not adequately staffed with properly trained personnel, and there are limits to the ability to provide continuing medical education (CME) to ER personnel and emergency medical service (EMS) providers in the rural setting. Another reason for poor outcomes for rural trauma patients is the lack of access to immediate subspecialty care (trauma surgeons, neurosurgeons, orthopedic, vascular or cardiac surgeons) in remote locations”.⁴

Advances in technology including telemedicine and telepresence applications may be the solution to discrepancies in trauma care. However, the implications of telemedicine extend beyond video teleconference capabilities. The patient population for a Level I trauma
center consists largely of patients who have been transferred from rural communities for definitive tertiary trauma care. In most current systems, the decision to transfer a patient to a trauma center is based on a phone call from the referring rural physician to the emergency room physician or trauma surgeon. Based on the experience of many trauma centers, a large number of patients transferred to trauma centers could be adequately cared for in the rural or community hospital with the help or “telepresence” of a trauma surgeon in these remote hospitals from a central location. In order to accomplish this goal, small emergency rooms or other centers in rural areas need to have access to major trauma centers and trauma surgeons 24 hours a day, seven days a week with modern technology. This “telepresence” undoubtedly will have a major impact in major trauma centers that will evaluate and eventually manage most critically ill patients who need specialized and definitive trauma care.

**Intensive Care Unit And Telemedicine**

More than 5.7 million adults are admitted yearly to intensive care units (ICUs) in the United States. Hospital costs for critically ill patients admitted to the ICU are more than $67 billion annually. Mortality rates for these patients average 10 – 15%, which is equivalent to approximately 540,000 deaths each year. Evidence shows superior clinical outcomes with a dedicated intensivist staffing model; however, 85 – 90% of U.S. hospitals do not use this model. Further recommendations include intensivist led care for all patients in ICUs, recognizing the opportunity to reduce in-hospital mortality. However, it is currently projected that the need for intensivists will steadily increase while the supply is likely to stay the same, leading to greater
intensivist shortages and thus more difficulty meeting the proposed standards of care.\textsuperscript{10}

The term “telemedicine” is used broadly to describe medical services delivered over distances using communication technologies. As practiced in the intensive care unit (ICU), telemedicine comprises networks of audiovisual communication and computer systems that link hospital ICUs to intensivists and other critical care professionals at a remote location.\textsuperscript{11} These networks can be used to store and forward data (such as medical records), to conduct remote real-time monitoring of vital signs or chronic conditions, or to facilitate staff interactions via video, phone or online computer. Some examples of applications include:\textsuperscript{12}

- Video cameras near the ceiling of an ICU patient room which can zoom to see equipment and monitors, even a patient’s eyes or nails
- Cameras which have an electronic “doorbell” to announce that tele-ICU staff are in visual contact to share observations and care recommendations with bedside caregivers
- Data tracking on multiple patients using screens at the remote location with sentry alarms alerting tele-ICU staff when a monitored measurement starts to change in an unusual or dangerous way

Telemedicine expands access to high-quality critical care by using electronic medical records and video teleconferencing to provide care from a remote location. Providers can use telemedicine to complement bedside care for a large number of patients at several locations simultaneously. The remote ICU team can “consult on critical issues,”
monitor patients for changes in physiological status, and facilitate communication between care providers. As such, telemedicine has the potential to improve patients’ outcomes in the ICU. Given the current need for additional critical care services, limitations of the existing workforce, and access issues related to geography, the use of telemedicine in critical care is likely to expand in the coming years.”

Telemedicine services used in the intensive care setting today, which provide continuous monitoring to hundreds of patients across multiple sites, have been in use since the year 2000. The term tele-ICU is now used to describe a concept of care in which a centralized or remotely based critical care team is networked with the bedside intensive care unit (ICU) team and patient via state-of-the-art audiovisual communication and computer systems. Tele-ICUs provide additional expert critical care medical and nursing services to the bedside staff to watch for trends and early signs of clinical deterioration in a patient’s status. With the increased reach of tele-ICU services throughout the country, collaboration and communication (in addition to expert clinical knowledge) are key components of a healthy working relationship between bedside clinicians and the tele-ICU staff.

Tele-ICU was founded as a means of delivering clinical expertise of intensivists located remotely to hospitals with inadequate access to intensive care specialists. Tele-ICU intensivists and nurses use audio and video links to assist bedside caregivers in monitoring and managing critically ill patients. The terms “tele-ICU,” “virtual ICU,” “remote ICU,” and “eICU” all refer to the same care concept; a centralized or remotely based critical care team is networked with the bedside ICU team and patient via state-of-the-art audiovisual
communication and computer systems. Approximately 13% of the nation’s adult ICU beds have tele-ICU coverage with a majority of coverage in academic and private hospitals.\(^\text{11}\)

The ICU patient population has the highest cost impact in any organization. The patients are critically ill with many concurrent and emergent needs that occur throughout their ICU stay. The tele-ICU team is comprised of clinical experts such as an intensivist and critical care nurses. By using advanced communication technologies, these teams are able to leverage clinical expertise across a spectrum of patients in a variety of clinical settings.\(^\text{15}\)

**Model of Care**

The model of care depends upon several factors including the number of patients requiring tele-ICU services, patient acuity, existing bedside resources (includes both human and technology or equipment resources), and contractual arrangements. The models of care described below are general; specific programs may include various combinations of each.\(^\text{16}\)

- **Continuous Care Model:**
  Continuous care is monitoring of the patient without interruption for a defined period of time (\textit{i.e.}, on an 8, 12, or 24 hour basis).

- **Episodic Care Model:**
  Episodic care occurs intermittently with a periodic consultation on a pre-determined schedule (\textit{i.e.}, during patient rounds) or at unscheduled times.
• Responsive Care Model:
  In this model virtual visits are prompted by an alert (*i.e.*, telephone call, page, monitor alarm).

These tele-ICU clinical models function as a safety net for patients, nurses, and physicians. Using remote video and voice technology, tele-ICU leverages critical care expertise while striving to improve patient outcomes through the consistent use of evidence-based medicine in collaboration with the ICU clinical teams.\(^{17}\)

**Care Delivery Mechanisms**

Networked programs link tertiary care hospitals and clinics with outlying clinics and community health centers in rural or suburban areas. The links may use dedicated high-speed lines or the Internet for telecommunication links between sites. The American Telemedicine Association (ATA) estimates the number of existing telemedicine networks in the U.S. at roughly 200 providing connectivity to over 3,000 sites. The following includes additional mechanisms for telemedicine care delivery in the ICU.

• Point-to-point connections using private high-speed networks are used by hospitals and clinics that deliver services directly or outsource specialty services to independent medical service providers. Such outsourced services include radiology, stroke assessment, mental health and intensive care services.

• Monitoring center links are used for cardiac, pulmonary or fetal monitoring, home care and related services that provide care to patients in the home. Often normal landline or wireless
connections are used to communicate directly between the patient and the center although some systems use the internet.

- Web-based e-health patient service sites provide direct consumer outreach and services over the internet. Under telemedicine, these include those sites that provide direct patient care.

**Primary Uses and Applications**

Decision-making aids are a crucial part of telemedicine application. The simplest application of telemedicine is the use of on-line computer databases in the clinical practice of medicine. Search engines list abstracts from selected texts and journals that address specific or cross-referenced topics. This is the oldest application of telemedicine.

Use of search engines by non-medical persons has become more common. Easy access of detailed medical information to laypersons creates new opportunities for self-diagnosis, or misdiagnosis, by those seeking to escape the financial and time burdens of standard medical care. Additionally, the following applications support electronic access of information.¹⁹

*Remote sensing*

Remote sensing involves the transmission of patient information from one site to another. This includes electrocardiographic (ECG) and digital X-ray data. Remote sensing raises the issues of patient record confidentiality and patient consent.
Collaborative real-time patient management

This represents the most innovative category of telemedicine and is the primary focus of this review. Collaborative video management, or videoconferencing, allows a remote practitioner to observe and discuss symptoms with a patient or another practitioner. Two-way workstations produce quality digital motion pictures across long distances. Equipment needs include a communications network and peripheral equipment, such as an electronic stethoscope, otoscope, ophthalmoscope, and dermascope. Endoscopy equipment is used by some telemedicine centers.

The promise of higher-speed transmission technology in the near future will allow transmission of cinematographic data, such as angiography and echocardiography. Videoconferencing raises pivotal issues of credentialing, liability, cross-state licensing, referral practices, and reimbursement. The most prevalent applications of video telemedicine are for rural health services, remote specialty and subspecialty consultation, correctional facility health care, and military health care. Videoconferencing is used by a growing number of medical specialties, including cardiology, dermatology, home health care, oncology, psychiatry, radiology, surgery, and wound management.

The deceleration in health care spending prompted by decreased governmental funding, coupled with the influence of managed care will encourage the broad application of telemedicine in the near future. Currently, the majorities of telemedicine programs are funded by government grants and are based in academic centers.
History Of Telemedicine

While the concept of telemedicine has existed for approximately forty years, it was not a feasible option for care until the 1980’s with the expansion of digital communication. Some early telemedicine applications began to emerge in the 1970’s, including emergency medical service (EMS) voice-based medical oversight, pre-arrival notifications, and remote transmission of ECG telemetry. However, lack of reliable and inexpensive technology impacted the incorporation of telehealth into practice. Primary concerns included cost, privacy, reimbursement, as well as logistics of setting up a telehealth network. However, recent access to high-speed, cost-effective technology, such as 3G and 4G LTE (the standard wireless telecommunication) network, greater definition on reimbursement policies, and successful models demonstrating its effectiveness have increased the opportunities for telemedicine.20

The following describes the first attempts to use telemedicine to address care needs in rural settings:21

*The first attempt to simulate the use of telemedicine in trauma resuscitation was recorded in 1978 by Dr. R. Adams Cowley, who staged a disaster exercise at Friendship Airport in an aged DC-6 aircraft. He transmitted real-time images of burn victims via satellite transmission to San Antonio’s Burn Unit and other medical centers around the Washington DC area. This was accomplished with an old and cumbersome technology, yet it is the first successful attempt to use technology and telemedicine in trauma care. Since then, numerous efforts have been made to resuscitate trauma patients from a distance. Rogers, et al., reported their use of*
a tele-trauma service in rural Vermont, where 68% of the population lives in rural areas. Their initial experience with 41 teletrauma consultations was very encouraging. Ninety-five percent of the injuries were caused from blunt trauma, primarily MVC (49%), pedestrians/bicyclist struck by vehicles (10%) and injuries caused by all terrain vehicles (7%). Thirty-one of 41 patients that were seen via the tele-trauma system were transferred to the tertiary care center. In 59% of the cases transfer was recommended immediately, due to the critical condition of the patient; 41% of transfers were accomplished by helicopter. While in three cases, tele-trauma consultation was considered life saving, the most common recommendations from the tele-trauma consultant were regarding patient disposition. For example, in 15% of cases the trauma surgeon recommended keeping the patient at the referring facility. Other recommendations included suggestions for diagnostics such as obtaining or foregoing a CT scan, as well as recommendations for additional therapeutics (placement of an NG tube, or a chest tube, transfusion of blood, etc.).

Other investigators have also reported various techniques to establish trauma tele-consultations in rural settings. In a study of 40 orthopedic trauma cases, radiographic images were photographed by a digital camera and transmitted via dedicated T1 based network to a consulting hub, where two orthopedic and two radiologists reviewed the cases. This and other reported studies have demonstrated that a simple digital camera can be used effectively in many cases, as long
as the proper region of interest on the X-ray has been photographed and transmitted to the consultant. Lambrecht et al., also demonstrated the effectiveness of telemedicine technology in the evaluation and treatment of extremity and pelvic injuries.

The most important element in this report was that 68 of 100 patients referred for tele-consultation remained in the rural community hospital. This certainly has major implications on the cost of transferring of these patients to major medical centers, increased utilization of local health care facilities and other social and financial issues of treating these patients away from their families.

Key Academic Telemedicine Centers

Telemedicine is expanding throughout the world. However, there are a number of key academic centers that have spearheaded telemedicine collaboration and delivery. The following centers have provided the resources and framework for the expansion of telemedicine.\textsuperscript{22,23}

<table>
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<tr>
<th>Kentucky TeleCare</th>
<th>The Kentucky TeleCare program, located at the University of Kentucky Medical Center (UKMC) in Lexington, began in 1994. This program’s interactive video network links hospitals throughout the state with UKMC-based services in adult and child psychiatry, dermatology, pediatric cardiology, and pre-operative anesthesia. TeleCare has performed trials in at least ten other clinical specialties, including emergency medicine, and forecasts the opening of regular video clinics in five of these specialties. UKMC’s emergency medicine application of telemedicine involves the prevention of unnecessary transfers.</th>
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A case example cited included a posterior pharynx puncture wound that was discharged home from a rural hospital emergency department (ED) following video consultation with an UKMC-based physician.

<p>| <strong>East Carolina University School of Medicine</strong> | The East Carolina University School of Medicine (ECU) initiated a telemedicine program in 1992 when Central Prison, the state’s largest maximum-security prison, contracted with ECU to provide telemedicine services. The video network is connected to six rural hospitals and four medical centers in the region and provides telemedicine and distance learning programs. ECU’s future plans include the testing and implementation of virtual reality tools in the telemedicine environment. |
| <strong>The Oklahoma Telemedicine Network</strong> | The OTM is a collaborative effort between the Oklahoma Department of Commerce, Oklahoma State University, and Oklahoma University. The OTM consists of five hub centers connecting approximately 40 participating hospitals. |
| <strong>The Medical College of Georgia (MCG) Telemedicine Center</strong> | The MCG Telemedicine Center, founded in 1992, is a statewide network linking 59 health care and correctional facilities. MCG’s telemedicine initiatives include an early intervention program that links the families of children with special needs with a team of MCG-based practitioners. This team includes a pediatric neurologist, occupational therapist, physical therapist, speech and hearing specialist, nutritionist, and developmental pediatrician. Dodge County Hospital in Eastman, Georgia maintains a telemedicine suite in its ED. The suite links Dodge County Hospital patients and physicians with real-time consultants at Medical College of Georgia, which is 130 miles away. |
| <strong>University of Tennessee (UT) Knoxville Medical Center</strong> | Sam Burgiss, Ph.D. and emergency medicine specialist Patrick O’Brien, MD, manage the UT Knoxville Medical Center telemedicine program. The program provides video telemedicine services to suburban and rural facilities throughout Knox County, Tennessee. |</p>
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<tr>
<th>University of Maryland at Baltimore</th>
<th>This program investigates the transmission of real-time vital signs and video images of ambulance patients from the ambulance to the hospital’s trauma center.</th>
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<tr>
<td>The Alaska Telemedicine Project</td>
<td>This four-year old project deployed telehealth informatics to Russia and the Far East and signed a letter of intent with the Ministry of Health in Romania.</td>
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**Telemedicine Technology**

Successful telemedicine programs rely heavily on the use of advanced information technology. This technology can extend the reach of medical facilities and resources, promoting efficiency, productivity, and accuracy in clinical decision-making, coordination, and integration. In addition, these programs rely heavily on redesigned network systems that offer quality of service, bandwidth on demand, and a more effective business model that provides solutions and payment options for the basis of data flow and appropriate speed.

Although a number of the technological requirements for telemedicine systems are already available, they are offered at various degrees of efficiency and various levels of cost. Telecommunication links are expanding continuously, but they still do not reach all communities, leaving segments of the population unserved. Many basic devices that are currently available provide all the necessary hardware and software for operating telemedicine systems. However, the development of more advanced technology will enable the creation of telemedicine devices to support more applications and expand coverage and service options.24
Currently, the focus is on the ways in which technology can expand to offer more efficient and effective telemedicine solutions to a larger demographic area. The following questions only illustrate the range of issues yet to be resolved:  \(^{25}\)

- Does the future of wireless and broadband offerings imply that we are on the brink of a revolutionary change in health care delivery?
- Will the cost of these advancements slow progress, or will competitive pricing resulting from better standards and improved interoperability across products accelerate progress?
- In view of pending privacy regulations, can the security and privacy arrangements now available meet the needs of the medical profession and patients without compromising quality of service?
- What are the barriers for the future expansion of telemedicine in the home environment and in the community?
- Will the expansion of broadband networks, such as the internet, bring benefits equitably to all segments of society and to all countries?

To truly begin to explore these issues, it is important to consider the following two topics of technical design and intraoperability.  \(^{23,26-33}\)

**Technical Design**

Telecommunications support has varied from basic telephone service to broadband internet, incorporating online diagnostics, remote patient monitoring, and today’s virtual touch computer interfaces (referred to as haptics). The key item to note is today’s multitude of high-speed
service offerings that can be used in the design of telemedicine systems.

The asynchronous transfer mode (ATM) is one of the new high-speed offerings available in today’s telecommunications market. ATM systems are preferable when high data rate transfers of information are required. When coupled with the resilient synchronous optical network (SONET) configurations, ATM systems offer high-quality and low-delay conditions. Currently, fiberoptic systems are being designed to support data rates as high as 40 gigabytes per second (Gbps) (OC-768) for advanced medical systems.

Mobile service for medical applications, such as those encountered in ambulance operations, is critical. Mobile communication systems can be defined in five groups: cordless, cellular, satellite, paging, and private mobile radio systems. These mobile communication systems will all be included at a common system, referred to as the Universal Mobile Telecommunications System, (UTMS). Prehospital management in emergency care can be essential for patient survival. A portable medical device that transfers patient diagnostic information to physicians at a distant location while in the ambulance has been developed and evaluated.

Wireless systems are defined as first and second generation (1G and 2G or 2.5 G). These network designs offer services for analog voice as well as digital services up to 38 kbps. The next generation of wireless (3G) incorporates broadband, multimedia mobile operations with digital services ranging from 144 kbps across all environments and from 384 kbps pedestrian outdoors up to 2 mbps indoors. As the next
A generation digital cellular network will have faster and larger transmission capabilities, more complex medical services can be delivered reliably and without degradation of quality. The concept of intelligent “mobile agents” to support telemedicine applications was described by various authors. Essentially these are software agents that can analyze large data sets and retrieve specific information relevant for clinical decision-making.

The range and complexity of telecommunications technology requirements vary with specific medical or health applications. However, generically defined digital medical devices impose the telecommunications performance requirements. The majority of vital sign medical devices require relatively low data transmission rates. Capabilities currently offered by these systems, even 1G and 2G wireless and basic telephone connections, would support the transfer of information provided error free or as “error detecting and correcting” processes. Tradeoff must be considered when choosing a telecommunications system for high data intensive services. However, the newest telecommunications offerings reduce the time per view to less than a second per view (at OC-768).

A few demonstration projects from several countries are briefly described below to illustrate the range of applications:

- The first is a collaborative model system developed by Mitre Corporation (McLean, VA). It used two ATM high-speed switching units to support concurrent transfer of voice, data, and video between several medical facilities. This system demonstrated a practical application of ATM systems using real-time microscopic image transfers, concurrent with magnetic resonance imaging.
(MRI) images, live video and audio, and collaborative capabilities between research facilities.

- A novel emergency telemedicine system based on wireless communications, AMBULANCE5 demonstrated a successful wireless telemedicine system at four different sites in Europe. The goal of the project was to transmit medical information from an emergency ambulance to distant medical facilities for consultation. The project reported less than 10% interruptions in communication, and only 5% of wireless connections were actually lost.

- A digital wireless system, referred to as the global system for mobile (GSM) communications, the system used for cell phones proved more than capable of meeting the minimum thresholds of medical data transfer rates. Generally, GSM was employed in cases where the emergency site was on average 40 minutes away from a medical facility. In some instances, myocardial infarctions (MIs) were treated with thrombolytic therapy before the patient was transported to the hospital.

- There has been ongoing demonstration in Taiwan using hybrid fiber coaxial cable (HFC). Integrated service digital network (ISDN) and ATM configurations as well as basic “twisted pair” telephone service were also considered before settling on HFC as the most cost-effective solution. These services included a three-channel electrocardiogram (ECG), blood pressure, and live video and audio service. ECG transmissions were successfully completed.
Interoperability

To date, much of the engineering work in telemedicine has consisted of integrating off-the-shelf components to enable various clinical applications. As a result, these systems can be costly and inflexible. While they perform well in terms of their intended functions, adding new features can be costly and time consuming. Moreover, the “closed” designs of these systems means that the telemedicine stations from one vendor may not be able to communicate with those produced by another vendor.

To address these shortcomings, the telemedicine community needs a three-level approach to telemedicine system interoperability. First, stations developed by independent vendors must be able to interact with each other. Second, medical devices and other “peripherals” connected to one vendor’s station must be able to interact with stations created by other vendors. Finally, it should be possible to create individual stations in plug-and-play fashion from components developed by multiple vendors. The first level of interoperability can be implemented with only limited change in existing systems, and the second level does not necessarily require the first. Reaching consensus on the third level will require substantial effort but will be rewarded by equally substantial benefits.

At the first level, a station wanting to interact with other stations advertises its existence in a “registry server” — a public resource that contains both address and attribute data describing various telemedicine stations. The station wanting to find a specific station or a certain type of station queries the registry server and is provided with the address of at least one station that fits the query. Using this
address, the station contacts the desired station and inquires about
the specific medical devices and other resources installed at the host
station. Subsequently, the requesting station reserves specific
resources and a proposed quality of service and security parameters to
be used during the session. If the host station responds positively, the
two stations negotiate with the network to establish the quality of
service requirement for the session. Once a session is established, the
requesting station interacts with the resources that it has “leased”
from the host station as if these resources were local at the requesting
station. This is the simplest form of interoperability.

To address the second level requires standardizing the interfaces of
devices (i.e., medical instruments or patient record cards) that attach
to a station. It also requires that the station be able to monitor when
devices have been added or removed, and that other components in
the station be able to explore and employ devices dynamically
attached in this way. One approach to achieving this would be through
the use of a “station registry,” which maintains descriptions of all the
components that make up the station and is able to alert other station
components when a given kind of device has been added. If
implemented, this level of interoperability makes it possible for end
users to create, in plug and-play fashion, a range of stations to meet a
diverse collection of healthcare delivery needs.

The third level requires the creation of systems that are based on
shared, distributed resources. For instance, in the future, this might
allow medical peripherals and software to be added to a home’s
existing computing and communications infrastructure to create a
home-based telemedicine station.34-40
Emergency Telemedicine: Four Essential Components

Emergency telemedicine requires even more advanced, efficient technology to assist with multiple care needs. At the most basic level, the installation of high-speed technologies that allow the transfer of images and videos in an efficient fashion can improve emergency telemedicine delivery.

The success of this transfer depends on four essential components:

1. Speed at which data can be transferred:
   The speed at which data is transferred is known as bandwidth or “pipes,” and is measured in multiples or diminutives of Bits/seconds. The bandwidth of a system can vary widely based on the type of communication, i.e., radio vs. cellular vs. wired. To put this in a telehealth perspective, sending an ECG requires about 1-2 Kbps, whereas a complete video telehealth consult requires a higher quality, more secure network; most complete video-based telehealth operations utilize 384 Kbps bandwidth speed, but 1-2 Mbps provides higher definition.

2. Reliability of the system:
   With regard to reliability, wired technologies are less prone to latency, dropouts, or complete loss of connectivity, as they provide a constant connection that allows thorough transmission of voice, text, or images. Wireless, as one could imagine, can be more vulnerable to such inconsistencies depending on the service connectivity.
3. Security of the system:
Of utmost consideration in medicine is system security. A 3G or 4G public network, such as the Long Term Evolution (LTE) initiative in Mississippi, is an example of a public safety system that has high security without sacrificing quality. As with all patient health information (PHI), encryption on telehealth products, following proper HIPAA compliance guidelines, should be considered a priority.

4. Technology used in the system:
In addition to appropriate bandwidth speed, security, and reliability, equipment to conduct a proper video teleconferencing (VTC) consult requires either an add-on desktop hardware program or a dedicated system that is sold with remote-controlled camera, control computer, TV monitor, CODEC software/hardware ("Coder/Decoder" which converts analog to digital technology), and microphone. To ease this process, a number of programs have recently been marketed for physician-patient conferencing. Two of these, VSee and Vydio, are similar to Skype in their functionality, but are advertised as having the additional benefits of being Health Insurance Portability and Accountability Act (HIPPA) compliant, encrypted, and run at a lower bandwidth.

A teleconference system that may be used on a personal laptop, or downloaded as a free “app” for a 3G/4G cellular phone or Apple iPad, also sync with medical devices such as otoscopes, stethoscopes, and ultrasounds.\textsuperscript{28,41-44}
Emergency Treatment: Audio and Video Capabilities

Emergency medical treatment requires fast, definitive, precise care as well as major resources and continuous expertise. Most trauma centers around the world are concentrated in urban settings; consequently, most of the world’s population is not covered by specialized trauma systems. Telemedicine for trauma and emergency management is therefore emerging as a new frontier and is evolving as an integrated part of trauma care in modern trauma practice. Recent technological advances have enabled trauma centers to provide care to regions with limited medical resources. The majority of emergency telemedicine has been delivered using audio and video resources. This has served as the foundation of telemedicine programs.

In emergency situations, there are a limited number of medical specialties on duty in a local hospital. A possibility to improve the accessibility of emergency specialists is to communicate over distance in the emergency situation. However, if proper equipment is not used, the risks may outweigh the benefits. To prevent problems from occurring, The International Telecommunication Union (ITU) has defined several technical standards for video conferencing (VC) equipment. These standards determine whether VC equipment from different manufacturers (i.e., Tandberg, Polycom, Sony, Microsoft, Aethra, among others) can communicate and handle data transport. In addition, ITU has defined several subgroup standards, such as sound, video, parallel video streams, and data encryption. The latter is important for patient security, confidentiality, and privacy. Four technical solutions for data transmission during a VC are possible: satellite communication, Internet Protocol (IP)-based communication,
Integrated Services Digital Network (ISDN), and third-generation (3G) mobile phones.

