The Value of Provider-to-Provider Telehealth Technologies

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Center for Information Technology Leadership
Improving Healthcare Value

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The Value of Provider-to-Provider Telehealth Technologies

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Commonly Used Acronyms | CITL !

The following are acronyms used in this report:

AHRQ	Agency for Healthcare Research and Quality
AMA	American Medical Association
BLS	Basic Life Support
CDC	The Centers for Disease Control and Prevention
CF	Correctional Facilities
CMA	Controlling Medical Authority
CMS	Centers for Medicare and Medicaid Services
CPT	Current Procedural Terminology
ED	Emergency Departments
EMRs	Electronic Medical Records
E&M	Evaluation and Management Codes
HIT	Health Information Technology
HPSAs	Health Professional Shortage Areas
MEPS	Medical Expenditure Panel Survey
MHS	MetroHealth System
NF	Nursing Home Facilities
NHAMCS	National Hospital Ambulatory Medical Care Survey
PACS	Picture Archiving Computer System
RUS	Rural Utility Service
tPA	Tissue Plasminogen Activator
USAC	The Universal Service Administrative Company
UTMB	University Texas Medical Branch

Executive Summary | CITL !

Telehealth technologies, the use of communications technology to transmit medical information from one location to another, have evolved to remove geography as a barrier to care by allowing patients to receive care when and where they need it. These technologies bring the promise of ending access-to-care issues for both medically underserved areas and under-represented specialties. With this improved access comes an improvement in the quality of care provided in this country, and improvements in outcomes likely follow. However, there are many barriers to the adoption of telehealth technologies, foremost among them the lack of definitive evidence for a value proposition in implementing these technologies.

In this report, the Center for Information Technology Leadership (CITL) examines the value of a subset of telehealth technologies: those in which providers are involved in both the near, or patient side, and far side of the encounter. This report does not consider telehealth technologies used on inpatient floors, home monitoring, interpretive services (telepathology and teleradiology), or continuing medical education. The lack of inclusion of these other uses of telehealth in this report does not imply lack of importance and impact: CITL recognizes their significant value as well. The findings in this report may thus be considered to be conservative, with the benefit of these technologies likely far greater than those estimated here.

CITL considered six levels of technology as follows:
Level 0: Pre-telehealth: Postal Mail, Telephone
Level I: Pre-telehealth: Simple Electronic Communications such as Email, Fax
Level IIa: Store-and-Forward
Level IIb: Real-Time Video
Level III: Hybrid
Level IV: Advanced Telehealth – Fully Integrated EHR with Telehealth Capabilities

CITL modeled Levels IIa, IIb, and III to compare and contrast the costs and benefits in various healthcare settings; we did not model a pre-telehealth state, nor a state integrating telehealth technologies with an EHR.

Store-and-forward technologies represent the collection and storage of clinical data or images that are forwarded for interpretation at a time distant from a face-to-face* clinical encounter. *Real-time video* is the use of live video to conduct an interactive

* For the purposes of this report, CITL uses the phrases 'face-to-face' and 'in-person' interchangeably to mean a real life interaction.

clinical encounter in real time. *Hybrid technology* integrates both store-and-forward and real-time video technologies. This last technology is not merely the ability to use either store-and-forward or real-time video capabilities. In combining these technologies, there is the added functionality of simultaneously transmitting high-resolution images in real time during a high-resolution videoconferencing encounter. CITL recognizes that in reality, these technologies would be intermixed; modeling them on their own is a construct used to compare and contrast their effect. CITL did not model individual provider specialties, but instead considered all specialties together on a macro level. If any provider specialty, such as dermatology, was examined in isolation, the findings might differ substantially from those projected here.

Overall, the benefits far outweigh the costs of these systems to implement. Of the three scenarios, the hybrid (Level III) scenario is projected to be the most cost-effective system. Findings on the projection of the hybrid (Level III) systems are summarized below:

From the perspective of the healthcare system, the cost to equip all US emergency departments with hybrid telehealth technologies could easily be covered by savings from a reduction in transfers between emergency departments.

From a baseline of 2.2 million patients transported each year between emergency departments at a cost of $1.39 billion in transportation costs, hybrid technologies would avoid 850,000 transports with a cost savings of $537 million a year.

Correctional facilities could cover their costs of hybrid telehealth equipment by savings from a reduction in transporting patients to emergency departments and to physician offices, and by avoiding the costs of the emergency department visit.

From a baseline of 94,180 transports made annually from correctional facilities to emergency departments at a cost of $158 million in transportation and visit costs, hybrid technologies could avoid almost 40,000 transports with a cost savings of $60.3 million a year. Further, hybrid technologies could avoid visits to physician offices. From an annual baseline of 691,000 physician office visits at a cost of $302 million, hybrid technologies could avoid 543,000 inmate transports with a cost savings of $210 million.

From the perspective of the healthcare system, the costs of implementing hybrid telehealth equipment in nursing homes could be covered by savings from a reduction in transferring residents to emergency departments and physician offices, and by avoiding the costs of the emergency department visit.

From a baseline of 2.7 million transports made annually from nursing facilities to emergency departments at a cost of $3.62 billion in current transportation and emergency department visit costs, hybrid technologies could avoid 387,000 transports with a cost savings of $327 million. In addition, of the 10.1 million physician office visits made annually from nursing facilities at a cost of $1.29 billion for in-person physician office visits and transportation, hybrid technologies could avoid 6.87 million transports with a cost savings of $479 million.

There is a loss to the system from physician-to-physician hybrid teleconsults when considering only professional fees. These loses could be far out-weighed by involving specialists early in the care of a patient and reducing the number of redundant or unnecessary tests.

This loss is far outweighed by involving specialists early in the care of a patient and reducing the number of redundant or unnecessary tests. In reducing face-to-face visits and redundant and unnecessary tests, hybrid technologies are projected to have a cost savings of $3.61 billion.

From an overall cost-benefit perspective, the benefit of implementing telehealth technologies in these areas far outweighs the costs.

With a five-year roll-out, the first-year national cost for hybrid technology is $254 million, with a mid-implementation, third year peak of $2.78 billion, and a steady-state, ongoing annual cost of $950 million. Nationwide implementation of hybrid technologies reaches a break-even point in year 5, with a total annual net of $4.28 billion in the steady-state.

Beyond what CITL modeled in this report, evidence in the literature suggests additional benefit from the use of telehealth technologies in provider-to-provider care settings. Telehealth technologies can lead to a reduction in admissions from emergency departments, as well as a reduction in the need for referrals from emergency departments to outside specialists. The impact of increasing access to care is potentially large, improving the quality of care given to individuals, and likely improving clinical outcomes. Increasing the speed of a diagnosis in cases where rapid diagnosis is linked to improved outcomes also is impacted by telehealth technologies, such as is the case with management of acute strokes. The use of telehealth technologies in ambulances can also help speed the time to diagnosis and the initiation of important, potentially lifesaving interventions.

CITL has found in previous reports that healthcare technologies frequently have costs borne by provider organizations (e.g. hospitals and provider offices), while providing savings that accrue to payors. A similar finding was found with provider-to-provider telehealth technologies. This finding has critical implications to the entire healthcare system and is a reflection of the traditional third-party payor system. In this report, CITL found a clear exception to this: as closed systems, correctional facilities bear both the costs and the benefits of telehealth technologies. The reduction in the need to transport prisoners outside of the facility adds directly to the facility's bottom line. This, however, is not the case for emergency departments, nursing home facilities, or physician offices, where the costs of the telehealth system are borne by those facilities, while much of the benefit accrues to the payors. These findings should provide an impetus for payors to support the implementation of these systems and begin to reap the benefits that they provide.

Despite these positive economic findings, CITL recognizes the existence of other barriers to the implementation and full adoption of telehealth technologies. Given the impact that telehealth can have on the quality of care of our patient population, it is imperative that these other barriers to adoption be addressed head on and steps taken to remove them. Major barriers needing to be addressed include a reimbursement model that favors face-to-face visits; concerns around medical liability; and a lack of cross-state licensure.

In the end, the broad integration of telehealth technologies into clinical practice could produce quantum leaps in the efficiency of the healthcare system. Healthcare stakeholders, providers, and payors alike should not be fearful of whether telehealth might lead to an increase in the number of visits or increase utilization from demands previously unmet. Any of those increases will be overshadowed by the dramatic reduction in costs associated with decreased unnecessary tests, improved disease prevention, and improved chronic disease management that will come from a broad telehealth deployment, where we can virtually bring the collective wisdom of the entire healthcare system to any patient, anywhere, any time.

Chapter 1: Introduction | CITL !

Americans face an ongoing healthcare crisis. Mounting costs, dysfunctional reimbursement policies,[1] diminishing access,[2, 3] an impending physician shortage,[4] and concerns about quality[5] command attention at the personal and national level. Healthcare information technology (HIT) may play a key role in addressing these problems, but the relative value of many HIT systems is difficult to determine. In particular, telehealth may provide a critical component of HIT solutions, but the body of evidence supporting the use of telehealth has been slow to evolve. As a result, significant questions exist about the value, efficacy, and effectiveness of these technologies. This uncertainty has prompted providers, payors, and policy-makers to call for evidence to guide decision-making regarding the implementation of telehealth systems.

There are numerous definitions of "telehealth" and "telemedicine"[6-11] (Appendix A). The terms "telemedicine" and "telehealth" are used in a variety of ways. Some use the terms to refer to any transfer of patient data to another site; others implicitly include the use of computers in their definition. Fundamentally, telehealth is the use of communications technology to transmit medical information from one location to another, allowing patients to receive care when and where it is needed. These technologies allow a patient without local access to a particular specialty, even those in nursing home facilities and correctional facilities, to "see" that specialist remotely. A stroke victim who arrives at a non-stroke center may be evaluated in order to receive potentially lifesaving tissue plasminogen activator (tPA) treatment by a stroke specialist; an inmate with heart disease may consult his cardiologist on a regular basis for management of his heart disease.

Telehealth implementations have existed in various forms since as early as 1955, when the Nebraska Psychiatric Institute began using closed circuit TV to monitor patients remotely.[12] Despite this early start, telehealth has been adopted slowly, with only an estimated 125 telehealth programs in the United States today.[13] This slow start is due to a variety of adoption barriers: a lack of evidence around the clinical and financial value of these technologies; a perception that the increase in access to care will lead to large increases in the cost to pay for that care; a current reimbursement model that favors face-to-face* visits; concerns around medical liability;[14] and a lack of cross-state licensure.[14-20]

The greatest of these barriers is the lack of clarity around telehealth's value proposition,

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* For the purposes of this report, CITL uses the phrases 'face-to-face' and 'in-person' interchangeably to mean a real-life interaction.

particularly the assumption that telehealth will increase healthcare costs. Research has attempted to clarify the value of telehealth. In 2001, Hersh and colleagues[21] completed an extensive, systematic review of the existing telehealth literature and updated that review in 2006.[22] The authors reported that while the number of telehealth programs is growing, evidence of their cost-effectiveness was insufficient to make definitive statements supporting the use of telehealth. Studies with small sample sizes and poor research methodologies were cited as key deficiencies. Whitten *et al.* recently completed a comprehensive review on research methodology in telehealth studies and noted similar issues with the methodologies being used in telehealth research.[23]

The lack of conclusive evidence for telehealth value prompted the Center for Information Technology Leadership (CITL) to model the value of telehealth technologies in provider-to-provider settings. CITL sought to determine the cost effectiveness of the use of telehealth in these areas. To this end, CITL searched the published evidence, interviewed experts, and developed a taxonomy of both telehealth encounters and technologies. Using this taxonomy as a framework, evidence was synthesized to develop a computer-based model using the best-available data. The model projects the costs and benefits of this subset of telehealth technologies over ten years. This report details our approach to this analysis, model projections, and implications from our research. Ultimately, our intention is that this report will help providers, payors, and policy-makers make more informed decisions about the adoption of telehealth technologies.

Chapter 2: Approach to Analysis | CITL

CITL performed multiple steps to develop a value model for telehealth technologies. First, the scope of the project was defined. Next, CITL conducted a literature review to elucidate where value had been noted in the literature. A taxonomy was then developed to form a framework for the model and necessary data was gathered. Finally, an expert panel was formed to provide guidance and advice. Details on CITL's approach are outlined in the sections below.

Scope of Analysis and Major Assumptions

Telehealth is an extremely broad field, and one that would take years to model in its entirety. CITL thus chose to limit the scope of this project to look at interactions in which a registered healthcare professional ("provider") was on both ends of an outpatient encounter. As such, CITL did not model in-patient care, home monitoring, or medical education. In addition, only clinical encounters were modeled. Interpretive services, i.e., telepathology and teleradiology, were not studied.

CITL considered three major areas of technology: store-and-forward, real-time video, and hybrid technologies. *Store-and-forward* technology represents the collection and storage of clinical data or images that are forwarded for interpretation at a time and place different from a face-to-face clinical encounter. *Real-time video* is the use of live video to conduct an interactive clinical encounter in real-time. *Hybrid* technology integrates both store-and-forward and real-time video technologies. This last technology is not merely the ability to use either store-and-forward or real-time video capabilities. In combining these technologies, there is the added functionality of simultaneously transmitting high resolution images in real time during a high-resolution videoconferencing encounter. For example, a dermatologist receives high-resolution images of a patient's rash. During the virtual encounter, the addition of real-time video conferencing allows the dermatologist the added benefit of interacting directly with the patient and seeing the context of the rash. If additional views are needed, they can be taken and transmitted to the dermatologist in real time.

CITL examined the impact of provider-to-provider telehealth technologies in various care settings: emergency departments, physician offices, correctional facilities, and nursing homes. CITL did not model the impact of telehealth technologies on specific individual specialties, such as dermatology, but instead focused on all specialties, i.e., "all comers," as an intention to treat the model.

The model developed is utilization based: CITL did not model satisfaction or quality of care. CITL assumed that telehealth technologies are equivalent to traditional methods of providing care and thus did not model concordance or equivalence of these technologies. In considering a future telehealth state, CITL assumed that issues related to medical licensure have been resolved and that negative financial incentives have been removed.

In developing the model, the goal was to quantify the financial value of telehealth technologies in improving access to care for the patient. While the adoption of telehealth technologies has been slow, these technologies exist throughout the United States today in varying degrees of sophistication. An inventory of these systems would have been a valuable adjunct to our model, allowing us to reduce our estimates of costs to implement telehealth across the nation, as well as to answer questions regarding the current utilization of telehealth for all types of encounters. However, such an inventory does not exist today. As a result, CITL did not consider the current status of telehealth in its model and assumed no telehealth technologies as its beginning point. Costs estimated in this report are therefore conservative, as those facilities with telehealth programs today would not need to purchase this equipment.

CITL did not model the cost of telecommunications, neither telephone nor Broadband Internet access. While once a barrier to adoption due to high costs and the need to implement dedicated lines, Internet access is now ubiquitous,[24] with rapidly decreasing costs. There are many initiatives to increase Broadband Internet access throughout the country.[25] In addition to these initiatives, there are also programs in place to help ease the burden of Internet usage charges.[26, 27]

Literature Review

CITL completed a systematic review of the literature aimed at US academic and trade journals most likely to contain data relevant to the model that was being built. CITL used systematic review methodologies and standard techniques adapted from leading academic sources, including the Harvard School of Public Health, the American College of Physicians, and the Stanford University's Evidence-based Practice Center, to find, review, and analyze disparate literature.[28-30]

CITL defined a search strategy that was vetted with experts in the field as well as a medical librarian. In order to find the most relevant data, we chose to search and abstract review articles as a proxy for validity and acceptance of studies and data by the field of telehealth. The main search was completed using MEDLINE via OVID to identify those review articles, and additional searches were conducted on CINAHL and EMBASE. Finally, our Advisory Board was asked to identify key articles in the field of telehealth.

The abstract of each review article was analyzed by two researchers to determine relevance. If one or both reviewers thought the review article was relevant, a deep abstraction of the article was performed. This abstraction was used to identify primary articles that might contain data relevant to our model. Each of these primary articles was abstracted by two reviewers to identify data to inform our model. Discrepancies in interpretation were resolved through discussion to reach a consensus.

Details on the search strategy and results of the literature review may be found in Appendix B.

Telehealth Taxonomy

In order to form a conceptual framework of telehealth technologies on which to base the model, CITL set out to develop a telehealth taxonomy. It soon became apparent that consideration needed to be given to both the interaction of the provider* to the patient and to the technology that is in use in this field. Thus, CITL devised two telehealth taxonomies: an encounter taxonomy and a technology taxonomy.

Encounter Taxonomy

The field of telehealth is vast, with many different ways that telehealth equipment is being used to conduct these encounters and the individuals who are involved. From a review of the literature and interviews with experts in the field, three aspects of telehealth emerged to serve as the basis for the encounter taxonomy: the location of the patient, the setting in which it is used, and the timing in which the encounter is conducted.

Location of Patient

CITL first considered the location of the controlling medical authority (CMA)† with respect to the location of the patient. For the purposes of this report, the CMA is the provider who has ultimate responsibility for the patient's care. For interactions in which the CMA is with the patient, or at the near side, we refer to this as a "consultation." When the CMA is not with the patient, or at the far side of the communication, we refer to this as a "provider extension" relationship.

Setting

The second area CITL considered in our taxonomy was the setting in which care was provided, be it emergent or non-emergent. For the purposes of this report, an emergent encounter is a medical encounter that requires decisions on medical care to be made in a matter of minutes or hours, as opposed to days or weeks. A non-emergent encounter includes all other encounters in which decisions may be made over a longer timeframe.

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* Providers are considered to be any registered health professional.

† For the definition of terms used throughout this report, please see Appendix C.

These two types of encounters cover the majority of patient visits to providers.

Timing

The last area CITL considered was the timeframe in which the communication of the encounter is transmitted. There are two timeframes in which a telehealth consultation can occur: store-and-forward and real time. A store-and-forward encounter collects data that is sent to a provider for evaluation at a later date, such as an email to transmit patient data and photographs to a consulting provider. A real-time encounter transmits information to be interpreted at that time, whether via a telephone call to review a patient's case or via video conferencing.

Based on these three aspects, CITL developed the following telehealth encounter taxonomy:

1. Consultation, emergent, real time

   The CMA is at the near, patient side caring for the patient in an emergency setting. The provider at the far side brings specialized knowledge to the care encounter. This scenario requires a dynamic telehealth network that is capable of supporting consultation on demand.
2. Consultation, non-emergent, real time

   The CMA is at the near side caring for the patient in a routine setting. The provider at the far side brings specialized knowledge to the care encounter. Ideally, this would occur on-demand but would typically require scheduling the consultation at a date and time when the far provider is available for the consultation.
3. Consultation, non-emergent, store-and-forward

   The CMA is at the near side caring for the patient in a routine setting. The two providers are not interacting in real time, but rather sending data, images, and messages for later interpretation and response.
4. Provider extension, emergent, real time

   The CMA is the provider at the far side caring for a patient in an emergency setting. Typically, the provider at the near side is an ancillary healthcare professional being directed to collect patient data, examine the patient, and treat the patient in real time. As with #1, this requires a dynamic telehealth network that is capable of supporting consultation on demand.
5. Provider extension, non-emergent, real time

   The CMA is the provider at the far side. Typically, the provider at the near side is an ancillary healthcare professional being directed to collect patient data, examine the patient, and treat the patient. This encounter is typically conducted during a pre-scheduled date and time.
6. Provider extension, non-emergent, store-and-forward

   The CMA is at the far side. Typically, the provider at the near side is an ancillary healthcare professional who has been trained to collect patient data, examine the patient, and treat the patient as previously established by the CMA. Data collected is transmitted to the CMA at a later date and time for analysis and interpretation.

CITL's telehealth encounter taxonomy is represented by Table 2-1.

Telehealth Encounter Taxonomy — *Table* **2-1**

	Emergent Setting	Non-Emergent Setting
Consultation (CMA at near, patient side)	Real time	Real time Store-and-forward
Provider Extension (CMA at far side)	Real time	Real time Store-and-forward

We have purposely avoided the terms "synchronous" and "asynchronous" in our taxonomy, as our intent was to capture the type of encounter and not the technology employed. In the telehealth literature, these terms are frequently used to capture both the technology and the timing of the encounter (e.g., synchronous as a real-time encounter with video conferencing). However, telehealth encounters can employ any type of technology, whether it is still image, video conferencing, or transmitted data. We have employed the terms "real time" and "store-and-forward" to better identify the type of encounter and not the technology to be used.

Technology Taxonomy

CITL developed a taxonomy of telehealth technologies. In analyzing the breadth of what could be considered "telehealth," i.e., the transmission of clinical data to be used at a distance from where it was collected, it became clear that there is a hierarchy of how information can be exchanged, as determined by available bandwidth. The critical issue is not overall network connectivity to each site, such as T-1, ATM, DSL, or cable, but instead is the minimum bandwidth needed per connection between the two end-points of the telehealth encounter, and whether it is technologically and financially feasible for the organizations involved. Bandwidth not only impacts how patient information may be moved, store-and-forward versus real time, but also the volume and the speed that the data may be moved. As such, bandwidth became the basis for CITL's telehealth technology levels. These levels are described below and summarized in Table 2-2.

Level 0

Level 0 is the traditional, non-computerized method of communication. Traditional postal mail is the classic example of the store-and-forward modality: we drop off our mail, the information travels to the recipient, and it is received at a later time, typically measured in days to weeks. The delay in transmission is accepted by users as a trade-off between lower cost for potentially large volumes of information that may be impractical or impossible to transmit in real time. In addition, this form of communication is only feasible in non-urgent situations where immediate attention is not required.

Table **2-2** ***Telehealth Technology Taxonomy***

	Level	Store-and-Forward	Real Time	Type of Data Transmitted	Minimum Bandwidth Kbit/s per Connection
Advanced Telehealth	**IV**	Convergence of traditional telehealth functionality throughout medicine, including integration with interoperable-EMR systems, such that a distinction between telehealth and traditional medicine becomes meaningless		Convergence: Images, high-resolution video, EHR	High (512 kbit/s or greater)
Modern Telehealth	**III**	**Hybrid with high-resolution video and image**		**Images, high-resolution video**	**Medium (364 kbit/s)**
	II	**a. High-resolution still images**	**b. Low-resolution video**	**Images, low resolution video**	**Low (128 kbits/s)**
Pre-Telehealth	**I**	Email of textual information	Faxing of textual information	Electronic transmission of textual data	Modem (<10 kbits/s)
	0	Postal mail	Verbal report via telephone	Traditional, non-electronic, methods of communication	Telephone network

The classic example of Level 0 real-time transmission of information is the telephone. When providers need to communicate urgently with a consultant, they merely pick up the telephone and have a discussion with the consultant in real time. While offering immediacy, the telephone is limited in the type of information that can be transmitted: describing radiologic studies or skin lesions is restrictive in its ability to clearly translate that data. The telephone is also limited in the volume of information that is practical to be communicated. For example, few healthcare providers would ever consider dictating a patient's entire medical chart over the telephone.

Level I

The earliest attempt at applying IT to enable transmission of healthcare information is captured in CITL's Level I. The store-and-forward modality is the common email system that most people use today. With constrained bandwidth, such as with dial-up, data transmission is limited to textual information. With time, as bandwidth capability has increased, so has the ability to email pictures and videos.

The real-time corollary in Level I is the common facsimile (fax) system, ubiquitously in use today. While a fax system offers immediacy, there are ongoing costs involved, such as toner, paper, and maintenance, whereas once established, the marginal cost of faxes is minimal.

Level II

Most telehealth systems implemented within the past five to ten years fall into what

CITL has termed Level II systems. The store-and-forward image system (Level IIa) is characterized by a web-based secure consultation system where providers upload patient information, high-resolution photographs, radiological images, laboratory data, and pathology slides to enable consultation by remote specialists. These systems require Integrated Services Digital Network (ISDN) or broadband level connections, although some remote sites have tolerated the slow image transmission associated with analog modems over plain telephone lines.

In Level IIa, the response from consultants is never immediate, but typically delayed by hours to days. The implicit trade-off in store-and-forward systems is that immediate, real-time interactions are sacrificed to enable high-resolution image content and more flexible use of network resources and provider-patient time. This trade-off in removing immediacy has made store-and-forward image systems poorly suited for any urgent, time-critical clinical interactions.

The real-time modality in Level II is real-time video systems (Level IIb). The trade-off here is that earlier real-time video systems sacrifice high-resolution still images for immediate visual interaction because of network bandwidth thresholds. This mode of transmission is optimal in encounters where face-to-face interaction may be necessary, as in the case of a neurological consultation or a psychological session. In non-emergent situations, because the patient-provider interaction is in real time, these teleconsults require scheduling and the use of space, such that patients may not receive a consultation earlier than an in-person specialist consultation.

Level III

Telehealth practitioners have increasingly recognized the limitations of store-and-forward image systems and real-time video systems. With technology improvement, miniaturization of telehealth equipment, and falling technology costs, a hybrid system has evolved, which CITL has termed Level III. In its simplest form, hybrid technology combines the functionality of a store-and-forward image system with a real-time video system. A user of a hybrid system can choose to use it as a store-and-forward image system, as a real-time video system, or as a combination of the two on an encounter-by-encounter basis.

Modern hybrid telehealth systems are able to create a real-time channel of communication that is not only capable of transmitting video, but also high-resolution images, patient records, and other data traditionally associated with store-and-forward systems working in synergy. While hybrid systems may be installed in sites having only the limited network bandwidth needed to support Level IIa or IIb systems, the full potential of a hybrid system is realized when installed in sites with more plentiful bandwidth, where this synergistic data transmission capability can be fully utilized.