- **VC via satellite:**
  Conducting VC via satellite provides a portable method and can be used anywhere in the world provided the necessary satellite coverage for that area is available. This makes the equipment especially suitable for use in disasters and in rural areas with poor infrastructure. However, the cost is high—for the equipment itself (Tandberg 30,000 USD) and for the rental to access a satellite (500–1000 USD/month). There is usually considerable latency in both video and audio (1–2 seconds) compared to VC via IP.

- **VC via IP**
  The use of IP for VC has several advantages. In closed networks, such as the Norwegian Healthcare Network, there is usually minimal time latency, and the signal quality is good. However, if the open internet is used, there are no guarantees of quality of service, as it is dependent on the amount of traffic on the internet. There is usually a reasonable price for line rental.

- **VC via ISDN**
  ISDN use for VC has seen a reduction in the Western world after introduction of the 3G mobile phone.

- **VC via 3G mobile phone**
  Using a 3G mobile phone for VC is widely used in the medical community. Services include wide-area wireless voice telephony,
video calls, and broadband wireless data, all in a mobile environment. It is easily accessible for a reasonable price on the commercial market. The 3G phone method is dependent on special features in the mobile telecommunication network.

Although such features are not available in all countries, 60% of the population of South Africa has access to 3G bandwidth; and in Nigeria and Uganda 90% of the population has access to 3G bandwidth. There are, however, several disadvantages. There is usually a small display, and the quality of the video is poorer than standard video equipment. The camera lenses are usually of lower quality than standard VC equipment. The 3G mobile phones use separate communication standards and cannot communicate with traditional VC equipment. Data encryption is not possible with a 3G mobile phone.41,46-48

**Mobile and Wireless Platforms**

Telemedicine provides an opportunity for patients to connect with their medical providers regardless of the geographical distances between them. It is not unusual for patients in rural areas and developed nations to routinely meet with their physician via real-time teleconferencing. Typically these sessions involve the physician reviewing an electronic medical record that contains the patient’s history and laboratory findings, imaging studies and other medical testing done in typical medical centers. Through this exchange of data and a real-time discussion with the patient, many routine and specific medical problems can be well managed and treated.49 With the addition of patient-side diagnostic instruments (such as stethoscopes, cameras, blood test and skilled medical technicians), the range of
medical services provided via telemedicine rapidly expands. For example, an individual in a rural area can be treated by a specialist without traveling to the specialist’s office; a new mother can get advice from her child’s pediatrician late into the night from her home; and a rural emergency department can get a consult from a specialist in an urban setting on how to treat a patient with a stroke.

All of these scenarios are possible because of the evolution and implementation of a high-speed data transmission infrastructure. With more advances on the horizon, telemedicine and remote healthcare delivery is primed to expand significantly. The recent development and installation of inexpensive high-speed wireless telecommunications networks, along with the emergence of large-scale search engines and handheld smartphones, has significantly changed healthcare delivery as well as the scope of healthcare services.\(^{33}\)

There are approximately 305 million wireless subscriber connections and more than 26 percent wireless-only households in the United States. In fact, in recent years, mobile phones have become a standard element in American life. Therefore, wireless phones, specifically smart phones and the associated data network, provide another method of telemedicine delivery. This new method has already begun to have a significant impact on the healthcare system, with more opportunities developing daily.

Today’s smartphones are not only powerful computing devices (1 to 1.5 GHz processors) connected to a worldwide, high speed data network, but they can also be configured with various onboard applications that connect to special sensors via a standard wireless
interface (Wi-Fi or Bluetooth). In addition to the underlying hardware, these devices now support powerful standardized software operating systems like Android and iOS. This powerful computing system, capable of networking with local and distant devices, opens an interesting set of healthcare possibilities.\textsuperscript{50-52}

Smart phones provide physicians with the ability to conduct a videoconference with a patient from any distance in the same way that telemedicine consultations have been conducted between two different medical clinics or a physician’s office and a patient’s home. In fact, this mobile platform-based conference is not very different from earlier forms of telemedicine consultation. However, the “addition of real-time biometric monitoring or telemonitoring with data fusion made possible by our high-speed wireless data networks adds a level of sophistication and is part of our immediate future.”\textsuperscript{48} Beyond standard teleconferencing capabilities, smartphones can also provide additional patient monitoring opportunities. A mobile phone can be:

“connected wirelessly to physiologic monitors worn on a patient’s body or embedded into a patient’s garment. Physiological monitors may be configured into a home health or medical station with minimal space requirements. Some of the small monitors such as blood glucose, blood pressure, temperature, kinematic, EKG, imaging and electromagnetic field monitors are currently available and can foreseeably be interfaced with portable micro sample blood chemistry test sets, which are also available today. It is not difficult to imagine a patient being given a specific set of monitors tailored to his or her specific health care needs, and the data from these monitors and systems can be routed to the physician for either evaluation or to a
monitoring program designed to give the doctor an alert or warning based on observed findings.”

Adopting a wearable or portable embedded physiological and cognitive monitoring system will enable a medical team to closely monitor patients without bringing them into a hospital or a specialty care center. This level of monitoring allows a healthcare team to address patient problems before they require major intervention in a specialty care center. It is especially helpful when managing chronic conditions such as diabetes, hypertension, and cardiovascular disease and has been shown to reduce hospitalization and, in some cases, reduce mortality rates. Collecting and integrating patient data is also used to tailor patient educational sessions that address actual observed patient conditions. With the availability of technology, patient education or consultation sessions can also be delivered directly to patients via their smartphones.\textsuperscript{54,55}

The opportunity to provide tailored medical care and services to remote patients offers a number of benefits that contribute to better and more effective healthcare. Mobile technology provides an approach and a level of access to healthcare services that enhances patients’ expectations of their healthcare system and service providers, as well as societal expectations of the medical system. It is quickly becoming a standard of care to offer and deliver proactive patient educational or informative sessions via mobile technology.\textsuperscript{36} In the past, these sessions could only be delivered face to face and in person. However, mobile technology has provided a more economic method for dispensing this information. At the basic level, providers can make use of distributed text or video messages tailored to the
specific needs of the individual patient. At the advanced level, healthcare can become a virtual medical home distributed over a secure wireless network accessible by the patient and his/her healthcare team regardless of who is part of the team today or where the patient is located.\textsuperscript{48}

Using a standardized platform, along with operating systems of mobile platforms and the ability to collect and manage large distributed data sets, provides an opportunity to target health care to individual patients and entire populations. Through the application of data mining and data fusion techniques along with anonymous geographical information, it is possible to monitor a disease as it emerges and migrates between geographical regions. Distributed systems that monitor body temperature can track probable influenza outbreaks, and utilizing data sets from consultations for nausea and diarrhea can help identify a contaminated food distribution chain. Given the ability to collect and use unprecedented amounts of patient and population information in near real-time presents a wide range of opportunities for treating and monitoring patients, both individually and as a large group.\textsuperscript{19,56,57}

**Risks of Telecommunication**

In addition to offering an improved ability to serve the patient population, the ability to capture and use data also presents real and imagined risk. To mitigate these risks, “the medical and the telecommunications industries will have to develop plans and policies to protect individual patients from privacy violations, particularly with issues surrounding access to medical information, confidentiality and security. Methods of ensuring privacy such as controlled access,
encryption and authentication can and must be employed to assist in securing and protecting privacy of medical data.”24,57,58-60

Mobile Health (mHealth) and Medical Apps

Mobile phones have been widely used in telemedicine in recent years. However, most recently, there have been a number of advancements in the mobile health field. The most significant of these advances is in the field of mobile health apps. Recently named one of the top healthcare initiatives by the director of the National Institute of Health (NIH), Francis Collins, an estimated 84% of physicians are already using smartphones, with 25% more also using tablets to access the over 13,000+ smartphone apps available for medical-decision making. Collins stated:

“mHealth apps are just beginning to transition from “gee-whiz toys” to a low-cost, real-time ways to assess disease, movement, images, behavior, social interactions, environmental toxins, metabolites and a host of other physiological variables. A promising use of mHealth in the emergency setting is for acute wound assessment. A recent study at the George Washington University in Washington, D.C., studied images taken by 94 patients with acute wound lacerations over an 8-month period. Patients provided a medical history, took four pictures of their lacerations, and were assessed by ED providers about need for repair; the same provider then assessed the patient in person. The study found concordant decision-making between mobile and in-person assessments to be 87% (κ statistic=0.65), with the degree of under-triage due to poor image quality or poor representation of the problem to be 5 out of 94, or 5%. Limitations included variety of phones used for assessment,
The use of mobile medical apps on smart phones and tablets has had a significant positive impact on health care delivery. With the advent of the iPhone and iPad, software has been made to give emergency physicians the ability to view sensitive patient images for use in medical management. Mobile MIM is one such free app. Approved for use by the FDA in 2011, it “transfers radiologic images from the hospital and transfers them securely to other appropriate portable wireless devices via cloud-based DICOM software. This important mobile technology provides physicians with the ability to immediately view images and make diagnoses without having to be back at the workstation or wait for film,” said William Maisel, M.D., M.P.H., chief scientist and deputy director for science in the FDA’s Center for Devices and Radiological Health. Following its induction in February 2011, a six month analysis of its portable device characteristics and accessibility showed that all performance requirements met intended specifications, and “that Mobile MIM (RT) provides a safe and effective diagnostic viewer of the following medical imaging modalities: SPECT, PET, CT, MRI, X-ray and ultrasound.”

In addition to an increase in medical provider use of mobile health apps, patient use of mobile health apps is also on the rise. The market for medical applications for patients reached $718 million in 2011. Of these, Apple and Google offer over 500,000 apps each. One app that specifically targets emergency patients is iTriage, a free app created by two ED physicians in 2008. The description for this app explains that it “helps you answer the questions: What medical condition could
I have? Where should I go for treatment? Save, easily access, and share the healthcare information that’s most important to you.”

**Data Integration And Patient Monitoring**

Telemedicine provides healthcare opportunities that extend beyond treating and monitoring patients. The use of technology provides opportunities for improved health information management. The use of electronic health records and data integration software provides opportunities for accessing and sharing patient data across multiple channels. However, it also requires additional consideration for the management of such a complex system. The most important considerations include “aggregating large data sets (i.e., remote monitoring); using and storing numerous file formats (video, audio, text, digital images, film); establishing safeguards for sharing data with virtual providers and distant sites; determining the appropriate location for data storage (if more than one provider or entity is involved); and more. All of these challenges create issues relating to medical record management, maintenance, ownership, and storage.”

**The Medical Record**

Prior to the advent of telemedicine and telehealth programs, it was easy to define what was and was not considered the “medical record” for a patient. Typically, the medical record was the patient’s paper file and/or a basic electronic medical record (EMR). However, with the addition of the internet, telehealth, and other electronic means of data transmission, the scope and composition of the patient’s medical record has changed. At this point, there is still confusion regarding what new mediums must be included in a patient’s medical record.”
The medical record is a crucial component of telemedicine, and it is necessary to understand the definition and scope of the term. The Health Insurance Portability and Accountability Act (HIPAA) Privacy Rule requires that an individual has the right to access and/or amend his or her protected health (medical record) information that is contained in a “designated record set” (DRS). Thus, healthcare providers must understand what they are required to include in the patient’s medical record and provide for the patient upon request. Telemedicine has made this more manageable in many ways, as patients can now access their records electronically. However, it has also introduced a scope of potential risks and some confusion regarding what should be included in the record.56

To better understand electronic health records and patient data, it is important to know the definitions of the various terms used within the HIPAA Privacy Rule. The term “medical record” generally refers to the collection of information regarding a patient and his/her health care. The term “designated record set” is defined within the Privacy Rule to include medical and billing records, and any other records used by the provider to make decisions about an individual. Each healthcare organization is required to define the data or documents that meet this definition.65

In addition to HIPAA, some organizations are subject to state laws that provide specific definitions relating to telehealth and medical record documentation or retention. Another common theme in many state statutes and codes is that telehealth documentation retained in the medical record must be comparable to an in-person office visit. For example, in order to be reimbursed for telemedicine services
“documentation in the patient’s medical record for a telemedicine medical service or a telehealth service must be the same as for a comparable in-person evaluation.”

Other sections of the privacy rules set forth specific telehealth record retention requirements. The following is an example of a standard set of guidelines:

*Medical records must include copies of all relevant patient-related electronic communications, including relevant patient-physician e-mail, prescriptions, laboratory and test results, evaluations and consultations, records of past care and instructions. If possible, telemedicine encounters that are recorded electronically should also be included in the medical record.*

**American Health Information Management Association (AHIMA)**

The American Health Information Management Association (AHIMA) is a leading national organization for health information management practices, and its data retention practices are often cited by numerous health care organizations and publications as the current industry standard. At this point, AHIMA has established that:

*Organizations only need to include documents that can be provided in a human-perceptible form to patients, and/or documents that are reasonably feasible to provide to patients. Thus since it is not explicitly required by state or federal law, large data sets and streams from remote monitoring devices which are sometimes too large and cumbersome to store long-term and/or too difficult to*
provide to patients, may be exempt from being considered part of the legal medical record. It is up to the organization to make the decision on what can reasonably and feasibly be included in the record. The organization should capture this information in a corporate policy or data matrix. Employees will need to be informed and properly trained on compliance with these policies. It is also important to note that secondary data (notes, images, videos) that are not related to these patient-centered or billing functions likely do not need to be included in the medical record. In addition to federal and state laws and regulations, organizations should also consult with any payers they have contracted with for guidance or billing requirements. Often large payers have specific requirements for medical record documentation and retention relating to telemedicine. Further, once an organization develops its definition of the “legal” record, it should develop its own corporate policy.\(^{68}\)

The American Health Information Management Association provides additional clarification regarding the collection and management of patient health records. Utilizing federal and state laws, regulations, and guidance to ensure accurate and secure transfer of patient data is one component if telemedicine. While the focus appears to be on creating an exhaustive list of exact documents that must be included in the medical record, it is actually an attempt to include documents or media that are directly used in medical decision-making and treatment of patients and/or documents that are necessary for supporting billing claims. According to the AHIMA: “The determining factor in whether
something is to be considered part of the legal health record is not where the information resides or the format of the information, but rather how the information is used and whether it is reasonable to expect the information to be routinely released when a request for a complete medical record is received.”69

**AHIMA Standards for Telemedicine Services**

As telemedicine services are rendered, capturing the documentation and ensuring the accuracy and timely completion has been a challenge for many organizations. However, based on those who have telemedicine programs in place, it can be concluded that telemedical record requirements, regardless of media, are the same as for other health records. Therefore, the information of the visit, the history, review of systems, consultative notes, or any information used to make a decision about the patient must be addressed.

Telemedical record content is not specifically addressed in the standards of the Joint Commission, the National Committee for Quality Assurance, the American Osteopathic Association, the U.S. Department of Health and Human Services, or the Accreditation Association for Ambulatory Health Care. However, it is understood that telemedical records should be consistent, accurate, and timely, and should contain non-duplicative documentation.70 The AHIMA has developed the following guidelines for the maintenance and management of telemedical records:71

- Individual practices should address maintenance of images or recordings that should be considered part of the patient's health
record and those records should be retained according to state retention laws.

- Availability and location should be noted in the health record. Redundant systems for electronic records should be maintained and an emergency plan established in case of electronic system failure.

- Telemedical records should be kept in the same manner as health records. The specific documentation needed varies depending upon the level of telemedical interaction.

- The organization using the telemedical information to make a decision on the patient's treatment must comply with all standards, including the need for assessment, informed consent, documentation of event (regardless of the media), and authentication of record entries.

- At minimum, AHIMA recommends that each telemedical record contain the following:
  
  o Patient name
  o Identification number
  o Date of service
  o Referring physician
  o Consulting physician
  o Provider organization
  o Type of evaluation performed
  o Informed consent, if appropriate (in many telemedicine programs, the referring physician or organization retains the original and a copy is sent to the consulting physician or organization)
  o Evaluation results (in many telemedicine programs, the consulting physician or organization retains the original
and a copy is sent to the referring physician or organization

- Diagnosis or impression
- Recommendations for further treatment

- It is also important to ensure that patient registration information needed by the consulting physician or organization is obtained, in addition to information routinely obtained.
- Retention of telemedical records should be in accordance with state laws or regulations and any reimbursement requirements.
- Maintenance of telemedical records should ensure that the organization can quickly assemble all components of a patient's record, regardless of their location in the organization.
- In the absence of policies specifically addressing disclosure of telemedical information, disclosure should be allowed upon receipt of written authorization from the patient or legal representative or in accordance with court order, subpoena, or statute.
- Informed consent for telemedical encounters should include the names of both the referring physician and the consulting physician, and it should inform the patient that his/her health information will be electronically transmitted.
- Telemedical records media may be hard copy, video or audiotape, monitor strip, or electronic files. Some states specify acceptable media for health records.
- Review the appropriate state laws and regulations for any specific requirements.
- To avoid duplication of information and determine custodianship, identify the responsible holder and owner of the legal telemedicine record.
Emerging Technologies

Within the past decade, there have been significant advances in technology, which provide greater opportunities for healthcare providers to utilize telemedicine. This is especially true in emergency care environments, where treatment requires reliable and fast services. The following is a list of some of the most recent advances in technology:47

| Digital Video Transport System | Digital Video Transport System (DVTS) is a simple and inexpensive application for sending and receiving digital video (DV) streams using broadband Internet. This software was developed by the WIDE (Widely Integrated Distributed Environment) Project in Japan. Although it is a powerful and internationally authorized program, it is freely downloadable (http://www.sfc.wide.ad.jp/DVTS/software/). With DVTS, providers can transmit high quality video with low latency, because the system skips the compression process, which inevitably degrades the quality and is time-consuming. To secure this high quality, however, stable Internet with at least 30 Mbps of bandwidth and a public IP address is required. The minimum devices needed are as follows: personal computer (PC), running either Windows, Linux, or Mac OS and equipped with a FireWire (IEEE1394) interface, DV camera or other video source with FireWire capability, and audio devices such as microphones and speakers.

The biggest advantage of a DVTS system is the price. DVTS is definitely the least expensive of all telemedicine systems, but only if the appropriate Internet capability is available. DVTS software is free; a DV camcorder, microphone, speaker, and PC are all very common products, which the hospital may already have. |
Thus, this system does not require special and expensive equipment for use in telemedicine. Moreover, National Television System Committee/Phase Alternating Line conversion is automatically carried out between different color formats.

Additional advantages are easy handling, portability, and high compatibility with audio and video devices. Due to skipping compression, the processing delay of DVTS, which is known as latency, is between 200 ms and 400 ms, which is good enough for interactive conversation.

Considering the disadvantages, the DVTS system consumes over 30 Mbps network bandwidth for the highest quality of communication. It cannot use the commercial Internet, but instead needs an academic network (an Internet leased line with high bandwidth and high performance). Although such a government-funded network is now available in many countries and connects many universities and academic institutions worldwide, it is not yet an easy task for certain developing countries or private hospitals to get connected to this network.

Regarding equipment, DTVS is not a complete system although it is compatible with a variety of common devices. Therefore, users themselves need to ascertain the most suitable equipment. Nevertheless, the package of necessary equipment is illustrated for their convenience.

In addition, because the DVTS solution is free and without any technical support, the engineer needs to have appropriate knowledge and skills to set up, troubleshoot and optimize the system. As this system does not come with either an echo-canceller system or a quality of service (QOS) system, the local engineers need some experience to run it properly.
| **H.323 Video Conferencing Solution** | The H.323 protocol is a recommendation from the International Telecommunication Union that defines the protocols for providing audio-visual communication sessions on any packet network. The H.323 standard addresses call signaling, multimedia transport, and bandwidth control for point-to-point and multi-point conferences. It is widely implemented by videoconferencing equipment manufacturers, is used within various Internet real-time applications, and is widely deployed worldwide by service providers and enterprises for both voice and video services over IP networks. In contrast to DVTS, this system comes in an all-in-one package. All the necessary video and audio equipment for transmission is built into a set of hardware that performs compression of audio and video streams in real-time.

The system is compatible with standard-definition (SD) video, which is referred to as 480p video mode, was developed in the early 1990s, and has become quite popular. The bandwidth required is 0.3-2 Mbps, much smaller than that for DVTS. Although this system has frequently been used for general teleconferencing and e-learning using slides without video presentations, it has never become popular in telemedicine mainly due to insufficient quality for video streaming. Nevertheless, a high-definition (HD) video conferencing system, an upgraded version of the SD system, has recently been developed and commercially released, providing much better quality video transmission, with 30 or 60 fps (frames per second) at resolutions of 1080i or 720p.

Currently, this solution is still quite expensive, and is not yet widely used in the medical community. However, with the expansion of HD medical devices in hospitals and a growing number of the upgraded videoconferencing system in companies and public institutions, this system is promising in telemedicine. |
The bandwidth required by this videoconferencing system is around 2 to 8 Mbps, which is not too large. Streaming images have sufficient quality and motion, and are attached to HD devices for input and output.

The all-in-one system provides easy handling and requires less preparation during setup. Sound quality with a built-in echo cancelling system is also an advantage. Another merit is that there are many suppliers of these products, and they are pretty much compatible with each other. Therefore, there is more choice and greater support from the vendors, such as Polycom Inc., LifeSize Communications Inc., Tandberg Inc., Sony Electronics Inc., Cisco System Inc., amongst others. Despite all these advantages, this system also has some disadvantages. The first of these disadvantages is the image quality with the SD version of the system. Although the number of HD systems is increasing in the market, the availability of this high-end equipment is still limited and many centers are working with the old version, which cannot provide smooth and clear video transmission. The problem is that when the two different versions are connected, the quality is downgraded to SD even in the HD-equipped centers.

As far as multiple connections are concerned, companies offer various solutions, from MCU software support for up to 6 station connections, to a hardware system supporting dozens of connection points. It should be noted that suppliers now also offer a software version of the H.323 video conferencing system. Using a normal PC and webcam, users can conduct point-to-point calling or join a multipoint videoconference. This solution is simple and easy to use with acceptable quality for personal remote meetings. The main disadvantage is the quality of the shared content. H.323 software works well with still images and presentations; however, transmitted video has low quality, is noisy and loses frames.
| **Vidyo** | Vidyo, a new company from the U.S., has developed its own videoconferencing system. This is one of the previously mentioned H.323 videoconferencing systems, but is based on the latest H.264 standard, which is currently the most advanced and effective compression technology as opposed to the conventional H.263 protocol. Vidyo provides low latency and high quality video conferencing from hardware devices, PCs, and mobile devices over the Internet. Using their new Vidyo network architecture, videoconferencing can be carried out over the commercial Internet or academic networks, even using a wireless or mobile network, thereby providing flexibility for users. Although the connection speed is limited to 8 Mbps, the transmitted image quality is perfectly acceptable with a good compression standard. High-quality video communication means the Vidyo system is ideally suited to telemedicine. Vidyo provides a strong ability to connect from a PC, using VidyoDesktop software. Users can work on hardware and devices already owned, and the VidyoDesktop is compatible with other audio-visual devices, and is built to run on Windows, MacOS or Linux. Not requiring a global IP is another big advantage. As a new system with the many advantages mentioned above, there are good reasons to choose Vidyo for our telemedicine activities. However, there are also some disadvantages.

One of these is the fact that this is a new system that is not that popular yet. This means that not many stations and engineers are familiar with it and the only support available is from the Vidyo company. Compared with companies that have had many years of experience, the Vidyo product is not entirely perfect, the features are less complete, and one still has to wait for the upgrades from the company. Although the VidyoDesktop is compatible with most audiovisual devices, only recommended specialized equipment can be used with |
VidyoRoom, the hardware for this system. This is really a problem if one wishes to use one's own devices or create a flexible system.

The "community" can be a disadvantage with Vidyo, too. One needs to participate in a community of users, and thus, independent hospitals or individuals cannot use Vidyo. Moreover, as far as video transmission is concerned, the stations that can send a clear enough signal are restricted to those that have installed a VidyoRoom system, whereas stations without this system cannot send video clearly; they can only receive it. In addition, the compatibility of Vidyo with other videoconferencing systems is not that good. Sometimes users have difficulty connecting to other popular and widely accepted H.323 videoconferencing systems.

Vidyo has also developed a multi-point connectivity solution, called VidyoGateway, to bridge traditional systems with their Vidyo system and extend multipoint conferencing. The VidyoGateway supports Vidyo endpoints and other videoconferencing systems and MCUs from other vendors. However, the problem here is that the monitor only shows up to 9 stations, with the rest hidden, which is unsatisfactory for communication.

**Implementation And Application**

There are a number of ways that technology and telemedicine can be used in emergency healthcare. This section discusses the unique aspects of implantation and application of telemedicine in emergency scenarios.
Telemedicine in Emergency Care

Depending on the needs of the patient, emergency care providers can use telemedicine as a supplement to the consultation, or as a replacement for face-to-face care. As technology expands, the opportunities for emergency telemedicine will grow as well. At this point, telehealth consultations and the following applications of telemedicine are the most common seen in the emergency setting.\(^{19,35,53,72,73,74}\)

**Telehealth Consultations**

Emergency department physicians are masters at multi-tasking and triaging patients. However, some diagnoses have beneficial but risky treatments that are best administered in conjunction with other medical specialists. The emergency provider’s knowledge and experience, the patient’s acuity of care, and available facilities are all factors that may alter the level of care. The role of telehealth in the management of acute stroke, rapid interpretation of radiologic images, and management of traumatic injury requires evaluation as a means to create a standard mechanism for accessing high-quality care in any setting.