Level IV

Finally, some mature telehealth systems have developed into what CITL terms Level IV systems. These integrate the use of a hybrid telehealth system with an electronic medical records system (EMR). Early experiences suggest that this integration leads to additional synergistic effects in terms of the richness of patient data that can be shared. It is envisioned that a true Level IV telehealth system ceases to be seen separately from standard medical care, but instead is one more tool in the armament of a practicing clinician.

The potential of a Level IV system is exciting but was not able to be modeled in this report since few such programs exist today. For the purposes of this project, CITL has focused on Levels II and III and calculated the cost-benefit of 100% still image capability (Level IIa), 100% video capability (Level IIb), and 100% hybrid capability (Level III), comparing against a pre-telehealth (Level 0 and I) environment.

Value Clusters and Value Chains

Following completion of the literature abstraction, each category of the encounter taxonomy was examined to determine where telehealth benefits clustered in the literature. We refer to these groupings of benefits as "value clusters." Two such clusters were identified: (1) Avoided patient transport/transfers and (2) Reduction in healthcare utilization.

CITL distilled the evidence in these value clusters into a series of value chains. A value chain is the representation of the process for transforming healthcare system statistics and impact data into projected value outcomes. The chains built in CITL's model were as follows:

1. Avoided patient transport/transfers
    a. Benefit of avoided transfers and transports:
        i. Emergency departments to emergency departments
        ii. Correctional facilities to emergency departments
        iii. Nursing home facilities to emergency departments
        iv. Correctional facilities to physician offices
        v. Nursing home facilities to physician offices
2. Reduction in healthcare utilization
    a. Benefit of avoided emergency department visits from:
        i. Nursing home facilities
        ii. Correctional facilities
    b. Benefit of teleconsults due to:
        i. Avoided face-to-face visits
        ii. Reduction in duplicate and unnecessary testing

These chains were used to frame the model construction and identify the data needed to inform the final telehealth model. For each data input need, data from the literature was identified and assigned in our database to that particular input. Inputs lacking data, or "data gaps," were identified, and a targeted search was conducted to fill those gaps.

Data Collection

CITL employed a variety of methods to gather and synthesize the evidence included in this report. These methods include the literature review described above, additional targeted literature searches, expert interviews, and advisory board Modified Delphi estimates (described below). In general, CITL depends on published sources for data, calling on experts to fill critical gaps only when data is lacking elsewhere. In looking for data, CITL searches academic publications and a wide array of non-academic literature, including trade journals, government publications, general press, vendor and consultant studies, proprietary research services, and studies by foundations and professional associations. Searches are conducted on the web to increase the breadth of the data search.

Advisory Board

CITL worked with an advisory board of nationally recognized telehealth experts throughout this project. The board met monthly via teleconference with one face-to-face meeting in February of 2007. The board was consulted to review and advise CITL on the analytic framework, taxonomy, model estimates and preliminary findings. The members of the board include:

- **Karen E. Edison, MD**, Medical Director of the Missouri Telehealth Network, Co-Director of the Center for Health Policy at the University of Missouri in Columbia
- **Joseph C. Kvedar, MD**, Director, Center for Connected Health, Partners HealthCare
- **Jonathan Linkous**, Executive Director, American Telemedicine Association
- **Hon S. Pak MD,** Director of Advanced Information Technology Group, Army Telemedicine and Advanced Technology Research Center (TATRC)
- **Jay H. Sanders, MD, FACP, FACAAI**, President and CEO of the Global Telemedicine Group
- **Joseph A. Tracy, MS**, Vice President, Telehealth Services, Lehigh Valley Hospital and Health Network
- **Ronald S. Weinstein, MD**, Program Director, Arizona Telemedicine Program

Full biographies for the advisory board may be seen in Appendix D.

Modified Delphi Method

When CITL exhausted other means to find data, the advisory board was consulted. Data sources reviewed were shared with the board, who were then asked to provide additional resources to potentially fill the data gaps, from published or unpublished literature or advice from other experts in the field. When this process did not yield data, CITL asked the board members to participate in a Modified Delphi process as detailed below.

As opposed to a traditional Delphi method,[31-33] available evidence was presented to the advisory board members with our reasoning as to why we believed existing data could not be used in the model. The best evidence available was intended to be reference points for the board members in making their own estimates. All members gave their own estimates for the data point, and estimates were then shared anonymously with all members via email. Participants were allowed to leave their estimates unchanged, or were given the opportunity to provide new estimates if they so chose. This process was repeated a second time. Estimates were averaged, and a standard deviation was determined for inclusion into the model.

System Costs

CITL estimated the expenses involved in implementing and operating each of the telehealth technologies across our taxonomies. We considered three types of systems: a low-end system containing the minimum amount of equipment needed for a telehealth encounter; a mid-range estimate containing equipment needed for a typical installation of telehealth; and a high-end system containing cutting-edge, top-of-the-line equipment. The mid-range system was used to calculate the net benefit, and the low- and high-end systems were used in the sensitivity analysis.

Data Sources

Because published cost estimates are not widely available, CITL relied primarily on market research for these data. The University of Texas Medical Branch (UTMB) provided CITL with system specifications and requirements for telehealth implementations, as well as cost estimates. CITL updated these costs with common retail and technology vendors, including Best Buy, Dell, and Polycom, during the time period between April and June of 2007.

Cost Components

The system costs are comprised of the following components: software, hardware, training, and installation costs. Software components include the software to run the system itself, as well as licensing costs and encryption software. Hardware components considered included:

- Document Scanners
- Live Document Cameras
- Digital Cameras
- Video Conferencing Equipment
- Video Medical Scopes
- Headphones
- Electronic Stethoscopes
- Sound Equipment
- Computers
- Monitors
- Cables
- AV Carts

A full description of the cost components and the costs used in the telehealth model may be seen in Appendix E.

Key Assumptions: Cost Estimates for Components
Several assumptions were made to model system costs. Hardware was assumed to be replaced every five years. Cost estimates for each scenario were not intended to account for all of the costs associated with telehealth installations. Therefore, CITL excluded the following costs from the model:

- Governance
- Sales or pre-sales activities, such as contracting
- Directories of providers for consultation on demand
- Additional office equipment added to existing space
- Program planning and development

The CITL Provider-to-Provider Telehealth Model

CITL translated each of the value chains into a provider-to-provider telehealth model. The model projects adoption of Levels IIa, IIb, and III over a ten year time frame and enables comparison of costs and benefits between the levels. The model was developed using Analytica™ modeling software.[34] Analytica™ is a visual tool used for creating, analyzing, and communicating decision models and includes features to model uncertainty and variability in data inputs. In addition, the software is able to perform robust sensitivity analyses on model variables. Details on the telehealth model construction may be seen in Appendix F.

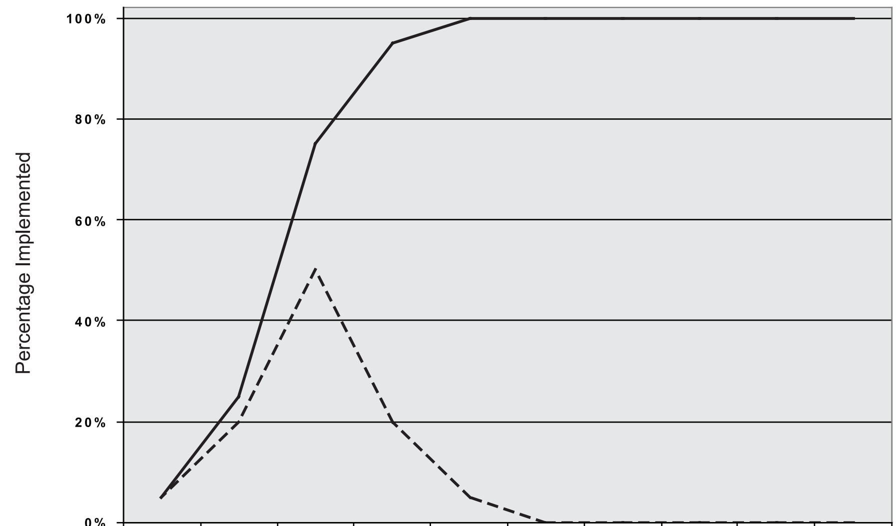
Model Building Blocks

Cost Rollout

CITL has projected costs over 10 years. Acquisition (system and install) costs occur in year one, with recurring costs, set at 20% of capital costs, occurring in years 1 through 10. We have assumed that facilities and providers would participate in telehealth at different times, and thus our model does not begin with 100% adoption in year one. CITL based its adoption curve on Roger's Innovation Adoption Curve, which assumes adoption occurs along a sigmoid curve.[35] CITL assumed initial adoption of 5% at year one, reaching 100% adoption in year 5 (Figure 2-1). Costs are estimated only for Levels IIa, IIb, and III, with the assumption that Levels 0 and I exist today in provider and facility settings.

Figure
2-1

Implementation Cost Rollout Schedule



	1	2	3	4	5	6	7	8	9	10
Cumulative	5%	25%	75%	95%	100%	100%	100%	100%	100%	100%
Annual	5%	20%	50%	20%	5%	0%	0%	0%	0%	0%

Year

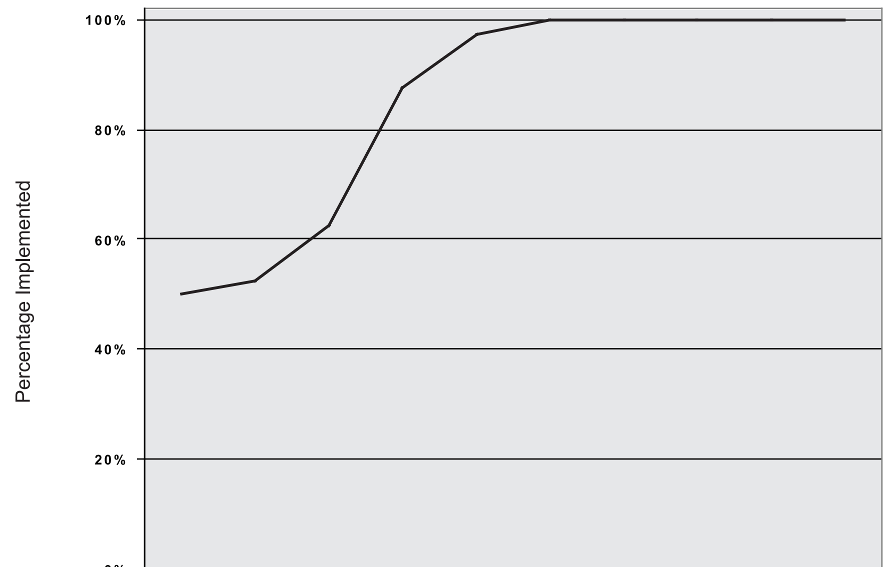
Benefit Rollout

CITL has assumed that stakeholders realize 50% of the total benefit of telehealth technologies in their first-year of adoption and assumed that the benefit increases via a sigmoid curve such that stakeholders reach 100% of potential benefit in year six after adoption (Figure 2-2).

Given the adoption assumption discussed previously, 100% of participants reach 100% of potential benefit by year 10. Figure 2-3 shows this benefit realization schedule for a national implementation of telehealth.

Benefit Rollout Schedule of Individual Implementers

Figure **2-2**

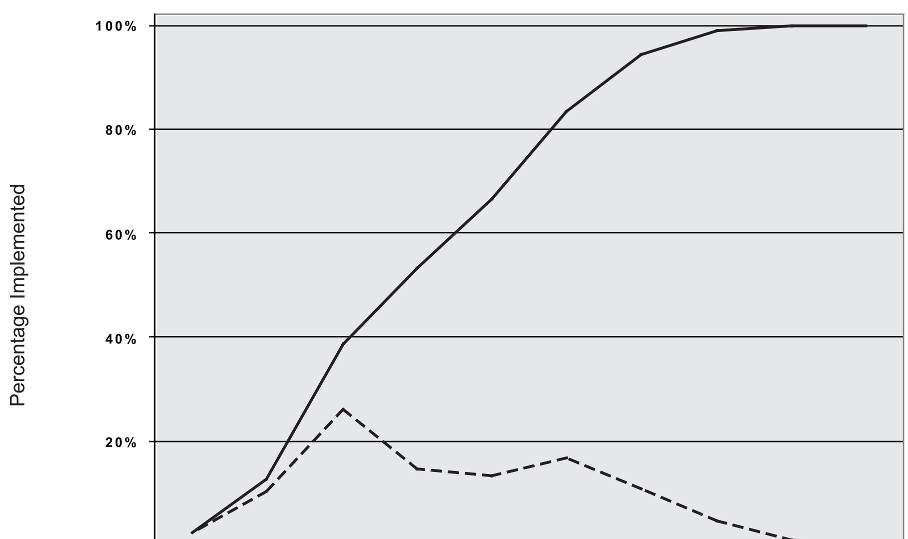


Year	1	2	3	4	5	6	7	8	9	10
Individual Benefit	50%	53%	63%	88%	98%	100%	100%	100%	100%	100%

Year

Benefit Realization Schedule for National Telehealth Adoption

Figure **2-3**



Year	1	2	3	4	5	6	7	8	9	10
Total US Benefit	3%	13%	39%	53%	67%	83%	94%	99%	100%	100%
Annual Benefit	3%	10%	26%	15%	14%	17%	11%	4%	1%	0%

Year

Usage Gap

Not all patients seeking medical attention are suitable for care via telehealth. There will always be situations in which patients, regardless of the technology available, require an in-person visit to an emergency department or provider office, as in the case of severe trauma or patients needing procedures. In addition, the type of technology available may preclude the use of telehealth. For instance, store-and-forward technologies are only applicable if the consulting provider does not need to interview or observe the patient in real-time, such as with telepsychology or a physician-directed cardiology examination.

CITL accounted for this by estimating a usage gap, or the percentage of encounters that would not be conducted by telehealth. This allowed for a more accurate estimate of the baseline number of telehealth encounters for use in our model. There has been little discussion of this issue in the literature, and CITL could not find estimates for a usage gap. Therefore, CITL internally estimated the usage gap as detailed in Table 2-3.

Table **2-3** ***Usage Gap Estimates***

	Store-and-Forward	Real-Time Video	Hybrid
ED to ED Transport	N/A	52.50%	37.50%
CF/NF to ED Visits	N/A	40.00%	31.25%
CF/NF to MD Transport	30.00%	25.00%	10.00%
Physician-to-Physician Teleconsults	61.80%	43.80%	21.40%

CITL did not model store-and-forward technologies in emergency settings as it was assumed there would always be a real-time component to these encounters.

Success Rate

CITL calculated the rate at which patients would be successfully treated with telehealth, thus avoiding an in-person visit. The success rate was derived from the usage gap and impact estimates with the following formula:

Success Rate = Impact of Telehealth/(1-Usage Gap)

Sensitivity Analyses

CITL measured the sensitivity of its projections to uncertainties surrounding key model inputs. Where possible, actual variations in published experiences or expert estimates were used to reflect the known uncertainty of our parameters. For those parameters where there were no published measures or expert estimates of uncertainty, CITL used a factor of ±25% to reflect potential uncertainty in the parameter. The variations in the parameters were then applied to the model in a univariate analysis to quantify the impact of each parameter's uncertainty on CITL's projected results. Some well-established parameters, such as the US population, were excluded from the analysis due to the relatively low uncertainty in their measurement. Table 2-4 contains a list of each variable examined in the sensitivity analysis as well as how the uncertainty was estimated.

Table **2-4**

Sensitivity Analysis Estimates

Model Input	Sensitivity Analysis Method
ED to ED Transfer Cost	High/Low Provided by Source
NF Transport Cost to MD Office	+/- 25%
CF Transport Cost to MD Office	+/- 25%
CF Security Cost	+/- 25%
Ambulance Cost	High/Low Provided by Source
ED Admission Cost	+/- 25%
Face-to-Face Visit Fee	+/- 25%
Televisit Fee	+/- 25%
ED to ED Transfer Rate	High/Low Provided by Source
ED Visit Volume	High/Low Provided by Source
MD Referral Volume	+/- 25%
CF Transport Rate to ED	+/- 25%
CF Transport Rate to MD Office	+/- 25%
NF to ED Transfer Volume	High/Low Provided by Source
NF to MD Office Volume	+/- 25%
Test Cost	+/- 25%
Redundant Test Rate	+/- 25%
Usage Gap	+/- 25%
CF Population	+/- 25%
NF Population	+/- 25%
System Cost	High/Low by System Type
Install Cost	High/Low by System Type
Success Rate	+/- 25%

Format of Reported Results

Sums in tables may appear to be incorrect due to rounding. The majority of amounts are in 2007 dollars. When unavailable, and where appropriate, prior year amounts were inflated to 2007 dollars based on US budgetary inflation figures[36] and indicated as such.

Cost of Visit

CITL's model incorporates costs associated with visits. These include the fees for routine and consultation care, for both face-to-face (in-person) and televisits (virtual). To determine these visit fees, CITL used the Centers for Medicare and Medicaid Services (CMS) average reimbursement fees for the American Medical Association's (AMA) Common Procedural Terminology (CPT) codes.[37] For the routine visit fees, applied to provider office visits with inmates and nursing home residents, CITL used two evaluation and management (E&M) codes for established routine, regular care: Established Outpatient Visit Level II (99212) and Level III (99213). For consultation visit fees, applied to physician-to-physician consults, CITL used two E&M codes: Established Outpatient Consultation Level II (99242) and Level III (99243). These CPT codes and their associated fees may be seen in Table 2-5.

Table **2-5** ***CPT Codes and Their Fees***

Type and Level of Care	CPT Code	Fee
Routine Care, Level 2	99212	$37.08
Routine Care, Level 3	99213	$51.27
Consultation Care, Level 2	99242	$88.26
Consultation Care, Level 3	99243	$119.77

CITL assigned the appropriate (routine or consult) Level 3 fee to all face-to-face visits. Televisits in real time, either real-time video or some hybrid visits (those conducting at least a video component), were assumed to be Level 3. Delayed visits, via store-and-forward, or some hybrid visits (those conducting only a store-and-forward component), were assumed to be a Level 2, on the generalization that delayed visits to a consultant answer a focused question on the basis of a subset of all clinical data.

CITL assumed that a visit fee would be charged by both the referring (near) and consultant (far) providers. CITL also included the use of a facility fee for patients undergoing real-time video or hybrid encounters, with the assumption that many of these visits require a scheduled return visit in the future for their teleconsult. This facility fee was not included if the patient was originating in an emergency department, since the fee would be included in the emergency department global charges, nor in correctional or nursing home facilities, where patients would be seen in contained healthcare areas in these facilities. Patient data for a store-and-forward teleconsult were assumed to have been collected by the patients' primary care physician during their initial visit, and thus a facility fee was not included in these visits. CITL used the CMS facility fee of $22.33, for the originating site of a telehealth encounter.[38]

Cost of Transports

CITL estimated several costs to transport patients: between emergency facilities, and from nursing homes and correctional facilities to both emergency departments and physician offices.

Emergency Transport

For emergent transport estimates, CITL used the CMS 2007 Ambulance Fee Schedule.[37] For transports between emergency facilities, CITL used $631.87 per transport, the CMS fee for Specialty Care Transport, defined as: "Hospital-to-hospital transportation of a critically injured or ill patient, including the provision of medically necessary supplies and services, at a level of service beyond the scope of the EMT-Paramedic." All emergency transports were assumed to be ground transportation. While we recognize that a portion of emergency transfers will occur via a fixed or rotary wing aircraft, CITL was unable to locate a national estimate of their frequency of use. Using only land-based transport costs is thus a conservative estimate, with total savings due to avoided emergency transports likely being higher than what is estimated in this report.

For transports from correctional facilities and nursing facilities to emergency departments, CITL used $311.07 per transport, the CMS fee for Basic Life Support (BLS), defined as "Transportation by ambulance and the provision of medically necessary supplies and services, including the provision of BLS ambulance services as defined by the state." For correctional facility emergency transports, CITL included the cost of a security escort at $336 per transport, assuming two officers working six hours each at $28 per hour,[39] for a total inmate transport cost of $647.07.

Emergency transport costs do not include the cost of the return trip to the correctional facility, nursing facility, or the transportation costs after transfer between emergency departments. These costs were not considered due to the number of variables involved after a patient transfer. The patient might remain at the new hospital, be transferred back to the original hospital, be transferred to another hospital such as a rehabilitation hospital, or be discharged home. Thus, this assumption underestimates the cost savings from reduced transports.

Table 2-6 provides a summary of the emergency transport costs for each type of transportation.

Table **2-6**

Summary of Cost per Emergency Transport

Transport	Cost	
Between Emergency Departments	$631.87	
Correctional Facilities to Emergency Departments	Cost of Ambulance	$311.07
	Security Cost	$336.00
	Total	$647.07
Nursing Facilities to Emergency Departments	$311.07	

Non-Emergency Transports

CITL estimated costs for non-emergency, round-trip transports to physician offices, originating from correctional facilities and nursing facilities. CITL assumed inmates are transported from correctional facilities to physician appointments in vans or buses, with each transport carrying several prisoners and security personnel. CITL estimated the vehicle cost at $50 per prisoner per transport[40] and included the security cost of $336 per transport[39] for a total per inmate transport cost of $386. For nursing home transports, CITL assumed that residents are transported by a van service. CITL estimated the average cost of transport of a nursing home resident to a physician office at $76.00 per transport.[41]

Table 2-7 provides a summary of the emergency transport costs for each type of transportation.

Table **2-7**

Summary of Cost per Non-Emergency Transport

Transport	Cost	
Correctional Facility to Physician Offices	Cost of Van/Bus	$50.00
	Security Cost	$336.00
	Total	$386.00
Nursing Facility to Physician Offices	$76.00	

Chapter 3: Benefit of Avoided Transports between Emergency Departments | CITL !

From the perspective of the healthcare system, the cost to equip all US emergency departments with telehealth technologies could easily be covered by savings from a reduction in transfers between emergency departments.

CITL projected the impact of telehealth on the reduction of transports from one emergency department (ED) to another emergency department. It is not uncommon, especially in rural areas, for a patient to present to an emergency department requiring unavailable specialty care. In an emergent situation, these patients are transferred to other emergency departments, typically in tertiary care centers, to receive that specialty care. A prime example of this is a potential stroke victim needing assessment by a neurologist for anticoagulation therapy. Recent estimates indicate that up to 50% of the 4,516 emergency facilities in the United States have difficulty providing at least one type of physician specialty for consultation;[42] in cases where rapid diagnosis and treatment is linked to outcomes, patients are often transferred. With over two million annual transports between emergency facilities,[43] the availability of telehealth technologies has the potential to greatly reduce costly patient transports.

The type of transportation, the distance between facilities, and the personnel required to accompany a patient, all have major cost implications. With telehealth, providers can receive specialized guidance, and their patients can receive specialty care, thus avoiding the transport of many of these patients. The existing literature demonstrates that telehealth successfully decreases the number of transfers between emergency departments when specialty care is unavailable at the originating emergency department.[44-54] A majority of this work has focused on radiology and neurological consultations for trauma and potential stroke victims.

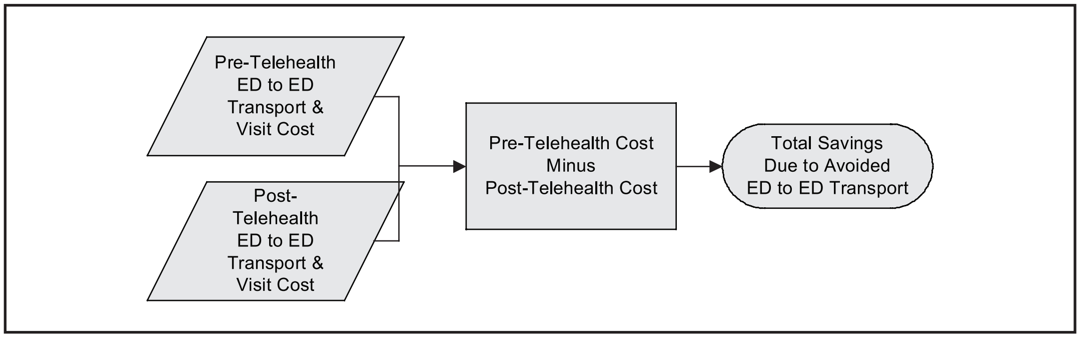
Approach to Analysis

Savings Calculation

CITL modeled pre- and post-telehealth implementation scenarios by calculating the pre-telehealth costs and then subtracting the post-telehealth costs to determine the savings (Figure 3-1). The savings included here are the benefits of the telehealth technology only; system costs are presented in Chapter 9, and the net benefit is detailed in Chapter 10.

Figure **3-1**

Savings Due to Avoided Emergency Department to Emergency Department Transports



To calculate these costs, CITL determined the total number of baseline transports from one emergency department to another, the cost of an ambulance transport, and the potential impact of emergent telehealth on the number of transports. The pre- and post-telehealth calculations for these costs are seen in Figures 3-2 and 3-3.

Figure **3-2**

Pre-Telehealth Costs

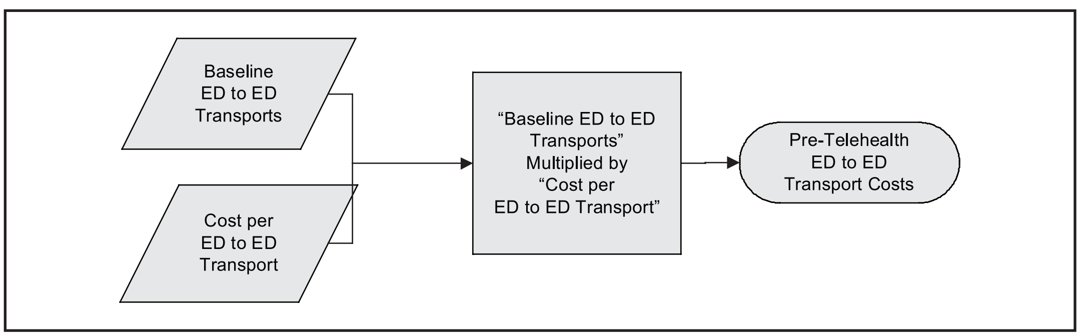
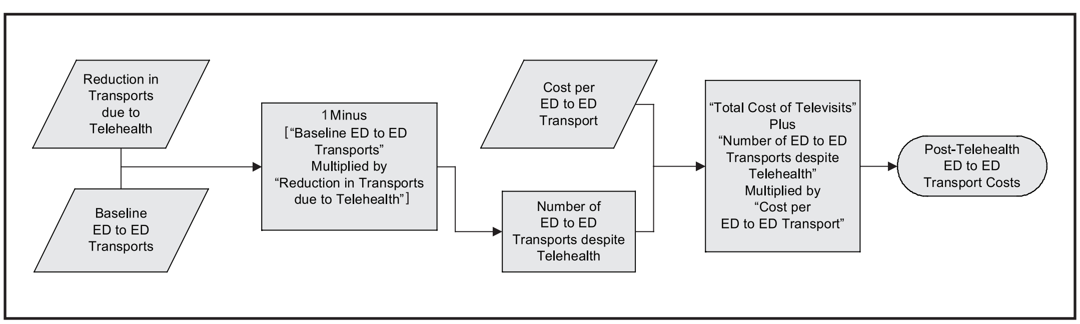


Figure **3-3**

Post-Telehealth Costs



Model Building Blocks

Baseline emergency transport estimates were calculated from the Centers for Disease Control and Prevention's (CDC) 2004 National Hospital Ambulatory Medical Care Survey (NHAMCS), a national survey of hospital emergency department and outpatient department utilization.[43] In 2004, there were approximately 110 million emergency department visits in the United States, of which 2.0% were transported to another emergency facility, for a total of 2.2 million baseline transports between emergency departments.[43] The cost of a transport from one emergency facility to another is estimated at $632 per transport (see Chapter 2: Cost of Transport). CITL did not include a teleconsult cost, since that cost would be incurred regardless of whether the consultation occurred in-person or virtually.

Impact Estimates

CITL found several estimates for the impact of telehealth on reducing patient transports from one emergency department to another, but the majority of these were specialty specific, prominently in neurology and cardiology. The non-specialty specific literature had problematic study designs, such as low sample sizes and only single cohorts. Thus, the advisory board participated in a Modified Delphi process to estimate the impact of telehealth on ED to ED transfers. The board estimated a 29.3% reduction in transports for the real-time video scenario. The impact estimate for hybrid technologies, 38.6%, was estimated based on this value and the usage gap (see Chapter 2: Usage Gap). CITL assumed that in an emergent situation, a pure store-and-forward scenario would never be attempted due to the necessity of an immediate response.

National Benefit Projection

CITL projected the impact of telehealth on the reduction of transports from one emergency department to another. Prior to telehealth, CITL projected 2.2 million transports per year for an estimated cost of $1.39 billion. For the real-time video scenario, telehealth could avoid 646,000 transports and save $408 million annually, roughly 30.0% of pre-telehealth costs. For the hybrid scenario, telehealth could avoid 850,000 transports and thus save $537 million annually or almost 40.0% of pre-telehealth costs (Table 3-1).

Table **3-1**

Summary of National Benefits of Avoided Emergency Department to Emergency Department Transports

	Store-and-Forward (Level IIa)	Real-Time Video (Level IIb)	Hybrid (Level III)
Baseline Transports ED to ED	2,204,320		
Transport Cost	$632		
Pre-Telehealth Transport Cost	$1,390,000,000		
Usage Gap	N/A	52.5%	37.5%
Reduction in ED to ED Transports	N/A	29.3%	38.6%
Success Rate	N/A	61.7%	61.7%
Avoided Transports ED to ED	N/A	646,000	850,000
Post-Telehealth Transport Costs	N/A	$982,000,000	$853,000,000
Annual Telehealth Savings	N/A	$408,000,000	$537,000,000

Chapter 4: Benefit of Avoided Visits from Correctional Facilities to Emergency Departments

CITL !

Correctional facilities could cover their costs of telehealth equipment by savings from a reduction in transporting patients to emergency departments and by avoiding the costs of the emergency department visit itself.

CITL projected the impact of telehealth on the reduction of visits from correctional facilities (CF) to emergency departments. While many correctional facilities have on-site healthcare providers, these providers may be unable to manage emergent healthcare matters, often because of lack of expertise in evaluation or management of the inmate's presenting symptom(s). Telehealth has the potential to allow an inmate's healthcare to be managed at the correctional facility thus avoiding the transport cost to emergency facilities. By avoiding a transport, the cost of vehicles and correctional officers to accompany patients, as well as the cost of security at the healthcare facilities, could be avoided. In addition, if an inmate can be managed on-site, the correctional facility avoids the cost of the emergency department visit.

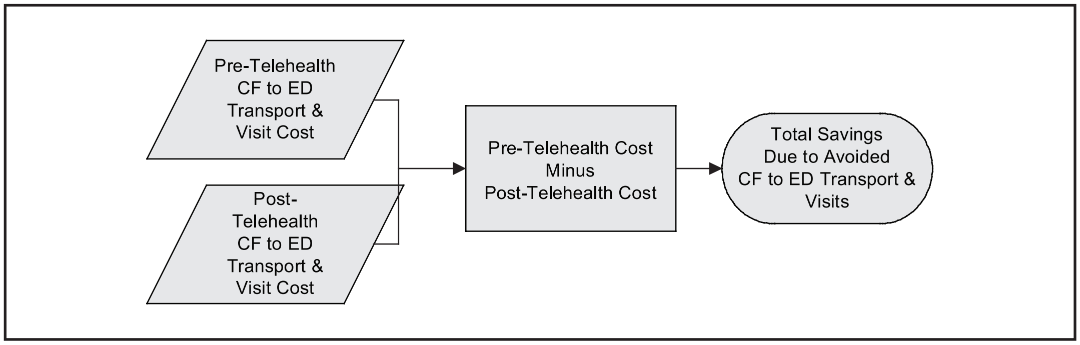
Telehealth programs in correctional settings have demonstrated a decrease in patient transports to emergency departments.[55-57] Programs in New York State and Texas have reported that telehealth technologies avoided 38.0%[56] and 36.0%[57] of patient transports, respectively.

Approach to Analysis

Savings Calculation

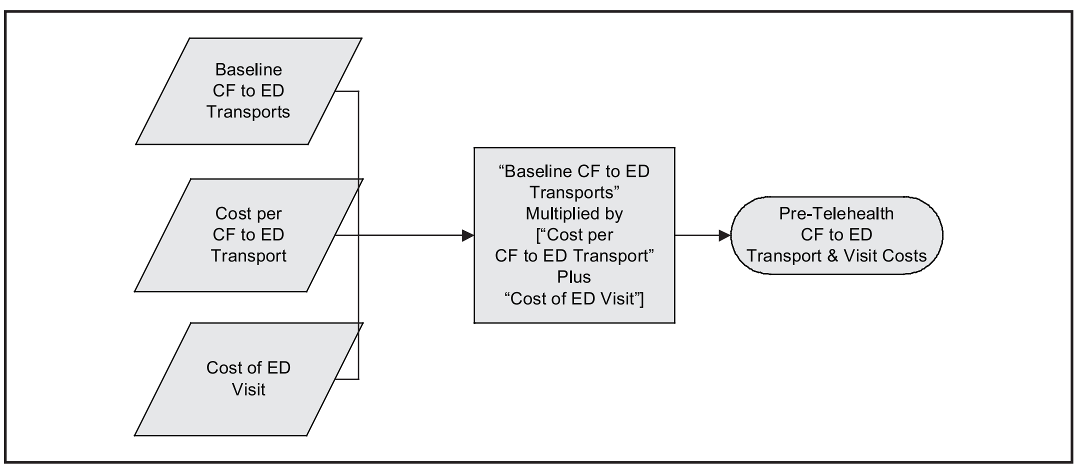
CITL modeled pre- and post-telehealth implementation scenarios by calculating the pre-telehealth costs minus the post-telehealth costs to determine the savings from avoided visits between correctional facilities and emergency departments (see Figure 4-1). The savings included here are the benefits of telehealth technology only; system costs are presented in Chapter 9, and the net benefit is detailed in Chapter 10.

Figure 4-1 **Savings Due to Avoided Visits from Correctional Facilities to Emergency Departments**



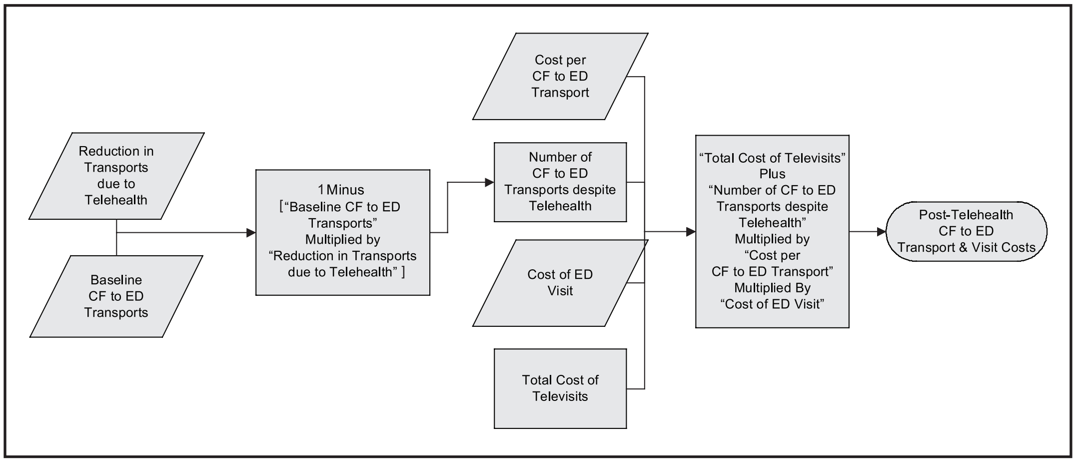
To calculate these costs, CITL determined the baseline number of transports from US correctional facilities to emergency departments, the cost of an ambulance transport with appropriate security, the cost of an emergency department visit, the cost of a tele-visit to a specialist, and the potential impact of emergent telehealth on the number of visits from a correctional facility. The pre- and post-telehealth calculations for these costs are seen in Figures 4-2 and 4-3.

Figure 4-2 **Pre-Telehealth Costs**



Post-Telehealth Costs

Figure **4-3**



Model Building Blocks

CITL was unable to find national estimates for baseline transports from correctional facilities to emergency departments. A baseline rate was therefore obtained from Texas and Oregon correctional facilities and extrapolated to the nation using the population of US correctional facilities. In 2003, there were 10,251 inmate transports to emergency departments[57] in Texas from a total correctional population of 169,003,[58] for a 6.1% transport rate. In 2006, there were 842[59] transports in Oregon, in a correctional population of 13,411,[58] for a transport rate of 6.3%. CITL calculated the average, 6.2%, and applied this rate to the US correctional population, 1.5 million,[58] to estimate 94,180 transports from correctional facilities to emergency facilities or approximately one transport per 16 inmates each year.

For the average cost of an emergency department visit, CITL used $1,031, based on a 2004 dollar estimate of $947, reported by the Agency for Healthcare Research and Quality's (AHRQ) Medical Expenditure Panel Survey (MEPS) and inflated to 2007 dollars.[36, 60] The cost of the ambulance from the correctional facility to the emergency department was $647, which includes the ambulance and security escort costs (see Chapter 2: Cost of Transport). The cost of a televisit was estimated at $119.77 (see Chapter 2: Cost of Consult).

Impact Estimates

There is literature that demonstrates the ability of telehealth to reduce transports from correctional facilities to emergency departments. However, the 38.0% impact from New York State included only inmates that received a teleconsult and not those who were triaged and transported directly to an emergent facility. Applying our usage gap to this estimate would underestimate the impact of telehealth.[56] The 36.0%[57] impact from Texas came from a program that had already implemented a telephone triage system, which potentially confounded the impact of telehealth on avoided transports. Using these reported impacts as references, our advisory board participated in a modified Delphi process and estimated a 37.0% impact for the real-time video scenario. The impact estimate for the hybrid scenario, 42.4%, was projected based on this value and the usage gap (see Chapter 2: Usage Gap). CITL did not model a store-and-forward scenario, assuming an emergent situation would always warrant a real-time component.

National Benefit Projection

CITL projected the impact of telehealth on the reduction of visits from correctional facilities to emergency departments. Prior to telehealth, CITL projected 94,180 transports per year for an estimated cost of $158 million (Table 4-1). For the real-time video scenario, telehealth could avoid almost 35,000 transports and save $51.7 million annually, or one-third of the pre-telehealth costs. For the hybrid scenario, telehealth could avoid almost 40,000 transports and thus save $60.3 million annually, or almost 40.0% of pre-telehealth costs. This translates to savings of $34 per inmate/per year in the real-time video scenario, and $40 in the hybrid scenario.

Summary of National Benefits of Avoided Correctional Facility to Emergency Department Visits

Table **4-1**

	Store-and-Forward (Level IIa)	Real-Time Video (Level IIb)	Hybrid (Level III)
Baseline Transport CF to ED	94,180		
ED Admission Cost	$1,031		
Security Cost During Transport	$336		
Transport Cost	$311		
Pre-Telehealth Transport and Visit Cost	$158,000,000		
Usage Gap	N/A	40.0%	31.3%
Reduction in Visits from CF to ED	N/A	37.0%	42.4%
Success Rate	N/A	61.7%	61.7%
Cost of Televisit	N/A	$119.77	$119.77
Avoided Visits from CF to ED	N/A	34,900	39,900
Post-Telehealth Transport and Visit Costs	N/A	$106,000,000	$97,700,000
Annual Telehealth Savings	N/A	$51,700,000	$60,300,000

Chapter 5: Benefit of Avoided Transports from Correctional Facilities to Physician Offices

CITL !

Correctional facilities could cover their costs of telehealth equipment by savings from a reduction in transporting patients to physician offices.

CITL projected the impact of telehealth on the reduction of transports from correctional facilities to physician offices. Healthcare services in correctional facilities typically consist of primary care provided by physicians and nursing staff on site. Specialty care is usually provided by off-site, private sector physicians. This requires the prisoner to be transported to and from the correctional facility. As a result, there are major cost implications to the transportation of inmates. Transport can be a day-long event for the prison guards, depending on the distance to be traveled, the extent of the visit, and the numbers of inmates being transported.

Numerous studies in correctional settings have reported the decrease in patient transports to provider offices with the implementation of telehealth, thus realizing financial savings. In a series of papers, McCue and a team of researchers at the Virginia Commonwealth University undertook a multi-year study of telehealth for correctional facilities.[61-63] These researchers reported a net benefit for telehealth within a few months in spite of the high cost of telehealth equipment prevalent at that time.

The University of Texas Medical Branch (UTMB) also conducted a study of its early adoption of telehealth for correctional facility healthcare. UTMB was one of the first adopters of telehealth in correctional settings in the United States, undertaking the effort in 1993. Researchers at UTMB found that telehealth avoided at least one trip for care for 95.0% of prisoners examined.[64]

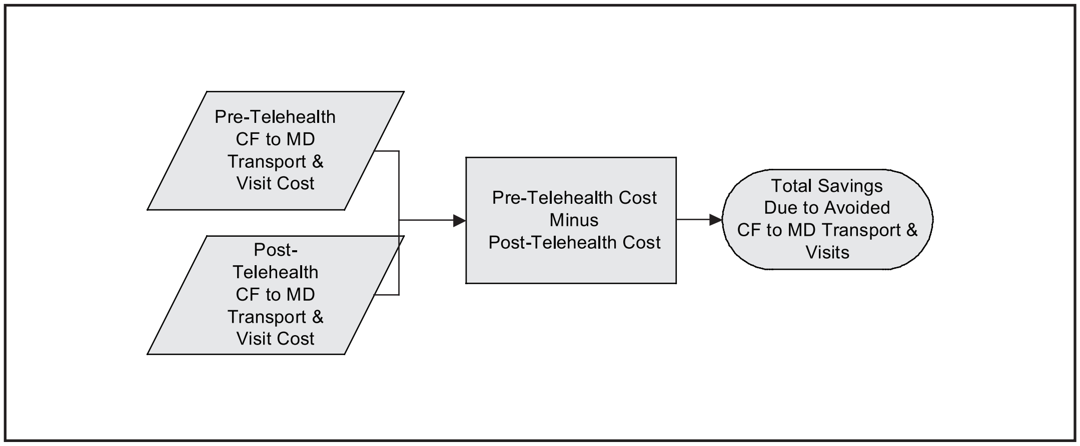
Approach to Analysis

Savings Calculation

CITL modeled a pre- and post-telehealth implementation scenario calculating the pre-telehealth costs minus the post-telehealth costs to determine the savings from avoided visits from correctional facilities to physician offices (Figure 5-1). The savings included here are the benefits of telehealth technology only; system costs are presented in Chapter 9, and the net benefit is detailed in Chapter 10.

Figure
5-1

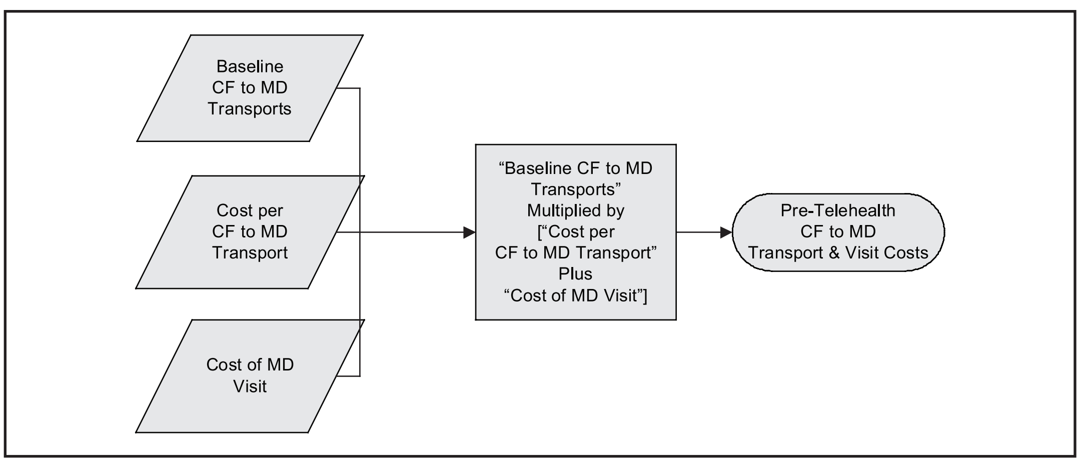
Savings Due to Avoided Transports from Correctional Facilities to Physician Offices



To calculate these costs, CITL needed to determine the total number of baseline transfers, the cost of a routine consultation, the cost of a televisit, the cost of the inmate transport, and the potential impact of telehealth on the reduction in face-to-face visits. The pre- and post-telehealth calculations for these costs are seen in Figures 5-2 and 5-3.

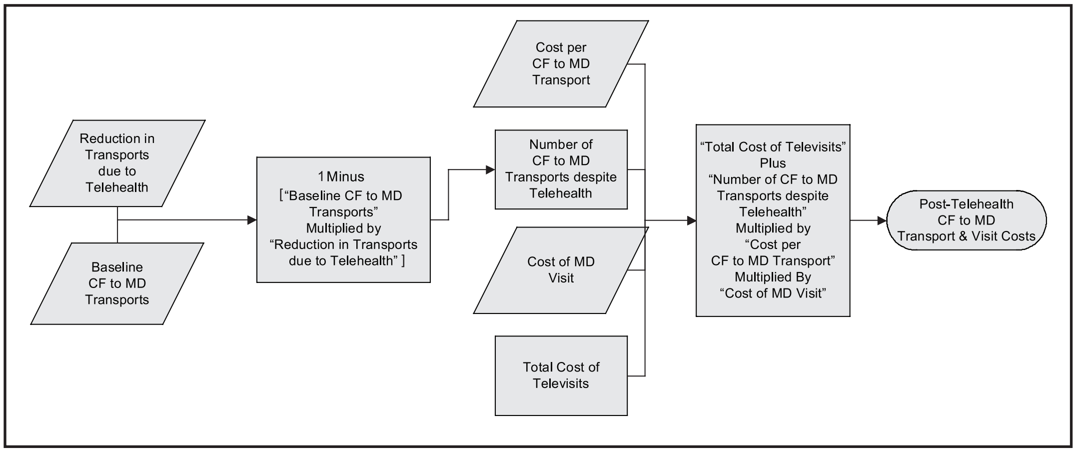
Figure
5-2

Pre-Telehealth Costs



Post-Telehealth Costs

Figure
5-3



Model Building Blocks

CITL was unable to find national estimates for baseline transports from correctional facilities to physician offices. A baseline rate was therefore obtained from unpublished data from a MedUnison Study,[40] which offers telehealth consultations to correctional facilities in Oklahoma. In its baseline period of 18 months prior to telehealth, a monthly average of 924 inmates of the total correctional population of 24,500 were transported to physician offices. CITL extrapolated this baseline rate, of 0.45 transports per inmate per year, to the US Federal and State prison population, 1.5 million inmates,[58] estimating 691,000 inmate transports per year to physician offices for the nation.

CITL's cost of a prison transport includes both the vehicle and the prison guard escort costs, estimated at $386 (see Chapter 2: Cost of Transport). The cost of the televisit was estimated to be $37.08 for the store-and-forward scenario and $51.27 for the real-time video and hybrid scenarios. The cost for the face-to-face visit was estimated to be $51.27 (see Chapter 2: Cost of Consult).

Impact Estimates

CITL used data from correctional telehealth programs to estimate the impact of telehealth on transports from correctional facilities to physician offices. For the store-and-forward scenario impact, CITL calculated a reduction of 59.5% using data from a MedUnison Study,[40] where the average number of inmate transports per month to physician offices decreased from 924 to 374. For the real-time video scenario impact, CITL used data from the Colorado correctional system.[65] A medical chart review of 53 inmates, representing 55 telehealth encounters, revealed that in 65.5% of telehealth encounters the inmates did not need to be transported from the correctional facility. The impact estimate for the hybrid scenario, 78.6%, was estimated based on these two values and the usage gap (see Chapter 2: Usage Gap).

National Benefit Projection

CITL projected the impact of telehealth on avoided transports from correctional facilities to physician offices. For the store-and-forward scenario, telehealth could avoid 411,000 transports and save $162 million annually. For the real-time video scenario, telehealth could avoid 452,000 transports and save $171 million annually. For the hybrid scenario, telehealth could avoid 543,000 transports and save $210 million annually (Table 5-1). These estimates translate to between 50.0% and 70.0% of the $302 million in pre-telehealth visit costs and would save $106 per inmate per year in the store-and-forward scenario, $112 in the real-time video scenario, and $138 in the hybrid scenario.

Table **5-1** ***Summary of National Benefits of Avoided Correctional Facility to Physician Office Transports***

	Store-and-Forward (Level IIa)	Real-Time Video (Level IIb)	Hybrid (Level III)
Baseline Number of Transports CF to MD	691,000		
Cost of Transport	$386		
Cost of Face-to-Face Consult	$51.27		
Pre-Telehealth Transport and Visit Costs	$302,000,000		
Usage Gap	30.0%	25.0%	10.0%
Reduction in Transports CF to MD	59.5%	65.5%	78.6%
Success Rate	85.0%	87.3%	87.3%
Cost of Televisit	$37.08	$51.27	$51.27
Avoided Visits CF to MD	411,000	452,000	543,000
Post-Telehealth Transport and Visit Costs	$140,000,000	$131,000,000	$92,000,000
Annual Telehealth Savings	$162,000,000	$171,000,000	$210,000,000

Chapter 6: Benefit of Avoided Visits from Nursing Facilities to Emergency Departments

CITL !

From the perspective of the healthcare system, the costs of implementing telehealth equipment in nursing homes could be covered by savings from a reduction in transferring residents to emergency departments and by avoiding the costs of the emergency department visit.

CITL projected the impact of telehealth on the reduction of visits from nursing facilities (NF) to emergency departments. Finding primary care physicians willing to cover nursing home facilities can be difficult. It is not uncommon, therefore, for coverage to occur infrequently, leaving lesser-trained individuals to the day-to-day management of resident care; these individuals may be unable to make acute decisions in a perceived urgent situation. In the absence of this knowledge, nursing home patients are transported to emergency departments, especially when such questions arise during off-hours.

With almost 1.5 million nursing care residents in approximately 16,100 nursing facilities throughout the United States,[66] telehealth has the potential to reduce the number of emergency department visits in the nation. In addition to the cost savings from these avoided visits, the ability to utilize telehealth technologies in nursing facilities avoids the need to transport frail patients.