**Telestroke**

The motto “time equals brain” signifies the importance of acute stroke intervention with t-PA, the current thrombolytic agent used for ischemic stroke. With only a 4.5-hour window period to administer from onset of symptoms to presentation, the use of t-PA involves a series of complex decision-making processes, often best managed by an experienced provider.
One such method to increase the use of t-PA is the creation of Primary Stroke Centers (PSCs), which must meet criteria of providing 24 hour, 7-day a week ability to diagnose and treat patients with stroke, among other strict criteria outlined by The Joint Commission. Unfortunately, PSC facilities represent a minority of facilities across the U.S. For this reason, the involvement of remote experts in stroke management, or “telesstroke” consultations, is designed to bring the highest standard of care to patients in rural, community, and urban centers alike. This system functions with a “hub and spoke” model, where the “hub” is the PSC with a vascular neurologist available for consult, and the “spokes” are non-PSC facilities staffed primarily by emergency physicians.

One such successful program includes Remote Evaluation of Acute Ischemic Stroke (REACH), a low cost, web-based system that provides a link between the Medical College of Georgia and eight rural community hospitals in east-central Georgia. In this model, the vascular neurologist at the “hub” site logs into the REACH website to access patient vitals, review CT images via DICOM software, and perform a video consultation over broadband internet to determine an NIHSS score and give the appropriate t-PA recommendations. In addition to improving patient outcome through rapid treatment, the requirements of the “spoke” hospital are feasible: a CT scanner capable of transmitting DICOM imaging, broadband Internet access, and other equipment costs less than $10,000.

It is important to highlight that PSC-underserved areas exist even in urban environments; unfortunately, a major limitation of the current model is that reimbursement is limited only to services performed in a
“rural health professional shortage area” or in a “county not classified as a metropolitan statistical area.” This loophole must be addressed to allow greater access to stroke consultation.

**Teleradiology**

Teleradiology is a branch of telehealth in which radiologists provide remote reporting on radiologic images. The field has been widely used for more than a decade, providing a good example of the rapid change in infrastructure and the results of transitioning from an on-site to remote form of communication. Indeed, teleradiology exploded in the early 2000’s. Between 2003 and 2007 the number of providers utilizing teleradiology jumped from 15% to 50%. The rise in the use of these services was initially related to the rise in CT scanners in emergency departments, with “night hawks” available for off-hours shifts. As the market increased, many hospitals saw an advantage to utilizing such services at all hours; their interpretations were affordable, and provided a rapid turn-around time of 30 minutes for preliminary reports and 24 hours for final reports. The Joint Commission began to accredit companies providing teleradiology services in 2004, further establishing their place in the world of radiology.

One of the largest providers of teleradiology currently includes the Minnesota-based VRad, which partnered with NightHawk in 2010, to expand to more than 2,700 healthcare facilities nationwide. According to CTO Rick Jennings, VRad has spent $50 million over the last eight years building out its I.T. infrastructure, stating “we were cloud before it was called the cloud.” While teleradiology surely is an added benefit to emergency situations when radiologist interpretations of studies are
limited, limitations to patient care exist. Coordination of care — such as compiling final reports based on follow-up examinations, imaging study comparisons, and collaborations across specialists — is reviewing a patient’s images across time, which may create incongruence in treatment and care. Such considerations should be taken into account, as EMRs develop to provide more patient-focused care that reduces interpretation difficulties.

*Teletrauma*

The “golden hour” is an important concept in trauma, as it provides rapid, excellent care to critically injured patients and improves outcomes by 25%. Unfortunately, only some 30% of the U.S. population has access to designated trauma centers within the first sixty minutes of their trauma, posing a major public health concern. Teletrauma, therefore, is an especially exciting field in the spectrum of emergency medicine, as it allows remote regions of the country to stay connected to provide a high standard of care. One large-scale example of such a facility is Eastern Maine Medical Center (EMMC) in Bangor, Maine. As one of the state’s three regional trauma centers, it serves as the referral center for more than 20 community-level hospitals. In 2004, EMMC became the first center to conduct telehealth consultations through live audiovisual connections at eleven sites throughout the state. With initial start-up costs totaling $70,000, maintenance of the system has been facilitated by internet provider-based services, utilizing large video screens that display the trauma bay to trauma consults at distant sites.

Its implementation demonstrates a number of valuable lessons on the impact of teletrauma by involvement in the initial patient survey,
experienced trauma surgeons can bypass obsolete practices such as “spine clearance,” suggest against CT scans and X-rays in certain cases, and provide current guidelines for reversal of therapeutic anticoagulation — all issues that have been found in less-experience providers. Additionally, their experience with teletrauma has created an enhanced, rather than decreased sense of teamwork and partnership amongst those participating in the interactions. The EMMC coined the term “the 130 million square foot trauma room” to describe the success of their collaborative efforts.

A challenging aspect to the teletrauma program at EMMC is that the trauma surgeons, while available 24/7, were often not physically able to get to computer sites that connected to the remote hospitals at the time of trauma; additionally, some providers noted difficulty navigating cumbersome computer menus. More recently, a solution to this problem emerged with expanding Apple iPhone technology with programs such as Facetime, which allow face-to-face video interaction with a simple WiFi connection. In the first-ever launch of its kind,

Desktop-based trauma consults can be supplemented with iPod Touches, where they are able to perform assessment of patients via crystal-clear video and audio capacity; i.e., zooming on a patient’s pupils during a neurological exam for a boy with craniofacial injuries. As with all considerations, while such programs will likely result in an overall decrease in cost, financial reimbursement for services is a concern and will likely drive the expansion or demise of such programs.
Clinical Accuracy of Telemedicine in Trauma Care

The clinical accuracy of telemedicine in evaluating trauma patients has been a concern, as it is imperative that care delivered in this manner is efficient and reliable. Recently, the level of clinical accuracy has been assessed in a study that determined the following:

When telemedicine was used for minor trauma consultation and compared with face-to-face consultations in two hundred patients, skin color changes were accurately defined in 97%, the presence of swelling or deformity in 98%, diminished joint movement in 95%, presence of tenderness in 97%, weight bearing and gait 99%, and radiological diagnosis was made correctly in 98% of cases. The severity of injury was overestimated in one and underestimated in five cases, but the final diagnosis was correct in all but two cases. Similarly, other authors have shown that remote evaluation of trauma patients using telemedicine is accurate and feasible. In a two-phase project using ATLS-based evaluation tools, it was found that accurate clinical data could be recorded, tasks delegated, and therapeutic measures advised and applied using telemedicine. This application of telemedicine can make expert trauma care available to patients in hospitals and emergency rooms without advanced trauma systems, and potentially reduce costs, prevent unnecessary transfers, and promote early transfer when indicated.6

Telemedicine in Follow-Up Care of Trauma Patients

Until recently, telemedicine in emergency care has been limited to the actual emergency consult. However, with new advances in technology,
telemedicine is now being applied to the follow-up care of trauma patients. Many telemedicine based follow-up assessments of trauma patients can be performed with the assistance of a nurse, an electronic stethoscope and a close-up imaging instrument. In most instances, video teleconferencing is used, with the average duration of the video-teleconference appointment lasting approximately fifteen minutes. In instances of follow-up care, both patient and physician satisfaction is high, due in part to significantly decreased travel distances and time. In a follow-up survey, all patients involved strongly agreed with the statement “Telemedicine makes it easier to get medical care”.  

Telemedicine tools have also been applied to the field of wound care management. In one study, bedside wound examination of 38 wounds in 24 vascular surgery patients was done by onsite surgeons and was compared with viewing digital images of those wounds by remote surgeons. Agreements regarding wound description (the presence of edema, erythema, cellulitis, necrosis, gangrene, ischemia, and granulation), management issues (such as, the presence of problem wound healing, need for emergent evaluation, antibiotics and hospitalization) were analyzed and compared between onsite and remote surgeons. Agreement between onsite and remote surgeons matched for wound description and wound management. Sensitivity of remote diagnosis ranged from of 78% for gangrene to 98% for identification of problem wound healing respectively, whereas specificity ranged from 27% for erythema to 100% for ischemia. The agreement was influenced by the wound type (p < 0.01), but not by the certainty of diagnosis or level of training (p > 0.01). This combination of telemedicine and digital photography may prove to be
very useful for outpatient wound care in complex vascular surgery and in trauma patients in their post operative care.\textsuperscript{41,45,76}

**Cost of Telemedicine**

Telemedicine requires the purchase and implementation of expensive equipment and networking services. Of course, there are expenses to the set-up and maintenance of such systems. Standard equipment needed for a full telehealth suite include: televideo monitor with camera, initial network setup, patient monitoring devices, a room with well-adjusted lighting, security, and sound for clinical events. Operational costs include telehealth personnel, consultant costs, information technology (I.T.) support, equipment licenses, monthly connectivity charges, and clinical or medical records management to get information to and from distant sites.\textsuperscript{77}

The following is an approximation of the costs associated with establishing a telemedicine program:\textsuperscript{78}

- $8,000 for telehealth consultant suite ($7,000 for the interactive video display, $1,000 for telecommunications)
- $16,600 for patient suite ($9,600 for a video cart, $6,000 for an AMD Derm Camera, and $1,000 for telecommunications)
- Maintenance fees of $400/month (for ~30 patients with an average visit length of 30 minutes)
- Optional additional teleradiology costs: $12,000 for the hospital suite site and $15,000 for the patient site.

Although the cost can be significant, telemedicine is often used as a means to reduce spending. Remote access to patients can reduce
travel time, result in fewer transfers, and provide earlier intervention and access with lower “global cost” for services and social consequences, and lower readmission rates, among others. Different sites have used various means to offset the costs of building and maintaining a telehealth suite.

Federal or state grants, in addition to foundation grants, venture capital, internal funds, or other private donations are all viable options. In addition to mobile health apps, technologies, such as VSee, provide a less expensive alternative to implementing entire telehealth video consultations. Basic VSee telehealth “kits”, which include a laptop, HD webcam, electronic stethoscope, otoscope, and one-year subscription cost $6,000, whereas an advanced kit containing a pan-tilt camera, portable EKG, and portable ultrasound cost about $18,000.79

Healthcare Providers’ Satisfaction

Patient and healthcare provider’s satisfaction with telemedicine is a major issue that has been examined in the past, and continues to be an important element. Multiple studies have demonstrated that patients’ satisfaction has been one of the positive elements of telemedicine. When 52 patients with brain injury were interviewed via high quality teleconferencing these patients were very satisfied and wanted to repeat their sessions more than patients interviewed in person, especially those in the assessment phase of their disease.73

In order to fully implement remote trauma care, the remote trauma surgeons and referring health care providers must feel comfortable and confident in their ability to supervise and manage trauma care in the remote site from a central location. When the level of satisfaction
with teletrauma was analyzed, 83% of referring doctors and 61% of the trauma surgeons thought that the consultation improved patient care. In addition, 67% of all the physicians involved in teletrauma care thought that the consultation could not have been performed as well by telephone. This study demonstrated the effective use of telemedicine for consultation, expert opinion, and to determine the need for transfer of the patient to the major trauma center and, as such, has been successfully implemented in a rural setting, where both patients and the referring doctor benefited greatly from the expert at a distance.

Senior trauma experts located centrally have used Advanced Trauma Life Support (ATLS) protocol to supervise trauma scenarios performed by a physician at a remote site and recorded the degree of confidence in the supervision of the tasks on a five point predetermined Likert scale (1 – poor; 2 – unsure; 3 – satisfactory; 4 – sure; 5 – certain). Fifteen trauma scenarios were evaluated on three points: the primary survey, resuscitation and secondary survey. The average score was between 3 and 4 for the assessment of the primary survey and resuscitation phase. Such reports suggest valuable outcomes with the use of telemedicine in trauma scenarios and a basis for ongoing development and evaluation for future programs.

**Research Findings of Telemedicine and Improved ICU Outcomes**

Recently, a comprehensive assessment of telemedicine intervention and ICU outcomes was conducted. The following is a detailed report regarding their research methods and findings.
Methods

We preformed an unblinded study of Tele-ICU intervention at a large community-based hospital. Telemedicine physicians were located at a central location at Mercy Hospital; however, the community-based hospital monitored by telemedicine is located remotely in another state. For the primary analysis, a representative sample of pre-intervention cases was obtained by identifying consecutive hospital cases from a database of all ICU admissions. This investigation was a retrospective study of patients admitted to a 17-bed medical-surgical ICU of a community hospital, between July 2009 and March 2011.

Tele-ICU was implemented starting January 1st, 2010. Hospital staff physicians were asked at the time of the Tele-ICU program implementation to indicate their requested level of intervention from the Tele-ICU between level I and level II. As a result, Tele-ICU physicians were automatically consulted on the patients based on the level assigned by hospital staff physician. For level I staff physicians (52.5%), the Teleintensivist could initiate interventions for any urgent/emergent conditions as well as evidence-based therapies and hospital-approved protocols. For level II staff physicians (47.3%), the Teleintensivist had full order writing privileges and fully managed the patients. There was no phase-in (learning period) for this institution, as Tele-ICU has been implemented for other institutions for about a year before this community hospital was added. By the time this hospital was monitored by Tele-ICU, no new learning was needed. Baseline data collected for 6 months before Tele-ICU was compared with data collected for 15 months after Tele-ICU program.

The ICU model of care in the pre-intervention period was an “Open” ICU where the primary care provider (PCP) admitted patients to the ICU and continues to act as the primary physician, with consult on some patients with an in house intensivist who will manage these patients during day time only. The ICU in the intervention period remained “Open.” The only new ICU intervention was by Tele-ICU. The Tele-ICU program operated on a 24/7 schedule and was staffed by two board-certified intensivists, five critical care nurses with at least 5 years of bedside critical care experience (5–35 years, with an average of 18.6 years), and two unit secretaries.

Each telemedicine workstation consisted of the following: Philips VISICU eCare
Manager electronic critical care system, Philips VISICU Smart Alerts, Philips VISICU camera system (Philips, Amsterdam, The Netherlands) in each ICU room allowing two-way voice and two-way video communication in each ICU room, mirrored real-time Philips bedside monitors and PACS (Picture Archiving and Communications System) for Radiology, and a Powerchart for patient data from the hospital. The eCare Manager has an outbound link for all notes, physician orders and nursing documentation from eCare Manager to patients electronic and paper charts. Mercy Hospital St. Louis Institutional Review Board approved this study. Informed consent was waived for this study, since this was a retrospective review of data that pertained no harm to the patients and confidentiality was maintained at all times.

**Statistical Analysis**

The study was powered to have an 80% probability for detecting a 3% improvement in ICU LOS using 1:4 allocation patients in the Tele-ICU and control groups at a significance level of 0.05. Admission and laboratory values were extracted electronically.

The Acute Physiologic Scores (APS) and Acute Physiologic and Chronic Health Evaluation IV (APACHE IV) scores were used to measure severity of illness. Severity-adjusted ICU and hospital mortality were prescribed as the main outcomes. Other outcomes included ICU and hospital LOS. Basic descriptive statistics were calculated for continuous variables and included, presented as the frequency, percentage, or mean +/- standard deviation (SD). Log transformation and geometric mean comparison were preformed when data was distributed non-normally. Comparison of log-transformed means was made using an \( F \) test.

Comparison of categorical data was made using Fisher exact test, \( \chi^2 \)-squared test, or by logistic regression. Logistic regression analysis was used to compare the risk of mortality with the presence or absence of TeleICU program between the study periods. Comparisons of continuous outcomes were modeled using general linear models. In addition, the same outcome comparisons were made for patients admitted during the day (7 am till 7 pm) and patients admitted at night (7 pm till 7 am). All analyses were two sided and performed on SPSS 20.0 (SPSS Inc., Chicago, IL, USA).
**Results**

Whole Study Population: A total of 2823 adult patients were studied. The patients in the pre-intervention period and during the Tele-ICU period were controlled for baseline characteristics, APS, and APACHE IV scores. Mean APS scores were 37.1 (SD, 22.8) and 37.7 (SD, 19.4), and mean APACHE IV scores were 49.7 (SD, 24.8) and 50.4 (SD, 21.0), respectively. ICU mortality was 7.9% during the pre-intervention period compared with 3.8% during the Tele-ICU intervention period.

Hospital mortality was 8.8% compared with 6.9% respectively. ICU length of stay (LOS) in days was 2.7 (SD, 4.1) compared with 2.2 (SD, 3.4), respectively. Hospital LOS in days was 5.2 (SD, 6.1) compared with 6.2 (SD, 7.4), respectively.

Study Population Stratified by AM Shift versus PM Shift: Since the ICU under study was staffed by bedside PCPs during the day, we wanted to see if the outcome benefit found above was primarily at nighttime rather than during the day. As a result, we evaluated the outcomes of patients admitted between 7 am and 7 pm (AM shift) separately from patients admitted to the ICU between 7 pm and 7 am (PM shift). There were a total of 1026 patients admitted during AM shift (199 in the pre-intervention group, and 827 in the Tele-ICU group). ICU mortality was 9.0% during the pre-intervention period compared with 4.9% during the Tele-ICU intervention period.

Hospital mortality was 9.5% compared with 9.0%, respectively. ICU LOS and Hospital LOS results were similar to the whole study population results (data not shown). There were a total of 1797 patients admitted during PM shift (431 in the pre-intervention group, and 1366 in the Tele-ICU group). ICU mortality was 7.6% during the pre-intervention period compared with 3.4% during the Tele-ICU intervention period. Hospital mortality was 8.8% compared with 6.0%, respectively. ICU LOS and Hospital LOS results were also similar to the whole study population results.

**Discussion**

This study was designed to assess the impact of Tele-ICU on outcomes. Tele-ICU intervention significantly improved ICU mortality, and ICU LOS. There was a trend towards improvement in hospital mortality; however, it was associated with
Increased hospital length of stay in this study. This could be because more patients survived in the ICU and thus stayed more days in the hospital. Similar findings were shown whether patients were admitted at night (PM shift) or during the day (AM shift). ICU mortality significantly decreased with Tele-ICU intervention in both PM and AM shift groups. There was a trend towards decrease in hospital mortality in the AM shift group and a statistically significant decrease in hospital mortality in the PM shift group. Hospital LOS increased in both groups, which again could be because more patients survived.

Although patients were divided into level I patients (52.5%, the Tele-intensivist could initiate interventions for any urgent/emergent conditions as well as evidence-based therapies and hospital-approved protocols) and level II patients (47.3%, the Tele-intensivist had full-order writing privileges and fully managed the patient), similar findings to the above were found for the two groups (data not shown). The overall conclusion of this analysis supports the claim that Tele ICU can improve ICU survival, hospital survival, and shorten ICU LOS. Our findings are similar to other studies on Tele-ICU. Breslow, et al., demonstrated lower hospital mortality for ICU patients during the period of remote ICU care (9.4% versus 12.9%; relative risk 0.73; 95% CI, 0.55–0.95) and shorter ICU LOS (3.63 days; 95% CI, 3.21–4.04 versus 4.35 days; 95% CI 3.93–4.78).

Rosenfeld, et al., reported a decrease in severity-adjusted ICU mortality by 45% and a decrease in hospital mortality by 30%. McCambridge, et al., reported 29.5% reduction in hospital mortality with Tele-ICU. The New England Healthcare Institute showed that ICU mortality decreased by more than 20% and hospital mortality decreased by 13%. ICU LOS decreased by an average of almost 2 days or 30%. A study by Zawada, et al., showed that Tele-ICU was associated with a reduction in severity-adjusted ICU mortality, decreased ICU LOS, and reduced hospital LOS.

Lilly, et al., looked at the association of a Tele-ICU intervention with hospital mortality, LOS, and complications that are preventable by adherence to best practices. They reported a hospital mortality rate of 13.6% (95% CI, 11.9% to 15.4%) during the pre-intervention period compared with 11.8% (95% CI, 10.9% to 12.8%) during the Tele-ICU intervention period and hospital LOS of 9.8 days and 13.3 days, respectively. Most recently, Willmitch, et al., found significant decreases
in severity-adjusted hospital LOS of 14.2%, ICU LOS of 12.6%, and relative risk of hospital mortality of 23% with Tele-ICU intervention. In the current study, however, the major outcome benefit was observed in ICU mortality and LOS rather than hospital outcomes. It is not likely that a Tele-ICU program would impact hospital outcomes but does raise the question as to whether there is potential benefit of telemedicine if applied to hospital ward patients.

Our study has several limitations. This was a retrospective study and thus reports associations rather than cause and effect relationships. The fact that this was a single medical center study should be taken into account when considering the results of this study. The results may not be generalized to other institutions. However, because the design of the study included a heterogeneous ICU population, it may better reflect the outcomes that could be achieved in an actual clinical practice rather than those observed in randomized controlled trials.

Another limitation is the potential difference in number of cases with “do not resuscitate” status and life withdrawal cases between the 2 groups; these were not reported in our study. In addition, the study did not evaluate the effect of Tele-ICU on compliance with critical care processes before intervention such as deep vein thrombosis, stress ulcer prophylaxis, ventilator associated pneumonia, ventilator-free days, and catheter-related blood stream infections. The data from the Tele-ICU period revealed compliance of almost 100% with these processes. Another limitation of this study is that it was not possible to account for temporal changes that occur over time and may influence the outcome. The current study represents a large number of patients (2823) and its findings are similar to other studies on Tele-ICU, both of which are points of strength.

Strength of this study was the ability to control for important markers of severity of illness (APS and APACHE IV) helping to validate the results. A strong association of Tele-ICU interventions for patients admitted during the nighttime than those admitted during the daytime for ICU mortality and LOS was found in our study, suggesting that intensivist involvement in off-hour’s cases was an important contributor to the association of the intervention with improved outcomes. Studies reporting higher mortality for ICU patients admitted at night may suggest that part of the lower mortality and shorter length of stay may be due to the fact that a well-
rested on duty intensivist was assisting in the management of the patients at night using Tele-ICU workstations and tools.

The deployment of a Tele-ICU program is a complex process consisting of hundreds of discrete elements and the introduction of a new culture for management of ICU patients. In addition, building relationships and fostering acceptance of a Tele-ICU program by bedside nurses, private practice physicians, and bedside intensivists take time and patience. Our Tele-ICU physicians and nurses were instructed to be as proactive as possible. In addition, dozens of protocols have been instituted by collaboration among the Tele-ICU team and the bedside team of administrators, physicians, and nurses. A major reason why some studies failed to detect significant associations between Tele-ICU interventions and outcome is the low rates of collaboration among Tele-ICU and bedside physicians and nurses (34%–36%). We attest from our own experience that bedside and Tele-ICU team collaboration is an important determinate of favorable outcomes resulting from Tele-ICU intervention.

What makes us unique is our approach to Tele-ICU with two board-certified intensivists and five highly experienced critical care nurses heavily involved in patient care 24 hours/day. The intensivists worked 12-hour shifts and were thus well rested for the shift. In addition, our approach excelled in building relationships and fostering acceptance of a Tele-ICU program by bedside nurses, private practice physicians, and bedside intensivists in the monitored facility. We believe that all the above-mentioned are necessary for the outcome benefits from any remote telemedicine intervention to be implemented.

**Conclusion**

This retrospective pre- and post-Tele-ICU study documented statistically significant decreases of severity of illness adjusted mortality and length of stay in cases admitted to an adult ICU in a single ICU of a community hospital.
Legislation And Guidelines

One concern with telemedicine is the lack of consistency between providers. With the remote delivery of care, guidelines are required to ensure that patients require equivalent treatment regardless of the method. The following are standard telemedicine guidelines that are used to ensure quality care in critical care situations.¹⁴

| Leadership | Executive leadership shall cultivate a shared vision of the incorporation of the teleICU model of care into the innovative care delivery model. This vision should be clearly articulated throughout the entire organization. Executive leadership should incorporate principles of change management and the American Association of Critical-Care Nurses’ AACN Standards for Establishing and Sustaining Healthy Work Environments (AACN 2005) to guide strategic planning and executive decision-making. Executive leadership should recruit and develop leaders to implement and sustain care models that support interprofessional partnerships with the goal of transforming clinical work by building collaborative relationships to enhance patient care.

Executive leadership shall ensure that teleICU clinical leaders are appropriately positioned within the organization to participate in key decision-making forums with the authority to make necessary decisions. Policies and procedures shall reflect that teleICU roles are integrated into the critical care team including quality assurance processes and sentinel event review.

Escalation processes should be created and sustained to focus on patient safety and allow healthcare professionals advocacy on behalf of patients and their families regardless of practice setting. |
All healthcare professionals should have a mechanism to report, investigate and resolve issues surrounding patient safety and quality. The mechanism should be non-punitive and sensitive to assuring that the close collaborative relationship between the teleICU and ICU staff is not compromised.

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<th>Health Professional: Regulatory Consideration</th>
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<td>TeleICU professionals shall be fully licensed, registered and credentialed with their respective regulatory, licensing, and accrediting agencies and with consideration to administrative, legislative, and regulatory requirements of the site where the patient and healthcare professional are located.</td>
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This shall include all federal and state regulations regarding prescriptive authority and shall be updated as changes occur. State licensure and regulation rules are undergoing increasing national and regional debate.

The American Telemedicine Association (www.americantelemed.org), the Federation of State Medical Boards (FSMB) (http://www.fsmb.org/grpol_telemedicine.html) and The Robert J. Waters Center for Telehealth & e-Health Law (CTel) (http://ctel.org) provide helpful resources to research the most current state requirements to practice telemedicine. Healthcare professionals shall be aware of their locus of accountability and all requirements (including those for liability insurance) that apply when providing teleICU services.

The teleICU leadership and the organization’s legal counsel should insure that the malpractice carriers are notified when a new clinician is planning to provide clinical services via telehealth. Likewise, when a physician is no longer providing clinical care, the carrier should also be notified. The use of teleICU modalities shall establish a healthcare professional-patient relationship, which includes all responsibilities inherent in that relationship.
TeleICU healthcare professionals may need to negotiate with local facilities to allow an exemption from certain obligations contained in the facilities’ regulations and bylaws (i.e., TB testing requirement, ER call, non ICU related committee meetings) while providing teleICU services. This should not exempt teleICU healthcare professionals from participation in local hospital committees relevant to the teleICU program. Healthcare professionals providing teleICU services should have the necessary clinical preparation, orientation, ongoing education and professional development to ensure they possess the necessary competencies to promote quality care and patient safety.