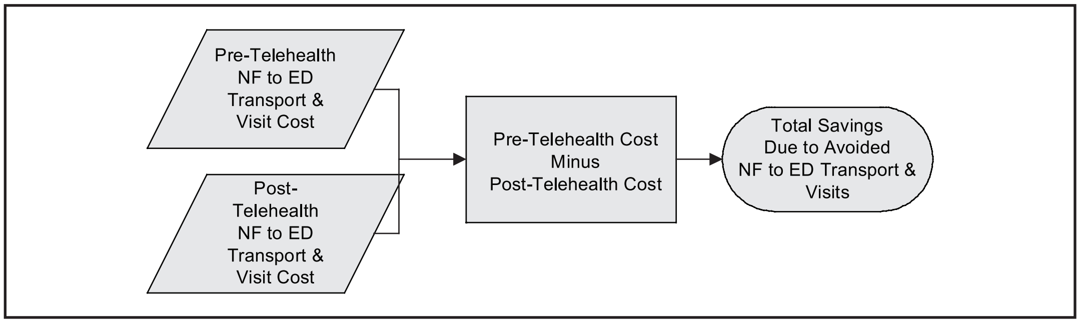
Telehealth has the potential to manage patients on-site with technologies that allow nursing staff to consult with a patient's physician, another primary care physician, or a specialist. Research suggests that telehealth can decrease residents' transfers to emergency departments for care.[67, 68]

Approach to Analysis

Savings Calculation

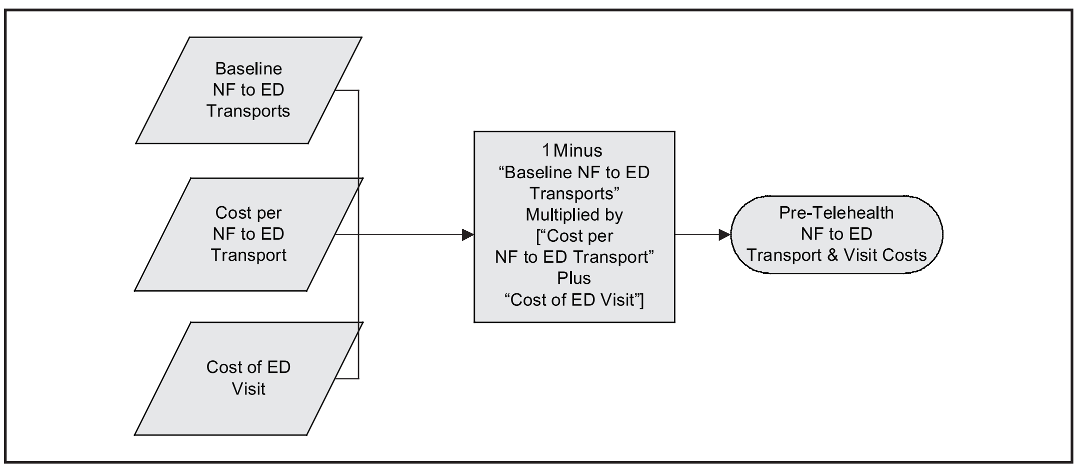
CITL modeled pre- and post-telehealth implementation scenarios by calculating the pre-telehealth costs minus the post-telehealth costs to determine the cost savings (Figure 6-1). The savings included here are the benefits of telehealth technology only; system costs are presented in Chapter 9, and the net benefit is detailed in Chapter 10.

Figure
6-1
Savings Due to Avoided Visits from Nursing Facilities to Emergency Departments



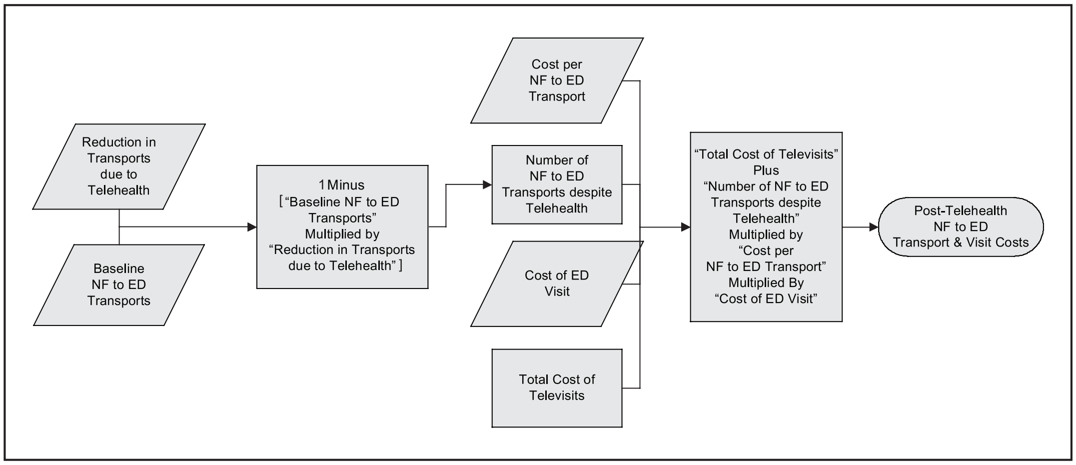
To calculate these costs, CITL determined the total number of baseline transports from nursing facilities to emergency departments, the cost of an ambulance transport, the cost of an emergency department admission, the cost of a televisit, and the potential impact of emergent telehealth on the number of transports from a nursing facility. The pre- and post-telehealth calculations for these costs are seen in Figures 6-2 and 6-3.

Figure
6-2
Pre-Telehealth Costs



Post-Telehealth Costs

Figure **6-3**



Model Building Blocks

Baseline transport estimates were used from the CDC's 2004 National Hospital Ambulatory Medical Care Survey (NHAMCS), a national survey of hospital emergency and outpatient department utilization.[43] In 2004, there were approximately 2.7 million emergency department visits in the United States that originated from nursing facilities.[43] For the average cost of an emergency department admission, CITL used $1,031, based on a 2004 dollar estimate, $947, reported by MEPS and updated to 2007.[36, 60] The cost of the ambulance from the nursing care facility to the emergency department was $311 per transport (see Chapter 2: Cost of Transport). The cost for the televisit was $119.77 (see Chapter 2: Cost of Consult).

Impact Estimates

The only published research that CITL found on reduced transports to emergency departments from nursing facilities was conducted in Hong Kong.[67, 68] Because of the potential differences in the healthcare environments between Hong Kong and the United States, CITL did not use this 8.8% reported impact in the model, but instead used the estimate as a reference point to conduct a Modified Delphi with the advisory board. The board estimated a 12.5% reduction in transports for the real-time video scenario. The impact estimate for the hybrid scenario, 14.3%, was estimated based on this value and the usage gap (see Chapter 2: Usage Gap). CITL did not model a store-and-forward scenario, assuming an emergent situation would always warrant a real-time component.

National Benefit Projection

CITL projected the impact of telehealth on the reduction of visits from nursing facilities to emergency departments for the nation. Without telehealth, an estimated

2.7 million nursing residents would be transported to emergency departments for care, at an estimated $3.62 billion. For the real-time video scenario, telehealth could avoid 337,000 transports and save $259 million annually, roughly 7.0% of pre-telehealth costs. For the hybrid scenario, telehealth could avoid 387,000 transports and thus save $327 million annually, or 9.0% of pre-telehealth costs (Table 6-1). These estimates translate to a savings of $174 per resident per year in the real-time video scenario and $219 in the hybrid scenario.

Table **6-1** ***Summary of National Benefits of Avoided Nursing Facility to Emergency Department Visits***

	Store-and-Forward (Level IIa)	Real-Time Video (Level IIb)	Hybrid (Level III)
Baseline Transport NF to ED	2,699,000		
Transport Cost	$311		
ED Admission Cost	$1,031		
Pre-Telehealth Transport and Visit Cost	$3,620,000,000		
Usage Gap	N/A	40.0%	31.3%
Reduction in Visits NF to ED	N/A	12.5%	14.3%
Success Rate	N/A	20.8%	20.8%
Cost of Televisit	N/A	$119.77	$119.77
Avoided Visits NF to ED	N/A	337,000	387,000
Post-Telehealth Transport and Visit Costs	N/A	$3,360,000,000	$3,290,000,000
Annual Telehealth Savings	N/A	$259,000,000	$327,000,000

Chapter 7: Benefit of Avoided Transports from Nursing Facilities to Physician Offices

CITL !

From the perspective of the healthcare system, the costs of implementing telehealth equipment in nursing homes could be covered by savings from a reduction in transferring residents to physician offices.

CITL projected the impact of telehealth on the reduction of transports from nursing facilities to physician offices. Few physicians routinely make visits to nursing facilities, and those who do are typically internists or family practice providers.[69] Moreover, the need for specialty care may be greater for this population than the general population, particularly for residents who may need care for chronic conditions that require several visits to specialists, such as diabetes or wound care. Telehealth allows nursing facilities to manage residents on-site rather than transport those residents to physician offices.

Published literature in this area of telehealth is limited. Research in Hong Kong reveals that telehealth used to replace physician outreach clinics reduced costs associated with visits and transportation.[67] These investigators also found that 89.0% of all care could have been provided by telehealth alone.[70] Wakefield and colleagues reported that 72.0% of patients seeing a specialist with a telehealth system connecting a veterans nursing facility to Veteran Affairs Medical Centers could be managed at the nursing facility and avoid patient travel.[71] In unpublished findings, investigators at the Maine Telehealth Services found that telehealth for nursing home residents was particularly beneficial, avoiding an average transport of 208 miles roundtrip for specialty care.[72]

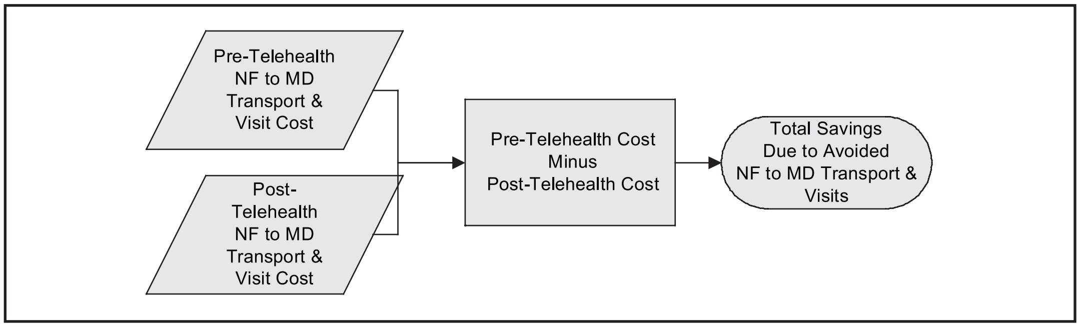
Approach to Analysis

Savings Calculation

CITL modeled a pre- and post-telehealth implementation scenario by calculating the pre-telehealth costs minus the post-telehealth costs to determine the savings in this area (Figure 7-1). The savings included here are the benefits of telehealth technology only; system costs are presented in Chapter 9, and the net benefit is detailed in Chapter 10.

Figure
7-1

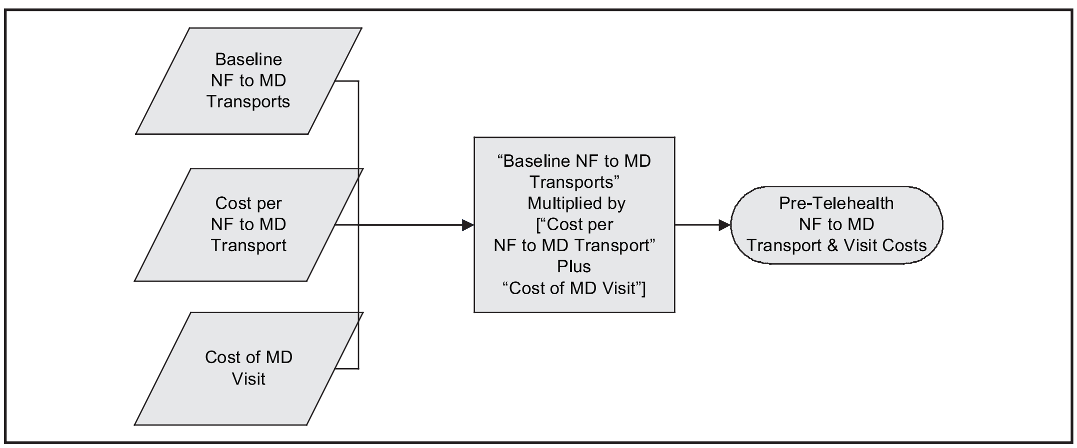
Savings Due to Avoided Transports from Nursing Facilities to Physician Offices



To calculate these costs, CITL needed to determine the total number of baseline transports from nursing facilities to physician offices, the costs of these transports, and the potential impact of telehealth on physician office transports. The pre- and post- telehealth calculations for these costs are seen in Figures 7-2 and 7-3.

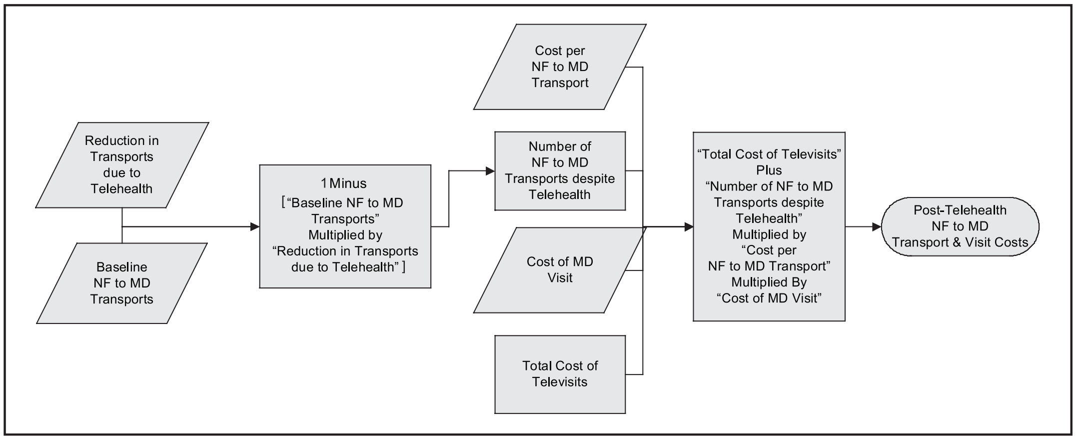
Figure
7-2

Pre-Telehealth Costs



Post-Telehealth Costs

Figure
7-3



Model Building Blocks

CITL was unable to find a baseline national estimate of the number of transports from nursing homes to physician offices. Therefore, CITL used the average number of physician visits, 6.75 per year, made by the US population aged 65 or older.[73] CITL applied this rate to the US average nursing facility population, 1.5 million,[66] to estimate 10.1 million transports per year. The average cost to transport a nursing home resident to a physician office is $76.00.[41] CITL estimated the cost of the televisit to be $37.08 for the store-and-forward scenario and $51.27 for the real-time video and hybrid scenarios; the cost for the face-to-face visit was estimated at $51.27 (see Chapter 2: Cost of Consult).

Impact Estimates

There was only one US-based research study on the impact of telehealth on transports from a nursing facility to a physician office. However, this study was conducted within the Veterans Health Administration system, not felt to be generalizable to the US nursing home population.[71] Therefore, the advisory board participated in a Modified Delphi process. This process resulted in an estimated reduction of 40.6% for the store-and-forward scenario and 53.8% for the real-time video scenario. The impact estimate for the hybrid scenario of 68.2% was based on these two values and the usage gap (see Chapter 2: Usage Gap).

National Benefit Projection

CITL projected the impact of telehealth on the reduction of transports from nursing facilities to physician offices. For the store-and-forward scenario, telehealth could avoid 4.09 million transports and save $261 million annually. For the real-time video scenario, telehealth could avoid 5.42 million transports and save $305 million annually. Finally, for the hybrid scenario, telehealth could avoid 6.87 million transports and save $479 million annually. These estimates translate to between 20.0% and 37.0% of the $1.29 billion in pre-telehealth visit costs (Table 7-1). On a per-resident annual basis, this equates to $175 in a store-and-forward scenario, $204 in a real-time video scenario, and $321 in a hybrid scenario.

Table **7-1** ***Summary of National Benefits of Avoided Nursing Facility to Physician Office Transports***

	Store-and-Forward (Level IIa)		Hybrid (Level III)
Baseline Number of Transports NF to MD	10,100,000		
Cost of Transport	$76.00		
Cost of Face-to-Face Consult	$51.27		
Pre-Telehealth Transport and Visit Costs	$1,290,000,000		
Usage Gap	30.0%	25.0%	10%
Reduction in Transports NF to MD	40.6%	53.8%	68.2%
Success Rate	58.0%	71.7%	71.7%
Cost of Televisit	$37.08	$51.27	$51.27
Avoided Visits NF to MD	4,090,000	5,420,000	6,870,000
Post-Telehealth Transport and Visit Costs	$1,030,000,000	$985,000,000	$811,000,000
Annual Telehealth Savings	$261,000,000	$305,000,000	$479,000,000

Chapter 8: Benefit of Physician-to-Physician Teleconsults

CITL !

There is a loss to the system from teleconsults with real-time video and hybrid technologies when considering only professional fees. These losses could be far out-weighed in the hybrid scenario by involving specialists early in the care of a patient and reducing the number of redundant or unnecessary tests.

CITL projected the impact of teleconsults on avoided face-to-face visits and the reduction of redundant and unnecessary tests.

Avoided Face-to-Face Visits

In the outpatient setting, referral visits may be avoided by teleconsults, allowing patients to receive specialty care through store-and-forward technologies or video-conferencing. While store-and-forward technologies allow patients to avoid a return trip to their primary care physician for a specialty consultation, both modalities allow the avoidance of a face-to-face visit with a specialist. Numerous studies have shown that teleconsults can reduce the need for an in-person referral[74-78] and allow patients to receive care and management plans without a face-to-face visit with a specialist.

Reduction in Redundant and Unnecessary Tests

A series of reports from the United Kingdom[79-81] has shown that fewer tests and procedures are ordered at a teleconsult compared to an in-person visit. This is likely due to the early involvement of the specialist and their ability to order targeted testing for their patient's condition. In addition, in a teleconsult, specialists have access to test results ordered by the primary care provider, frequently unavailable at the time of an in-person consultation. This bi-directional information sharing results in cost savings.

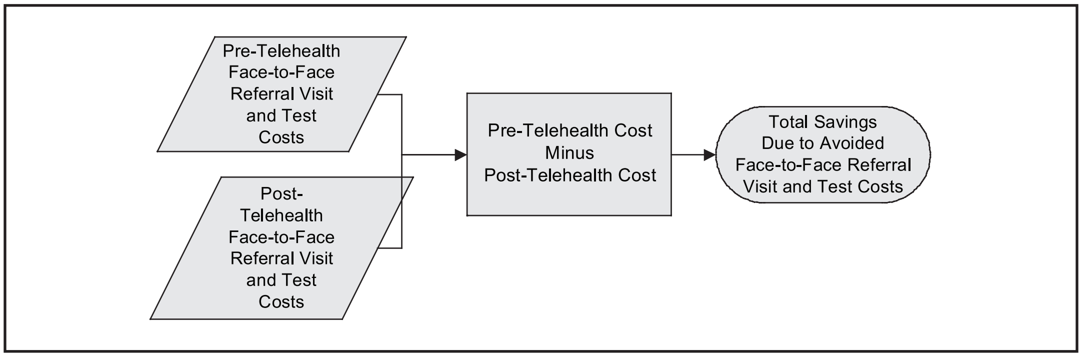
Approach to Analysis

Savings Calculation

CITL modeled a pre- and post-telehealth implementation scenario calculating the pre-telehealth costs minus the post-telehealth costs to determine the savings (Figure 8-1). The savings included here are the benefits of the telehealth technology only; system costs are presented in Chapter 9, and the net benefit is detailed in Chapter 10.

Figure
8-1

Calculation of Total Savings from Physician-to-Physician Teleconsults



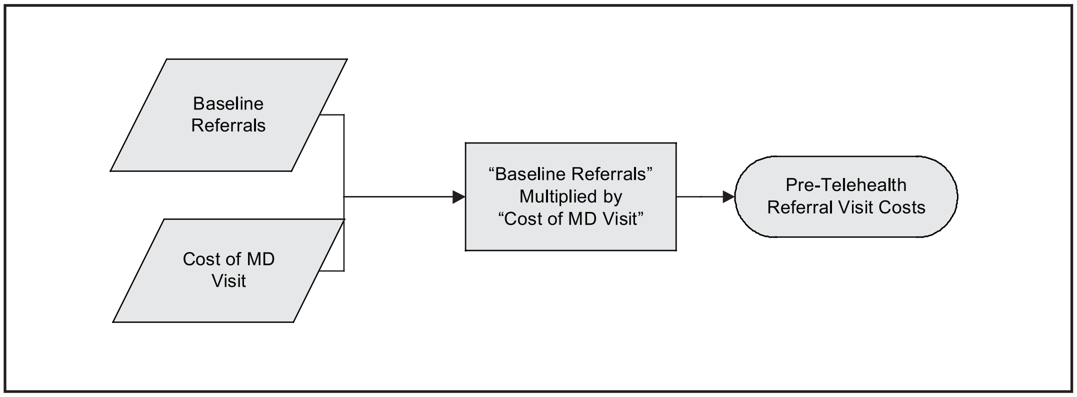
In the model, CITL considered avoided face-to-face visits and the reduction in redundant and unnecessary tests separately.

Avoided Face-to-Face Visits

To calculate the costs involved with avoided face-to-face visits, CITL determined the baseline number of referral visits, the cost of a specialty consultation, the cost of a televisit, and the potential impact of telehealth on the reduction of face-to-face visits. The pre- and post-telehealth calculations for these costs are seen in Figures 8-2 and 8-3.

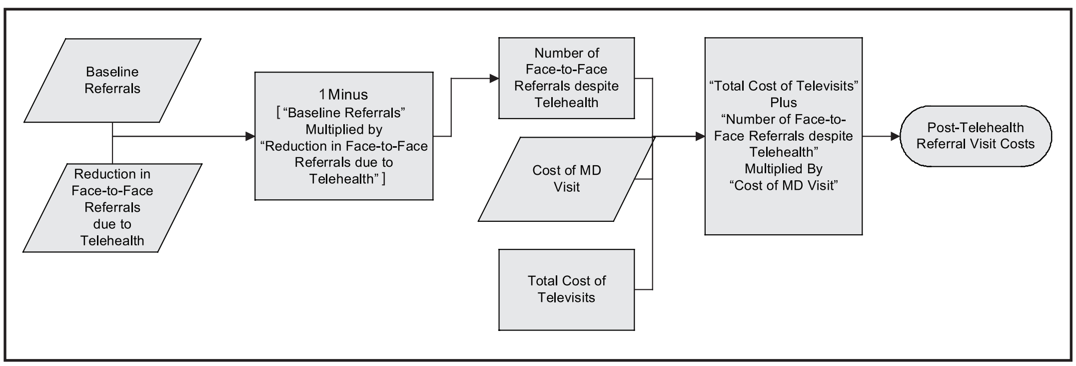
Pre-Telehealth Face-to-Face Visit Costs

Figure **8-2**



Post-Telehealth Face-to-Face Visit Costs

Figure **8-3**



Reduction in Redundant and Unnecessary Tests

To calculate the costs involved in reduced testing, CITL determined the baseline annual laboratory and radiology expenditures from outpatient visits and the potential impact of telehealth on redundant and unnecessary tests. The pre- and post-telehealth calculations for these costs are seen in Figures 8-4 and 8-5.

Figure **8-4**

Pre-Telehealth Test Costs

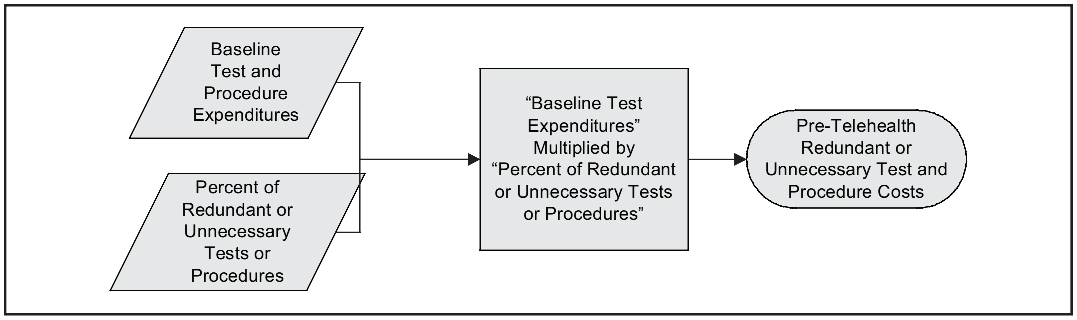
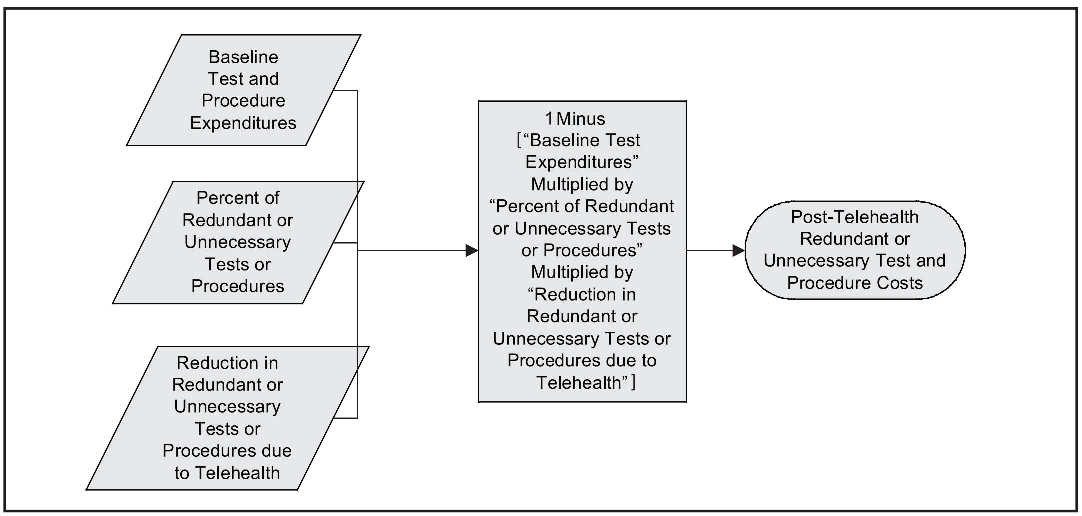


Figure **8-5**

Post-Telehealth Test Costs



Model Building Blocks

Avoided Face-to-Face Visits

A baseline outpatient referral estimate was calculated from the CDC's 2004 National Ambulatory Medical Care Survey (NAMCS), a survey that collects data on the utilization of ambulatory medical care services provided by office-based physicians.[73] In 2004, 14.4% of the 910 million visits to physician offices and 12.7% of the 85 million visits to outpatient departments necessitated a specialty referral, for a total of 142 million specialty referrals.

CITL estimated a televisit cost of $88.26 for the store-and-forward scenario and $119.77 for both the real-time and hybrid scenarios; for a face-to-face specialty consultation, a cost of $119.77 was used (see Chapter 2: Cost of Consult).

Reduction in Redundant and Unnecessary Tests

CITL used estimates from Wang[82] on outpatient laboratory and radiology expenditures, $86.52 and $185.40 respectively, to estimate annual testing expenditures of $271.92 per individual and $82 billion nationally. CITL applied a redundant testing estimate from our prior research, 14.3%,[83] to estimate a pre-telehealth baseline redundant test cost of $11.6 billion annually.

Impact Estimates

Avoided Face-to-Face Visits

CITL found literature that examined the impact of telehealth on the reduction of face-to-face specialty visits, but all the literature was specialty specific. The advisory board participated in a Modified Delphi process to estimate the impact of telehealth on avoided face-to-face office visits for a 30.9% reduction for store-and-forward technologies and a 49.0% reduction for real-time video technologies. The impact estimate for the hybrid scenario of 73.1% was estimated based on these two values and the usage gap (see Chapter 2: Usage Gap).

Reduction in Redundant and Unnecessary Tests

CITL failed to find any data for the impact of store-and-forward technologies on the reduction of redundant and unnecessary tests. Therefore, the advisory board participated in a Modified Delphi process and estimated an impact of 21.8%. For the real-time video scenario, CITL used data from a large, randomized control trial in the UK,[79] which reported a 19.7% reduction in the number of tests when comparing individuals undergoing real-time video teleconsults to standard outpatient consultations. The impact estimate for the hybrid scenario of 44.9% was estimated based on these two values and the usage gap.

National Benefit Projection

Avoided Face-to-Face Visits

CITL projected the national impact of telehealth on avoided face-to-face visits. Prior to telehealth implementation, CITL projected face-to-face outpatient visit costs at $17 billion a year. For the store-and-forward scenario, avoided face-to-face visits could save an estimated $468 million. For the real-time video and hybrid scenarios, post-telehealth visits costs were projected at $20.0 billion and $18.6 billion, respectively. Therefore, as opposed to the store-and-forward scenario, the costs for real-time video and hybrid scenarios outweighs the benefits, with a loss of $3.00 billion and $1.62 billion respectively (Table 8-1). The primary cause of this loss is due to "unsuccessful" teleconsults, in which a face-to-face visit to a specialist is required despite a teleconsult: thus, the cost of both the televisit and the face-to-face visit are incurred.

Reduction in Redundant and Unnecessary Tests

CITL projected the impact of telehealth on redundant and unnecessary tests. The baseline redundant test cost was estimated at $11.6 billion. For the store-and-forward scenario, reducing redundant and unnecessary tests could save $2.54 billion. For the real-time video scenario, reducing redundant and unnecessary tests could save $2.29 billion. For the hybrid scenario, reducing redundant and unnecessary tests could save $5.23 billion (Table 8-2).

Total Benefit of Physician-to-Physician Teleconsults

CITL combined the two modeled benefits of physician-to-physician teleconsults, reduction in face-to-face visits and reduction in redundant and unnecessary testing, in order to examine the total benefit. There is a total benefit of $3.00 billion and $3.61 billion for the store-and-forward and hybrid scenarios, respectively. However, there is a loss for the real-time video scenario of $709 million (Table 8-3). For the store-and-forward scenario, both the avoidance of face-to-face visits and redundant tests create financial savings. For the hybrid scenario, the cost incurred due to additional visits is offset by the early involvement of a specialist in the patient's care. This early involvement allows for the avoidance of redundant and unnecessary testing, such that even accounting for "unsuccessful" teleconsults, there is still an overall savings from using telehealth in this area.

Table **8-1** ***Summary of National Benefits of Avoided Face-to-Face Visits***

	Store-and-Forward (Level IIa)	Real-Time Video Level IIb)	Hybrid (Level III)
Baseline Number of Specialty Referrals	142,000,000		
Cost of Face-to-Face Consultation	$119.77		
Pre-Telehealth Face-to-face Visit Costs	$17,000,000,000		
Usage Gap	61.8%	43.8%	21.4%
Reduction in Face-to-face Visits	30.9%	49.0%	73.1%
Success Rate	86.1%	89.0%	89.0%
Cost of Televisit	$88.26	$119.77	$119.77
Post-Telehealth Face-to-Face Visit Costs	$16,500,000,000	$20,000,000,000	$18,600,000,000
Annual Telehealth Savings	$468,000,000	($3,000,000,000)	($1,620,000,000)

Table 8-2: Summary of National Benefits of Avoided Redundant and Unnecessary Tests

	Store-and-Forward (Level IIa)	Real-Time Video (Level IIb)	Hybrid (Level III)
Pre-Telehealth Redundant and Unnecessary Test Costs	$11,600,000,000		
Reduction in Redundant and Unnecessary Tests	21.8%	19.7%	44.9%
Success Rate	57.1%	35.1%	57.1%
Post-Telehealth Redundant and Unnecessary Test Costs	$9,060,000,000	$9,310,000,000	$6,370,000,000
Annual Telehealth Savings	$2,540,000,000	$2,290,000,000	$5,230,000,000

Table 8-3: Summary of National Benefits of Physician-to-Physician Teleconsults

	Store-and-Forward (Level IIa)	Real-Time Video (Level IIb)	Hybrid (Level III)
Total Pre-Telehealth Costs	$28,700,000,000		
Total Post-Telehealth Costs	$25,700,000,000	$29,400,000,000	$25,100,000,000
Total Annual Telehealth Savings	$3,000,000,000	($709,000,000)	$3,610,000,000

Chapter 9: The Costs of Provider-to-Provider Telehealth

CITL !

CITL estimated the expenses involved in implementing and operating each of the telehealth technologies across our taxonomies. Costs were estimated for both acquisition and annual costs, i.e., the costs to purchase and maintain these systems. Costs were then projected for the nation over 10 years. For each individual entity, CITL assumed that all acquisition costs are incurred during the first-year of implementation and annual costs are incurred for each of the following years. CITL assumed a 5-year implementation schedule (see Chapter 2: Roll-Out Costs). The model estimates costs for the store-and-forward (Level IIa), real-time video (Level IIb), and hybrid (Level III) scenarios, with the assumption that telephone, fax, and email (Levels 0 and I) are already in place.

Acquisition Costs

Acquisition costs consist of all the expenses necessary when first installing a system. For this report, two categories of acquisition costs were examined, the capital costs and the installation costs.

Capital Costs

CITL identified four types of data transmission that could take place during a telehealth encounter: textual, still images, video, and audio. Textual data includes the patient record and any text-formatted laboratory results for the patient. Still images include X-rays, photographs, and any visual labs, such as pathology slide pictures. Video images consist of general examination room images and any video from medical scopes such as an ophthalmoscope. Audio data consists of sounds captured from a stethoscope, microphone, or other audio capture device. For each of these, CITL considered the telehealth level necessary to transmit data: store-and-forward (Level IIa), real-time video (Level IIb), and hybrid (Level III).

Table 9-1 shows the components CITL included for each of the three levels of telehealth technologies and each type of data transmission: text, still image, video, and audio. A fifth category, "other," includes components that are necessary to connect all of the four other categories together, such as computers, monitors, and cables.

Table
9-1

Telehealth System Components

	Store-and-Forward (Level IIa)	Real-Time Video (Level IIb)	Hybrid (Level III)
Patient Textual Data	Document Scanner	N/A	Live Document Camera
Still Images	Digital Camera	N/A	Digital Camera
Live Images	N/A	Video Conferencing Video Medical Scope	Video Conferencing Video Medical Scope
Audio Data	N/A	Stethoscope Headphones Sound Equipment	Stethoscope Headphones Sound Equipment
Other	PC, Monitors, Encryption Software, Cables, AV Cart	PC, Monitors, Cables, AV Cart	PC, Monitors, Cables, AV Cart

Note that Levels IIa, IIb, and III all assume the use of phone, email, and fax, or Levels 0 and I, as the baseline. The technologies listed here are meant as an addition to, rather than a substitution of, these baseline technologies.

CITL recognizes that various stakeholders will have differing goals around the use of telehealth equipment, and therefore each component was priced for a low, medium, and high-end system. A low-end system contains the minimum amount of equipment needed for a telehealth encounter; a mid-range system contains equipment that a typical telehealth installation would require; and a high-end system contains cutting-edge, top-of-the-line equipment. Some components are not included in all systems. For instance, the utility of a digital equalizer and amplifier for stethoscope sounds would be limited to cardiologists, and thus is only included in the high-end system. These costs are detailed in Appendix E.

Installation Costs

CITL included installation costs associated with telehealth implementation. According to the experience of UTMB, the installation for a high-end system takes roughly two days for a technician and costs $2,000. For low-end and mid-range systems, CITL assumed that the installation would take a half-day for the former and a full day for the latter, with an associated cost of $500 and $1,000, respectively.

Annual Costs

In addition to the components of a telehealth system that are considered above, there are recurring annual costs required to maintain these systems. Organizations typically budget for these expenditures as a percentage of the cost of the capital equipment. CITL has estimated these as 20% of acquisition costs and include:

- Upgrades: any new software or hardware that is necessary for the improved functioning of the system.
- Troubleshooting: any technical support that might be necessary when the system fails to perform as expected.
- Replacement Parts: any new hardware that is necessary due to equipment failure.
- Training: any training required on the system outside of the initial training sessions provided by the vendor.
- Support Staff: any on-call staff needed for hardware or software support.

Aggregation of Costs

To extrapolate costs to the nation, CITL determined the telehealth equipment needed by facility and the number of installations required at each facility type.

Telehealth Equipment by Facility

CITL aggregated system costs by type of facility. CITL's cost model includes four different types of facilities: physician offices (MD), emergency departments (ED), nursing home facilities (NF), and correctional facilities (CF). All four types of facilities require the same type of equipment to conduct near side encounters, while only the physician offices and emergency departments require the extra equipment to participate in the far side encounters. Table 9-2 shows the breakdown of equipment required by facility type.

Installations per Site

CITL estimated the number of telehealth equipment sets for each of the four facility types.

Emergency Department

There are 4,516 emergency departments in the United States[42] with just over 2.2 million patients a year transported between these facilities.[43] This equates to approximately 500 transfers per emergency department annually, or almost 1.4 per day. Given this low daily rate of transfers, CITL assumed that each emergency facility would need only one telehealth installation, for a total of 4,516 telehealth equipment sets to cover the nation's emergency departments.

Physician Offices

CITL used the AMA's[84] physician data to estimate the number of physician offices and physicians in the United States, as well as the average number of physicians per office. CITL's advisory board estimated that up to ten providers could share a telehealth system. From this, CITL derived the number of telehealth sets that would be required to cover all practices and physicians in the United States, for a total of 312,401 (Table 9-3).

Table
9-2

System Components by Facility and Scenario

		Store-and-Forward (Level IIa)				Real-Time Video (Level IIb)				Hybrid (Level III)			
		MD	ED	NF	CF	MD	ED	NF	CF	MD	ED	NF	CF
Patient Textual Data	Document Scanner	X	X	X	X	-	-	-	-	-	-	-	-
	Document Camera	-	-	-	-	-	-	-	-	X	X	X	X
Still Images	Digital Camera	X	X	X	X	-	-	-	-	X	X	X	X
Live Images	Video Conferencing	-	-	-	-	X	X	X	X	X	X	X	X
	Medical Scopes	-	-	-	-	X	X	X	X	X	X	X	X
Audio Data	Stethoscope	-	-	-	-	X	X	X	X	X	X	X	X
	Headphones	-	-	-	-	X	X	-	-	X	X	-	-
	Sound Equipment	-	-	-	-	X	X	-	-	X	X	-	-
Other	Computers	X	X	X	X	X	X	X	X	X	X	X	X
	Monitors	X	X	X	X	X	X	X	X	X	X	X	X
	Encryption Software	X	X	X	X	X	X	X	X	X	X	X	X
	Cables	X	X	X	X	X	X	X	X	X	X	X	X
	AV Carts	X	X	X	X	X	X	X	X	X	X	X	X

Table
9-3

Number of Telehealth Installations by Physician Office Size

	Number of Offices	Number of MDs	Average Number of MDs per Office	Number of Telehealth Sets per Office	Total Telehealth Installations
1 to 4	276,275	353,367	1.3	1	276,275
5 to 9	12,413	77,594	6.3	1	12,413
10 to 15	3,094	36,755	11.9	1	3,094
16 to 25	1,675	33,042	19.7	2	3,350
26 to 49	961	33,785	35.2	4	3,844
50 to 75	283	17,078	60.3	6	1,698
76 to 99	124	10,767	86.8	9	1,116
100 plus	393	106,552	271.1	27	10,611
Total	295,218	668,940	2.3	N/A	312,401

Nursing Homes

There are an estimated 16,100 nursing homes in the United States with an estimated daily population of 1.5 million,[66] or approximately 94 residents per nursing home. Given an 8 hour workday, 16, 30 minute consultations could be conducted a day using one set of equipment, covering one telehealth consultation per resident per week. CITL thus assumed one installation per nursing facility, or 16,100 telehealth installations in the United States, to cover the nation's nursing facilities.

Correctional Facilities

There are 1,668 prisons in the United States.[85] Given that a typical prison has only one healthcare facility, CITL assumed that correctional facilities would have on average one telehealth equipment set, an estimate the advisory board thought was sufficient. CITL thus estimated a total of 1,668 telehealth installations in the country for correctional facilities.

National Cost Projection

The national costs for telehealth installations are presented in Tables 9-4, 9-5, and 9-6 for the low-end, mid-range, and high-end systems. The totals were derived by multiplying the number of installations by the capital, installation, and annual costs for each installation. Store-and-forward installations are inexpensive compared with their real-time video and hybrid counterparts. However, the low-end system cost for hybrid systems shows that costs can be kept at a minimum while ensuring that telehealth is conducted effectively. While we expect that a combination of these types of systems will be installed throughout the United States, the mid-range system was used to calculate net benefits in Chapter 10.

Table **9-4**

Total Cost of Telehealth Installations by Type of Site, Low-End Estimate

		Acquisition Costs (In Thousands)				Annual Costs (In Thousands)		
	Number of Installations	Store-and-Forward (Level IIa)	Real-Time Video (Level IIb)	Hybrid (Level III)	Installation Costs	Store-and-Forward (Level IIa)	Real-Time Video (Level IIb)	Hybrid (Level III)
MD	312,400	$305,000	$625,000	$775,000	$156,000	$61,000	$125,000	$155,000
ED	4,516	$0	$9,040	$11,200	$2,260	$0	$1,810	$2,240
NF	16,100	$15,700	$31,900	$39,600	$8,050	$3,150	$6,380	$7,920
CF	1,668	$1,630	$3,300	$4,100	$834	$326	$661	$821
Total	334,684	$322,330	$669,240	$829,900	$167,144	$64,476	$133,851	$165,981

Table **9-5**

Total Cost of Telehealth Installations by Type of Site, Mid-Range Estimate

		Acquisition Costs (In Thousands)				Annual Costs (In Thousands)		
	Number of Installations	Store-and-Forward (Level IIa)	Real-Time Video (Level IIb)	Hybrid (Level III)	Installation Costs	Store-and-Forward (Level IIa)	Real-Time Video (Level IIb)	Hybrid (Level III)
MD	312,400	$477,000	$4,180,000	$4,430,000	$312,000	$95,500	$835,000	$887,000
ED	4,516	$0	$60,400	$64,100	$4,520	$0	$12,100	$12,800
NF	16,100	$24,600	$214,000	$228,000	$16,100	$4,920	$42,900	$45,500
CF	1,668	$2,550	$22,200	$23,600	$1,670	$510	$4,440	$4,720
Total	334,684	$504,150	$4,476,600	$4,745,700	$334,290	$100,930	$894,440	$950,020

Table **9-6**

Total Cost of Telehealth Installations by Type of Site, High-End Estimate

		Acquisition Costs (In Thousands)				Annual Costs (In Thousands)		
	Number of Installations	Store-and-Forward (Level IIa)	Real-Time Video (Level IIb)	Hybrid (Level III)	Installation Costs	Store-and-Forward (Level IIa)	Real-Time Video (Level IIb)	Hybrid (Level III)
MD	312,400	$766,000	$7,330,000	$7,820,000	$625,000	$153,000	$1,470,000	$1,560,000
ED	4,516	$0	$106,000	$113,000	$9,030	$0	$21,200	$22,600
NF	16,100	$39,500	$364,000	$389,000	$32,200	$7,900	$72,900	$77,900
CF	1,668	$4,090	$37,800	$40,300	$3,340	$818	$7,550	$8,070
Total	334,684	$809,590	$7,837,800	$8,362,300	$669,570	$161,718	$1,571,650	$1,668,570

Chapter 10: Net Value of Provider-to-Provider Telehealth

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To this point, CITL has considered telehealth benefits and their associated system costs separately, as summarized in Table 10-1. To assess the net value, this chapter combines the benefits from Chapters 3 to 8 and the mid-range system costs from Chapter 9 over a ten-year period.

Total Annual Benefits by Chain and Cost of Telehealth Installations

Table **10-1**

	Store-and-Forward (Level IIa)	Real-Time Video (Level IIb)	Hybrid (Level III)
National Benefits of Avoided Transports Between EDs	N/A	$408,000,000	$537,000,000
National Benefits of Avoided Visits from CFs to EDs	N/A	$51,700,000	$60,300,000
National Benefits of Avoided Visits from CFs to MD Offices	$162,000,000	$171,000,000	$210,000,000
National Benefits of Avoided Visits from NFs to EDs	N/A	$259,000,000	$327,000,000
National Benefits of Avoided Visits from NFs to MD Offices	$261,000,000	$305,000,000	$479,000,000
National Benefits of Physician-to-Physician Teleconsults	$3,000,000,000	($709,000,000)	$3,610,000,000
Acquisition Costs	$835,000,000	$4,810,000,000	$5,090,000,000
Annual Costs	$101,000,000	$895,000,000	$950,000,000

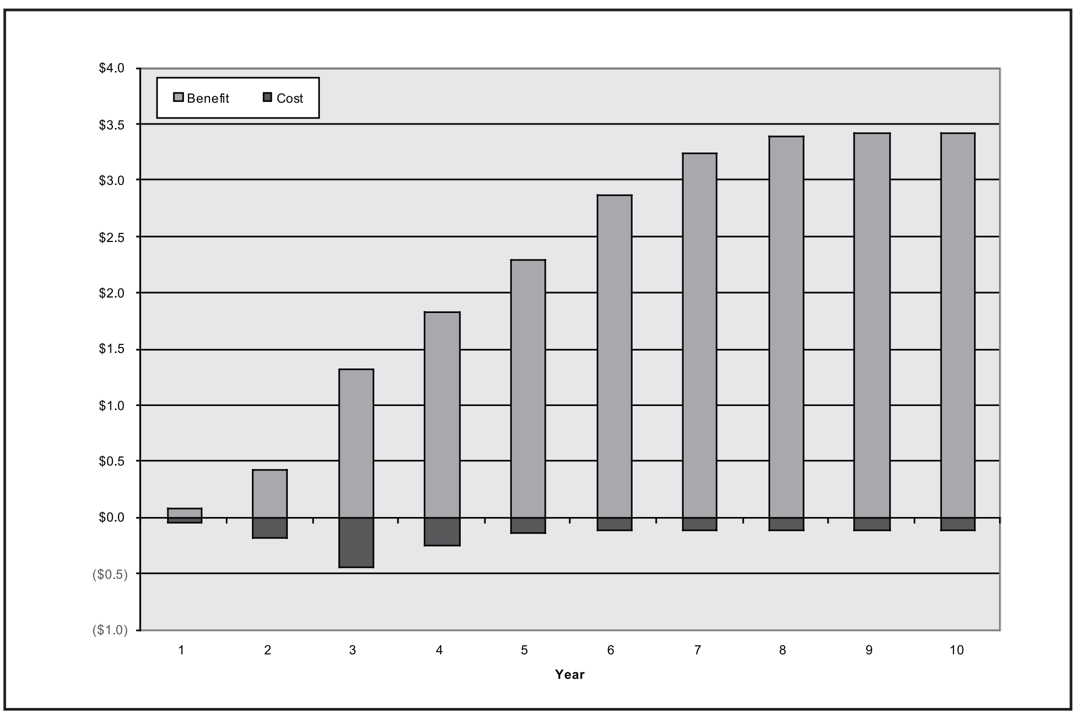
As described in Chapter 2, CITL used an implementation and benefit accrual schedule that simulated a 5-year nationwide implementation roll-out. Since our projections are based on an annual model, the model simulates five cohorts of implementation groups (i.e., year 1 implementers, year 2 implementers, and so forth). For each cohort, we included the acquisition cost during their year of implementation and the associated annual cost during each of the subsequent years.

For the encounters we have considered in this report, users on the near and far side must have installed equipment in order for an encounter to occur. Thus, it is possible that when any given facility or provider is equipped to participate in telehealth, other providers may not have the equipment to participate in that encounter. CITL has accounted for this by assuming that stakeholders will realize only 50% of the benefit of these technologies in year 1, increasing via a sigmoid curve to 100% of benefits realized in year 6 after adoption. This same benefit realization schedule is applied to the other cohorts. Thus, 100% of participants reach 100% of the potential benefit by year 10, which is when the nation reaches steady-state in benefit and cost.

National Net Value Store-and-Forward Scenario (Level IIa)

Given the assumptions presented above and the benefits from Chapters 3 through 8, the store-and-forward scenario shows a total combined benefit of $85.7 million in year 1, which rapidly increases to the steady-state annual total benefit of $3.43 billion. To determine the net annual savings, CITL then subtracted the cost of implementing the store-and-forward scenario nationwide. This cost ranged from $41.7 million in year 1 to a peak of $443 million in year 3, due to our assumption that 50% of telehealth installations would occur in year 3. This cost then decreased to the steady-state, annual cost of $101 million, resulting in a net benefit of $44 million in year 1, with a net annual savings of $3.33 billion at steady-state after the 10-year implementation period (Figure 10-1).

Figure **10-1** ***National Annual Cost and Benefit for the Store-and-Forward Scenario (Level IIa)***

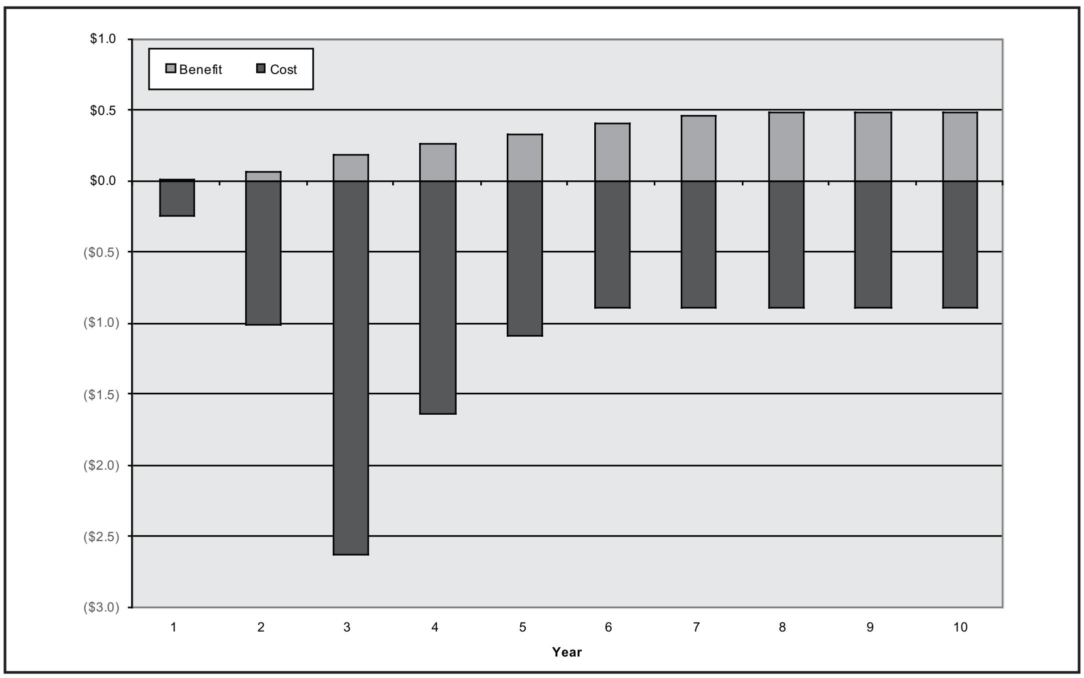


National Net Value Real-Time Video Scenario (Level IIb)

Similarly, the real-time video scenario shows a combined benefit of $12.2 million during the first-year that increases to the steady-state benefit of $486 million annually. However, the costs for the real-time video scenario are much higher than for the store-and-forward scenario, leading to a first-year cost of $240 million, a third year peak of $2.63 billion, and a steady-state annual cost of $895 million in year 6. Therefore, the real-time video scenario results in a net loss to the nation even after the initial 10 years, with a net annual cost of $409 million in steady-state (Figure 10-2).