**Privacy and Confidentiality**

TeleICU healthcare professionals and healthcare organizations in the United States shall incorporate the requirements for privacy and confidentiality in accordance with the Health Insurance Portability and Accountability Act (HIPAA) and the Health Information for Economics and Critical Health Act (HITECH). In the United States, additional state regulations shall be followed for privacy, confidentiality and patient rights apply above and beyond requirements in place for general health care interactions.

TeleICU services provided to patients physically located in other countries shall operate in conformance with the privacy laws in effect for that country. Other international laws shall be consulted and implemented as appropriate.

Policies and procedures shall address the privacy and security needs of the patient from both a technological and human rights perspective. Organizations providing teleICU services shall have policies to maintain patient privacy/confidentiality when visitors from outside of the organization tour the teleICU center. All ICU patients and families shall receive information, which includes the role of the teleICU program in patient management, the use of the technology, and how confidentiality is maintained.
Some state regulations require consent for telemedicine consultations so these shall be included as part of the organizations general consent process. More often, telemedicine consent is included in the conditions of admission.

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<th>Management of Patient Records</th>
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<td>The teleICU should use processes and policies for documentation, storage, and retrieval of health records consistent with the organizational, industry and governmental standards. Interoperability should be prioritized to ensure the seamless flow of information between patient information systems to enhance clinical support and promote continuity of care. Direct interfaces between the teleICU and hospital electronic medical records, laboratory, pharmacy and bedside monitor system represent the highest standard of interoperability.</td>
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<th>Patient Rights and Responsibilities</th>
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<td>Patients and families shall be informed and educated about the role of the teleICU in the integrated care delivery model. The use of remote care healthcare professionals and audio/visual technology shall be included as part of teleICU specific patient education. Healthcare professionals should be particularly thoughtful with the use of audio/visual technology for the provision of patient/family privacy and sensitivity to cultural considerations. This may include appropriate language translation services for patients and families. Apprehensions regarding the role of the teleICU and/or components of the audio/visual technology should be addressed collaboratively with the patient/family, the teleICU and the bedside team and may be addressed through organizational policies.</td>
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<th>Operational or Service Hours</th>
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<td>Centralized Continuous Care Model</td>
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<td>TeleICU leadership shall provide clear communication of service hours with all bedside ICU participants. The majority of continuous care models provide service with 24/7 nursing presence.</td>
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The teleICU RN performs continuous rounding based on patient acuity, evaluates alerts (vendor dependent) for intervention, and assists the local team as requested or indicated. Current national trends for teleICU RN to patient staffing levels are 30–35 patients per RN on average. However, staffing levels should be determined by the type of technology utilized and additional nursing tasks required, such as the auditing of quality indicators. In continuous teleICU models, there is a 24/7 nursing service, even if physician hours are limited, for the enhancement of the continuity of patient care. The hours of continuous teleICU physician presence are dependent upon the balance between program goals and intensivist availability. The intensivists’ presence may range from 12 to 24/7. The teleICU physician could monitor 100–250 patients depending on program design. Some programs augment the intensivist staffing with a critical care nurse practitioner or physician’s assistant, others add additional RNs to triage for the intensivist, or provide a second nonintensivist physician such as a hospitalist or internal medicine physician.

TeleICU intensivist availability does not obviate the necessity for local physician care for critically ill patients. Other teleICU resources such as teleICU pharmacists, educators or others may provide hours based on resource availability and program goals. Changes in staffing levels may be impacted by workflows, acuity of population, level of interaction among clinical sites and should adjust to meet the needs of the patient population. Several validated studies have been done to explore the effectiveness of the continuous care model.

**Decentralized Care Model**
Scheduled or responsive teleICU models and their service hours vary as per the model structure and resource availability. In this model there is no defined established central monitoring facility.
The decentralized model typically involves computers equipped with camera, speakers, microphones located at sites of convenience such as physician offices, homes, or mobile sites utilizing laptop computers or smart phones. Therefore, the decentralized teleICU is not a specific or single site but rather a process. Activities during encounters include routine patient rounds, admissions, responding to urgent/emergent calls or pages from ICU staff, ICU staff mentoring and education, and family counseling. Remote physician services may be supplemental to onsite hospitalists and/or intensivists during prescribed hours when on site resources are limited. There have been no peer review studies of the impact of scheduled models on clinical or financial outcomes at this time.

| Types of Patients Served | By definition, the teleICU service is designed to provide oversight and interventional services to critically ill patients. However, how an organization defines the utilization of the teleICU resource and/or the utilization of the ICU geographic space varies. For example, an 8-bed community ICU may house stepdown or intermediate care patients in the same geographic space as the ICU patients. For example, the average daily ICU patient census could be 4 with an additional 3 non-ICU patients. The decision to provide teleICU services to all patients, regardless of status, in this geographical location should be determined by the teleICU and ICU leadership team. Additionally, some teleICU programs provide service to critically ill patients located outside the traditional ICU environment, such as Post Anesthesia Care Units (PACU), Emergency Departments, Rapid Response Teams (RRT) or Long Term Acute Care Hospitals (LTACHs) with the use of either mobile or hardwired technology. Given the rapid expansion of wireless technology, it is anticipated that critical care resources and expertise may be deployed in a variety of non-traditional settings based on patient need and program goals. |
Once the scope of teleICU responsibility is determined, flexibility should be based on patient needs and the maintenance of the standard of care according to the goals of the teleICU program.

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<th>Staffing Models</th>
<th>Centralized Continuous Care Model</th>
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<td>Staffing levels are influenced by the type and number of patients monitored, the availability of resources at the sites monitored and the teleICU program model. For example, academic settings with house staff and fellow availability and/or 24/7 local intensivist staffing may require less teleICU physician service than a community hospital managed by the hospitalist service. Given the remote nature of the teleICU model, the physician staffing model shall not replace the need for bedside resource availability for invasive and/or emergency care provisions such as chest tube placement, central line placement or intubation. All teleICU physician staffing models are designed to support and supplement the plan of care of the attending physician of record. National trends indicate a minimum of 3-5 years of recent critical care experience is recommended for a teleICU nursing position with specialty certification either required or preferred.</td>
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TeleICU nursing models include dedicated, shared or hybrid models. In the dedicated model, the teleICU nurse works only in the teleICU; bedside hours may be required annually to maintain competence, however are not assigned as such. In the shared model, the teleICU nurse works hours both in the teleICU and is also scheduled at the bedside in an ICU. The hours can occur in the same week or may be part of a rotation schedule. In the hybrid model, a combination of the other two occurs. Some staff work only in the teleICU while others work a combination of providing both onsite care and remote care. Each model has benefits and challenges; it is not unusual for the model to change over time with the changing needs of the program.
### Decentralized Care Model
Staffed by intensivists, other specialty physicians, or non-physician clinicians (nurse practitioners, physician assistants, other) utilizing a 2-way audio video connection from various locations - clinic, office, home, other. Nurses and other staff members at the patient location interact with the remote care providers as necessary for patient care, provide hands on assistance and may, if trained appropriately, serve as surrogate examiners.

### Roles
Professionals providing teleICU services shall demonstrate the knowledge, skills, and experience needed to provide complex assessment, high-intensity therapies and interventions, and continuous clinical vigilance. Demonstrated competency in communication, collaboration, decision making, systems thinking, cultural diversity and computer literacy are essential to program success.

The continuous care model of teleICU is typically staffed with experienced intensivist physicians, critical care nurses, advanced practice healthcare professionals (nurse practitioners, physician assistants), pharmacists, additional clinical experts (wound care specialists, specialty physicians), and information services. Other models also include multidisciplinary members such as pharmacists, data entry staff, quality management consultants, educators and clinicians for training fellows and residents. The teleICU leadership shall develop policies and procedures to address initial/ongoing competency assessments for teleICU healthcare professionals and support staff.

### ICU Training
Adequate orientation and training of the ICU staff and physicians in the role of the teleICU and its technology is vital to enhance collaboration between the teleICU and ICU team. Ongoing training may be necessary during software upgrades, for new ICU employees and physicians or in response to quality initiatives.
| **Training** | Training should encourage staff acceptance of the use of teleICU services. This should include efforts to build trust and develop integrated team workflows incorporating both onsite and teleICU staff. |
| **Patient/Family Education** | Patient/family education is a right; teleICU programs shall provide the necessary information to educate both the patient and family to the following components of the teleICU: role of the teleICU in care provision, in room technology, protection of patient privacy and dignity, role of the patient/family in communication with the teleICU, and the role of consent in the teleICU standard of care. A variety of learning options should be developed to address various learning styles. For example: brochures, an A/V kiosk in the waiting room, in room posters on the use of the camera, and/or online resources. Careful attention should also be paid to the appropriate comprehension level for patient/education tools. However, teleICU research has indicated that the preferred method of patient/family education is verbal information directly from the ICU nurse. ICU staff should be provided the appropriate educational materials and encouraged to orient the patient/family to the teleICU technology along with other ICU room orientation. Patients/families should also be provided contact information should they have additional questions or concerns. |
| **Quality/Program Performance** | The ability to demonstrate impact and value on patient outcomes is highly dependent upon the collaborative relationship established between the teleICU and ICU. Organizations providing teleICU programs shall have a systematic quality improvement and performance management process that complies with any organizational, regulatory, or accrediting requirements for outcomes management. The quality improvement indicators shall address the critical components or outcomes of providing teleICU services and shall be used to make programmatic and clinical changes based on best practice principles, evidence-based guidelines, and current research. |
Outcome metrics may include direct measures of care such as ICU mortality, length of stay or time on ventilators. Proxy measures such as patient, family, or ICU staff satisfaction, and financial measures such direct cost of care may be included. TeleICU quality process metrics such as the number of interventions, response time or staff satisfaction should also be measured.

<table>
<thead>
<tr>
<th>Documentation</th>
<th><strong>Documentation and Electronic Health Record</strong></th>
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<tbody>
<tr>
<td></td>
<td>Coordination and integration of the EHR within the teleICU should be done as it is important for the prevention of errors and timely access to accurate patient data.</td>
</tr>
</tbody>
</table>

**Workflow and Communication**

Documentation policies and procedures shall be developed for the successful patient care hand-off or transfer of responsibility. Direct peer-to-peer communications shall be encouraged to minimize possible miscommunications.

**Data Retrieval**

There should be the ability to access and review current data from both the teleICU and bedside to facilitate communication and decision making process.

| Equipment | Organizations should refer to the American Telemedicine Association’s Core Guidelines for Telemedicine Operations documentation for baseline technical requirements. Organization shall provide technology that optimizes audio and visual clarity for enhancement of clinical assessment (options included real time, two-way audio visual solutions as well as one-way visual surveillance with audio support via traditional phone access). Technology such as assessment peripherals and medical devices ranging from hardwired equipment to ‘bring your own device’ (BYOD) may be used to address clinical needs. Organizations should provide adequate telecommunications bandwidth to connect near and far end equipment to support the program goals and assure quality patient care services. |
The minimum bandwidth used should be determined in consultation with the clinical, information technology and biomedical staff of all facilities for sufficient clinical diagnosis and data transfer. Because different technologies provide different video quality results at the same bandwidth, each end point should use bandwidth sufficient to achieve dependable and reliable quality service during normal operation.

If using a personal computer or mobile device, the healthcare professional should conform with the IT policies of the enterprise. Devices shall have up-to-date security software that is HIPAA compliant. Healthcare professionals should ensure their personal computer or mobile device has the latest security patches and updates applied to the operating system and third party applications that may be utilized for this purpose. Healthcare professionals and organizations should utilize mobile device management software to provide consistent oversight of applications, device and data configuration and security of the mobile devices used within the organization.

When the healthcare professional uses a mobile device, special attention shall be placed on the relative privacy of information being communicated over such technology and ensuring access to any patient contact information stored on the mobile device is adequately restricted. Mobile devices shall require a passphrase or equivalent security feature before the device can be accessed. If multi-factor authentication is available, it should be used. Mobile devices should be configured to utilize an inactivity timeout function that requires a passphrase or reauthentication to access the device after the timeout threshold has been exceeded. This timeout should not exceed 15 minutes. Mobile devices should be kept in the possession of the healthcare professional when traveling or in an uncontrolled environment.
Unauthorized persons shall not be allowed access to sensitive information stored on the device, or use the device to access sensitive applications or network resources. Healthcare and institutional IT professionals should have the capability to remotely disable or remove data from any mobile device containing PHI or sensitive institutional data, should the device be lost or stolen.

Remote management of the system should permit far end camera control (FECC), maintenance or diagnostic capabilities such as auto restart, remote configuration, proactive monitoring and/or alerts. System should allow point-to-point connectivity from within or outside of the healthcare facility. Organizations should consider technology interoperability when selecting systems for integration of other telemedicine services or documentation systems. Systems shall comply with all current and applicable State and Federal laws and regulations, governing the use of medical devices and medical information i.e., FDA, HIPAA, HITECH, Waste Electrical and Electronic Equipment (WEEE). All efforts shall be taken to make audio and video transmission secure by using point-to-point encryption that meets recognized and accepted standards. Systems shall comply with the Federal Information Processing Standard, the US Government security standard used to accredit encryption standards of software and lists encryption such as AES (Advanced Encryption Standard).

Healthcare professionals should familiarize themselves with the technologies available regarding computer and mobile device security, and should help educate the patient. Organizations shall ensure proper testing and maintenance for all functionalities for each newly installed infrastructure or endpoint. Organizations should implement planned and unplanned downtime procedures that ensure continued service and may include the use of appropriate backup technologies.
Examples may include: N+1 redundancy, geographic dispersed infrastructure, fast failover, failure notifications/alerts, and/or documented on call procedures during planned or unplanned teleICU downtime.

Policies and procedures should proactively address on-going equipment maintenance, anticipated equipment and software upgrades, performance of periodic remote tests for operation and functional verification, evaluation of resource allocation and 24/7 technical support.

<table>
<thead>
<tr>
<th>Infection Control</th>
<th>Organizations shall have infection control policies and procedures in place for the use of teleICU equipment and patient peripherals that comply with organizational, legal, and regulatory requirements.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Policy and Procedure</td>
<td>Organization shall implement policies that address adequate data storage and retrieval, device security, time zone management, and follow long term storage standards such as Storage Management Initiative Specification (SMI-S).</td>
</tr>
</tbody>
</table>
clinical and technological aspects of telemedicine; (2) will assist the national specialty societies in their efforts to develop these guidelines and standards; and urges national private accreditation organizations (i.e., URAC and JCAHO) to require that medical care organizations which establish ongoing arrangements for medical care delivery from remote sites require practitioners at those sites to meet no less stringent credentialing standards and participate in quality review procedures that are at least equivalent to those at the site of care delivery. (Res. 117, I-96; Reaffirmed: CSAPH Rep. 3, A-06; Reaffirmed: BOT Rep. 22, A-13; Reaffirmed: CMS Rep. 7, A-14)

**H-480.974 Evolving Impact of Telemedicine**

The American Medical Association: (1) will evaluate relevant federal legislation related to telemedicine; (2) urges CMS, AHRQ, and other concerned entities involved in telemedicine to fund demonstration projects to evaluate the effect of care delivered by physicians using telemedicine-related technology on costs, quality, and the physician-patient relationship; (3) urges professional organizations that serve medical specialties involved in telemedicine to develop appropriate practice parameters to address the various applications of telemedicine and to guide quality assessment and liability issues related to telemedicine; (4) encourages professional organizations that serve medical specialties involved in telemedicine to develop appropriate educational resources for physicians for telemedicine practice; (5) encourages development of a code change application for CPT codes or modifiers for telemedical services, to be submitted pursuant to CPT processes; (6) will work with CMS and other payers to develop and test, through these demonstration projects, appropriate reimbursement mechanisms; (7) will develop a means of providing
appropriate continuing medical education credit, acceptable toward the Physician’s Recognition Award, for educational consultations using telemedicine; (8) will work with the Federation of State Medical Boards and the state and territorial licensing boards to develop licensure guidelines for telemedicine practiced across state boundaries; and (9) will leverage existing expert guidance on telemedicine by collaborating with the American Telemedicine Association (www.americantelemed.org) to develop physician and patient specific content on the use of telemedicine services - encrypted and unencrypted. (CMS/CME Rep., A-94; Reaffirmation A-01; Reaffirmation A-11; Reaffirmed: CMS Rep. 7, A-11; Reaffirmed in lieu of Res. 805, I-12; Appended: BOT Rep. 26, A-13; Modified: BOT Rep. 22, A-13; Reaffirmed: CMS Rep. 7, A-14)

**H-160.937 The Promotion of Quality Telemedicine**

The American Medical Association (1) adopts the following principles for the supervision of nonphysician providers and technicians when telemedicine is used:

(a) The physician is responsible for, and retains the authority for, the safety and quality of services provided to patients by nonphysician providers through telemedicine. (b) Physician supervision (i.e., regarding protocols, conferencing, and medical record review) is required when nonphysician providers or technicians deliver services via telemedicine in all settings and circumstances. (c) Physicians should visit the sites where patients receive services from nonphysician providers or technicians through telemedicine, and must be knowledgeable regarding the competence and qualifications of the nonphysician providers utilized. (d) The supervising physician should have the
capability to immediately contact nonphysician providers or technicians delivering, as well as patients receiving, services via telemedicine in any setting. (e) Nonphysician providers who deliver services via telemedicine should do so according to the applicable nonphysician practice acts in the state where the patient receives such services. (f) The extent of supervision provided by the physician should conform to the applicable medical practice act in the state where the patient receives services. (g) Mechanisms for the regular reporting, recording, and supervision of patient care delivered through telemedicine must be arranged and maintained between the supervising physician, nonphysician providers, and technicians. (h) The physician is responsible for providing and updating patient care protocols for all levels of telemedicine involving nonphysician providers or technicians.

(2) The AMA urges those who design or utilize telemedicine systems to make prudent and reasonable use of those technologies necessary to apply current or future confidentiality and privacy principles and requirements to telemedicine interactions.

(3) The AMA emphasizes to physicians their responsibility to ensure that their legal and ethical requirements with respect to patient confidentiality and data integrity are not compromised by the use of any particular telemedicine modality.

(4) The AMA advocates that continuing medical education conducted using telemedicine adhere to the standards of the AMA's Physician Recognition Award and the Essentials and Standards of the
Accreditation Council for Continuing Medical Education. (CME/CMS Rep., I-96; Reaffirmed: CMS Rep. 8, A-06)

D-480.999 State Authority and Flexibility in Medical Licensure for Telemedicine


H-480.956 Commercialized Medical Screening

American Medical Association policy is that relevant specialty societies continue to evaluate the validity and clinical use of screening imaging procedures that are advertised directly to the public and make available to the broader physician community unbiased evaluations to help primary care physicians advise their patients of the risks and benefits of these procedures. (CSA Rep. 10, A-03; Reaffirmed: CSAPH Rep. 1, A-13)

Prescription Writing

Each state has unique laws regarding the scope of practice permissible through telemedicine. The variations in state laws and policies range from a complete prohibition on the practice of telemedicine (ID) to permissive environments where there are no additional regulations above existing standards of medical care (FL). The immense range in law means that it is essential for physicians to consult with the laws of all applicable states before providing telemedicine services. These
states include both the state where the physician is located and the state where the patient is located.

A source of confusion is the practice of prescribing medication via telemedicine. While state regulations of telemedicine run the gamut, there is a general consensus (one that the AMA supports) that care provided via telemedicine needs to meet the same standard as care provided in person and that there must be, at a minimum, an established patient-physician relationship before any prescriptions are issued.

In general, AMA policy supports the practice of prescribing medicine using telemedicine technologies. However, AMA policy makes it clear that physicians who prescribe using telemedicine need to first establish a patient-physician relationship that includes obtaining a medical history, describing treatment risks, benefits, and options, arranging for appropriate follow-up care, maintaining health records, and recording any prescriptions issued in the patient’s file. AMA Policy H-120.949, Guidance for Physicians on Internet Prescribing (Reaffirmed at the 2005 Annual Meeting). Therefore, while the AMA supports the practice, it is essential that a patient-physician relationship exists. The issues that arise are when does that relationship develop, can that relationship be established through remote interactions alone (i.e., in the absence of any physical encounters), and if a relationship exists is it permissible for the physician to issue prescriptions. The second question is where states differ the most.
Establishing a Physician-Patient Relationship

The American Medical Association’s Code of Medical Ethics states that “a patient-physician relationship exists when a physician serves a patient’s medical needs”. Opinion 10.015, The Patient-Physician Relationship, AMA Code of Medical Ethics (Adopted June 2001). By itself, this definition is ambiguous as to whether or not the patient-physician relationship can be formed via telemedicine.

The AMA’s Council on Medical Service (CMS) provided additional guidance in a report adopted at A-14. In this report, CMS clarified how a patient-physician relationship can be established, stating that “prior to delivering services via telemedicine, the Council believes that a valid patient-physician relationship must be established, through at minimum a face-to-face examination. The face-to-face encounter could occur in person or virtually through real-time audio and video technology” (AMA Policy H-480.956, Coverage of and Payment for Telemedicine). This allows physicians to establish a patient-physician relationship and to prescribe medications via telemedicine but would still prohibit issuing prescriptions based on a relationship established solely through online questionnaires.

American Medical Association policy also endorses the establishment of a patient-physician relationship when consultation is with another physician who has an established relationship with the patient or when the encounter meets evidence based standards of a specialty society, such as radiology or pathology. Finally, AMA policy lists certain situations in which a relationship is not required. These include on-call, cross coverage situations, emergency medical treatment, and other exceptions that become recognized as standards of care. AMA policy
requiring a face-to-face encounter sits in the middle of the spectrum of state law which ranges from requiring an in-person encounter to establish a relationship (NH) to accepting relationships formed through telemedicine technology with no detailed requirements (FL).

The Federation of State Medical Boards’ (FSMB) Model Policy on telemedicine is similar to that of the AMA. The FSMB policy would permit patient-physician relationships to be formed based solely on virtual encounters, but later clarifies that the term telemedicine does not apply to audio only encounters. It is important to note that unlike the FSMB, many states do include email and telephone communication in the definition of telemedicine. The issue of regulation of formation of patient-physician relationships is further complicated by the fact that many states use “face-to-face” to mean an in-person encounter (i.e., CA, NH).

**State Licensure**

Once a relationship has been established, the practice of telemedicine still requires appropriate licensing. The CMS report reinforces the AMA’s position that telemedicine providers need to abide by the appropriate licensing and credentialing requirements (AMA Policy H-480.956, Coverage of and Payment for Telemedicine). Physicians who use telemedicine to practice across state lines need to have a full, unrestricted license in the state where the patient is located in addition to the state where they are located. This requirement mirrors the most recent position taken by the FSMB.

One unique approach to licensing across stateliness for telemedicine is restricted telemedicine only licenses. These licenses had been
contemplated by the FSMB but have since been eschewed in favor of the multistate compact, a proposed system that would allow multistate licensing for physicians already board certified in one state. The compact is not aimed at telemedicine specifically. Its purpose is to create a system that would allow states to recognize the license to practice medicine issued by other states such that physicians could practice outside of their home state without having to apply for full licensure in each subsequent state.

The resolution that gave rise to this compact passed unanimously in the FSMB’s House of Delegates, and has been publicly supported by a bipartisan group of fourteen senators. However, it is still in its draft stages.

Currently, limited licenses for the practice of telemedicine, like those originally contemplated by the FSMB, do exist in some states (i.e., AL, LA, MN, MT, NM, OH, OR, TN, TX). The limited licenses allow physicians to practice across state lines without obtaining a full license in each state where patients are located. These limited licenses are offered and regulated by states where patients reside, and are not a universal license to practice anywhere within the United States.

While licensing and credentialing requirements can create obstacles for telemedicine providers it is essential that physicians follow them in order to avoid costly sanctions in addition to legal and professional consequences. Finally, physicians are advised to check that their liability insurance policy covers the practice of telemedicine and the practice across state lines if applicable.
General Concerns or Considerations

Physicians must consult with legal counsel to ensure that they are not violating state law. Each state has its own laws regarding telemedicine and many states do not allow physicians to issue prescriptions to patients whom they have never met in person. Some states go so far as to prohibit issuing prescriptions to existing patients if the physician has not physically examined the patient for that acute illness (ID). Reviewing the laws across states shows how critical it is for physicians to check the laws of the applicable states before writing a prescription for a patient whom they have not personally physically examined in connection with the prescription. Furthermore, it is important to bear in mind that beyond what has been discussed here, standards of care that relate to the traditional, in-person practice of medicine still apply.

Some traditional standards that should be remembered include: a patient’s right to choice of provider, patient access to a provider’s qualifications prior to an encounter, local regulations, evidence-based practice guidelines, and follow-up care. Things to consider when practicing telemedicine:

- What requirements must be met in order to establish a patient-physician relationship?
- What are the laws regarding internet prescribing?
- What are the local laws governing issues such as consent, care of minors, reproductive rights, and end-of-life care?
- How will the physician document this encounter and coordinate with the patient’s other providers?
- What protocols does the physician have in place for emergency care?
• Are there scopes of practice laws in the physician’s state or patient’s state that may apply to the encounter?
• Does the physician have the necessary licenses to practice in a state as well as the patient’s state?
• Does liability insurance cover the physician for the manner in which they intend to practice?
• Are there considerations pertinent to the patient’s health insurance that should be contemplated?

_Federation of State Medical Boards Telemedicine Policies^83_  
The following relates to state jurisdiction telemedicine policies joined to regulate practice. Providers are urged to contact their state jurisdiction of licensing to continuously update on changes to regulations that affect practice.

• Forty-nine (49) state boards, plus the medical boards of District of Columbia, Puerto Rico, and the Virgin Islands, require that physicians engaging in telemedicine are licensed in the state in which the patient is located.