National Annual Cost and Benefit for the Real-Time Video Scenario (Level IIb)

Figure **10-2**

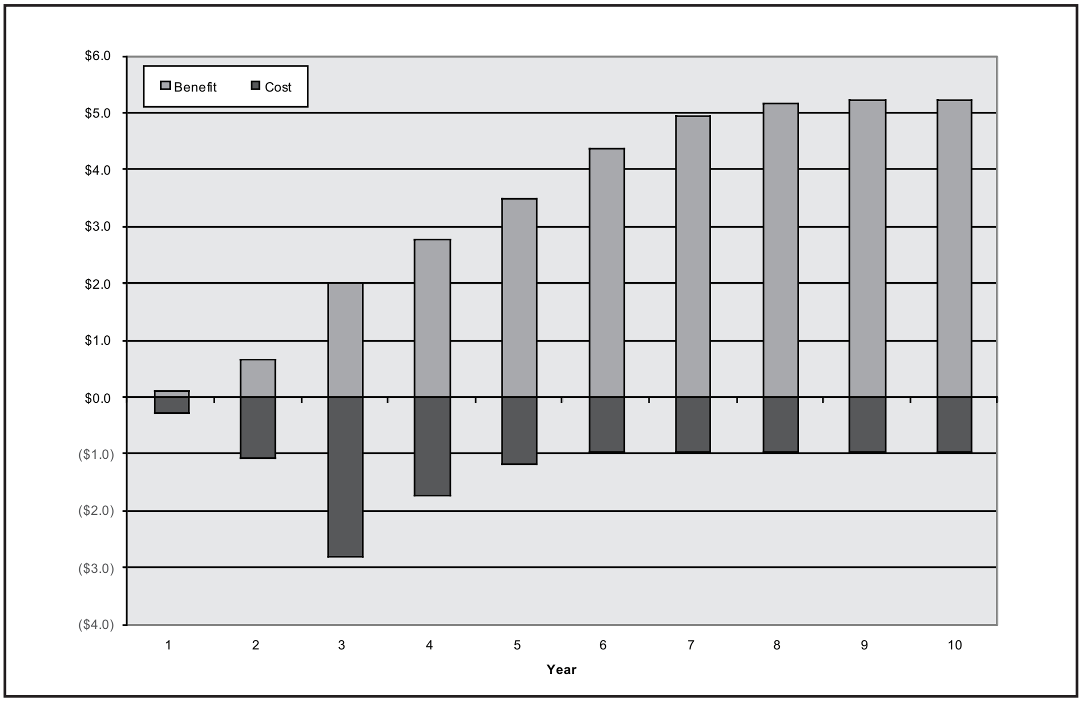


National Net Value Hybrid Scenario (Level III)

The hybrid scenario shows the highest combined benefit with a total first-year benefit of $131 million, and a steady-state annual benefit of $5.23 billion. However, the hybrid scenario is slightly more expensive than the real-time video scenario, and much more expensive than the store-and-forward scenario. Therefore, the first-year national cost for hybrid technology is $254 million, with a third year peak of $2.78 billion, and a steady-state, ongoing annual cost of $950 million. As a result, nationwide implementation of hybrid technologies projects a net national loss until year 4, with a total annual savings of $4.28 billion in steady-state (Figure 10-3).

Figure **10-3**

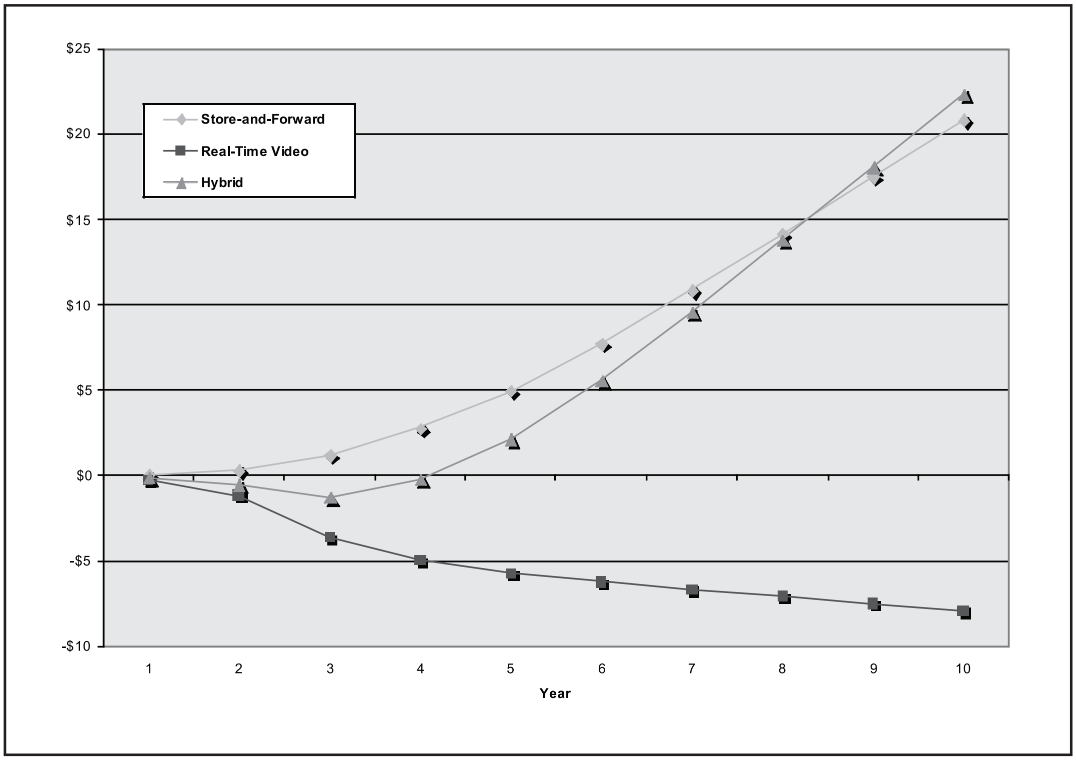
National Annual Cost and Benefit for the Hybrid Scenario (Level III)



Comparison of Net Value

Figure 10-4 compares the net value for each of the three technologies. The real-time video scenario does not produce positive financial returns for the nation. Comparatively, both the store-and-forward and hybrid scenarios produce positive returns in different ways. The store-and-forward scenario produces positive returns immediately, whereas the hybrid scenario does not reach positive annual return until year 4. However, the cumulative net value for the hybrid scenario exceeds the store-and-forward scenario by year 9, and continues to outpace the store-and-forward scenario thereafter.

National Cumulative Net Value *Figure* **10-4**



Sensitivity Analysis

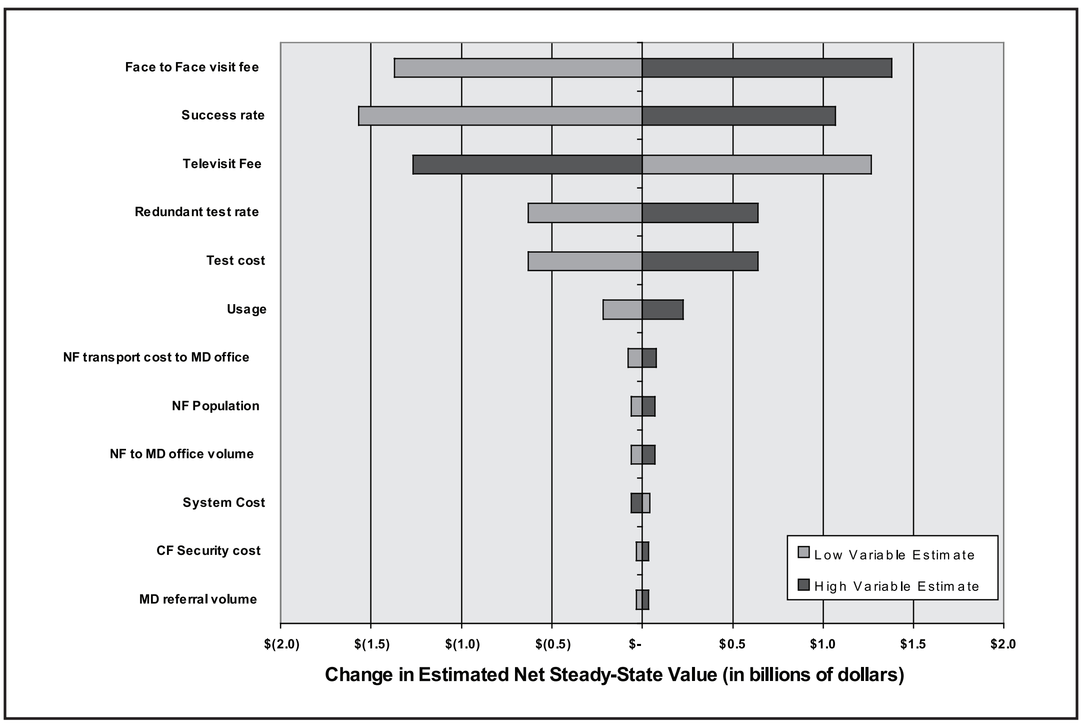
A sensitivity analysis was conducted on the steady-state net value for each of our three scenarios. Each tornado diagram below displays the financial amount, in billions, by which the steady-state net financial value would change if input factors were increased and decreased by 25%, or by actual variations in published literature or expert estimates (see Chapter 2: Sensitivity Analysis). Unlike a traditional tornado diagram, these graphs show whether the high or low estimate for the top twelve variables increased the overall net value, and vice versa.

For all scenarios, the top three most influential variables were the cost of the face-to-face visit, the success rate of the televisit, and the cost of the televisit, although in varying order for each scenario. For example, the net value of the store-and-forward scenario increases with both the success rate and face-to-face visit cost, and decreases with increases in the televisit cost (Figure 10-5). If the system cost for the store-and-forward scenario were increased by 25%, then the annual net value would decrease by 1.8%, or $61 million. Similarly, if the system cost were decreased by 25%, then the annual net value would increase by 1.1%, or $37 million. The real-time video scenario was the most sensitive of the three scenarios. The change in net value from the cost of the televisit, the cost of the face-to-face visits, and the success rate of the televisit were all more than $1.5 billion, which could shift the annual value of real-time video scenarios from negative to positive (Figure 10-6). In contrast, while both the store-and-forward scenario and the hybrid scenario were sensitive to the visit fees, success rate, and other variables, no single variable could reduce the annual net of these scenarios sufficiently to shift them from producing positive returns (Figure 10-5 and Figure 10-7).

The sensitivity analysis around the real-time video scenario estimates exceeds the average estimate presented earlier in this chapter. This indicates that the value of the real-time video scenario is highly sensitive to many variables, and could shift widely from negative to positive returns depending on the particularities of each setup. Most notably, the system costs, which represent the cost of purchasing the equipment, yields this kind of result. If we were to assume that all installations were the low-end system described previously, this would result in a steady-state net value of $352 million.

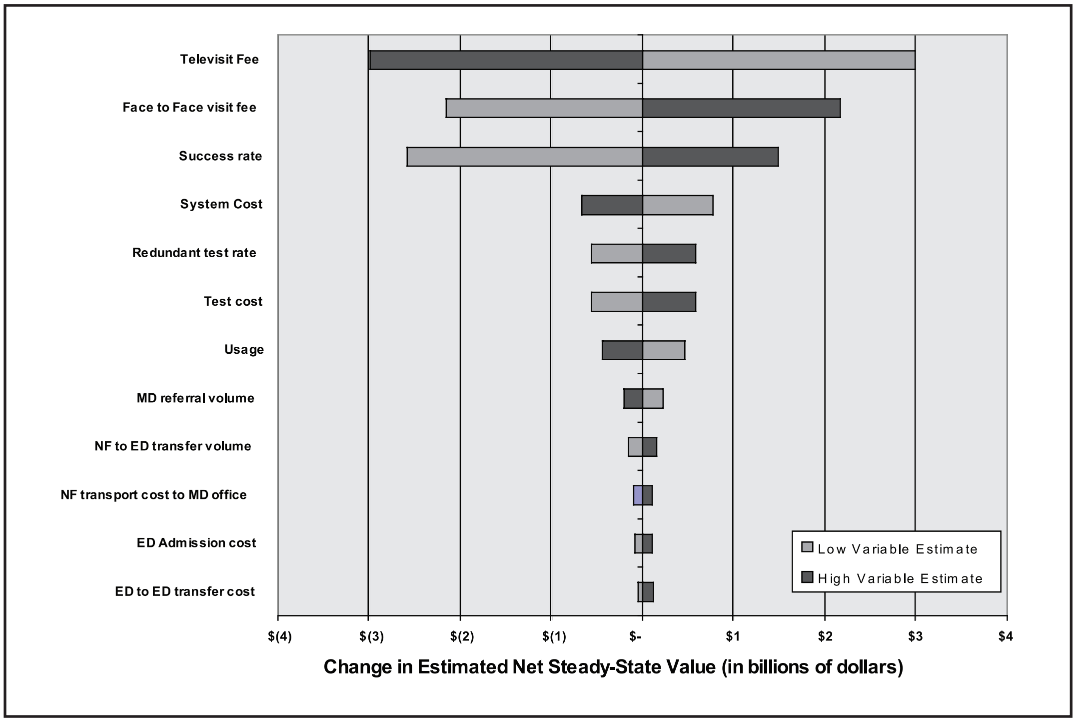
Figure
10-5

Sensitivity Analysis for the Store-and-Forward Scenario



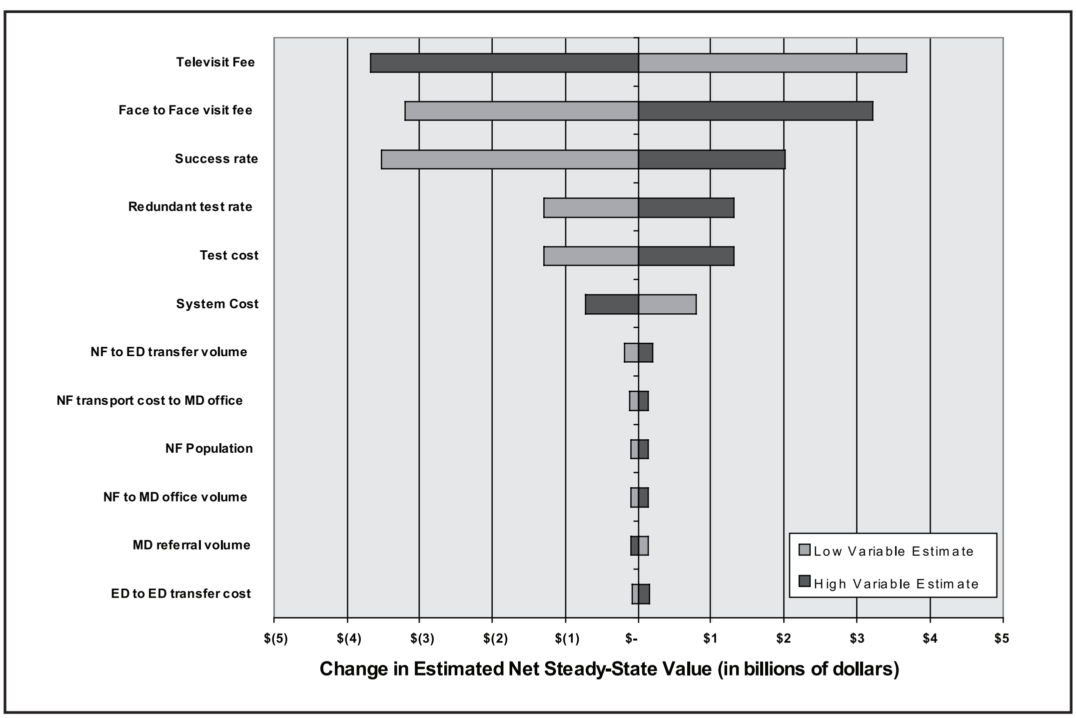
Sensitivity Analysis for the Real-Time Video Scenario

Figure
10-6



Sensitivity Analysis for the Hybrid Scenario

Figure
10-7



Chapter 11: Other Potential Value from Provider-to-Provider Telehealth

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There are other potential quantitative and qualitative benefits of telehealth in provider-to-provider settings that were not included in CITL's telehealth model. These are discussed in the sections that follow.

Increased Access to Care

Potentially the most important benefit of teleconsults is to improve access to primary and specialty care for patients who live in medically underserved areas, or for patients who may have difficulty traveling to healthcare facilities. The Institute of Medicine addresses improved access to care in two of its six Aims of Improvement. They first cite *equitable care,* defined as "providing care that does not vary in quality because of personal characteristics such as gender, ethnicity, geographic location, or socio-economic status" and second *timely care*, defined as "reducing waits and sometimes harmful delays for both those who receive care and those who give care."[5] According to Hersh, improving access to clinical services is the key goal of telehealth and the impetus for its use.[86] Telehealth studies report improved access to specialty care for rural patients,[87-89] illustrating its function in reducing geography as a barrier for those seeking specialty consultations.

The focus of telehealth has largely been access to specialty care, but recent programs have demonstrated the ability of teleconsults to reach rural populations for primary care services in areas where there is a lack of primary care providers.[90] This improvement in access likely brings about long-term healthcare savings by treating conditions before they become critical, and by managing chronic care conditions before serious complications arise. This improved management of chronic care conditions directly leads to savings by avoiding the cost implications of more complex care of these conditions.[91-94]

In the prison population, it has been difficult to provide mental health services to those who need it, due to a lack of providers in this arena. Telepsychiatry is an important means of increasing access to this type of care and may affect prison life in unexpected ways. For instance, one study reported that the introduction of telepsychiatry correlates with a reduction in violent acts in correctional facilities.[95]

Provider Education

The barriers of access can also extend to providers: those providers who are practicing in rural areas may not have access to continuing medical education (CME), which may put them at a disadvantage when compared to their urban counterparts. Telehealth with videoconferencing capabilities can improve provider access to CME[96-99] by removing financial and geographic barriers, and subsequently helping them provide better care for their patients. Delivery of programs through telecommunications allows for the dissemination of new developments and research, provides training opportunities, and increases educational experiences for primary care providers through consultations with specialists and attendance at virtual academic Grand Rounds.[99] In addition, CME via the web can be done in an asynchronous fashion. Providers can download and review materials and take examinations at times convenient to them.

Telehealth can increase the skills and expertise of primary care providers, by being part of the consultative process during the telehealth encounter with the specialist.[100, 101] For example, prior to telehealth, a provider would refer a patient to a dermatologist with an unusual rash. With telehealth, the provider works in concert with dermatologists during the teleconsultations, learning from this interaction. With time, the primary care provider gains confidence in treating a particular type of rash on their own, without the need to consult a dermatologist. Thus, telehealth programs may initially increase the number of referrals to specialists but in time may decrease as providers are educated and gain confidence, enabling them to make management and treatment decisions on their own.

Improved Quality of Care

Lack of access to specialty care may be a contributing factor to poorer quality of care: a significant benefit of telehealth may be its potential impact on quality. Research in outpatient settings suggests that teleconsults with appropriate specialists can change patient management and diagnosis.[74, 78, 102] While not quantifiable in clinical outcomes, this data suggests increased quality of care as patients receive more appropriate and necessary care in a timelier manner.

Clinically, telehealth may have a large impact on patient outcomes where rapid diagnosis and treatment are linked to improved outcomes. In emergent settings, timely diagnosis and initiation of treatment are often imperative to improved clinical outcomes. For example, the use of tissue plasminogen activator (tPA) for patients with symptoms of acute stroke is underutilized due to the lack of stroke specialists who can evaluate a patient within the necessary three-hour therapeutic window.[103] Without available stroke specialists, patients must be transferred to stroke centers for evaluation, and as a consequence a delay in diagnosis results in the inability to administer tPA therapy to appropriate patients. The overall percentage of tPA usage is reported to be below

5.0%.[104, 105] Studies have reported that telehealth linking a stroke specialist at a stroke treatment center to emergency departments is effective in increasing the number of stroke victims who receive the therapy.[106-108]

The emerging use of telehealth linking ambulances to hospitals may also have an impact on quality. For example, this link can allow for pre-hospital diagnosis of patients suspected of heart attack, thus allowing treatment to occur sooner.[109]

Even in cases when emergent transport is inevitable, lack of specialty care may necessitate the transfer of patients to tertiary care facilities prior to an ideal level of stabilization. The availability of telehealth technologies allows for increased specialty input prior to patient transfer. For example, in one study conducted in Hong Kong,[45, 110] patients with head injuries had fewer adverse events during transfer after being evaluated by teleconsults with neurosurgeons, compared to those without the pre-transfer teleconsult.

Reduction in Admissions from Emergency Departments

Patients presenting to the emergency department with an acute issue, such as ruling out myocardial infarction, may spend extended periods of time waiting for testing or to see a specialist. Patients may even be admitted for observation during this wait. The availability of telehealth can decrease the number of patients admitted to await that specialty care,[111] realizing significant cost savings. Even for patients who need to be admitted for evaluation, telehealth may allow for a more timely evaluation, decreasing the time patients await specialty consultation for diagnosis or treatment.[46, 112-114]

Reduction in Referrals from Emergency Departments

For patients who present to the emergency department with less urgent needs, for example a patient with an unusual rash, the condition may not be treated, but instead the patient may be sent home with an outpatient referral for specialty care. Telehealth may decrease the need for outpatient referrals by addressing the issue at the time of visit to the ED.[48, 115]

Reduced Wait Times for Outpatient Consultation

The availability of teleconsults can reduce the wait time for an outpatient consultation in underserved areas and underrepresented specialties.[74, 102, 116] This has been noted as well in correctional facilities, where one study reported the average wait time for a consultation decreased from 99 days to 23 days with the introduction of telehealth.[95] As a result, telehealth has been shown to reduce the specialty backlog of physicians.[117]

Increased Productivity

Store-and-forward teleconsults create increased efficiencies beyond those realized by standard outpatient consultations, as providers can "see" more patients in the time it takes for a traditional visit. Studies have shown that the duration of a store-and-forward teleconsult is less than the duration of a traditional in-person visit.[76, 77, 118]

Reduction in Patient Travel

The availability of telehealth directly impacts the distances patients travel for care. Telehealth allows patients to have access to a specialist through a teleconsult at a local site, such as their primary care provider's office, rather than be forced to travel to a specialist at a more distant location. The teleconsult, therefore, helps to reduce the cost of patient travel, including lost time from work. This is particularly important to patients in health professional shortage areas (HPSAs) or those who need to see an under-represented specialist, as these patients may travel long distances for care. This, in turn, would likely improve the quality of care provided to patients both in HPSAs and in more populated areas lacking easy access to specialty care. While several studies have looked at this issue,[119-123] no studies have looked at patient travel with respect to the type of care being sought, such as routine care versus consultation care. This distinction is necessary to understand the impact of teleconsults.

In an analysis described in Appendix G, CITL found that for the 142 million referral visits in the United States each year, a reduction in patient travel, from mileage costs alone, could save $736 million for the store-and-forward scenario, $160 million for the real-time video scenario and $912 million annually for the hybrid scenario. This savings in mileage costs from reduced patient travel, based on the General Services Administration 2007 reimbursement rate of $0.445,[124] does not include the cost associated with missed time from work and its associated lost productivity. CITL estimated that the savings in travel time, based on telehealth technologies, would equate to 70 million hours, or 36,000 full-time equivalent employees, per year. Savings can be realized in the store-and-forward scenario even with low success rates. For savings in the real-time video and hybrid scenarios, they must be successful (i.e., a face-to-face encounter is eliminated) at least 75.0% and 33.0% of the time, respectively.

Chapter 12: Limitations | CITL !

With little available research in real-world telehealth experiences, the projections in this report naturally have limitations. These limitations are outlined below.

This report was not intended to examine the impact of telehealth on specific, individual specialties, but instead focused on looking at the impact across all healthcare specialties within the provider-to-provider spaces. Unfortunately, current literature primarily reflects the impact of telehealth on specialty specific care and largely ignores an intention to treat a model. CITL, therefore, was forced to turn to estimates where data was lacking. The process for determining estimates was rigorous, utilizing a Modified Delphi process with a group of renowned experts in the field. However, these are estimates, and may not be reflective of the real world.

Similarly, because we modeled non-specialty specific care, we may have underestimated the value of particular technologies for individual specialties. For example, although the model projects a national net loss for real-time video technologies, the value of real-time video may be cost-effective for telepsychiatry.

Our results are based on outputs from a simulation model, which are predictive and may not mirror findings from a true study done in the field. Models are built as closed systems, and cannot account for all factors experienced in the real-world. CITL only modeled quantifiable impacts where data could be found to support them and did not model qualitative impacts. Some stakeholders may find these un-modeled impacts critical to their own decision making on whether to pursue telehealth implementations.