• Thirteen (13) state boards issue a special purpose license, telemedicine license or certificate, or license to practice medicine across state lines to allow for the practice of telemedicine.

• One (1) board requires physicians to register if they wish to practice across state lines.
• Nineteen (19) states require both private insurance companies and Medicaid to cover telemedicine services to the same extent as face-to-face consultations.

• Twenty (20) states currently require only Medicaid to cover telemedicine services.

• Three (3) states require only private insurance companies to reimburse for services provided through telemedicine.

The table below outlines individual state regulation related to telemedicine.

<table>
<thead>
<tr>
<th>State</th>
<th>License Required</th>
<th>Reimbursement Parity</th>
<th>Other Rules/Regulations (citation only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>State</td>
<td>Medicaid &amp; Private.</td>
<td>Law/Issue Brief</td>
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<tr>
<td>AR</td>
<td>√</td>
<td>AR Code § 17-95-206 “When Does Telemedicine or Internet- Based Patient Healthcare Violate Regulation 2.8?” Arkansas State Medical Board Newsletter, Fall 2012</td>
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<tr>
<td>CA-M</td>
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<td>Ca. Business &amp; Prof. Code § 2290.5 Medical Board of California</td>
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<td>CA-O</td>
<td>√</td>
<td>Same as CA-M</td>
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<tr>
<td>CO</td>
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<td>Colo. Rev. Stat. § 12-36-106(1)(g)</td>
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<tr>
<td>CT</td>
<td>√</td>
<td>No unique laws regulating practice of telemedicine.</td>
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<tr>
<td>DE</td>
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<td>No unique laws regulating practice of telemedicine.</td>
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</tbody>
</table>

Medicaid & Private.
| DC | √ | Medicaid & Private. | “Telemedicine Policy” DC Board of Medicine, Nov. 2014 |
| FL-O | √ | -- | Fla. Admin. Code § 64B15-14.0081 |
| GU | #2 | -- | 10 GCA § 12202(b) |
| ID | √ | -- | No unique laws regulating practice of telemedicine. |
| IL | √ | -- | 225 ILCS 60/49.5 |
| IN | √ | Medicaid Only. “IHCP to cover telehealth services by home health agencies” IHCP Bulletin, October 2014 | 844 IAC 5-3-1 et seq. |
| IA | √ | Medicaid Only. | “A Policy Statement on Telemedicine” Iowa Board of Medicine, April 10, 1996 |
| KS | √ | Medicaid Only. | No unique laws regulating practice of telemedicine. |
Ky. Rev. Stat. § 311.5975  
“Policy: Telemedicine Statement”  
Kentucky Board of Medical Licensure,  
Sept. 1997  
“Board Opinion regarding the use of Telemedicine Technologies in the Practice of Medicine”  
Kentucky Board of Medical Licensure,  
Sept. 1997 |
La. Admin. Code 46:XLV.408  
“Advisory opinion: The use of telemedicine technologies with established patient”  
LA State Board of Medical Examiners,  
March 24, 2014 |
<table>
<thead>
<tr>
<th>State</th>
<th>Coverage</th>
<th>Type</th>
<th>Document/Source</th>
</tr>
</thead>
</table>
“Policy: Medical Practice Across State Lines” Northeast Region State Medical Boards, Sept. 1999  
“Advisory Ruling: Telemedicine – Radiology” Maine Board of Licensure in Medicine, May 1994  
“Advisory Ruling: Telemedicine – Psychotherapy” Maine Board of Licensure in Medicine, August 1993 |
| MD    | ✓^3       | Medicaid & Private. | Code of Maryland and Rules (COMAR) 10.32.05  
“Telemedicine” MD Dept. of Health and Mental Hygiene |
<p>| MA    | ✓         | Private Only.        | 243 CMR 2.01(4) |
| MI-M  | ✓         | Medicaid &amp; Private. | MCL 550.1401k |
| MI-O  | ✓         | Medicaid &amp; Private. | See MI-M |</p>
<table>
<thead>
<tr>
<th>State</th>
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<tbody>
<tr>
<td>MN</td>
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<td>Medicaid Only.</td>
<td>Minn. Stat. § 147.032 “Telemedicine Registration” Minnesota Board of Medical Practice</td>
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<td>MS</td>
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<td>MS Code Ann. § 73-25-34 MS Admin Code title 30, part 2635, ch. 5</td>
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<td>NC</td>
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<td>“Position Statement: Telemedicine” North Carolina Medical Board, November 2014</td>
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<tr>
<td>ND</td>
<td>√</td>
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<td>“Statement on Telemedicine Policy” ND Board of Medical Examiners, March 21, 2014</td>
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<td>OH</td>
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<td>OAC § 4731-10-11 ORC § 4731.296 “Position Statement on Telemedicine” State Medical Board of Ohio, May 2012</td>
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<td>“Guidelines on Telemedicine” Oklahoma State Board of Osteopathic Examiners</td>
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<td>Pa. Code § 17.4</td>
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<td>20 LPRA § 6001 et seq.</td>
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<td>RI</td>
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<td>RI Gen Laws § 5-37-12 “Guidelines for Appropriate Use of Telemedicine and Internet in Medical Practice” Rhode Island Board of Medical Licensure and Discipline</td>
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<td>SC</td>
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<td>“Primary Diagnosis by Out-of-State Physicians” South Carolina Board of Medical Examiners, May 1997</td>
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<td>SD Codified Laws § 36-4-41 SD Codified Laws § 36-2-9</td>
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</tr>
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<td>Utah Code § 58-1-307</td>
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<td>WY</td>
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<td>WY Board Rules § 1.4(e)</td>
</tr>
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1. √* denotes that a state may issue a special purpose license, telemedicine license or certificate, or license to practice medicine across state lines to allow for the practice of telemedicine.
2. Guam Code, 10 GCA § 12202(b), requires only that physicians are licensed somewhere within the United States.
3. √^ denotes that Maryland Revised Statutes § 14-302 exempts physicians licensed in adjoining states from being required to obtain a Maryland license.
4. √^+ denotes that a state requires physicians to register if they choose to wish to practice medicine across state lines. Non-cited laws, regulation, and/or policy could impact analysis on a case-by-case or state-by-state basis. All information should be verified independently.

The following provides a thorough overview of the current policies and priorities related to telemedicine. These will be used as guidelines in telemedicine delivery and development.

The American Telemedicine Association (ATA) supports public policies — at both the state and federal level — that allow patients, providers and payers to realize the benefits of telemedicine. The ATA base priorities on four principles:

- Eliminate artificial government barriers to telehealth, such as geographic discrimination and restrictions on the use of telehealth in managed care;
- Prevent new barriers to telemedicine, such as practice rules that impose higher standards for telehealth services than in-person care;
- Encourage use of telehealth to reduce health delivery problems, such as provider shortages; and,
- Promote payment and service models to increase consumer value, in part using telemedicine.

Priority Policies of the ATA

Priority policies of the ATA include those discussed below, and inform practitioners of future directions in a variety of practice settings.

Fix outdated licensure and practice rules for health professionals

The existing system of health professional licensure and practice regulations limit a patient’s access and choice. Requiring duplicate
licenses and maintaining separate practice rules in each state has become an impediment to the use of telemedicine. Such state-by-state approaches prohibit people from receiving critical, often life-saving medical services that may be available to their neighbors living just across the state line. They also create economic trade barriers, restricting access to medical services and artificially protecting markets from competition. They cost health professionals and taxpayers hundreds of millions of dollars each year. Such requirements are outdated and restrain progress in the practice of 21st century medicine.

A number of approaches have been put forward regarding licensure including interstate compacts, mutual state recognition and even national licensure. Regardless of the approach used, ATA encourages policy makers to accelerate such change nationwide. Prolonged delay or regional solutions only exacerbate the problem.

Congress, with strong bipartisan support, recently expanded the exemption from multiple state licenses for the Department of Defense health care – one state license is now sufficient throughout the country. The “one state license” rule should be applied to all federal health care (covering all agencies, health programs, and federally funded health sites). In particular, H.R. 2001 for the Department of Veterans Affairs and H.R. 3077 for Medicare is supported by the ATA.

An increasing problem for telehealth is state medical boards adopting practice rules with higher specifications for telehealth than in-person care, such as requirements only for telehealth that a patient must be an established patient of the physician or has had an in-person
physical examination from that provider. Moreover “one size fits all” requirements that do not differentiate among different types of health services are clinically unnecessary and add to costs in many situations, such as remote reading of a MRI or patient emergencies. The ATA opposes higher standards for telehealth than in-person services.

Regarding online prescribing, state regulations should not interfere with the ability of a duly licensed healthcare provider from using telemedicine to provide a prescription to a patient with a pre-existing relationship, regardless of the patient’s location, with the exception of federally controlled substances requiring an in-person meeting.

**Coverage and parity for telemedicine services by all payers**

Improved coverage and parity of telehealth services includes those with medicare coverage. The focus is to promote telehealth through payment and service innovations. The ATA supports providers in value-based payment innovations, such as accountable care organizations, bundled payments for acute care episodes, and medical homes, should have the flexibility to fully use telehealth.

**Encourage chronic care management**

Medicare relies on an outmoded approach to manage the needs and costs for the growing number of beneficiaries with multiple chronic conditions, those who are homebound, and those at-risk for inpatient stays. The current system wastes billions of dollars and costs lives. To improve care to beneficiaries:

- Authorize a state Medicaid “health home” for chronic care to cover the state’s Medicare beneficiaries;
• Reward hospitals for reducing readmissions by sharing the extra savings from beating their benchmark and, thus, compensate a hospital for the costs related to patient monitoring, home video, etc.;
• Allow the use of home telehealth as a recognized and reimbursable component in the provision of home health care;
• Adjust Medicare payment methods for federally-qualified health centers to facilitate their providing chronic care coordination and remote monitoring; and,
• Cover innovative services, covered by some Medicaid plans, for on-line internet assessments, computerized clinical data analysis, and the collection and interpretation of physiological data.

*Remove artificial coverage barriers in fee-for-service Medicare*

Congress should remove statutory barriers in Social Security Act 1834(m) and allow Medicare telehealth services for:
• The almost 80% of Medicare beneficiaries not covered because they live in a “metropolitan area”;
• “Store-and-forward” services, such as for wound management and diabetic retinopathy;
• Provider services otherwise covered for Medicare, such as physical therapy, occupational therapy and speech-language-hearing services;
• Services delivered wherever the beneficiary is, including home or mobile; and
• Any already-covered health procedure code possible by a telehealth method.
Several of these recommendations are included in H.R. 3306, the Telehealth Enhancement Act, and a package of priority, incremental improvements for Medicare and other federal programs.

**Federal Health Benefit Plans**

The Federal Employees Health Benefits Plan, TRICARE, and other federal health plans should amend contracts to cover explicitly telehealth-provided benefits. There is no basis to deny a telehealth-provided claim for a service that is already covered when using a traditional delivery method.

**Medicaid Coverage**

Forty-five Medicaid plans cover some telehealth, other states cover none – and all can improve. Medicaid coverage should apply to all telemedicine-provided services, unless there is a contrary provision of state law. Nothing in Federal law or regulations bars the coverage of telehealth-provided services and CMS should notify states that Medicaid should cover telehealth-provided services, unless there is a contrary provision of state law.

The ATA will work with our members, state officials and stakeholder organizations on focused innovations, such as:

- Provide telemedicine coverage for specialty services and conditions related to high-risk pregnancies and premature births, traumatic brain injury, autism, and rehabilitation. Extend telemedicine coverage to urban areas and other patient settings, such as homes and schools;
- Maximize video use to reduce spending for non-emergency patient transport and unnecessary disruption for patients;
• Add remote patient monitoring to home and community-based service and “health home” programs to enable people with chronic conditions to continue living at home and avoid expensive hospital visits;
• Accommodate “store-and-forward” uses, such as sharing of medical images with a specialist for consultation or diagnosis;
• Allow for innovative payment and service models using telehealth, such as managed care, medical homes, accountable care organizations, chronic care management, and dual eligible initiatives.

_Private Insurance Coverage_

Twenty states and the District of Columbia specify that state-regulated health benefit plans need to pay for telehealth as a way of delivering services covered using “traditional” means. The ATA will encourage similar action in the other states.

_Federal health care programs_

The Departments of Defense and Veterans Affairs should take full advantage of the benefits and efficiencies telemedicine has to offer for those overseas. The Indian Health Service, federal prison health services and other health programs serving federal populations should fully utilize telemedicine to meet their health care obligations. As a major health provider, the federal government should support and participate in the development of professional practice standards and comparative effectiveness research on telemedicine applications.
**FCC’s Broadband Deployment and Universal Services**

The ATA strongly supports use of the new Healthcare Connect Fund from the Federal Communications Commission (FCC) to enable nationwide telehealth. To maximize the value of telehealth, the FCC should:

- Encourage a nationwide grid – Federal support of network bridging between and among the 200 telemedicine networks in the U.S. will serve as an important component in expanding healthcare services, improving medical education and collaboration and forming a national health information highway. Such a network can become a foundation for the development of reach-back networks, accessible for emergency response, and regional training and preparedness.

- Streamline and expand the Rural Health Program – The Rural Health Program should be expanded to provide broadband services to all Medicare and Medicaid telehealth sites. Also, the program’s application and administrative processes should be simplified.

**Encourage mHealth Integration into Delivery of Care**

Wireless devices are important for the transformation of healthcare and the ability for all consumers to access broadband services is now a national priority. Wireless broadband services, with comparable up and downstream speeds, should be ubiquitous and made affordable to all Americans. Of particular importance for mHealth is the Food and Drug Administration’s scope of regulation for the health uses of consumer devices and health software.
Federal Coordination and Impact on Telemedicine

The federal government has several different mechanisms that directly affect the growth and use of telemedicine: paying for services under health benefits plans, providing telemedicine services directly, funding telemedicine projects and innovations, and regulating devices, services and related applications. There are numerous and diverse federal agencies with a role in telemedicine. The ATA will encourage the Obama Administration and Congress to follow-through with:

- Federal reimbursement to federally funded health providers (such as community health centers) for telehealth services.
- Coordination of telehealth policy based on an Executive Order and with high-level leadership for programs, regulations, and funding to maximize the federal return on investment and better serve people’s needs. An example of an immediate issue is federal promotion of e-prescribing while wanting to control medically appropriate purchase of medications over the internet.
- Use of telehealth to achieve many of the federal government’s interests, such as reducing health costs, improving population health, sustaining world leadership in innovative job and business sectors, reducing carbon emissions, and global health security.

Integrate EHR/HIE and Telemedicine

Electronic health records (EHRs) provide an important resource for providers using telemedicine. The ATA will focus on:

- “Meaningful use” for Medicare and Medicaid funds - ATA will engage in the forthcoming proposed Stage 3 Meaningful Use standards to integrate telehealth, including machine-to-machine
remote patient monitoring readings, patient engagement tools and multimedia data.

- Federal funding of EHRs/HIEs - EHRs should be a means rather than an end. An end needs to be nationwide exchange of health information. Health Information Exchanges (HIEs) should compile data from multiple EHRs to develop a longitudinal record for patients with high priority health conditions. EHRs and HIEs should be a means to improve patient access to needed health care, reducing disparities and more efficiently using scarce specialist resources. Unique patient and provider identifiers are needed.

- Broader application of EHRs/HIEs and other data reporting - Medicare and Medicaid “meaningful use” standards, at a minimum, need to apply to all federal health care programs. Higher EHR/HIE standards and performance reporting should be expected for Affordable Care Act innovations. Patient encounter data needs to reduce professional-related administrative burdens of licensure, credentialing and privileging as well as to augment the National Practitioner Data Bank.

**Emergency Preparedness and Response**

Existing applications and networks are potentially critical components of the emergency communications and response capabilities of a region - including capacity to respond to health epidemics. The use of services such as alternate care sites, reach-back surge capacity, and access to advanced specialties, can prove critical in emergency situations. The federal government is in an important position to lead such efforts to ensure the coordination and usability of these resources for emergency communications.
Disaster Medical Assistance and Medical Reserve Corps teams should have telecommunications-based reach back capabilities with centers of specialized healthcare to access such expertise when needed.

*International Policy*

The ATA will work with a variety of international organizations to maintain a targeted, relevant set of policy priorities addressing the globalization of telemedicine – especially the growing use of telemedicine across national borders.

The driving forces behind ATA’s international involvement reflect the varied interests of our members and leaders. These can be summarized in four goals.84

- **Humanitarian:**
  Assisting those using telemedicine to provide services to populations without adequate access to healthcare, particularly in less developed nations;

- **Industry Growth:**
  Expanding international markets fueling the growth of the industry;

- **Medical Diplomacy:**
  Supporting the use of healthcare services to bring about better understanding, cooperation and goodwill across the globe; and,

- **ATA Sustainability:**
  Increasing support and reach of ATA as an organization.
American Telemedicine Association’s Addendum: Standards and Interoperability

Overview

Interoperability for telemedicine and health information technology (HIT) can be considered from two separate, yet mutually complimentary viewpoints. Viewed from a point of care perspective, what may be called internal or operational-level interoperability is an essential ingredient for success of any technology-enhanced health care delivery system. Internal interoperability allows components of health information systems to interact with each other. For example, a common physical interface standard, such as the Universal Serial Bus (USB), can allow hot-swapping of cameras and other peripherals, regardless of manufacturer, in PC-based health information systems. Similarly, communications standards, such as the ANSI H.32x series for videoconferencing, allow equipment from different manufacturers to successfully share audiovisual data.

Internal interoperability ensures that the point of care encounter succeeds. In terms of telemedicine and health information specifically, success often means achieving effective communication despite differences in location, time, equipment, levels of expertise, and health care organizations involved in the exchange.

The second form of interoperability, at the external or strategic level, complements this success. External interoperability focuses on effective networking and interaction between health information applications and health information systems. External interoperability is at the junction between health information and the rest of health informatics. As such external operability, it is directly impacted by health information standards which seek to tie together EMRs, image archival systems, diagnostic and laboratory systems, and practice management systems, along with health information applications and decision support systems to achieve an integrated continuum of care for the patient, regardless of location, time, or entity providing care. Standards seek to address overarching issues, such as availability, integrity, and confidentiality of health information, and include both industry-created standards, such as HL7 and DICOM, and rules specified through government legislation, such as the U.S. Health Insurance Portability and Accountability Act of 1996 (HIPAA), Europe’s EC 95/46 directive, and Japan’s HPB 517.
Jointly, internal and external interoperability provide the tools and framework necessary to ensure health care providers from differing locations, specialties, and organizations are able to work together to provide care and services when and where the patient requires them.

Standards and rules support clinicians’ efforts to:
• Easily exchange information with other clinicians, including those in other specialties
• Electronically exchange information with other health care and administrative organizations
• Adapt new applications to existing systems without undue effort and expense
• Ensure the availability, integrity, and confidentiality of protected health information
• Accommodate the wide variety of technological infrastructure employed among different clinical settings.

The objective of interoperability in a health information environment is to bring together the disparate elements of a digital approach to health care and facilitate networking and communications between them. The disparate elements, whether EMRs, practice management systems, telemedicine applications, or decision support systems, and facilitate networking and communication between them, need to be linked in order to achieve a common goal of improving access to quality health care, irrespective of geographic or temporal constraints.

Technology Standards with Telemedicine and Health Information Systems
Telemedicine and health information have made great strides towards improving the availability of specialty care and provider / patient education resources, despite geographic and economic factors that have historically hampered access by segments of the population. Technological need and budgetary constraints have driven the emphasis on interoperability among these applications, and indeed the advances in interoperability among telemedicine systems form fine examples of how to proceed in achieving interoperability across all elements of the health information environment.
Adaptable telemedicine systems and health information applications that rely on open source standards to efficiently provide clinical data, provider feedback, and patient education for incorporation into health information records and to support clinical decisions, form the clinical treatment piece of the digital approach to patient care and, because of their direct interaction with the patient, are a primary source of data collection for the longitudinal record of care.

Essential to interoperability of telemedicine and health information applications are the development and widespread adoption of open source standards among vendors, to ensure ease of communication between divergent systems. For example, a considerable segment of telemedicine relies on videoconferencing equipment to emulate the traditional patient encounter. Often telemedicine encounters are made between primary care and specialist facilities using different manufacturers and models of video conferencing hardware and means of connectivity.

The emergence of a series of widely adopted videoconferencing standards, ANSI H.32x, provides easily adaptable CODECs (coder-decoder protocols) that allow seamless communication between different models and brands of equipment. The adoption of standards has brought a new ease of use and greatly expanded compatibility to this vital link between rural populations and specialty care, and provides a working model for similar standards of interoperability between other types of telemedicine hardware.

As in the cultural climate changes necessary to ensure the most beneficial use of EMR systems, interoperability of telemedicine applications requires more than just negotiating communication standards. Focus on quality of audio and imagery, consistent up-time, patient and provider acceptance, and accuracy of data transmission to maximize equivalence to an in-person clinical encounter are also key aspects that will lead to full realization of the benefits of interoperability of telemedicine and health information applications. Ready integration of telemetric data and clinical observations from these applications into health information and decision support systems will form another vital link to support the overall digital continuum of care.
Several federally-recognized initiatives are underway. The Consolidated Health Informatics (CHI) initiative is a federally-guided collaborative effort to adopt health information interoperability standards, particularly health vocabulary and messaging standards, for implementation in federal government systems. About 20 department/agencies including the Department of Health and Human Services, the Department of Defense and the Department of Veteran's Affairs are active in the CHI governance process. In addition, ONC has been working with ANSI and the Commission for Systematic Interoperability to harmonize the various HIT standards that are in existence.

**Standards**

Standards arise through an identified need to promote quality, commonality, and interoperability within a certain industry or profession. Standards may be formally developed by an industry association or as the result of government legislation, or may appear as de facto standards, which gain acceptance through widespread adoption and use in a particular field. In terms of health information interoperability, both types of standards play an important role. Industry standards such as the H.30x video CODECs and the DICOM format for digital imagery provide a vital foundation to ensure quality communication between telemedicine systems.

Standards that are promoted by government policy and legislation, such as the HL7 language recognized by HIPAA, focus industry attention and set the stage for common business practices and procedures. Especially in the rural, isolated and disparate areas where telemedicine and health information hold their greatest promise, de facto standards also provide vital links to ensure effective communication and quality health care delivery. De facto standards such as the web browser, driven by Hypertext Markup.

Language (HTML) provides a widely accepted and nearly universally available vehicle for presentation and delivery of content, and has frequently been used to deliver database and program access independent of operating system platform. The scalable bandwidth requirements of web browsers provide ease of access to information under field conditions using a wide variety of computer equipment.
Another example of de facto standards are the growing body of how-to guides which describe best practices in terms of photography techniques for store-and-forward dermatology, methods for effective presentation of patients during real-time telemedicine consults, and similar procedures being developed in the growing field of telemedicine. Each element of a telemedicine system used in a patient encounter should conform to the appropriate regulations governing the use of medical devices (in the U.S., Federal Drug Administration (FDA) regulations). These elements include Image acquisition hardware (computers, cameras and other peripherals), systems for image transmission, storage and retrieval such as Picture Archiving and Communication Systems (PACS) and wired and wireless networks, as well as software applications for image analysis and clinical workflow management (scheduling follow-up examinations, clinical communication management, and decision support tools).

Uniform standards at all technical and operational levels among all participants in a health information system are essential to interoperability. Adoption of a range of industry standards by all partners (i.e., CPT, ICD9, TCP/IP, etc.) would be the most effective approach. Another important area for standardization is the reconciliation of the differences in clinical nomenclatures among the participants. Development of a “meta-thesaurus”, using the widely accepted XML for communicating the information, is one potential step toward a solution. Equally important, uniform standards of practice as they relate to EMR requirements would need to be established. In order for health information to be interoperable across systems it is critical to use a common language.

The need for controlled terminologies has long been recognized as a cornerstone of clinical information system infrastructure. The 2000 National Committee on Vital and Health Statistics Report entitled “Report on Uniform Data Standards for Patient Medical Record Information”, cited the importance of standard vocabularies in enabling more precise data acquisition, allowing exchange of comparable data across institutions, and facilitating the implementation of decision support systems. One of the report’s key recommendations has recently been implemented. On January 2004, the latest version of SNOMED (SNOMED CT) was made available for use in the U.S. through a national license procured by the National Library of Medicine.
The importance of consistent data encoding in electronic data interchange is reflected by the inclusion of code standards as part of the provisions in the HIPAA legislation. Adoption of formal or de facto technical computing standards is crucial in order to have effective computer environment support. From a network perspective standard internet technologies, such as TCP/IP are essential.

Currently, every health care organization has a unique method of identifying patients. Consequently, a system for coordinating the disparate medical record numbers, involving a single patient identifier, a master patient index, or an automated system of validating individuals’ identities, will be required. At the core of whatever system is developed is the need to protect individual privacy. A number of “Master Patient Identifier” systems are commercially available that can effectively address this need, and whether the USA should develop a single “health identifier” is still a very controversial area that is the subject of much debate.

Some countries, such as New Zealand, have already introduced such an identifier (National Health Index number, 2005). The Certification Commission for Health IT has been set up to address this issue, among others, and is set to establish a standard for electronic health records in ambulatory settings by mid-2005. The recent (January 2005) Request For Information from the Department of Health Services about the development of a National Health Information Network addressed questions as to the best type of systems for security, authentication, authorization, identification and data location to be employed on a large-scale basis, and received over 500 responses, which are currently being evaluated.

Clinical Guidelines for Telepathology

Technology

The selection of digital imaging systems for clinical use is determined at the discretion of the medical director of the pathology facility intending to use them. The facility is responsible for using such devices
for FDA-approved clinical applications as claimed by the manufacturer. The medical director is responsible for employing and validating these devices if they are to be used for non FDA-approved applications.

To date the FDA has not provided guidance with respect to whole slide imaging (WSI) use for primary diagnosis, but if guidance is issued it should be followed as appropriate.

*Technical Specifications*

- **Image acquisition:**
  One may select from a variety of devices to acquire an image, including cameras and scanners.

- **Displays:**
  One may use a variety of displays including computer monitors, TV screens, and mobile devices. The viewing device and its associated parameters (*i.e.*, monitor size, resolution and color) shall accurately display the pathology image to be viewed. The professional judgment of the pathologist may be used to determine whether or not an image is satisfactory to render a diagnosis. The consistent presentation of images is essential and influenced by software, graphic controllers, and display devices.

  Good visualization of displayed images is achieved when the diagonal dimension of the display distance is about 80% of the viewing distance. Zoom (magnification) and pan functions should be used for display of the image at the originally acquired spatial resolutions (*i.e.*, direct presentation of acquired pixels on the display pixels). Viewing devices should be color calibrated.
Although there is no accepted calibration standard for color medical displays, there are a variety of options in the literature and it is important to select one that can readily be implemented and maintained on the display of choice.

Users should be aware that color in digital pathology images can also be influenced by staining, image acquisition, and software issues. For the practice of telepathology one can select from a variety of mobile devices including tablets and smartphones, and may be used as long as they can securely display the pathology image to be viewed at an acceptable level of quality.

- Transmission and Storage:
  For the transmission of telepathology images appropriate connectivity, bandwidth and computing capabilities should be in place to support the transmitted image type. Bandwidth for real-time viewing of images will be higher than for asynchronous transmission. IT infrastructures for telepathology systems facilitate linkage of pathology images with necessary metadata (i.e., identifiers, clinical information and prior pathology findings). Adequate storage capacity should be in place if images used in telepathology are to be retained, manipulated and retrieved. A typical WSI captured with a ×20 objective lens typically represents 20+Gb of storage if uncompressed, but after compression, the size is reduced to an average range of 200-650 Mb.

Compression technology may be applied so long as it does not compromise the image for clinical use (i.e., should be “visually
“lossless” in that it does not change resolution as visible to the naked eye). Compression is defined as mathematically reversible (lossless) or irreversible (lossy). Reversible compression may always be used as there is no impact on the image. Irreversible compression may be used to reduce transmission time or storage space only if the resulting quality is sufficient to reliably perform the clinical task. Software should support image acquisition, viewing and, if desired, annotation and workflow (i.e., side-by-side viewing of multiple images).

Clinical Applications

Telepathology can be used for any of the following applications.

Primary Diagnosis:

Primary diagnosis can be successfully rendered using a variety of telepathology modes on a variety of substrate materials. There are studies that indicate that there is not always 100% concordance between digital versus glass slide interpretations, however, there is not always 100% concordance between glass vs. glass slides and both inter- and intra-reader variability can vary as a function of case complexity. There are also some studies that show that certain cases (cytopathology in particular) are more challenging to interpret using digital imaging and may therefore not be quite ready for primary diagnosis.

Intraoperative Consultation (frozen section):

Intraoperative consultation, with or without use of frozen section can be accomplished by telepathology using a variety of models, including
fixed images, robotic dynamic telemicroscopy, video microscopy and WSI. If an intraoperative consult is performed on a resection specimen or large biopsy specimens, access to imaging of the gross specimen should be available in addition to microscopic imaging materials.

Rapid Cytology:
Rapid cytologic assessment of cytologic samples (i.e., fine-needle aspiration) requires sufficient speed and image resolution to assist with a patient management decision such as whether to obtain further sample, or to direct specimen management. The consulting pathologist, based on their experience and expertise with respect to the specific samples and diagnostic task, should determine speed and resolution used.

Secondary Consultation:
Secondary consultation refers to any situation where a primary or initial review (with or without a formal diagnosis) has been performed on the primary materials (gross specimen, glass slides, etc.) and further opinion is sought by means of telepathology tools. Secondary consultation may be either formal or informal, differentiated primarily by whether or not a written or other formal report is rendered on the consultation. Informal secondary consultations used to direct patient care should not be referenced in the medical record without the knowledge of the rendering consultant. Secondary consultation is distinct from peer-review activity performed for quality assurance purposes. Secondary consultation via telepathology may be used to enhance quality of care by providing access to particular expertise more widely and at a potentially lower overall cost.
Special Studies:
Telepathology can be successfully used to expand access to specialized services not otherwise available on a cost-effective basis in a given location. These include but are not limited to specialized staining processes such as immunohistochemistry, FISH, CISH, etc., and their appropriate controls if required. Other technical procedures requiring physician interpretation are also amenable to remote interpretation via telepathology tools. Digital images of special studies include pertinent patient identifiers and access to appropriate control materials.

Archival Review:
Archival review for clinical purposes occurs when a case is being reviewed in the context of a new specimen from the same patient or other clinical reassessment of that patient. Availability of digitized materials for archival review should be indicated in some manner in the patient record. Archival material review should be documented to indicate limitations of possible material assessed. (i.e., only 3 images were reviewed even though the case had 20 slides originally). The lab should employ a data management system whereby processes and procedures are defined for short and long term image storage, and accurate and timely retrieval of images.

Quality Activities:
Telepathology tools may be utilized in accordance with local quality management plans to monitor laboratory and or personnel quality performance on a qualitative or quantitative basis, and should be reviewed according to laboratory standards. Digital pathology tools may be used to provide quality assurance of the diagnostic process.
itself. This can be done by means of regular diagnostic quality control cases, selected (automatic, semi-automatic, random, or directed) peer review or other means, either prospectively or retrospectively. Quality assurance of glass slides can be facilitated by digital pathology.

Standardization of histology lab output can benefit from the rigor required for slide digitization. Digital imaging when used for visual management of quality control materials should allow trend analysis. Quantitative or qualitative data obtained from digitized images incorporated into or used as a component of quality management systems should be retained for an appropriate period as determined by the referring and consulting institutions.

Consensus Conference:

Telepathology enables consensus review peer activity from multiple sites, either contemporaneously or asynchronously. The method used should be determined by the situation (diagnostic considerations, sample type, speed required, magnifications needed, etc.) and the resources available.

Multidisciplinary Interactions (Tumor Boards):

Telepathology enables review of cases for tumor boards and subspecialty conferences at the primary site or remote sites. Telepathology-tool facilitated pathologist-clinician interactions can enhance care by lowering the barriers to slide or other information sharing.
Patient Consultation:

Telepathology allows for the remote view of patient's pathology images either solely by the patient or in consultation with the clinical team including the pathologist. Patient access to their digital pathology materials should adhere to pertinent privacy and security guidelines.

Clinical Responsibilities

Sending (Referring) and Receiving (Consulting) Individuals

Referring and consulting parties should agree on a minimal acceptable data set that accompany digital material such as accessioning number, patient name and block/slide identification. The referring individual should:

- Include all relevant clinical information for the consulting pathologist.
- Ensure that the consulting pathologist has access to any necessary and/or relevant current and prior diagnostic material.
- Take responsibility that the correct image is being sent, as well as appropriate metadata.

 Appropriately trained personnel should be able to manage cases and relevant materials being transmitted to either the referring pathologist or consulting pathologists. A laboratory medical director should be responsible for training the support personnel including trainees and be available to the support personnel as needed; responsibilities may be delegated.
Prior to the implementation of novel telepathology, pathologists should engage nonlaboratory clinical personnel to identify situations that require adaptation to change their current practice or workflow.

Facility Responsibilities

Standard of Care (SOC):

The facility SOC should be defined by the organization and/or other accrediting/regulatory bodies such as the College of American Pathologists (CAP), The Joint Commission (TJC), or as is appropriate locally. The facility should engage the Medical Advisory Committee/Board to review and approve protocols around telepathology in situations where a traditional paradigm is substantially changed.

Technical Support:

Information Technical support personnel should have a basic understanding of the technical requirements for the required workflows and be familiar with aspects of networking, interfaces, and the operating systems involved. Technical support personnel, including vendors with an adequate understanding of the telepathology systems (hardware, software), should be available to ensure that the systems are operating appropriately. A technical support plan should match the urgency and critical nature of the use case implemented for telepathology applications.

Functional Verification of Equipment:

The facility should make sure that technology and instrumentation operate in accordance with manufacturer’s specifications.
Accreditation:

The laboratory should operate in compliance with applicable accreditation criteria.

Privileges:

The pathology department, and specifically the Laboratory Director (or equivalent) and/or his or her pathologist designee, is required to determine which individuals will have privileges to practice telepathology at the institution and any applicable practice settings.

Licensure:

The facility performing telepathology should adhere to the applicable licensure requirements, with respect both to facilities and to pathologists, for their location(s) and those with which they communicate.

Validation:

All laboratories implementing a telepathology service for clinical diagnostic purposes should perform their own validation studies. The validation shall encompass the intended use of the clinical case and setting anticipated to be deployed. Validation should encompass all components of the telepathology workflow. These should be validated as a single “system”.

Revalidation should be conducted if there is significant change in a component or use-case. Validation should use prepared human specimen(s) of the specific type that matches the type that will be used for the clinical use-case. Validation for specific tissues, diseases,
microscope changes or diagnoses are not necessary. Pathologist(s) who has been adequately trained to use the telepathology system should be involved in the validation process.

The validation process should also include all individuals that will use the telepathology system, including laboratory managers, laboratory staff, and IT personnel. The validation process should confirm that all of the material present, or purposefully selected areas on the glass slide, is included in the digital image/video. It should also confirm that the video/image being sent is identical to that which is received. However, it should be noted that with lossy compression, the image that results from compression/decompression may not be identical to the starting image but should be "visually lossless" with respect to diagnostic information and/or details or features.

Validation should comply with the most current accrediting standards of the facilities’ regulatory bodies; including methods, measurements, evaluations and approvals for the telepathology system. Validation documentation should be maintained for a sufficient period to satisfy regulatory bodies and legal institutions.

Diagnostic:
A validation process should include a sufficient number and mix of cases for each application that reflects the spectrum and complexity of specimen types and diagnoses likely to be encountered.

Training:
Personnel responsible for performing telepathology, using telepathology technology and following telepathology procedures
should be trained in the correct usage and adhere to any relevant Standard Operating Procedures (SOPs). The training and competency assessment of the staff should be determined by the local SOPs. Training procedures should be standardized. Training should be documented.

**Documentation and Archiving**

Reporting of Pathologic Findings:

A diagnostic consultation by telepathology should generate a formal report for the medical record, comprised of either the pathology report or as a documented report of the oral communication. Informal or internal “curbside/hallway” type telepathology consultations may be documented at the discretion of the pathologists involved and/or in accordance with departmental procedures. The referring pathologist should document in the formal pathology report that the telepathology encounter occurred, and detail the interpretation rendered by the consulting pathologist at their discretion, and/or in accordance with the institution or departmental SOP.

Disclaimer Statements:

Any disclaimer statements added to the formal report of the telepathology encounter may be facility specific and determined by an organization’s policies.

Logs:

Logs of telepathology interactions shall be tracked as is appropriate to the local requirements and regulations. These logs can be used for
clinical purposes, reimbursement records, quality assurance, research or any other appropriate reason.

Retention Policy:
The retention of associated artifacts of the telepathology event, including telepathology documentation, reports, and captured images should be retained as is appropriate to the local requirements and applicable regulations. Images should be retained for an appropriate period as determined by the referring and consulting institutions.

Quality Management

Technical:
An ongoing quality management program should address the technical performance of a telepathology system such as image quality, malfunction, network performance, device calibration, data integrity and image tracking. Examples of quality metrics that may be monitored include the number of discordant diagnoses due to poor image quality, re-scan rate as a technical quality indicator, and delays in turnaround time due to the technology.

Diagnostic:
A quality management (QM) program should address the diagnostic performance of the pathologists using the system. Examples of quality metrics that may be used to assess diagnostic performance include number of misdiagnoses (i.e., discordant glass versus digital diagnoses), delays in turnaround time, and deferral rates (i.e., failure or inability to render a telepathology diagnosis) for users. A
A pathologist knowledgeable in telepathology should be appointed to oversee the diagnostic QM program.

Operations

Maintenance:
The maintenance of the system shall be in accordance with vendor recommendations and other applicable regulatory standards. The maintenance records should be retained as per the local regulatory requirements.

Technical Support:
The facility should develop telepathology specific business continuity procedures as appropriate for their environment, if such procedures are different from complete downtime or system availability procedures. The facility should develop downtime SOPs for telepathology that are appropriate for their institutional needs.

Physical Facilities:
Institutions should ensure that the physical facilities and equipment provided for telepathology applications are adequate for safe and efficient operations; this includes appropriate environmental controls, network infrastructure, physical space and utilities.

Security and Privacy:
Organizations and health professionals providing telepathology services shall ensure compliance with relevant local, state and federal (or international if appropriate) legislation, regulations, accreditation and ethical requirements for supporting patient or client decision
making and consent, including protection of patient health information. All data transmission should be secure through the use of encryption that meets recognized standards. Individuals in charge of technology should familiarize themselves with the technologies available regarding computer and mobile device security, and should help educate users with respect to such issues as privacy and security options. If videoconferencing is going to be used (i.e., tumor boards), privacy features should be available to all participating parties. Privacy features should include audio muting, video muting, and the ability to easily change from public to private audio mode. When providers use a mobile device, special attention should be placed on the relative privacy of information being communicated over such technology.

Providers should ensure that access to any patient information stored on any device is adequately restricted. Devices should require a passphrase or equivalent security feature before the device can be accessed. If multi-factor authentication is available, it should be used. Devices should be configured to utilize an inactivity timeout function that requires a passphrase or re-authentication to access the device after the timeout threshold has been exceeded. This timeout should not exceed 15 minutes. Mobile devices should be kept in the possession of the provider when traveling or in an uncontrolled environment.

Unauthorized persons should not be allowed access to sensitive information stored on any device, or use the device to access sensitive applications or network resources. Providers should have the capability to remotely disable or wipe their mobile device in the event it is lost or stolen. Providers and organizations may consider establishing
guidelines for periodic purging or deletion of telepathology related files from mobile devices. Protected health information and other confidential data should only be backed up to or stored on secure data storage locations. Cloud services unable to achieve compliance should not be used for personal health information or confidential data.

Regulatory Compliance:

Telepathology programs should be mindful of regulatory agencies (i.e., FDA, CMS/CLIA, CAP) and their specific policies and guidelines that pertain to telepathology.86

**Benefits Of Telemedicine**

Telemedicine has been growing rapidly because it offers four fundamental benefits. These are reviewed below.58,87-89

**Improved Access**

For over 40 years, telemedicine has been used to bring healthcare services to patients in distant locations. Not only does telemedicine improve access to patients but it also allows physicians and health facilities to expand their reach, beyond their own offices. Given the provider shortages throughout the world - in both rural and urban areas - telemedicine has a unique capacity to increase service to millions of new patients.

**Cost Efficiencies**

Reducing or containing the cost of healthcare is one of the most important reasons for funding and adopting telehealth technologies. Telemedicine has been shown to reduce the cost of healthcare and
increase efficiency through better management of chronic diseases, shared health professional staffing, reduced travel times, and fewer or shorter hospital stays.

**Improved Quality**

Studies have consistently shown that the quality of healthcare services delivered via telemedicine is as good as those given in traditional in-person consultations. In some specialties, particularly in mental health and ICU care, telemedicine delivers a superior product, with greater outcomes and patient satisfaction.

**Patient Demand**

Consumers want telemedicine. The greatest impact of telemedicine is on the patient, their family and their community. Using telemedicine technologies reduces travel time and related stresses for the patient. Over the past 15 years multiple studies have documented patient satisfaction and support for telemedical services. Such services offer patients the access to providers that might not be available otherwise, as well as medical services without the need to travel long distances. The following is a list of the general benefits associated with a telemedicine program.\(^{58,90-93}\)

Patients:

- Have better outcomes because of timelier access to specialists who can apply the highest standards of care associated with their clinical discipline when evaluating the patient.
- Reduce unnecessary admissions or readmissions when through remote monitoring or remote consultations with clinicians, they are able to better manage their health situations while at home.
• Avoid unnecessary transfers to another facility when a remote specialist can determine if the patient’s best care option is to stay local and allowing the patient to remain closer to the support network of family and friends.
• Reduced Morbidity and Mortality
• Reduced Length of Stay
• Reduced Time in ICU
• Reduced Time in Hospital

Originating sites (where the patient is, if not at home):
• Enable their clinical staff to obtain access to a specialist support network to help provide better care for their patients and community.
• Retain some patients rather than transfer them to another facility and possibly out of their health system altogether, thereby retaining the revenues associated with care of the patient.
• Benefit from the “halo effect” of offering advanced healthcare solutions such that the community perceives them as being able to provide better care for other health conditions that might not even have a telehealth component.

Physicians:
• Extend their clinical reach to patients who can benefit from their expertise.
• In some cases, earn on-call pay for providing tele-consults.
• Save time traveling between facilities to see patients, increasing their productivity and improving their quality of life.
• Tertiary care facilities identify remote patients who can benefit from being transferred to the tertiary care facility, and subsequently generate more revenue for care of the new patient.

Tertiary care facilities:
• Develop relationships with underserved care facilities that need their help, and thereby get more transfers when a tele-consulting physician determines that the patient needs the level of care that only the tertiary care facility can provide. This accrues to additional revenue for the facility as well.
• That already have relationships with underserved facilities can screen for transferring in the patients they can best serve rather than indiscriminately transferring patients just so they can be seen by a specialist at the tertiary care facility (who might later determine that the patient could have received local care). This also helps optimize bed utilization at the tertiary care facility, and minimize the risk of diversion.

Payers:
• Experience reduced costs when specialist resources are used more efficiently to address patient conditions. For example, access to the right specialist can help eliminate unnecessary transfers, admissions or readmissions, and can reduce lengths of stay. In addition, timely access to the right physician can predict or prevent an adverse event, or at least reduce the chances of the most adverse events.
Healthcare system (as a whole):

- Enables its increasing number of patients with healthcare needs to access the decreasing supply of clinicians
- Experiences reduced costs as timelier access to the right clinician reduces overall inefficiencies in the system.

**Improved Access to Information**

Telemedicine can improve access to information for health professionals, for patients and for the population in general. The following discussion highlights methods of improved information access. 27,40,94-98

**Information for health professionals**

Electronic search engines such as MEDLARS, PUBMED and others have laid the foundation for a silent revolution that enables any health professional to have access to up-to-date ‘case-oriented’ information within seconds, via the internet. Wireless computer connections mean that searches can even be conducted at the bedside.

Full copies of articles in journals and books can be ordered and received as an attachment to an email message from a distant reference library. This application of telemedicine provides the basis for daily, continuous education, which should expand and maintain the skills of health professionals at all levels. The benefits of this application of telemedicine are obvious and cannot be overestimated.
Communication between health professionals

Communication between the primary and secondary healthcare sectors has traditionally been carried out by mail, but email is increasingly being used for this purpose. As a result, information kept in a computerized data file can be attached to an email message, permitting easy and instantaneous transfer of patient information between general practitioners (GPs) and hospitals. Health professionals in primary care can access patient records, kept in databases of individual hospitals, groups of hospitals or entire health regions, ensuring, for example, that hospital discharge letters are made available without delay.

Reduced costs

Specialists “team up” with local healthcare providers to improve disease management and improved disease management reduces complications and hospitalizations. The following include examples where reduced cost impacts waste and care outcomes.

- Nursing Home TeleMedicine reduces costly transports and unnecessary ED visits.
- High cost patient transfers for stroke and other emergencies are reduced.
- Home monitoring programs can reduce high cost hospital visits.
- Transportation savings to patients who would otherwise need to commute to an urban location.
- Missed work income savings to patients who would otherwise need to commute to an urban location.
- Sharing Costs among Hospitals for Staff
- Fewer Specialists Required Full-Time
**Improved Care in Remote Areas**

The use of technology to deliver health care from a distance, or telemedicine, has been demonstrated as an effective way of overcoming certain barriers to care, particularly for communities located in rural and remote areas. In addition, telemedicine can ease the gaps in providing crucial care for those who are underserved, principally because of a shortage of sub-specialty providers.

The use of telecommunications technologies and connectivity has impacted real-world patients, particularly for those in remote communities. This work has translated into observable outcomes such as:

- improved access to specialists
- increased patient satisfaction with care
- improved clinical outcomes
- reduction in emergency room utilization
- cost savings

**Improved Relationships**

The adoption of telemedicine has led to greater relationships between providers and patients. Telemedicine provides an opportunity for physicians and other medical professionals throughout the world to connect with one another and collaborate on patient concerns to find better diagnoses and treatment options. While many physicians already have good relationships with their patients, the adoption of telemedicine provides another opportunity to improve and enhance these relationships.
Through the use of a medical image transfer and a DICOM viewer for example, a patient’s provider can send that patient’s information to a specialist for consultation. That can help the patient get faster treatment, and provide a potentially higher level of accuracy. While the exchange of medical imaging won’t actually involve the patient, the trust built between physician and patient will increase due to the good treatment received.\textsuperscript{30,41,102,103}

The use of telemedicine to treat patients will have a significant impact on those patients who utilizes a physician on a regular or semi-regular basis. The doctor’s ability to correctly diagnose and treat the patient, quickly and efficiently, is a big part of whether the patient will return to that physician. Patients will be more satisfied and willing to comply with medical recommendations if they trust their provider. As such, it has to be carefully considered and addressed by the provider. Telemedicine provides an opportunity to build a solid foundation of trust between the provider and the patient.\textsuperscript{92}

Telemedicine allows for physicians to share medical imaging so quickly and easily; everyone who is a party to that transaction benefits. The patient receives better care, a more rapid diagnosis, and more thorough treatment, while the doctors are able to address the issue, make a decision, and move on to other patients. The collaborative nature of the medical image transfer can also build better relationships between providers.\textsuperscript{104}

\textbf{Challenges To Implementation}

Despite growth there is a general feeling that telemedicine has a long way to go before it reaches its full potential. A large proportion of rural
and urban communities that could benefit continue to lack access to telemedicine; so too do many developing nations. Furthermore, those programs that are initiated tend to be short-lived while those that do survive frequently experience levels of usage that have been disappointing. A number of factors contribute to this state of affairs. Impediments include the following:\textsuperscript{105,106}

- Financial barriers, in particular, the high costs of setting-up and implementing such systems and the prevailing lack of third party reimbursement for providers who operate and use them.

- Ethical and legal concerns, especially those related to confidentiality. To what extent can privacy be ensured, and, professional portability, in terms of the extent health care professionals can “move in person or virtually across barriers, and among and between jurisdictions;” and, uncertain malpractice exposure, in terms of to what extent does current legal criteria apply to novel consultation mediums such as this.

- The piecemeal development of the telecommunications infrastructure, which, due to a lack of interoperability, promotes use of technologies that cannot speak with or understand one another.

- Lack of infrastructure and resources necessary to sustain telemedicine use, particularly in some regions and nations and among certain vulnerable populations; for example, the elderly, disabled, members of certain minority groups, those with low literacy, low income, limited English proficiency, living in rural areas and situated in undeveloped nations.

- Dearth of systematically collected and analyzed evaluation data regarding telemedicine’s impact on cost, quality and access is often another cited barrier.
There are many exciting opportunities and remaining challenges to the continued implementation of successful telehealth programs within the field of emergency medicine. Opportunities and major challenges to the field are listed below.\textsuperscript{107,108}

Opportunities:

- creating a more cost-effective healthcare system by reducing unnecessary transfers
- consolidating healthcare records and visits through EMRs
- increasing access to high-quality stroke and trauma care regardless of a patient’s geographic location

Major challenges:

- lack of financial reimbursement for telehealth visits
- social adaptability to such changes both within and outside of the healthcare community
- the technology itself being expensive or cumbersome. Many of these challenges are soon to be overcome.

Interestingly, social acceptance of telehealth has been a large barrier to its growth. In an era where video chatting, social media, and movies like Avatar are commonplace, it is surprising to think of this as a major limiting factor in its widespread adoption, but deep-seated feelings by both patients and providers have been observed. Many providers, for example, have misconceptions that the use of a video-based telehealth visit or consult will decrease patient-provider relationships, and be poorly accepted by patients. In fact, research both in the U.S. and worldwide has shown high acceptance and satisfaction, in general, with telehealth interactions. Suggestions to
overcome the potential discordance have been introduced, and include beginning with a pilot launch and then expanding gradually.\textsuperscript{109}

**Barrier of Cost**

The primary barrier is cost — the cost of a telemedicine program exceeds $3 million annually and is not easily borne by hospitals that are already observing declines in revenue. Some experts have posited that these expenditures may be regained by reductions in ICU length of stay and prevention of ICU-acquired complications. However, these positive effects are not assured, and the true cost savings associated with reductions in ICU length of stay may not be large enough to meaningfully affect a hospital's bottom line.

Another source of cost recovery would be for physicians to bill for telemedicine services. Although physician reimbursement for telemedicine services is increasingly common, few payers currently reimburse for critical care services provided via telemedicine, given the importance of bedside assessment in the ICU as well as concerns about overutilization and a resultant devaluation of critical care services.\textsuperscript{110,111}

**Implementation Cost**

The cost of implementing an ICU telemedicine program can be a significant barrier to the expansion of such programs. However, a thorough understanding of these costs is necessary. To better understand implementation costs, and the barrier such costs might pose, a systematic review of studies published, between January 1, 1990 and July 1, 2011, reporting costs of tele-ICUs was conducted. Studies were summarized, and key cost data were abstracted. From
this point, researchers analyzed and summarized findings relevant to the cost of implementing a tele-ICU program. The following is a synopsis of these findings from the Veteran’s Health Administration (VHA):

We conducted a systematic literature review of the costs of tele-ICUs and evaluated the costs of implementing a tele-ICU in a network of VHA hospitals. Although our literature review revealed many shortcomings in the published literature, our review suggests an initial cost of tele-ICU implementation and operation of $50,000 to $100,000 per ICU-bed in the first year. In analysis of detailed VHA data, we found the total cost for implementation combined with the total first-year tele-ICU operation costs to be $123,000 per ICU-bed. When initial investments are depreciated over 5 years, the combined costs for technology and operation in the first year are estimated at $70,000 to $87,000 per ICU-bed. Our results provide much-needed data regarding the resources required for implementation of a tele-ICU.