Technology is changing rapidly. CITL could not account for future technology changes that might bring about improvements in how telehealth is delivered and the costs involved. Likewise, we did not account for future advances in the field of medicine itself.

Technology costs are dropping at rates faster than could be predicted in CITL's model. CITL used cost estimates from the market today and did not account for the pace of cost reductions being observed in the marketplace. CITL did not account for economies of scale, in which discounts might be given for either large organizational purchases or group purchasing arrangements. Therefore, the cost estimates used in this report are likely to be an overestimate of the true costs needed to implement these systems in the future.

CITL was interested in modeling a future state in which negative incentives did not exist, in order to show the potential benefit from a system with properly aligned incentives. In modeling this future state, CITL assumed that providers would be reimbursed for the care they gave, regardless as to whether or not it was provided in-person or virtually. Many payors today are not reimbursing virtual visits. If reimbursement issues are not addressed to correct these negative incentives, some of the savings modeled in this report will not be realized.

CITL considered telehealth encounters to be concordant and equivalent to in-person encounters. Evidence does exist that some telehealth encounters are not equivalent to their face-to-face counterpart;[125, 126] however, there is evidence that reports that telehealth is comparable.[122, 127-131] The lack of concordance in some areas may change some of the benefits projected in this report.

Finally, the nation has not fully embraced telehealth technologies to date. In order for benefits to be realized, these systems have to be adopted and implemented. If implementation and adoption occurs on a slower schedule than the one outlined in this report, benefits will likewise be slower to be realized.

Chapter 13: Discussion | CITL !

From its earliest days, telehealth technologies have brought the promise of solving access to care issues. While 20% of Americans live in rural areas, only 9% of physicians and 10% of specialists practice in rural areas,[132] leaving a large portion of the country without adequate physician-to-patient ratios. Access to specialty care can be an issue in urban areas as well, as evidenced by lengthy waits for dermatologic care and the lack of universal availability of neurostroke care.[133, 134] Telehealth as a field has thus evolved in an effort to eliminate geography and lack of specialty care as barriers to appropriate healthcare services. However, improved access is a double-edged sword: while an increase in access to care may help to improve quality of care, an increase in the actual number of patient visits leads to an increase in costs to the healthcare system. This increase in costs, or the perception of them, is likely an important barrier to the adoption of telehealth technologies.

In this report, CITL has examined the financial impact of provider-to-provider telehealth technologies. This research shows that overall the benefits of telehealth technologies far outweigh the costs of these systems to implement. The key findings of this report are summarized below:

> ***From the perspective of the healthcare system, the cost to equip all US emergency departments with telehealth technologies could easily be covered by savings from a reduction in transfers between emergency departments.***

Of the 2.2 million patients transported between emergency departments each year, CITL projected that the real-time video scenario would avoid 646,000 of these transports, resulting in total savings of $408 million. These savings equate to approximately 30.0% of the $1.39 billion in current transportation costs between emergency departments. Further, the hybrid scenario could avoid 850,000 transports between emergency departments. This reduction could result in a total savings of $537 million annually, approximately 39.0% of the current transportation costs between emergency departments. These savings alone outweigh the system costs to equip every US emergency department with real-time or hybrid systems, estimated at $60 and $64 million in one-time capital costs.

This important finding has implications surrounding who should pay for these systems. Emergency departments may not have the capital to spend on telehealth technologies, nor the financial incentive to do so. These potential benefits should incentivize payors to open a dialog with hospitals and other emergency medical facilities to discuss sharing costs in the investment of telehealth systems.

In addition to these savings, telehealth in emergent settings could have a large clinical impact on quality of care where rapid diagnosis and treatment is linked to improved outcomes. By equipping all emergency departments with telehealth technologies, patients could have immediate access to specialty care that might not be available at their local departments. This could have a profound impact on quality of care, especially for stroke patients where rapid treatment can significantly increase post stroke functionality.

The ability to treat patients locally has a direct impact on families and those caring for the patient. Families and caretakers would not need to travel long distances to emergency departments and hospitals. In addition, after an initial hospital stay for intensive treatment and stabilization, patients are often transported again to their local hospital for treatment and observation, thus incurring additional, potentially avoidable, transport costs.

> ***Correctional facilities could cover their costs of telehealth equipment by savings from a reduction in transporting patients to emergency departments and to physician offices, and by avoiding the costs of the emergency department visit.***

Of the 94,180 transports made annually from correctional facilities to emergency departments, CITL projected that the real-time video scenario could avoid 34,900 of these transports, resulting in savings of $51.7 million. These savings equate to approximately 33.0% of the $158 million in current inmate transportation and emergency department visit costs. Further, the hybrid scenario could avoid 39,900 visits each year, for savings of $60.3 million. These savings represent approximately 38.0% of current inmate transportation and emergency department visit costs.

In addition, telehealth technologies may reduce the number of inmates transported to provider offices for care. Of the 691,000 physician office visits made annually from correctional facilities, CITL projected that the store-and-forward scenario could avoid 411,000 transports for a total savings of $162 million, representing a potential savings of 54.0% of the $302 million in current costs for in-person physician office visits and transportation each year. CITL projected that the real-time video scenario could avoid 452,000 transports for a total savings of $171 million, or approximately 57.0% of current costs. Finally, CITL projected that the hybrid scenario could avoid 543,000 transports for a total savings of $210 million, or almost 70.0% of the current physician office visit and transportation costs.

Overall, when combining the benefits described above, CITL projected that correctional facilities could realize savings of between $106 and $177 per inmate annually. These savings would have major cost implications for correctional facilities, as both the system costs and the benefits accrue solely to the correctional facility system. Based upon this analysis, correctional facilities should consider supplementing their current healthcare programs with telehealth technologies.

In addition, telehealth has great potential to improve healthcare in these facilities, given that correctional facilities house a largely underserved population.[89] Many inmates may not receive regular medical care prior to incarceration. According to the National Commission on Correctional Health Care (NCCHC),[135] inmate populations have higher morbidities than the general public, including higher rates of AIDS, hepatitis and tuberculosis. Both primary and specialty care is greatly needed to serve this population, and telehealth can extend the access of care to inmates.

There are other potential non-financial benefits to society from this reduction in transports. Avoiding transportation of inmates directly reduces the risk of inmate escape during these transports. In addition, a reduction in transports frees up security personnel for other activities within the facility. Finally, the utility of telehealth systems can extend beyond healthcare. For instance, the video conferencing equipment may be used to conduct court hearings or be used for outreach to families.

> ***From the perspective of the healthcare system, the costs of implementing telehealth equipment in nursing homes could be covered by savings from a reduction in transferring residents to emergency departments and physician offices, and by avoiding the costs of the emergency department visit.***

Of the approximate 2.7 million transports made annually from nursing facilities to emergency departments, CITL projected that the real-time video scenario could avoid 337,000 of these transports, resulting in a potential savings of $259 million. These savings equate to approximately 7.0% of the $3.62 billion in current transportation and emergency department visit costs. Further, the hybrid scenario could avoid 387,000 visits each year, for savings of $327 million. These potential savings represent approximately 9.0% of current nursing facility transportation and emergency department visit costs.

Further, telehealth technologies can reduce the number of residents transported to physician offices for care. Of the approximately 10.1 million provider office visits made annually from nursing facilities, CITL projected that the store-and-forward scenario could avoid 4.09 million transports for a total savings of $261 million. This represents a potential savings of 20.0% of the $1.29 billion in current costs for in-person provider office visits and transportation. CITL projected that the real-time video scenario could avoid 5.42 million transports for a potential savings of $305 million, or 24.0% of current costs. Finally, CITL projected that the hybrid scenario could avoid 6.87 million transports for a potential savings of $479 million, or savings of approximately 37.0%.

Overall, telehealth is projected to save nursing facilities $175 to $540 per resident annually. In contrast to correctional facilities, the costs accrue solely to the nursing facility whereas the benefits accrue to healthcare payors, largely Medicare, Medicaid, and individual patients and their families. These potential savings should incentivize payors to begin a dialog with nursing home facilities to assist in the investment of these technologies.

The quality of care provided in nursing home facilities has been questioned by a number of groups.[136] Some evaluators have noted deficiencies in nursing home care, including the lack of adherence to published standards of care and treatment guidelines for diabetes,[137] pressure ulcer management,[138, 139] and pain management.[140] Adherence to guidelines and standards in nursing facilities may be poor due to a variety of reasons, most notably an inability to afford highly trained healthcare professionals.[141] As the US population ages, the nursing facility population will increase, likely exacerbating these problems.

Telehealth technologies could greatly improve the quality of care provided in nursing homes with minimal investment. These technologies could increase the availability of physicians, both for primary and specialty care, and improve the timeliness of care for residents. Providers would have the option to conduct routine visits remotely, potentially increasing the number of visits made to facilities. In addition, providers would have greater opportunities to address issues as they arise in between scheduled visits, such as with wound care.[142]

There is a loss to the system from teleconsults with real-time video and hybrid technologies when considering only professional fees. These losses could be far outweighed in the hybrid scenario by involving specialists early in the care of a patient and reducing the number of redundant or unnecessary tests.

Of the approximately 142 million physician referrals made annually, the store-and-forward scenario projected a savings of $468 million a year by substituting virtual care for a face-to-face visit. However, the professional fees associated with the real-time video and hybrid scenarios outweigh the benefits, with a loss of $3.00 billion and $1.62 billion respectively. This loss is directly attributed to "unsuccessful" teleconsults. Not all patients undergoing a virtual visit will be successful, and a face-to-face visit will still be required. In this situation, two professional fees will be incurred, resulting in an overall loss; whereas if the patient had initially begun with a face-to-face visit there would not have been the incursion of the additional virtual fee. For some, the risk of having a visit turn into two visits might not be acceptable. For others, the ability to receive care locally, avoiding travel to a specialist and being able to see an otherwise unavailable specialist virtually may be worth the risk of that second visit. For those living in an underserved area, a virtual visit may be the only option in order to receive needed care.

Early involvement of specialists in a patient's care obviates the need for the primary care physician to predict which labs a specialist might utilize during a referral. In addition, early collaboration between the primary care physician and specialist leads to a reduction in duplicate tests, in the typical occurrence where the consulting physician is unable to locate lab work done by the primary care physician. These savings are substantial. The store-and-forward scenario could save $2.54 billion in redundant and unnecessary testing, while the real-time and hybrid scenarios could save $2.29 billion and $5.23 billion, respectively.

When combining the benefit from professional fees with savings from the reduction of redundant and unnecessary tests, the store-and-forward scenario could save $3.00 billion, or 11.0% of the projected $28.7 billion in current outpatient consultative care. However, the real-time video scenario projected a loss of $709 million, while the hybrid scenario projected a savings of $3.61 billion, or approximately 13.0% of the current costs. Of note, CITL did not model specific specialties. It is likely that the use of real-time video is cost-effective for some specialties, especially those able to use lower cost equipment and those with high rates of successful televisits.

This finding has implications on how care might be provided in the future. Our current system of having primary care physicians manage as much of a patient's care as possible, reserving specialist referral as a last-resort, may not be the most cost-effective model of care. Instead, a collaborative care model, in which primary care physicians team with specialists early in a patient's care, has the potential to lead to large cost savings. Indeed, one can envision a robust triage model in the future. Patients call in to a triage center with a problem, and a decision is made as to whether to schedule the patient for a face-to-face visit with their primary care physician, with or without a combined virtual specialist visit; or schedule directly for a face-to-face visit with a specialist. This model has the potential to increase efficiency and is one step closer to a healthcare model focused on bringing care to patients when and where they need it.

While store-and-forward technologies produce immediate financial benefit for the nation, hybrid technologies produce the best long-term return on investment (ROI). Real-time video only telehealth technology users could upgrade their systems to hybrid technologies, and as a result, produce a dramatic improvement in ROI with limited investment.

After comparing the cumulative return on investment (ROI) for the first 10 years after implementation of all three scenarios, hybrid telehealth technologies are by far the best investment. Even though the hybrid scenario has the highest system cost of all the scenarios, it reaches a breakeven point during the 5-year national rollout. Moreover, in comparison to the real-time video and store-and-forward scenarios, the model predicts that hybrid implementations realize the highest steady-state annual ROI. However, the store-and-forward scenario produces measurable benefits as well. Compared with the hybrid scenario, the store-and-forward scenario reached a breakeven point in the first-year, and realized the highest cumulative ROI for the first eight years.

When considering care across all specialties, the CTIL telehealth model does not predict a positive financial ROI for the real-time video scenario. Due to its high costs and marginal returns, even after the first 10 years, the real-time video scenario continues to produce negative net earnings.

However, programs and sites that have already invested in real-time video technologies can easily upgrade to hybrid technologies with minimal incremental costs, yet with the potential of significant additional benefits. Hybrid telehealth technologies are largely an evolutionary improvement over real-time video technology. For modern real-time video systems, there are often easy and inexpensive upgrade paths to hybrid technology: these systems do not require a "rip-and-replace" upgrade. Given the increase in benefit, and minimal difference in purchase or upgrade costs, CITL recommends hybrid technologies as the best investment for telehealth programs.

When conducting the sensitivity analysis, the scenarios differed in which variables they were most sensitive to. However, all scenarios shared a high sensitivity to the face-to-face visit fees, the televisit fees, and the success rates of the televisit. Changes in these three variables could make the largest impact on the return on investment (ROI).

It should not be surprising that the professional expenses incurred with face-to-face visits and televisits are two of the critical determinants of telehealth value. The sensitivity analysis confirms that the higher the fee for the face-to-face visit, the expense avoided with a televisit, the higher the telehealth ROI. The lower the face-to-face fee, the lower the ROI. Similarly, the higher the fee for the televisit, the expense incurred with telehealth, the lower the telehealth ROI. Decreasing this fee could lead to a higher ROI.

The success rate for the telehealth visit also has a large impact on the ROI. In the telehealth model, the success rate variable represents how often a televisit was successful in replacing or avoiding a face-to-face visit. As the success rate increases, i.e., patients complete their care with a televisit and do not require a face-to-face visit, the ROI increases for these technologies. When more telehealth visits are unsuccessful, the ROI decreases. It is therefore critical to optimize healthcare processes, such as provider-to-provider communication, protocols to determine who is appropriate for a televisit, and workflow, in order to fully realize the value of telehealth.

Implications

Despite the above positive findings regarding financial value of these systems, CITL recognizes that there are many other barriers to the implementation and full adoption of telehealth technologies. Given the impact that telehealth can have on the quality of care for our patient population, it is imperative that these other barriers to adoption be addressed head on and steps made to remove them. These barriers include: a current reimbursement model that favors physical, in-person visits; concerns around medical liability; and a lack of cross-state licensure.

Payors have been slow to recognize the value of telehealth and have thus failed to create a model of reimbursement that is in step with the needs of their patient population. According to the Center for Telehealth and E-Health Law, the lack of adequate reimbursement policies is "one of the most serious obstacles to total integration of telemedicine into healthcare practice."[19] A recent survey of telehealth programs indicated that only 57.0% of respondents currently receive payments from private payors.[15] Medicare has adopted policies reimbursing for some interactive services, with Medicaid far behind even this level of reimbursement.[16, 20] In fact, the current reimbursement model has created disincentives to the adoption of telehealth technologies and has clearly been a barrier to widespread adoption.[143, 144]

The lack of real progress in creating a rational and reasonable reimbursement model for telehealth technologies may well be due to the fear that an increase in access will lead to an increase in costs to the payor. While this may be true in terms of professional fees for visits, CITL's current findings reveal that costs to the payor can be offset by savings achieved when specialists are involved earlier in a patient's care, and reductions in unnecessary and duplicative tests. Given the findings in this report, it behooves policymakers and payors to re-examine current policies and move toward models that create incentives to implement telehealth technologies, rather than the disincentives that currently exist.

Ongoing concern around who is medically liable in a telehealth encounter has also created a barrier to adoption. In our current healthcare paradigm, it is clear who holds responsibility for a patient's care, and thus who is at risk from a liability prospective. This liability for a telehealth encounter is less clear: is it the provider who is with the patient during the encounter; is it the provider who is being consulted; or is it both? To be potentially liable for care given by a provider at a distance has made many physicians nervous and unwilling to adopt these technologies. Work needs to be done in order to clarify where liability begins and ends when utilizing telehealth technologies.[14, 18]

For those who have begun to set up telehealth programs, our system of disparate individual state medical licensing has also proved to be a barrier. Unlike other countries, the US model of medical licensure managed by the states has meant that physicians have to undergo the licensing process in any state in which they practice medicine. Many states have failed to develop a model to support telehealth technologies, requiring physicians on the far side of the telehealth encounter to be licensed in any state in which the near side of the encounter is being conducted. This process can be onerous when going beyond one's home state with different applications and different requirements. Some states even require an in-person interview, furthering the burden incurred when seeking licensing beyond a home state. This model has proven difficult to overcome, limiting the pool of clinicians who are willing to participate in telehealth. If these technologies are ever to reach their potential of improving access to care, a new model will need to be developed to support cross-state licensure of physicians.[14, 17, 18]

CITL did not model Level IV telehealth systems in this report: the integration of hybrid technologies with an EMR, with the resultant blurring of lines between traditional methods of delivery care and televisits. Such integrated systems do exist today, but there was not enough data available to include them in this analysis. However, this advanced state may come more quickly than expected. Technology is advancing rapidly, directly impacting the field. The building blocks of information technology – bandwidth, storage, memory, processor speed – have improved so quickly that soon after an upgrade it is likely that an individual or group is already behind available capability. Even more impressive has been the rate at which the cost of technology has dropped. Storage purchased six months ago is significantly cheaper today. Similar price reductions can be seen in memory, processor speed, and Internet access costs. It is likely that at the time of publication, our cost estimates will prove to have been over-estimates due to continued reductions in technology costs.

This trend of falling costs has allowed the introduction of technology into our everyday lives in a way that has astounded the greater public. Computer chips can be found in our cars, phones, washers, dryers, and even our refrigerators. This ubiquitous presence of technology is filtering down to medicine. Already the vast majority of medical environments have easy access to the Internet. We have seen the growth in digitization expand to EKG machines, X-rays, ophthalmoscopes, and even thermometers. Just as few people today would question the need for electricity, telephone, fax, and network wiring in any modern office, it is easy to envision a near future where all medical offices will contain the basic tools enabling telehealth: digitized stethoscopes and ophthalmoscopes, digital cameras, and web cams. During our research CITL noted that several computer makers have integrated web cams into their standard computer setups, and that some videoconference vendors have made hybrid capabilities their standard setup. As the percentage of healthcare providers who grew up with technology increases, the numbers of providers at ease with technology will grow. We believe we are approaching a tipping point in which telehealth will no longer be seen as a novel technology, but will be integrated into every day practice.

CITL recognizes that what has been modeled in this report is not the full telehealth story. As outlined in Chapter 11, there are numerous other areas where telehealth likely brings value that we were unable to study; as well as numerous areas that were outside the scope of the current project, such as remote monitoring. CITL's estimates here can thus be viewed as conservative.

As with CITL's previous research, healthcare technologies frequently have costs that are borne by provider organizations, i.e., hospitals and provider offices, while providing savings that accrue to payors. This finding has critical implications to the entire healthcare system and is a reflection of our current third-party payor system. In this report, CITL found a clear exception to this: as closed systems, correctional facilities bear both the costs and the benefits of telehealth technologies. The reduction in the need to transport prisoners outside of the facility adds directly to the facilities' bottom line. This may suggest that other closed systems, where they can be identified, may also experience considerable savings with telehealth technologies. This, however, is currently not the case for emergency departments, nursing home facilities, or physician offices, where the costs of the telehealth system are borne by those facilities, but much of the benefit accrues to the payors. Payors and providers need to begin a dialog regarding shared investments in these technologies so that these benefits may be realized.

In the end, the broad integration of telehealth technologies into clinical practice could produce quantum leaps in the efficiency of the healthcare system. Healthcare stakeholders, providers, and payors alike should not be fearful of whether telehealth will lead to an increase in the number of visits, or that it might increase utilization from demands previously unmet. Any of those increases will be overshadowed by the dramatic reduction in costs associated with decreased unnecessary tests, improved disease prevention, and improved chronic disease management that will come from a broad telehealth deployment, where we can virtually bring the collective wisdom of the entire healthcare system to any patient, anywhere, any time.

Appendix A: Telemedicine and Telehealth Definitions

CITL !

American Telemedicine Association[7]

Telemedicine is the use of medical information exchanged from one site to another via electronic communications to improve patients' health status. Closely associated with telemedicine is the term "telehealth," which is often used to encompass a broader definition of remote healthcare that does not always involve clinical services. Videoconferencing, transmission of still images, e-health including patient portals, remote monitoring of vital signs, continuing medical education, and nursing call centers are all considered part of telemedicine and telehealth.

Telemedicine is not a separate medical specialty. Products and services related to telemedicine are often part of a larger investment by healthcare institutions in either information technology or the delivery of clinical care. Even in the reimbursement fee structure, there is usually no distinction made between services provided on site and those provided through telemedicine and often no separate coding required for billing of remote services.

Telemedicine encompasses different types of programs and services provided for the patient. Each component involves different providers and consumers.

Centers for Medicare & Medicaid Services[6]

Telemedicine is generally described as the use of communication equipment to link healthcare practitioners and patients in different locations. This technology is used by healthcare providers for many reasons, including increased cost efficiency, reduced transportation expenses, improved patient access to specialists and mental health providers, improved quality of care, and better communication among providers.

National Cancer Institute[9]

The delivery of healthcare from a distance using electronic information and technology such as computers, cameras, videoconferencing, the Internet, satellite, and wireless communications.

American College of Physicians[8]

The use of audio, video, and other telecommunications and electronic information processing technologies to provide health services or assist healthcare personnel at distant sites.

Food and Drug Administration

The delivery and provision of healthcare and consultative services to individual patients and the transmission of information related to care, over distance, using telecommunications technologies. Telemedicine incorporates direct clinical, preventive, diagnostic, and therapeutic services and treatment; consultative and follow-up services; remote monitoring of patients; rehabilitative services; and patient education.

Tricare[10]

An umbrella term that encompasses various technologies as part of a coherent health service information resource management program. Telemedicine is the capture, display, storage and retrieval of medical images and data towards the creation of a computerized patient record and managed care. Advantages include: move information, not patients or providers; enter data ONCE in a healthcare network; network quality specialty healthcare to isolated locations; and build from hands-on experience.

Wikipedia[11]

Telemedicine is composed of the Greek word τελε (tele) meaning "far," and medicine. It is therefore the delivery of medicine at a distance. A more extensive definition is that it is the use of modern telecommunication and information technologies for the provision of clinical care to individuals located at a distance and to the transmission of information to provide that care.

Appendix B: Literature Search Strategy | CITL !

For its literature search, CITL defined a search strategy that was vetted with experts in the field as well as a medical librarian. CITL targeted peer reviewed academic literature and trade journals. CITL limited its search to review articles from 1996 to 2006. The MeSH heading "Telemedicine" was used. Fields were limited to:

- EC = Economics
- SN = Statistics and Numerical Data
- TD = Trends
- UT = Utilization
- MA = Manpower

We further filtered by specifying humans and English language only. The search strategy was applied to MEDLINE and CINAHL via OVID.

Due to the difference in construct of the EMBASE database, a second search strategy was developed for this data base. Here, the following strategy was implemented:

#1 'telemedicine'/exp/mj AND [review]/lim AND [english]/lim AND [embase]/lim AND [1996-2006]/py

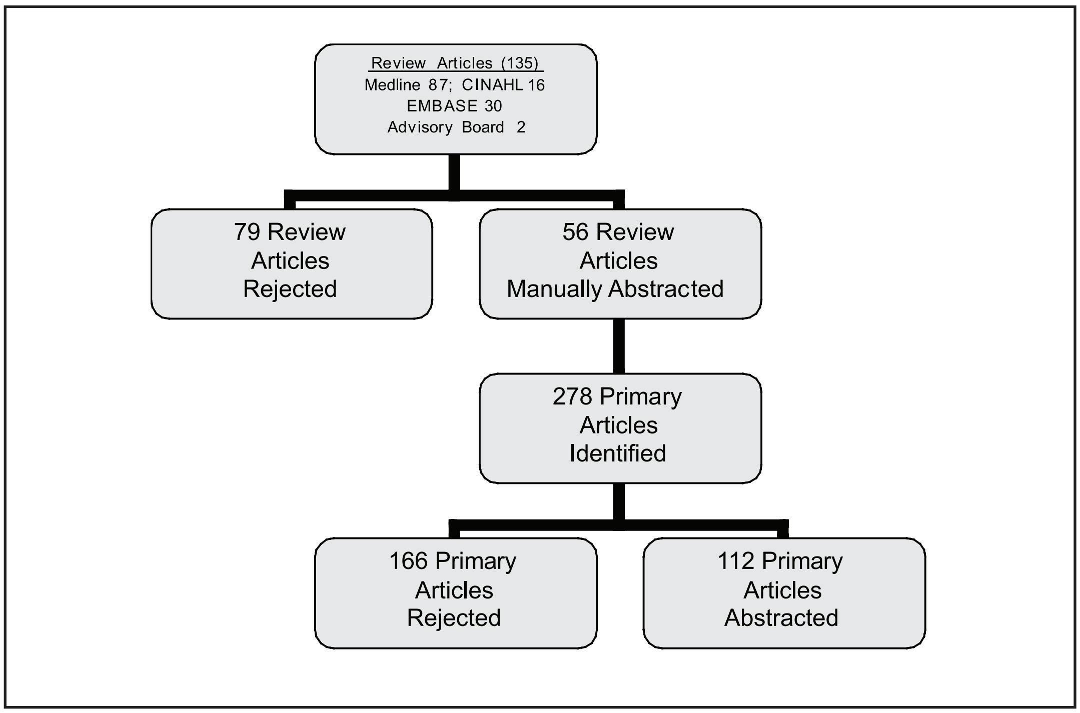
#2 'telehealth'/exp/mj AND [review]/lim AND [english]/lim AND [embase]/lim AND [1996-2006]/py

#3 #1 AND #2

Results of Literature Search

CITL's literature search strategy resulted in 133 review articles: 87 from MEDLINE, 16 from CINAHL, and 30 from EMBASE. Our Advisory Board members recommended an additional two review articles. The abstract of each review article was analyzed by two researchers to determine relevance. If one or both reviewers thought the review article was relevant, a deep abstraction of the article was performed. Of the 135 review articles, 79 were rejected. The deep abstraction was used to identify primary articles that might contain data relevant to our model. Each of these primary articles was abstracted by two reviewers to identify data to inform our model. In addition, the data abstracted was assigned to one of the six encounter taxonomy categories. Discrepancies in interpretation were resolved through discussion to reach a consensus. Two hundred seventy-eight primary articles were identified by abstraction of the review articles. Of these, 166 were rejected, and 112 were fully abstracted (Figure B-1). In all, 168 articles were included and abstracted (56 review articles and 112 primary articles).