Several findings merit further comment. First, it is critical to mention the significant variation in how prior studies measured and reported costs. Several studies failed to include details of critical cost components for the tele-ICU. For example, one-half of the studies did not provide the costs for implementation, technology, or staffing; and other studies failed to include a breakdown of the technology costs. None of the studies considered how tele-ICU coverage hours and interaction protocols might impact staffing costs for the monitoring centers or hospital profits. Although the technology is sold on a per-bed
basis, few studies reported tele-ICU costs in a systematic way (i.e., cost per patient or cost per bed). Smaller centers may initially consider a tele-ICU to be of high cost, but if a tele-ICU increases patient throughput and volume, a facility may realize a lower cost impact. With the availability of different technology options, interfacility comparisons may be difficult, as one facility may spend more than another to purchase technology. Likewise, few prior studies clearly specified the precise elements included in their cost analysis, including personnel costs, technology costs, and real estate costs. Authors, reviewers, and editors should work in concert to ensure that key cost elements are consistently reported to maximize the value of tele-ICU economic analyses.

Second, for tele-ICUs to be sustainable over the long term, hospital administrators will demand rigorous financial analyses of budgetary impact. Many of the prior studies purport cost savings based on improvements in surrogate outcomes (i.e., ICU length of stay, ventilator-associated pneumonia prevention, ventilator days) but fail to provide actual cost data demonstrating true cost savings for tele-ICU. Tele-ICUs have the potential to be economically viable if (1) they reduce costs or (2) they increase revenue. Long-term viability of tele-ICUs will require more detailed data that these programs are cost effective.

Third, our analysis of VHA data warrants discussion. We found that the costs of tele-ICU implementation combined with 1 year of operation was somewhat higher within VHA when compared with the detailed data obtained from a prior study. However,
after depreciation of initial investments was performed, costs within VHA appear similar to those provided in prior studies. It is important to recognize that none of the prior studies mentioned use of deprecation methods. Moreover, the VHA already has an advanced EHR in all VA hospitals. Since the VHA did not purchase an EHR, the VA was not burdened with the complex technology integration issues that other hospitals with assorted computer systems may encounter. Finally, as a large integrated delivery system, the VHA tele-ICU implementation may have benefited from economies of scale that smaller health-care systems might not realize. Taking this into consideration, the costs of tele-ICU implementation within VHA could actually be lower than what would be expected in the private sector.

Our study has a number of limitations that merit mention. First, our systematic review was limited by the quality of the prior studies that have been conducted to date. Although the limitations were significant, our evaluation should provide a framework for future research. Second, our VHA data are limited to the initial implementation and estimated first-year monitoring site operation costs. Third, we could not calculate the cost effectiveness or cost savings of the tele-ICU, as such an analysis would require longer-term estimates of effectiveness (i.e., reduction of ICU length of stay, reductions in imaging and laboratory testing, reduction in ICU complications) that are not yet available but will be a focus of our longer-term evaluation. Fourth, our study suggests that the cost effectiveness of a tele-ICU will vary between facilities and will depend on bed use and
patient throughput (i.e., case volume) and the number of beds over which the costs are depreciated (i.e., economies of scale).

In conclusion, our review and analysis suggest an implementation and first-year operational cost of tele-ICUs of approximately $50,000 to $123,000 per monitored ICU-bed. The long-term economic impact of these programs remains unclear. In the meantime, clinicians and administrators should carefully weigh the clinical and economic aspects of tele-ICUs when considering investment in this technology.79

Management Cost

The cost of managing a telemedicine program is significant. Therefore, telemedicine can only sustain itself on the basis of long-term business models that rely on recurring revenue and diverse sources of financing. Yet, in the current environment, business models that are limited to direct fee-for-service reimbursement may not be sufficient to sustain telemedicine in the long term because they are severely constrained. In addition, healthcare is approaching a point in which the fee-for-service method of reimbursement is being phased out. Without reliable revenue sources, business models for telemedicine will require demonstrable evidence of benefits to patients, providers, and/or society at large to warrant an institutional and/or governmental investment in both the infrastructure and the human resources necessary to operate the program.106,112

While sustainability in healthcare depends primarily on recurring revenue, the concept of return on investment can be thought of broadly or narrowly. It can take different forms and can be direct or
indirect, immediate or delayed, tangible or intangible. Regardless of the form of recurring revenue, it must occur and must be of sufficient size or accrued value if the enterprise is to remain solvent over the long term.

In instances where the amount of recurring revenue is inadequate, the organization must make structural adjustments. These include reducing the size and/or scope of service or improving its mode of production. When revenues or derived value in the form of an indirect return on investment cannot be sustained, the organization must find ways to reduce expenditures in order to maintain its financial integrity or otherwise cease to exist in its present form.\textsuperscript{113,114}

In most instances, telemedicine programs in the United States have relied heavily on non-recurring extramural funding or other provisions or appropriations from state and/or federal sources. Grant funding has also been used in various forms, including line items (set-aside funds) in state or federal budgets or as successful bids in competitive solicitations.\textsuperscript{66,115} In all forms, external funds have been instrumental in establishing telemedicine programs during the “maturation period” of telemedicine and beyond, particularly in the initial stages of development and in some instances sustaining them beyond the initial funding period. In many instances, the use of these funds allowed programs to demonstrate the benefits of telemedicine to policymakers and third-party payers. Unfortunately, grants and external funding only provide temporary support to programs; they are not intended to serve as sources of recurring revenue.\textsuperscript{27}
Although grants and other forms of external funding are short lived, the benefits they have provided to telemedicine over the last two decades have been substantial and vital. These funding sources have enabled the development of a critical mass of programs across the United States, which in turn have supported development of telemedicine applications and practitioners across almost the entire spectrum of clinical care.

Additionally, the “funding generated a generation of system development specialists and a proliferation of telemedicine vendors. This critical mass of gatekeepers now advocate actively for the wider adoption of favorable policies to advance the practice of telemedicine at local, state, and national levels. Their advocacy has proven effective in reducing barriers to reimbursement for telemedicine consultations and interstate licensure and practice. The growth in telemedicine is reflected in the growth of the American Telemedicine Association (ATA). The ATA was established in 1993 as a nonprofit organization headquartered in Washington, DC. Although originally organized as an “American” association, the ATA now has two international regional chapters (Pacific Islands and Latin-American & Caribbean Chapters) and a membership distributed across 45 countries. The ATA has also signed membership-based agreements with eight other countries.”\(^{81,90,116-118}\)

**Resistance by Medical Professionals**

Adoption of telemedicine has been rapid and widespread. However, the level of satisfaction and reported level of effectiveness has varied based upon staff perceptions. The level of impact telemedicine has on staff is crucial, yet often overlooked. However, in the most extreme
cases, staff dissatisfaction has resulted in the discontinuation of telemedicine programs after a short period of time. Negative reactions amongst staff can often be linked to their level of responsibility as it pertains to managing the telemedicine program. In many instances, staff can be overwhelmed by the amount of specialist monitoring and intervention involved. In addition, they are often responsible for implementing and operating the new system. One study attempted to systematically evaluate acceptance of tele-ICU coverage by ICU staff with a focus on benefits and challenges seen by frontline providers adopting this new technology. The following is a summary of the findings:

In a systematic review of staff acceptance of tele-ICU coverage, we found that this technology generally was viewed favorably by physicians and nurses across an array of settings. In particular, staff generally viewed tele-ICU coverage as improving ICU quality despite initial reservations regarding the implementation of these systems. Staff also expressed the strong belief that the benefit of tele-ICU coverage would be greater for ICUs with specific quality issues (i.e., difficulty in obtaining staffing) that could be affected. Our review also revealed important limitations in the methodologic rigor of many studies, highlighting the need for better evaluation of this costly new technology.

A number of our findings merit further discussion. First, it is important to address the quality and rigor of the available data. Although we identified 23 studies meeting our inclusion criteria, only seven were peer-reviewed studies that focused primarily on staff acceptance, and validated survey instruments were used in
only two studies. This lack of rigorous data places hospital administrators and intensivists contemplating implementation of tele-ICU coverage in a difficult situation.

Second, our results suggest that staff acceptance of tele-ICU coverage is generally high. Although staff members have appropriate concerns about the impact of this technology ahead of implementation, most studies suggest that those who have worked in an ICU with tele-monitoring view the technology favorably.

Third, our review suggests that context matters. In other words, staff members seem to appreciate the fact that the benefit of tele-ICU coverage depends on the baseline performance of the ICU where coverage is initiated. In particular, ICUs with poorer baseline performance or more-significant challenges might benefit more, whereas ICUs with better baseline performance might benefit less. One could argue that this assumption is intuitive, but at the present time, it is actually quite uncertain which hospitals are choosing to implement tele-ICU coverage. Indeed, it is possible that ICUs with highly engaged intensivist leaders and high baseline quality may be the facilities choosing to purchase these systems.

Fourth, our review highlights several specific strategies that might facilitate tele-ICU acceptance by staff. ICU clinicians should participate early in the design and implementation of the tele-ICU. Physicians and hospital administrators should build support for tele-ICU coverage among the ICU staff prior to
rollout. Clinicians from the monitoring center should visit the bedside teams in order to build trust on both sides of the camera. Audiovisual contact with the teleconsultant is better than audio contact alone. Hiring monitoring center physicians and nurses skilled in interpersonal communication is important for reducing the threat perceived by bedside teams.

The findings allow us to speculate on additional ways to facilitate integration of the tele-ICU. Uncertain and conflicting treatment approaches undermine patient care, so hospital administrators must establish absolute agreement between the ICU staff and the monitoring center on best practices for operation. Procedures for physician-to-physician sign-out should be explicit so that ICU nurses know at all times the scope of the tele-ICU consultants’ authority. Administrators should encourage nurses to identify conflicting treatment directives and provide clear instructions for resolving those conflicts for the best care of the patient. Administrators also could enhance acceptance and decrease suspicion by arranging periodic face-to-face meetings or site visits for bedside and consulting clinicians.

Our review has several limitations. First, most of the included studies addressed staff acceptance only as a secondary consideration, so the level of detail reported often was deficient. Second, the heterogeneity of study designs and measures prevented us from conducting meta-analyses of the reported quantitative data. Nevertheless, the reporting of qualitative results was a strength of this review. Third, all but one study neglected to evaluate tele-ICU acceptance among
administrators. This omission is important because administrators were typically the ones who determined whether tele-ICU coverage was purchased and implemented. Finally, acceptance by patients and families was not examined in the studies in this review and merits further investigation.

In conclusion, we found that although tele-ICU coverage was initially viewed with trepidation, after implementation, staff viewed this technology as improving ICU functioning in a number of diverse ways. This study highlights the need for careful planning and staff involvement prior to implementation of what can be viewed as a threatening and disruptive technology.120

Impact on Relationship Between Provider and Patient

The impact in the relationship between the provider(s) and the patient is a great concern when considering implementing telemedicine. Although there has been evidence that telemedicine can actually enhance provider patient relationships, many providers are hesitant to implement programs because they fear that they will negatively impact their relationships with their patients. There are a number of factors to consider when examining the impact telemedicine may have on these relations. They include the following:

- Interpersonal Communication:

  Interpersonal communication “provides the basis for establishing comfort and trust, for exchanging information that will be used to make health-care decisions and for negotiating patient and physician decision-making roles.” By affecting consultation behavior telemedicine may impact trust, which can facilitate
patient disclosure and cooperation, while reducing the likelihood of complaints, disputes, and lawsuits. It may also influence the extent of patient and physician participation during medical encounters, either facilitating movement toward patient centered and consumerist patterns, or reinforcing traditional paternalistic patterns.

With paternalistic interactions, physicians mainly exhibit what has been referred to as “doctor centered” behaviors (i.e., giving directions, asking closed-ended questions), aimed at efficiently gathering sufficient information to make a diagnosis and consider treatment options in the least amount of time necessary. This is in contrast to patient-centered interactions, which recognize patients as collaborators who bring strengths and resources to the interaction. This includes not only knowledge of their biomedical state (i.e., physical condition and well-being) but also knowledge of their psychosocial situation (i.e., personality, culture, living arrangements, relationships). Physician behaviors that encourage patient participation include asking more open-ended questions, ensuring and confirming patient comprehension, requesting patient opinions, and making statements of concern, agreement and approval.

Understanding the impact of telemedicine on the provider-patient relationship is also important because it may help overcome prevailing resistance to the technology, thereby promoting further use where appropriate. Perhaps this is best reflected in a recent study that examined the impact of remote monitoring on mortality, complications, and length of stay (LOS)
among intensive care unit (ICU) patients served in a large, non-profit health care system located in the Gulf Coast region of the United States. Each ICU patient received traditional on-site care in addition to remote 24 hour audiovisual and vital signs monitoring by an off-site specialist.

Physicians in the monitored units, however, could choose the level of outside intervention received, either minimal delegation, where the intervention would only take place in life threatening situations, or full delegation, where, in addition to life threatening situations, remote staff could give routine orders and change treatment plans. While remote monitoring was associated with improved outcomes among the sickest patients, no association was found between implementation of the telemedicine technology and outcomes more generally.

The authors attribute the lack of broader impact, in part, to a lack of acceptance by on-site staff. Local physicians delegated full treatment authority for a little less than one-third of the patients enrolled; for the remainder, remote specialists were granted the authority to intervene only during life-threatening events. Had local physicians been less reluctant to rely on remote monitoring additional improvements may be have been detected.

Reluctance to delegate derived from a variety of sources. Some feared that telemedicine might adversely affect care, say, by intruding on the autonomy of local providers or interrupting traditional workflow patterns. Others felt that remote monitoring
would adversely impact the relationships between on-site providers and their patients.

Perhaps most importantly, elucidating the effects of telemedicine on provider-patient communication is important because telemedicine may impact consultation outcomes by influencing the way providers and patients interact with one another. These include process outcomes during the medical encounter itself (i.e., patient assertiveness, provider empathy), short-term outcomes immediately after medical encounter completion (i.e., satisfaction, tension release, knowledge acquisition), intermediate outcomes within a few weeks or months after consultation (i.e., treatment compliance, psychological well-being, recall, understanding), and long-term outcomes recorded over more extensive periods of time (i.e., health status, symptom resolution, physiologic status, survival). Since a large body of research indicates that communication behaviors are an important determinant of health care outcomes, it is likely that if telemedicine impacts outcomes, it will do so, in part, through changes in the way physicians and patients communicate with one another.

- Communicating via Two-Way Interactive Video:

Use of real-time videoconferencing continues to expand in light of barriers to receiving traditional face-to-face services. With a telemedicine visit, the videoconferencing technology connects the healthcare provider (i.e., physician or other specialist) with the patient at the distant site. At the distant site, the adjunct coordinator, typically a general practitioner, nurse or other non-
physician provider introduces the patient to the equipment and assists them during the visit. This individual is called the telemedicine “presenter.” Family members also participate in many telemedicine encounters.

Data suggests that telemedicine's influence on the nature and content of provider-patient communication stems from both its technical aspects and interpersonal aspects. The technical aspects are primarily concerned with the communication technologies used, including hardware, software, standards, and support services, as well as the clinical processes enabled by those technologies, including case finding, diagnosis, treatment, and follow-up.

The interpersonal aspects are primarily concerned with relationships among system personnel, providers, and patients, and the way those relationships are organized. Technically, telemedicine may impact provider-patient communication through depersonalization of the provider-patient relationship, participatory enhancements and impediments, and sensory and non-verbal limitations. Interpersonally, telemedicine may impact provider-patient communication through third party participation, social and professional distancing, and underdeveloped norms and standards.

- Technical Aspects: Depersonalization of the Provider-Patient Relationship

Some observers believe that the doctor-patient relationship has become more impersonal as physicians increasingly rely on high-
tech instruments during their encounters with patients. Since telemedicine relies on advanced communication technologies, it would seem to continue modern medicine's movement in this direction. Such has been a concern of researchers who fear that “telemedicine may be mechanistic and interfere with the development of a personal physician-patient relationship,” or that providers may not be able to establish rapport or empathy with remote clients because of the impersonal nature of the service. Some speculate that by “dehumanizing, dissocializing and depersonalizing” human contact telemedicine exerts a subtractive impact on the provider-patient relationship.

In contrast to in person encounters where providers and patients are both located in the same setting, telemedicine participants usually use specially equipped rooms within their respective facilities. When institutional office space is used by a large number of physicians it is typically “devoid of personal mementos that might suggest the individuality of the practitioner,” providing no or little insight into practitioner personality and other attributes.

Since many different providers typically use the “hub” room, it is often standardized in appearance, and therefore does not provide the remote patient information regarding the physician's humanistic qualities and authority. For this reason, some suggest paying special attention to context; in addition to removing distracting items (and people) from the background, objects establishing the doctor’s authority — special clothing, a plaque — should be included. It further is suggested that a sense
of confidence and authority can be promoted by ensuring that the physician’s face and torso are clearly visible.

It also is possible that the distancing effect of telemedicine may help create a less threatening environment. Whereas psychiatric patients may feel less inhibited discussing their problems over video, those with sensitive conditions (i.e., sexually transmitted diseases) may be more likely to seek treatment. Telemedicine may also infuse physicians’ advice and information with greater respect and authority. Even the necessity of sharing institutional space may have its advantages. Not only might it provide an environment free of the usual distractions, but it may also provide patients with the sense that a particular time and place has been set aside specially for them. Remote consultation via telemedicine may also be less stressful for patients who would otherwise need to travel long distances for their appointments. This could impact communication favorably as well.

Although video may be more impersonal than in-person consultations, it is more personal than consultations that take place entirely over the telephone. The added value of the video channel is the creation of a “social presence” that allows consultation participants to share a virtual space and to feel comfortable discussing complex issues. Patients may be less anxious when visual cues are present.

- Technical Aspects:

  There exist participatory enhancements and impediments in the field of telemedicine. Aspects of the technology will likely
increase anxiety and discomfort among certain participants who may become more self-conscious and inhibited. This is particularly a risk with patients whose images, clinical information, and other intimate data are being recorded and transferred between multiple sites. This comparative lack of privacy associated with telemedicine likely hinders patient communication during some encounters. Being on camera may also make some clinicians uncomfortable; others, by contrast, may need to balance a number of different activities simultaneously — consulting with the patient and their onsite provider, taking notes, looking items up on their computer, etc. Perceived lack of confidence and distraction, in turn, could adversely impact patient trust, satisfaction and other outcomes.

- Technical Aspects:

Sensory and non-verbal limitations are aspects that need consideration. Telemedicine is primarily a visual and auditory medium. Lack of access to tactile and olfactory information may compromise physicians’ ability to make diagnoses, while lowering their confidence in the diagnoses they do make. Some consider this a major limitation in using two-way interactive video although most of the core sensory data used in clinical decision-making is in fact visual and auditory in nature. The absence of “laying on the hands,” in particular, may adversely affect the emotional and psychological bond between physicians and patients.

A number of qualities have been associated with this aspect of the physical examination beyond the placebo effect, including a
sense of comfort, relaxation, self-assertion and pleasure. Most experts, for example, recommend that physicians should break bad news in person, that they should sit close to their patients, avoid physical barriers and rely on touch when appropriate. The separation inherent in two-way interactive video makes following prescriptions such as these on the part of consultants impossible.

Separation between consultation participants limits non-verbal communication as well. When most clinical information is carried on the audio channel, important non-verbal cues — nods, blinks, facial expressions, and body language — were missing, possible making video a potentially ineffective tool for interpersonal communications. While participants may not seem inhibited or uncomfortable in exploring issues, useful body language and appearance information is largely absent. In some instances visual information is lost when providers check their notes or lean forward to convey intimacy or empathy with their patients. In others instances, missing information makes it difficult for patients to show side effects or symptoms. In certain cases, however, missing information may actually facilitate interaction by removing potentially distractive behaviors from view.

There is also evidence to suggest that excellent eye contact can be maintained even during encounters using cellular phone sized video screens. It would also seem that lack of non-verbal communication between a remote medical provider and patient can be made up, in part, by the presence of a second on-site provider.
Interpersonal Aspects:

Social and professional distancing are considerations as well since telemedicine often brings together unfamiliar combinations of patients and clinicians. Not only are remote patients less likely to know their consulting providers, but they are also less likely to derive from similar social, economic, cultural, and linguistic backgrounds. Without telemedicine, for example, rural residents often rely exclusively on local providers. With telemedicine, however, rural residents can consult with tertiary care specialists at urban centers without leaving their local communities. The result is greater social distance among consultation participants, which has been shown to compromise the communication process, including rapport development and psychosocial exchange.121

Data Integration

In many ways, the development and implementation of telehealth applications has resulted in greater management of patient data. The greatest benefit has been in the area of data integration. Electronic health records and wireless technology have enabled providers to share and collaborate on patient records without having to access traditional patient files. However, while telehealth has improved the field of data integration, it also poses some risks. Without proper management, electronic and wireless patient information sharing can be very risky. Many providers are hesitant to engage in such programs because of the potential security risks.122

The creation and implementation of web-enabled communication, patient services, and other e-Health initiatives have been significantly
developed and enhanced in order to improve the quality of health services and maintain a competitive advantage. As a result, the quality of health care has significantly improved. Traditionally, technology has supported health professionals by providing instruments, diagnosis, and different therapeutic treatments. Recently, information and communication technologies have expanded their application to management and planning activities of health areas. In most instances, physicians and nurses make use of the wireless networks in two capacities:

- for communication, to send information through email, and,
- as an extensive library, to consult the clinical information.

Most providers acknowledge that they have solid computer skills, a positive attitude towards using the computer and internet, and are motivated to use both ways on daily activities. However, some health professionals still show some resistance towards the acceptance of new technologies, even when some health sectors are beginning to integrate ICT in some of their fields. This is especially true in terms of patient data. Many providers are hesitant to adopt technology that will make patient data electronic as they have concerns about the reliability and security of such applications.

To address this concern, many technology providers offer opportunities for continuing medical education that complement educational programs for health professionals. Many of these organizations also provide assistance with the maintenance and transfer of clinical data. In addition, many organizations have implemented guidelines that require adoption of technology that will improve data integration. The American Psychiatric Association (APA) states that once the
information is stored, it is essential to have access to it. To assist with this process, many recent technological advances have enabled the introduction of a broad range of telemedicine applications, such as teleradiology, teleconsultation, telesurgery, remote patient monitoring, and healthcare records management that are supported by computer networks and wireless communication.\textsuperscript{53,128}

Unfortunately, while many advances have been made in telemedicine, a number of healthcare software developers have overlooked relevant user features, user tasks, user preferences, and usability issues. Thus, systems can provoke a decrease in productivity or simply be unusable. Several factors could be attributed to developing poor systems, such as cost and time restrictions and the lack of developers with sufficient knowledge on user-centered design.\textsuperscript{35,129} In a recent study, it was determined that only 61\% of information system projects meet the customer requirement specifications. In addition, 63\% of projects exceed their estimated budgets due to the inadequate initial user analysis. Incorporating good design principles in the beginning phase of a project not only saves time and cost, but also decreases changes in design late in the development process.\textsuperscript{47,130,131}

To address this problem, recent findings have shown the need for a design process and evaluation that pays attention to the intended user, focusing on what they will do with the product, where they will use it, and what features they consider essential. In particular, designers will need to address the needs of the patients and specialists about questions related to their condition.\textsuperscript{66}
Security and Risk

Similar to conventional medicine, a telehealth clinician has the same duty to safeguard a patient’s medical records and keep the treatment confidential under the Health Insurance Portability and Accountability Act (HIPAA). All patient data, including electronic files, images, audio/video tapes, etc., must be handled with utmost confidentiality. Telehealth presents some unique challenges to security. The method of telehealth may change the security concerns. For example, a patient participating in a video consultation may be concerned about other persons in the room, whereas someone with remote monitoring might worry about physical safety and reliability of the device. Without affecting any of the implications for providers, many of the security concerns may be related to patient demographic.

Research suggests younger patients are familiar with the use of such advanced technology and therefore may be less concerned about confidentiality than older generations, though this does not change how the clinician should handle patient data. Regarding legal implications to ED providers, as of 2009, there had been no malpractice claims related to the use of telehealth, attributed to the fact that it is a relatively new technology. One can imagine that with increasing use will come increasing concerns over liability exposure.

Emergency departments and trauma centers must understand the risk factors, legal considerations (which vary considerably by state), and technological challenges associated with practicing telemedicine. Any activity will need to be in compliance with HIPAA standards. Therefore, providers will need to ensure that they utilize technology that minimizes security risks. For example, it would be inappropriate
for a clinic to simply use Skype to chat with patients and call that a telemedicine e-visit. Such a practice would almost certainly be in violation of the HIPAA, the Health Information Technology for Economic and Clinical Health (HITECH) act, and state medical board regulations.135-137

Issues to consider differ from state to state, but some of the more common issues of which to be aware are listed below.

- **Notifications to patients and informed consent:**
  
  Many states have very specific requirements for notifications that must be provided to patients at the time services are rendered through telemedicine.

- **HIPAA and HITECH act compliance:**
  
  The entire software set-up and provision of service must ensure the privacy and security of patient data. This includes technical requirements such as encrypting data feeds, electronically logging who accesses medical records, and instituting password strength and expiration policies. It also includes process requirements, such as preventing inappropriate disclosure of personal health information to non-covered entities.

- **Malpractice coverage:**
  
  Not all malpractice policies currently cover telemedicine. Urgent care providers should be certain their policy covers telemedicine or purchase a separate policy that specifically covers telemedicine visits. Various telemedicine solutions and providers are now available to urgent care providers through subscriptions.
or partnerships. Some solutions providers even offer to cover the medical malpractice insurance associated with telemedicine visits. Urgent care owners and providers would be advised to make a thorough review of their state’s telemedicine regulations and available solution providers before launching their e-practice.138-140

Adoption of Telemedicine in Intensive Care Units: Research Study

A research study conducted in the United States from 2003 to 2010 analyzed adoption of telemedicine in intensive care units. The study examined adoption over time and compared hospital characteristics between facilities that have adopted ICU telemedicine and those that have not. The following is a synopsis of the findings:

Using a systematic accounting of ICU telemedicine in the United States linked to federal data we found a substantial expansion of ICU telemedicine from 2003 to 2010. This increase was most rapid immediately following the introduction of commercial programs in 2000 and the publication of an early study demonstrating significant mortality reductions and cost savings associated with the technology. However, the rate of increase slowed in more recent years, with few new installations in the latter part of the study period.

One way to interpret the slowing growth of ICU telemedicine is to infer that the technology has reached the saturation point, consistent with the classic Rogers model of diffusion of innovation. Under this model, the growth of ICU telemedicine is
expected to plateau as late adopters and laggards adopted the technology, and further expansion would be unlikely. This pattern would suggest that the existing barriers to further diffusion are quite substantial, limiting ICU telemedicine's potential applicability at less than 10% of all ICU beds. An alternative model might be the “tipping point” concept, in which an innovation is adopted at a linear rate until novel contextual factors drive additional rapid adoption. Under this model additional expansion may yet occur if current barriers are reduced and more compelling data create a clear sense of perceived usefulness among relevant decision-makers.

Our study underscores the fact that there are substantial barriers to telemedicine adoption that must be addressed prior to further adoption. The primary barrier is costs — the cost of a telemedicine program exceeds $3 million annually and is not easily borne by hospitals that are already observing declines in revenue. Some experts have posited that these expenditures may be regained by reductions in ICU length of stay and prevention of ICU-acquired complications. However, these positive effects are not assured, and the true cost savings associated with reductions in ICU length of stay may not be large enough to meaningfully affect a hospital’s bottom line. Another source of cost recovery would be for physicians to bill for telemedicine services. Although physician reimbursement for telemedicine services is increasingly common few payers currently reimburse for critical care services provided via telemedicine, given the importance of bed-side assessment in
the ICU as well as concerns about overutilization and a resultant devaluation of critical care services.

Another key barrier is the perception of telemedicine on the part of bedside practitioners, especially nurses who may be doubtful of the potential benefits and concerned about disruptions in daily workflow associated with remote monitoring. Lastly, there are reasonable questions of efficacy given the low quality of the literature and the number of negative studies. In support of this notion are several studies calling into question the benefits of nighttime intensivist staffing. These studies suggest that routine processes of care are more important than nighttime staffing by bedside or remote providers.

We found that a minority of adopting hospitals was small (i.e., <100 beds) and rural (i.e., located in a non-metropolitan area). These findings suggest that ICU telemedicine is only partly fulfilling its promise as strategy to extend the benefits of intensivist physicians to patients in small, rural hospitals. Currently the vast majority of hospitals in the U.S. do not have trained intensivist physicians. Although telemedicine has great potential to improve the quality of critical care in these hospitals, it appears that a substantial proportion of adoption is occurring in large, urban hospitals that are already well resourced. It is possible that small, rural hospitals are finding other approaches to dealing with severely ill patients, such as through transfers to higher levels of care or quality improvement cooperatives. It is also possible that, contrary to intuition, large, urban hospitals are the most appropriate hospitals types for ICU telemedicine.
This might be true if telemedicine improves outcomes at hospitals with extremely high acuity, even in the setting of high-quality bedside care.

These adoption patterns may also be a reflection of the varying reasons that hospitals adopt ICU telemedicine. In particular, there are two ways that ICU telemedicine can enter a health care market: through the initial introduction of a telemedicine “hub” and through the subsequent addition of new “spokes” onto an existing hub. It may be that these different forms of adoption have different barriers and facilitators. For example, initial introduction of a hub may be the result of an academic medical center's desire to invest in new infrastructure and community outreach, regardless of return on investment. Conversely, subsequent expansion into spoke hospitals may depend more strongly on local conditions, with adoption predicated on the availability of a hub site and potential return on investment playing a larger role. Thus it may be that although we observed preferential adoption in large, urban hospitals, this adoption is only a necessary precedent to more rapid adoption in small rural hospitals. Indeed, we show that later adopting hospitals are generally smaller than early adopting hospitals, suggesting that future growth may come by expanding the reach of existing hubs rather than the creation of new hubs.

Additional research is needed to best define the ideal use of this potentially transformative technology. As noted in a recent federally sponsored consensus conference on the research agenda in critical care telemedicine, the key questions are not
whether this technology should be applied, but where and how it can be applied most effectively and efficiently. Research is needed to determine the settings in which telemedicine technology is most effective and the organizational factors that are associated with its success and failure. For example, studies could compare the effectiveness of telemedicine programs in ICUs with varying case-mix and multidisciplinary staffing patterns. Without this research we risk investing in monitoring technology that, like previous monitoring technologies in the ICU such as the pulmonary artery catheter, fail to improve care on average and are ultimately abandoned.

Our study has several limitations. First, although we used the most comprehensive listing of existing telemedicine programs to date, it is possible that this list was incomplete. However, NEHI took several major steps to ensure the accuracy and completeness of their listing. Second, because we based our analysis on the NEHI report we only included ICU telemedicine programs that consisted of comprehensive remote monitoring. Period consultation via robotic telepresence, as is sometimes used in the emergency department or neuro-critical care setting, was not included in our analysis. We suspect that the issues surrounding adoption of robotic telemedicine models differ substantially from the issues surrounding continuous remote monitoring, warranting a separate study. Third, our study only includes programs through 2010, the most recent year of complete CMS data. It is possible that adoption trends have changed since that time. It is also possible that the adoption trends we observed were influenced by the overall US economy,
which entered recession in 2009, and thus are reflective of health care growth as a whole rather than issues specific to ICU telemedicine. Fourth, we assumed that hospitals using telemedicine use it in all their ICU beds and that ICU beds associated with a command center came live when the command center came live. These assumptions may not be true, particularly in large hospitals with multiple ICUs. Thus we may have slightly overestimated the extent of ICU telemedicine adoption in the United States or attributed some adoption to earlier than it actually occurred. However, the given the limited overall adoption we observed, the extent of this error is likely minor.¹⁴¹

**Future Developments**

Telemedicine is field that is quickly expanding. New technology is being developed on a regular basis and providers are finding many opportunities to implement this technology.

**Collaboration Between Telemedicine and Health IT**

There are four key areas of expertise and remaining need that have evolved over the years related to collaborative approaches between telemedicine and health IT (HIT). These are outlined below:

1. Establishing and maintaining networked, organizational relationships

   Many telemedicine networks have required multiple independent entities to work together toward a common goal of providing healthcare. The developers of telemedicine networks have had to
negotiate inter-organizational agreements to address such issues as governance, fiduciary responsibility, and oversight in an environment where there are multiple, equal partners, much like the anticipated structure of Regional Health Information Organizations (RHIOs) or other health information exchange organizations.

Telemedicine networks have had to focus on building trust relationships among institutions, practitioners and patients that will allow the delivery of care by a physician at another institution. Many times the physician/patient relationship exists between distant geographic locations where the provider and patient are located in separate institutions when they have never met face to face. Most hub and spoke telemedicine networks are built following natural alliances and do not always follow normal geographic boundaries. The relationships often start with the contour of established patient referral networks and institutions that are not competing for patients, using the network to accommodate patient referrals and paying for services through reimbursement, contracts, grants and health system underwriting.

Several successful telemedicine networks have created a grid of all major health institutions (usually within a defined geographic boundary), wherein the network is managed as a basic, shared infrastructure, allowing any node on the network to connect with any other user on the system without penalty and paying for the network through membership fees, contracts and grants. Both types of networks are built on a critical understanding of the existing political and economic structure of the health care system.
in the region and has been fundamental to the success of many telemedicine programs.

2. Potential Areas of Collaboration:

Networks already established for telemedicine should be used as the initial test beds and role models of mechanisms to exchange health information \(i.e.,\) RHIOs), taking advantage of already established networks for providing clinical care as well as using already established secure, high bandwidth networks for other health technology applications. At the same time, the development of regional approaches to creating uniform patient health records and a unified billing system is critical to fully realizing the benefits of remote clinical services.

3. Overcoming Resistance

Healthcare is historically a late adopter of technology. The late adoption curve has proven to be a barrier to all initiatives that rely on the use of technology for implementation. Accelerating the adoption of all forms of technology in healthcare is considered critical to improved outcomes, expanded access and increased efficiency. While telemedicine has focused on the use of medical and telecommunications technology to provide direct patient care, the development and adoption of related information technology including electronic records and billing systems is an integral part in the evolution of healthcare and critical to the successful implementation of remote medical services.

Telemedicine projects have had to face the problems of organizational change inherent in introducing a new system. The
problems have included introducing change into the way that medicine may be practiced and has required the identification of local champions and obtaining top-level administrative support to insure that the change takes place. Telemedicine initiatives have also had to deal with the training issues involved in introducing a new system into a health care organization. Training nurses, physicians and billing clerks, among many others, has been a critical step to successfully implementing a telemedicine network.

4. Potential Areas of Collaboration:

Champions for developing remote health and medical services and for implementing advanced HIT often come from different departments with different sets of individual and organizational linkages. New alliances should be made between such leaders from health technology, clinical medicine and public health to overcome resistance and develop joint plans for unified health information networks.

**Surmounting the Absence of Standards and Guidelines**

Standards have been a long-standing issue in telemedicine. Advocates for the development of telemedicine have wrestled with incompatible software and devices using proprietary specifications as well as a lack of agreed upon protocols, guidelines and business strategies. Until recently, the market for telemedicine-specific medical devices has not been large enough to attract major industry efforts to create unified technical standards. However, in some cases, telemedicine has benefited from technical standards developed for interrelated markets. For example, the use of ANSI H.32x set of standards has facilitated wide-scale videoconferencing interoperability that is leading to a
continued growth in that market, a steep decline in the cost of equipment and the ability to conduct interactions between parties independent of the particular hardware used.

Certainly the development of HL7 and DICOM standards has also been of great benefit. Much is yet to be done. Interoperability has not yet been achieved in the rapidly expanding applications in such areas as home telehealth and remote monitoring for patients and consumers. Fortunately, recent expansion in the telemedicine market, falling costs in the development of new technology and the convergence of telemedicine and other HIT applications provides new opportunities to create technical standards. Beyond technical standards, the telemedicine community also needs to further develop unified protocols and guidelines for both clinical and administrative activities related to remote patient care. The need for standards is especially true for the rapidly expanding applications in such areas as teledermatology and mental health.

*Potential Areas of Collaboration:*

With the growing maturity and size of the telemedicine market and the new governmental emphasis on implementing HIT, opportunities are now available for leaders in telemedicine and other HIT applications to work together. Specific areas of collaboration should focus on mutually needed technical benchmarks and high quality communication networks that assure interoperability on several levels. Such levels include allowing different medical record systems to share patient data, assuring that different remote medical devices can intercommunicate with each other or into the same system and
allowing health professionals providing distant care with immediate access to the patient’s health history.

Certainly not all standards currently under development for HIT may be relevant for telemedicine. ATA is currently working on clinical and administrative guidelines specific to telemedicine. However, significant areas exist for collaboration and it would be prudent for representatives from telemedicine and HIT to identify areas for cooperation.

**Financial Sustainability**

A final issue of common concern is the need for sustainability. It is evident that there is a need to build a convincing business case for the EHR. The same issue is also of major concern to various telemedicine applications, especially where those who are asked to pay for the required technology and services are not necessarily those who receive the revenue benefits. In telemedicine, several sustainability models have been created and public policy decisions made that may be instructive. For example, a number of telemedicine programs provide services on a sustainable basis to correctional facilities, which realize cost savings due to avoidance of costly prisoner transports to health care facilities.

Some telemedicine networks have implemented a membership model, requiring all facilities participating to pay an administrative fee to cover infrastructure related costs. In others, a unified package has been developed to set prices for both remote health services and information system support. Other business models have been built on providing off-hours support for emergency rooms or providing scarce
psychiatric services where there is sufficient additional business to justify the infrastructure costs.

These sustainability models should be able to provide useful lessons for the deployment of the infrastructure required for health information exchange organizations or RHIOs and the National Health Information Network (NHIN). Public policy decisions have also facilitated the development of remote health services Telemedicine programs in Arizona, Kentucky and Missouri have convinced their respective states to make support for telemedicine a line item in the state budget by successfully arguing the public benefit. Several other states have required private insurers to pay for remote health services (i.e., California). More is to be done and collaboration between telemedicine and HIT organizations could accomplish significant progress in advancing both the fields of telemedicine and HIT, including the development of unified business models that specify cost-benefit factors and identify appropriate technical, clinical and administrative pathways that should be followed.39

**Recommendations**

The agenda for technology development and deployment would necessarily require closer coordination between industry and the health care sector to design more efficient systems and to exploit the capabilities of these systems more fully to deliver remote health care. The following areas require special attention:17,43,44,108,142-146

**Middleware**

Hardware manufacturers and software developers typically try to design and develop proprietary systems. Successful proprietary
systems are highly rewarded in the marketplace because they limit competition and assure a certain market share with a lock on their product. The most pressing engineering need in telemedicine is *middleware*, an area that falls between software engineers and network engineers.

**Interoperability**

Whereas interoperability can be achieved at different levels through standardization and integration, some of these levels may not be achievable in the foreseeable future. Indeed, in the short term, we are not likely to develop fully interoperable telemedicine stations that can interact with each other and make use of each other’s devices. Hence, the most pressing need is for middleware (the area between software and network engineering), in both forms hardware and software. Middleware will be the glue that renders incompatible standards interoperable, and it is feasible in the short term.

Perhaps the first step in reaching interoperability is to streamline or create interoperability between seemingly divergent policies. Often, policies and regulations drive the development of technology. This is especially true for technologies that will be required to implement the security and privacy regulations mandated by the Health Insurance Portability and Accountability Act of 1996 (HIPAA). Once final agreement is reached on a set of compatible HIPAA-mandated policies, hardware and software development can proceed and implement these policies. The opportunity for compatibility between various policies and regulations should not be missed. Portability will also need to be assured through portable medical devices and smart cards. These portable devices must include all systems, including biosignal
monitoring, image acquisition and display devices and nomadic computing.

**Micro Engineer Machine Systems (MEMS)**

Micro Engineer Machine Systems (MEMS) and other forms of nano-technology represent new opportunities for telemedicine. MEMS can take different forms, including MEMS robots in noninvasive arthroscopic surgery, MEMS-encapsulated cameras that can be swallowed to provide detailed images of the digestive tract, and so on. Similarly, wearable wireless sensors can monitor physiological functions in various environments. Work must continue in this highly promising area.

**Human/machine interface**

Whereas output requires proper displays, input requires better sensors. The quest for designing optimal machine/human interface is ongoing. It is prompted by the need for better, more natural displays and for better, less invasive sensors. Indeed, the optimal design of a human/machine interface may be doubly important in telemedicine because every telemedicine episode requires two interfaces, one at the patient or remote provider site and the other on the consultant side. The interface renders certain pieces of equipment usable or not usable, and the use of telemedicine desirable or not desirable. The ultimate and most natural human/machine interface is natural language. The development of a human-to-machine natural language would have an especially substantial impact on the home telemedicine market. Research in this area must be a high priority.
Knowledge robots

The development of intelligent medical robots, called “know-bots,” will be critical for the future of telemedicine. Each person would have his/her own intelligent avatar that lives on the Internet as well as the person’s electronic health record. The know-bot would understand spoken natural language and could respond to inquiries for medical information on the Internet relevant to a person’s medical history. The know-bot could also act as a monitor to alert its owner about unhealthy trends in the health record and for inconsistencies in the record. The medical know-bots could decrease medical errors or enhance quality of care. They could provide relevant and timely information for health promotion, disease prevention, and clinical decision-making. Unfortunately, this technology is not likely to appear in resource constrained countries or isolated rural areas. The challenge here is economic and not technological.

Data integrity and validation

Security systems must be built into every telemedicine network. These systems must be able to ascertain a “real” image and derived images and to authenticate the source.

Technology transfer

The information technology that supports telemedicine is being developed in a variety of settings for a variety of purposes and applications. Much of this developmental work is occurring outside the health care field. Technology transfer, or borrowing, must become a high priority. The network infrastructure for future telemedicine is likely to be public and not private. Hence, it is important to encourage
the use of digital video, H. 323 (or Internet Protocols), Health Level 7 (HL7), as well as an open source for software. The ultimate goal is to guarantee end-to-end connectivity. Technology transfer between resource rich and resource poor countries must be a high priority.

**Summary**

Emergency situations require fast, definitive and precise care as well as major resources and continuous expertise. Without these, the consequences can be devastating. The major trauma centers and trauma specialists around the world are concentrated mainly in urban settings. Subsequently, most of the population of the U.S., and the world for that matter, is not covered by specialized trauma systems. Although only 23–25% of the population in the U.S. lives in rural America, 56.9% of deaths caused by motor vehicle crashes (MVC) occur in this population. Furthermore, only 15 states in the USA have state wide 911 or enhanced 911 systems. As a result, rural patients are at greater risk of traumatic death than their urban counterparts. In fact, patients involved in motor vehicle crashes in rural America have twice the rate of mortality when compared with those in an urban setting with the same injury severity score.

Advances in technology including telemedicine and tele-presence applications may be the solution to discrepancies in trauma care. However, the implications of telemedicine extend beyond video teleconference capabilities. The patient population for a Level I trauma center consists largely of patients who have been transferred from rural communities for definitive tertiary trauma care. In most current systems, the decision to transfer a patient to a trauma center is based on a phone call from the referring rural physician to the emergency
room physician or trauma surgeon. Based on the experience of many trauma centers, a large number of patients transferred to trauma centers could be adequately cared for in the rural or community hospital with the help or “telepresence” of a trauma surgeon in these remote hospitals from a central location. In order to accomplish this goal, small emergency rooms or other centers in rural areas need to have access to major trauma centers and trauma surgeons 24 hours a day, seven days a week, with modern technology. This “tele-presence” undoubtedly will have a major impact in major trauma centers that will evaluate and eventually manage most critically ill patients who need specialized and definitive trauma care.

Critical Care Units that are well-staffed with board-certified intensivists who provide proactive, one-on-one care to their patients tend to have the lowest morbidity and mortality rates, but due to cost and staffing shortages, many hospitals are not able to provide this level of care. Critical Care Telemedicine is a rapidly emerging alternative that uses technology to provide virtual hourly rounds, 24/7 patient monitoring, and continual availability for collaboration with on-site medical professionals to assess and treat patients. Although critical care telemedicine is not without challenges, it represents a modern approach to traditional medicine and offers significant benefits to patients, staff, and facilities.

Please take time to help NurseCe4Less.com course planners evaluate the nursing knowledge needs met by completing the self-assessment of Knowledge Questions after reading the article, and providing feedback in the online course evaluation.

Completing the study questions is optional and is NOT a course requirement.
1. The term “telemedicine” is used broadly to describe medical services:
   a. delivered over distances using communication technologies.
   b. that utilize computer systems.
   c. that utilize audiovisual communication.
   d. that utilize data storage.

2. TRUE or FALSE: Recent technological advances have enabled trauma centers to provide care to regions with limited medical resources.
   a. True
   b. False

3. According to the AMA’s Council on Medical Service, a patient-physician relationship may be established:
   a. solely through online questionnaires.
   b. only when there has been a face-to-face encounter, in person, between the patient and physician.
   c. even though the patient and physician encounter occurred “virtually” through real-time audio and video technology.
   d. online so long as the patient’s security, confidentiality, and privacy are maintained.

4. The medical record is a crucial component of telemedicine.
   Medical records must include:
   a. copies of all relevant patient-related electronic communications.
   b. relevant patient-physician e-mails.
   c. prescriptions, laboratory and test results.
   d. All of the above.
5. **TRUE or FALSE: Because telemedicine is delivered over distances using communication technologies the patient’s privacy, confidentiality and security are not an issue.**
   a. True
   b. False; it would be inappropriate for a clinic to simply use Skype to chat with patients and call that a telemedicine e-visit.

6. **The Episodic Care Model involves:**
   a. TeleICU services that includes technology or equipment resources only.
   b. monitoring of the patient without interruption for a defined period of time.
   c. monitoring of the patient intermittently with a periodic consultation on a pre-determined schedule or at unscheduled times.
   d. a virtual visit that is prompted by an alert.

7. **Real-time biometric monitoring and onboard applications that connect to special sensors with data fusion are now possible because of the capabilities of ____________.**
   a. web-based e-health patient service sites
   b. smart phones
   c. telemedicine
   d. patient-side diagnostic instruments
8. **One of the primary cost benefits of telemedicine is:**
   a. the remote evaluation of patients.
   b. the accuracy of clinical data that may be recorded.
   c. that it promotes early transfer when indicated.
   d. the availability of expert trauma care to patients medical facilities without advanced trauma systems.

9. **The AMA position on the practice of prescribing medication via telemedicine is:**
   a. that, at a minimum, an established patient-physician relationship must be established before any prescriptions are issued.
   b. that because state laws are not uniform, the AMA supports a single national federalized system of medical licensure and the issuance of prescriptions.
   c. that the laws of the state where the physician is located should control.
   d. that the laws of the state where the patient is located should control.

10. **One of the principal barriers or resistance to telemedicine has come from:**
    a. state laws that require a physician to be licensed in the state where the patient is located.
    b. state laws that bar insurance companies from covering teleconferences.
    c. patients who are concerned that their medical records will not be secure.
    d. medical professionals.
11. TRUE OR FALSE. A number of telemedicine programs provide services on a sustainable basis to correctional facilities, which realize cost savings due to avoidance of costly prisoner transports to health care facilities.
   a. *True
   b. False

12. TRUE OR FALSE. Telepresence extends support to remote hospitals from a central location, such as that of a trauma surgeon.
   a. *True
   b. False

13. In the Responsive Care Model virtual visits are prompted by
   a(n)
   a. a doctor's request to monitor progress
   b. *alert (i.e., telephone call, page, monitor alarm)
   c. a crisis line report
   d. an emergency triage nurse request

14. Telemedicine is primarily a ____________________ medium.
   a. visual
   b. auditory
   c. complete sensory
   d. *answers a and b above
15. “Doctor centered” behaviors aim at all EXCEPT:
   a. efficiently gathering sufficient information to make a diagnosis
   b. treatment options in the least amount of time necessary
   c. *including patients and families as collaborators
   d. None of the above

16. “Patient-centered” interactions
   a. recognize patients as collaborators
   b. recognize patients bring strengths and resources to the interaction
   c. are patient-centric and do not factor in collaboration
   d. *answers a and b above

17. True or False. Telemedicine may be less stressful for patients who would otherwise need to travel long distances for their appointments.
   a. *True
   b. False

18. “Closed” design of a telemedicine system means that the stations from one vendor may
   a. communicate with a like vendor
   b. *not be able to communicate with those produced by another vendor
   c. only communicate certain media options between vendors
   d. no longer exists in telemedicine
19. In telepathology, a quality management (QM) program should address the diagnostic performance of the pathologists by:
   a. number of misdiagnoses
   b. delays in turnaround time
   c. deferral rates (failure/inability to render a telepathology diagnosis)
   d. *all of the above

20. Medicare artificial coverage barriers in fee-for-service for telemedicine affect:
   a. 80% of Medicare beneficiaries living in a “metropolitan area”
   b. “Store-and-forward” services, such as wound management
   c. services delivered wherever the beneficiary is, including home or mobile
   d. *all of the above

21. A number of approaches have been put forward regarding licensure including all EXCEPT:
   a. interstate compacts
   b. mutual state recognition
   c. national licensure
   d. *international licensure

22. True or False. The American Telemedicine Association (ATA) supports public policies at the federal but not the state level.
   a. True
   b. *False
23. Some examples where TeleMedicine leads to reduced cost, waste and impacts care outcomes include:
   a. Nursing Home costly transports and unnecessary ED visits.
   b. Home monitoring programs can reduce high cost hospital visits.
   c. Fewer Specialists Required Full-Time.
   d. *All of the above.

24. Telepathology supports care through all EXCEPT:
   a. *Slide sharing has not been approved by federal or state regulations.
   b. Enables consensus review peer activity from multiple sites.
   c. Enable multidisciplinary interactions, such as Tumor Boards.
   d. Enhancement of care by lowering the barriers of information sharing.

25. True or False. It is not unusual for patients in rural areas and developed nations to routinely meet with their physician via real-time teleconferencing.
   a. *True
   b. False

26. Barriers to telemedicine programs include:
   a. Financial barriers, *i.e.*, high cost of sett-up and implementation
   b. Ethical and legal concerns, *i.e.*, confidentiality.
   c. Piecemeal development of the telecommunications infrastructure
   d. *All of the above.
27. True or False. Prescription writing is controlled by federal law and not by the unique laws of state jurisdictions.
   a. True
   b. *False

28. Telemedicine assessments of trauma patients can be performed with the assistance of:
   a. a nurse
   b. an electronic stethoscope
   c. close-up imaging instrument
   d. *All of the above

29. Video teleconferencing is used, with the average duration of the video-teleconference appointment lasting approximately _________________.
   a. *15 minutes
   b. 30 minutes
   c. 45 minutes
   d. 1 hour

30. Poor outcomes for rural trauma patients is the lack of access to immediate ________________ care.
   a. primary
   b. nursing
   c. *subspecialty
   d. community
Correct Answers:

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References Section

The reference section of in-text citations include published works intended as helpful material for further reading. Unpublished works and personal communications are not included in this section, although may appear within the study text.

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