Figure **B-1** ***Summary of Literature Review***



Appendix C: Telehealth Report Definitions

CITL !

Below are the definitions for terms used frequently in this report.

Asynchronous

The transmission of clinical information at a time distant from when the information was collected.

Consultation Encounter

A medical encounter in which the Controlling Medical Authority (CMA) is on the near side with the patient.

Consultation Patient Travel

Round-trip travel that patients undergo from their home to a provider for a consultation. For the purposes of this report, patient visits are classified "consultation" based on specific current procedural terminology (CPT) codes.

Controlling Medical Authority (CMA)

For the purposes of this report, the Controlling Medical Authority is the provider who has ultimate responsibility for the patient's care during the encounter.

Emergent Encounter

A medical encounter that requires decisions on medical care to be made in a matter of minutes or hours, as opposed to days or weeks.

Emergent Patient Travel

Round-trip travel that patients undergo from their home to a provider for emergent care. For the purposes of this report, patient visits are classified "emergent" based on specific current procedural terminology (CPT) codes.

Far side

The "far side" is defined by the location where the patient is not located, i.e., at a distance from the patient.

Intention to Treat Analysis

Analysis looking at "all-comers" in terms of the care intended to be delivered to patients, without regard to what treatment patients eventually receive.

Near side

The "near side" is defined by where the patient is located.

Non-Emergent Encounter

A medical encounter in which medical care decisions do not need to be made in the immediate future.

Primary Care Provider

As defined by the Institute of Medicine, Primary Care is the provision of integrated, accessible healthcare services by clinicians who are accountable for addressing a large majority of personal healthcare needs, developing a sustained partnership with patients, and practicing in the context of family and community.[145]

For this study, CITL applied the National Center for Health Statistics' definition of Primary Care Generalist: those physicians who practice in the general field of family medicine, general practice, internal medicine, obstetrics and gynecology, and pediatrics. They specifically exclude primary care specialists associated with these generalist fields.[146] This is also consistent with the AMA definition.[147]

Provider

For the purposes of this report, a provider is defined as any registered health professional who administers care to a patient.

Provider Extension Encounter

A medical encounter in which the CMA is on the far side from the patient.

Routine Care

A medical encounter that is part of a series of medical encounters involving the ongoing management of one or more medical issues.

Routine Patient Travel

Round-trip travel that patients undergo from their home to a provider for routine care. For the purposes of this report, patient visits are classified "routine" based on specific current procedural terminology (CPT) codes.

Specialist

For the purposes of this report, CITL used the Specialist, or Specialty Care Physician, as defined by the National Center for Health Statistics. This definition includes both primary care specialists and all other physicians not included in the generalist definition above.[146]

Store-and-Forward

The collection and storage of clinical data or images that is later forwarded for interpretation at a time distant from a face-to-face clinical encounter. These systems have the ability to capture and store audio, text, and digital still or moving images. They eliminate the need for the patient and the consulting provider to be available at the same time and place. Store-and-forward is therefore an asynchronous, non-interactive form of telehealth.

Success Rate

The rate at which patients are successfully treated virtually with telehealth avoiding an in-person visit.

Synchronous

The transmission of clinical information in real-time, typically during the clinical encounter.

Usage Gap

The percentage of encounters that would not be conducted by telehealth because of the need to conduct in-person visits.

Value Chain

The representation of the process for transforming healthcare system statistics and impact data into projected value outcomes. These chains are used to inform the model construction.

Value Cluster

The grouping of evidence of benefit from the peer-reviewed literature.

Appendix D: Advisory Board Biographies | CITL !

Karen E. Edison, MD

Medical Director of the Missouri Telehealth Network,
Co-Director of the Center for Health Policy at the University of Missouri at Columbia

Karen E. Edison, MD, is the Medical Director of the Missouri Telehealth Network (MTN). An active network with 127 sites in 43 counties, MTN has provided over 13,000 live-interactive clinical encounters in 33 specialties since 1994. She received her medical degree and completed her residency in dermatology at the University of Missouri at Columbia, where she joined the faculty in 1993, and is a seasoned clinician with a deep background in providing healthcare at a distance via telehealth.

Dr. Edison served as a Robert Wood Johnson Health Policy Fellow and then on the majority health policy staff for the Health Education Labor and Pensions (HELP) Committee in the United States Senate during the 106th Congress. While working with the committee, she was highly instrumental in expanding Medicare reimbursement for telehealth services.

In 2001, Dr. Edison returned to Missouri and assumed the position of Philip C. Anderson Professor and Chairman of the Department of Dermatology, Medical Director of the Missouri Telehealth Network, and Co-Director of the Center for Health Policy at the University of Missouri at Columbia. She currently serves on the Board of the American Telemedicine Association and the National Center for Telehealth and E-Health Law.

Joseph C. Kvedar, MD

Director, Center for Connected Health, Partners HealthCare

Joseph C. Kvedar, MD, is the Founder and Director of the Center for Connected Health, a division of Partners Healthcare that is applying communications technology and online resources to increase access and improve the delivery of quality medical services and patient care. The Center for Connected Health works with Harvard Medical School affiliated teaching hospitals, including the Massachusetts General and Brigham and Women's Hospitals. Dr. Kvedar is also a board-certified dermatologist and Vice-Chair of Dermatology at Harvard Medical School.

In his role with the Center for Connected Health, Dr. Kvedar launched the first physician-to-physician online consultation service in an academic setting. He is also leading important research into novel approaches for connected health in a variety of medical specialties, including post-operative care in the home, wound care, and remote monitoring of patients with chronic diseases.

Dr. Kvedar is a Past President of the American Telemedicine Association (ATA) and a Past Chair of the American Academy of Dermatology (AAD) Task Force on Telemedicine.

Dr. Kvedar is internationally recognized for his leadership and vision in the field of connected health and the application of communications technologies to improve healthcare to patients. Dr. Kvedar is co-editor of a new book, *Home Telehealth: Connecting Care within the Community*, the first book to report on the applications of technology to deliver quality healthcare in the home, published by RSM Press, London. He is a frequent lecturer and has authored over 60 publications on connected health. In 2003, Dr. Kvedar was honored by the New England Business and Technology Association for his extraordinary leadership in the field.

Jonathan Linkous

Executive Director, American Telemedicine Association

Jonathan Linkous is the Executive Director of the American Telemedicine Association (ATA), a leading resource and advocate promoting access to medical care for consumers and health professionals via telecommunications technology. Mr. Linkous holds a Master's Degree in Public Administration from the School of Government and Public Affairs at the American University. He has also completed postgraduate work at the LBJ School of Public Affairs.

Mr. Linkous has lectured and written extensively in the United States and other countries on health-related technology issues, emerging applications, and market trends. He has also served on a variety of national and international advisory panels, including the Department of Health and Human Services' Chronic Care Workgroup and the Federal Communications Commission's Hurricane Katrina Advisory Panel.

Mr. Linkous has 25 years experience in public policy related to telecommunications, healthcare, and aging in both the corporate and public sectors. He has provided consulting services to many of the nation's leading telecommunications and technology firms. Previously, he was a national leader in aging services as the Executive Director of the National Association of Area Agencies on Aging and has served as a senior executive with the National Association of Regional Councils and at the Appalachian Regional Commission.

Hon S. Pak, MD

Director of Advanced Information Technology Group,
Army Telemedicine and Advanced Technology Research Center (TATRC)

Hon S. Pak, MD, is currently assigned as the Director of Advanced Information Technology Group at the Army's Telemedicine and Advanced Technology Research Center (TATRC), located at Fort Detrick, MD. He is responsible for integrating advanced healthcare information technologies into the military healthcare system across the DoD. He also oversees the R&D arm of Military Healthcare System's CIO office.

Prior to this assignment, he served at Wilford Hall Air Force Medical Center as Chief of Dermatologic Surgery, at Brooke Army Medical Center as the Associate Program Director of the combined Army-Air Force SAUSHEC Dermatology Residency, and at Great Plains Regional Medical Command as Chief of Teledermatology. Since 2000, he has served as the Army Surgeons General Consultant for Teledermatology and he is internationally recognized as a leader and innovator in the field of telemedicine.

Dr. Pak has conducted extensive research and published numerous articles on telemedicine, teledermatology, and general dermatology. His publications include a large cohort study on Gulf War Veterans and a recently published outcomes study in telemedicine. Moreover, he is also on the editorial board for the *Telemedicine and eHealth* Journal.

Dr. Pak is the chair of the American Academy of Dermatology's Telemedicine Taskforce and a member of its Healthcare Delivery Committee and Informatics Committee. In addition, he is the President of the Association of Military Dermatologists, President of the American Telemedicine Association (ATA), and immediate Past Chair of the ATA Standards and Guideline Committee.

Jay H. Sanders, MD, FACP, FACAAI

President and CEO of the Global Telemedicine Group

Jay H. Sanders, MD, is President and CEO of The Global Telemedicine Group, Professor of Medicine at Johns Hopkins University School of Medicine (Adjunct), and a founding board member of the American Telemedicine Association where he serves as President Emeritus. He has also served on the NASA Biological and Physical Research Advisory Committee and as Scientific Director for the NASA Medical Informatics and Technology Applications Commercial Space Center.

Dr. Sanders has spent the majority of his professional career involved in teaching, patient care, and healthcare research. He has spent over 35 years in the development and implementation of telecommunications and information technologies as a means of addressing the problems relating to quality, cost, and access to care that now plague our healthcare system. He designed the telemedicine system for the State of Georgia that interfaced with rural hospitals, public health facilities, correctional institutions, ambulatory healthcare centers, and military bases.

Dr. Sanders has also served as a consultant for the Army's Telemedicine and Advanced Technology Research Center (TATRC), the Defense Advanced Research Projects Agency (DARPA), and the Air Force Center for Telehealth and Theater Informatics. He has served as a Visiting Professor at Yale University School of Medicine, a Professor of Medicine and Surgery and Director of the Telemedicine Program at the Medical College of Georgia, and was a member of the Department of Defense Telemedicine Board of Directors with the Surgeon Generals of the Army, Navy, and Air Force.

The author of numerous articles on telemedicine, Dr. Sanders is an Associate Editor of *Telemedicine and e-Health*. He is also an editor of the book, *Telemedicine: Theory and Practice,* a Charles C. Thomas publication. Dr. Sanders is a consultant for many academic, governmental, public, and industrial organizations nationally and internationally.

Joseph A. Tracy, MS

Vice President, Telehealth Services, Lehigh Valley Hospital and Health Network

Joseph A. Tracy, MS, has been working in the area of telehealth since 1993. He is currently Vice President for Telehealth Services at Lehigh Valley Hospital and Health Network (LVHHN), where he is responsible for all administrative and outreach efforts for telehealth. Prior to joining LVHHN in February 2006, he was the Executive Director of Telehealth at the University of Missouri's School of Medicine for 12 years.

Mr. Tracy is Chairman of the Board for the Center for Telehealth and eHealth Law (CTeL) in Washington, D.C., a member of the Advocacy and Public Policy Steering Committee of the Health Information and Management Systems Society (HIMSS), and former Vice Chair of the American Telemedicine Association's (ATA) Policy Committee.

Mr. Tracy drafted the telehealth Medicare reimbursement language for the Southern Governors Association in 1999 and for US Senate Bill 2505, which significantly improved Medicare reimbursement for telehealth in October 2001. He was also the lead author on a response to the FCC's Notice of Proposed Rule Making on the Universal Service Mechanism for Healthcare. That response was endorsed by and became the official position of both CTeL and ATA.

In 2003, Mr. Tracy and the Missouri Telehealth Network received the American Telemedicine Association President's Award, and, in 2006, he accepted ATA's Leadership Award in recognition of his contributions to the advancement of telemedicine.

Mr. Tracy is also the Editor of *A Guide to Getting Started in Telemedicine*, published by the Federal Office for the Advancement of Telehealth.

Ronald S. Weinstein, MD

Program Director, Arizona Telemedicine Program

Ronald S. Weinstein, MD, graduated from Tufts Medical School and did his internship and residency in pathology at the Massachusetts General Hospital in Boston, Massachusetts. He served as a Major in the US Air Force at the Aerospace Medical Research Laboratories in Dayton, Ohio, and became Chairman of the Department of Pathology at Rush Medical College in Chicago in 1975, a position he held for 15 years. He has been Head of the Department of Pathology at the University of Arizona College of Medicine since 1990. He is an expert on urinary bladder cancer.

Dr. Weinstein is founding Director of the national award-winning Arizona Telemedicine Program. The Arizona Telemedicine Network links over 160 sites, including hospitals and community health centers in rural communities, on the Navajo, Hopi and Apache Indian reservations, at state prisons, and in mental health centers. It has provided over 400,000 teleconsultations in 60 specialties.

Dr. Weinstein is a pioneer in the field of telemedicine. He carried out the initial formal human performance studies on video microscopy and invented robotic telepathology in the 1980s, for which he was awarded US Patents. He introduced the term "telepathology" into the English language. Telepathology has benefited tens of thousands of patients worldwide. More recently, he was a co-inventor of an array microscope which is the digital imaging engine of an ultra-rapid virtual slide scanner. He also designed a first-of-a-kind video conferencing center (the T-Health Amphitheater), which is being implemented at the T-Health Institute on the University of Arizona College of Medicine's new Campus in Phoenix, Arizona. This will be used to develop innovative curriculum for inter-professional education leveraging lessons learned from distance education programs over Arizona Telemedicine Program's state-wide telecommunications network.

Dr. Weinstein has been president of the US and Canadian Academy of Pathology, the International Society of Urological Pathology, and the American Telemedicine Association. He has authored or co-authored over 450 professional publications, including three books on telemedicine and telepathology. The Arizona Telemedicine Program and its affiliates have won nine national awards.

Components Used for the Model

For the model, we considered three levels of equipment: a low-end system containing the minimum amount of equipment needed for a telehealth encounter; a mid-range estimate containing equipment needed for a typical installation of telehealth; and a high-end system containing cutting edge, top-of-the-line equipment. The following is a list of the components that were costed out for the telehealth installations modeled in this report.

Document Scanners

A document scanner allows for any non-electronic patient data to be scanned into the computer for electronic transmission. For store-and-forward communications, it is not necessary to view the record in real-time, which makes a document camera less expensive compared to a live document camera used in real-time communications. Multi-function (i.e., copier/scanner/fax) machines were selected to accommodate the needs of the physician office beyond their use for telehealth. For low-end installations, we assumed the use of a 20-page, automatic direct feeder. For mid-range installations, we assumed the use of a 35-page, automatic direct feeder. For high-end installations, we assumed the use of a 50-page, automatic direct feeder.

Live Document Cameras

A live document camera is similar to an overhead projector, except that the images are transmitted over the computer, instead of on a screen. There are two types of live document cameras, one with and one without a backlight capable of sending X-ray images. CITL acknowledged the high prevalence of an associated PACS system in many modern healthcare facilities and therefore only accounted for costs of a backlight option for high-end systems that seek to transmit every available radiological study with or without the presence of an associated PACS system.

Digital Cameras

A digital camera allows for high-resolution images to be captured for diagnosis and transmission to a consulting physician. Due to the numerous models of digital cameras available today, CITL assigned prices based on the following assumptions. For low-end installations, we assumed the use of a 7-megapixel camera with image stabilization. For mid-range installations, we assumed the use of a 7-megapixel pseudo single-lens reflex (SLR) camera featuring image stabilization and limited close-up capability. For high-end installations, we assumed the use of an 8-megapixel SLR camera with a Macro lens for premium, close-up photographs.

Video Conferencing

Current video conferencing equipment incorporates multiple types of data ports, encryption software, and runs on both ISDN and IP. CITL assumed that low-end installations include a web-cam and video conferencing software to enable the PC to act as the link to other data peripherals. The mid-range installations were assumed to include the basic, stand-alone (i.e., without a computer) video conferencing equipment. The high-end installations were assumed to include the top-of-the-line video conferencing equipment.

Video Medical Scopes

Medical scopes are capable of conveying to a consulting physician greater amounts of information than what is available with simple video conferencing and digital cameras. The low-end installations were assumed to include a video attachment to an existing ear, nose, and throat (ENT) scope. The mid-range installations were assumed to include a complete video-incorporated ENT scope with illumination equipment. The high-end installations were assumed to include a multi-functional medical scope that allows for different attachments for ENT scopes, dermascopes, and otoscopes.

Electronic Stethoscope

An electronic stethoscope allows heart and lung sounds to be transmitted during a telehealth encounter. The low-end installations were assumed to install a digital stethoscope system. Mid-range installations were assumed to include a digital stethoscope system plus software for signal processing and analysis. The high-end installations were assumed to incorporate the digital stethoscope system with more advanced software and audio signal processing.

Headphones

While most computers and TVs used for telehealth already include speakers, they are not considered optimal in some situations. The broadcast of the visit to anyone within earshot could violate the privacy of the patient. Conversely, the physician may want to isolate background noise, whether noise from other patients and doctors or from outside the office all together. CITL included headphones in the telehealth installations. We assumed the low-end installations would opt for studio-quality headphones, which provide some measure of noise-cancelling ability. For the mid-range installations, we assumed the basic line of headphones designed specifically for noise reduction. The high-end systems were assumed to include the top-of-the-line, noise-cancelling headphones.

Sound Equipment

For high-end installations, CITL assumed physicians would want greater control over the audio output of their stethoscope systems, allowing for greater control over certain types of sounds. Therefore, CITL assumed the inclusion of digital equalizers and stereo headphone amplifiers in these systems.

Computers

CITL assumed Windows Vista-compatible computer installations. CITL assumed a Microsoft Vista Basic installation for low-end installations, a Windows Vista Business Edition system for mid-range systems, and the Windows Vista Ultimate system for high-end installations.

Monitors

CITL included one monitor for each installation to display both computer and video conferencing data. We recognize that some installations will have a separate monitor for both sides of video conferencing or multiple monitors for sites integrating an electronic medical record with their system. However, additional monitors are not absolutely necessary and thus were excluded from this analysis. For the low-end system, we included a 14" flat screen TV, for the mid-range we assumed a 19" monitor with DVI/VGA inputs, and for the high-end a 19" LCD monitor with DVI/VGA inputs.

Encryption Software

Encryption is necessary to ensure the privacy and security of the telehealth encounter. Encryption programs must make email accessible at the far end without need for the encryption software. For this analysis, CITL assumed the use of software that would password-encrypt each email. For store-and-forward installations, encryption software is necessary for the transmission of medical data via email. For real-time video and hybrid installations, the encryption functionality is already included with the video conferencing equipment.

Cables

There are other medical devices that monitor and collect data that would be useful during a telehealth encounter. While the majority of these devices are already configured with electronic data transmission, they require additional cables to connect to a PC or to the video conferencing equipment as they are using primarily USB, serial, or RS-232 ports. For all scenarios, two sets of cables were included.

Audio-Visual (AV) Carts

CITL assumed telehealth equipment would require a separate cart to store the computer, monitor, video conferencing equipment, and other devices. One cart was included in the installation costs for all scenarios.

Component Costs

Because published cost estimates are not widely available, CITL relied primarily on market research for these cost data. UTMB provided CITL with system specifications and requirements for telehealth implementations, as well as cost estimates. CITL updated these costs with common retail and technology vendors, including Best Buy, Dell, and Polycom, during the time period between April and June, 2007. Costs for these components are seen in Table E-1.

Table **E-1** ***Component Low-, Mid- and High-End System Costs***

Type of Data Transmission	Type of Equipment	Low	Mid	High
Patient Textual Data	**Document Scanners**	$99.99	$149.99	$349.99
	Live Document Camera	$350.00	$577.00	$775.00
Still Images	**Digital Cameras**	$129.99	$249.99	$777.00
Live Images	**Video Conferencing**	$269.00	$1,404.00	$4,822.00
	Video Medical Scopes	$826.00	$10,450.00	$13,855.00
Audio	**Electronic Stethoscope**	$199.00	$445.00	$2,695.00
	Headphones	$19.99	$49.99	$349.00
	Sound Equipment	N/A	N/A	$489.00
Other	**Computers**	$339.00	$538.00	$688.00
	Monitors	$145.00	$277.50	$395.00
	Encryption Software	$60.00	$60.00	$60.00
	Cables	$74.00	$74.00	$74.00
	AV Cart	$129.00	$129.00	$129.00

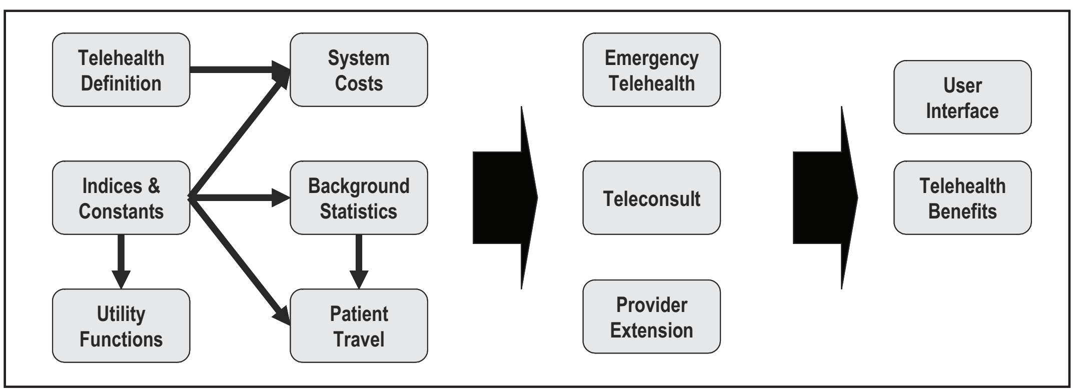
Software Model

CITL's telehealth model was created as an influence diagram using Analytica™ software from Lumina Decision Systems, Inc.[34] This software allowed CITL to consider many factors simultaneously and to incorporate probability distributions in the telehealth model to be explicit about uncertainties in the data used in the model. The results in this report were outputs from the model, and underlying calculations are summarized in tables and text throughout the report.

The telehealth model consists of numerous modules: Telehealth Definition, Indices and Constants, Utility Functions, System Cost, Background Statistics, Patient Travel, Emergency Telehealth, Teleconsult, and Provider Extension (Figure F-1).

Telehealth Model Modules

Figure **F-1**



Each of these modules interacts with one another via a user interface in order to project telehealth benefits. These modules are summarized in Table F-1 on page 104.

Table
F-1

Telehealth Model Modules

Module	Content
Telehealth Definition	All the indices and constants specific to telehealth needed to define the different types of systems and environments
Indices and Constants	Common indices used in all CITL models defining general structures such as physician group sizes, geographic locations, and so forth Common constants used in defining concepts, terms
Utility Functions	Common utility functions to ease model programming, such as inflation adjustments and sensitivity analysis
System Costs	Implementation and operating cost data
Background Statistics	General statistics on healthcare system used to model telehealth benefits to the United States Actual data on physician group size, prescription volume, visit volume, and so forth
Patient Travel	Current patient travel patterns and subsequent travel costs
Emergency Telehealth	Impact of emergency telehealth
Consultation	Impact of teleconsults
Provider Extension	Impact of provider extension telehealth
Telehealth Benefits	Project and compare the benefits of each telehealth technology modeled

A multivariable sensitivity analysis determined the behavior of the model in response to variations in input variables and key assumptions.

Appendix G: Patient Travel | CITL !

As stated throughout this report, a huge benefit of telehealth is to improve access by removing distance as a barrier to healthcare delivery. Telehealth allows patients both in health professional shortage areas (HPSAs) and areas lacking particular specialty care to have access through a teleconsult at their local or primary care provider's office. The teleconsult potentially avoids patient travel and its associated costs. Understanding current patient travel patterns is necessary to quantify this reduction in travel cost. As a subanalysis summarized here, CITL analyzed patient-provided transportation to outpatient providers, the travel typically required for a teleconsult.

CITL's patient travel analysis was designed to investigate the difference between teleconsults involving routine care and consult care visits. Prior research has not considered the type of care being sought, routine or consult, as a factor varying the amount of travel required by patients. Therefore, CITL developed a new methodology to investigate patient travel based on type of care. This methodology mirrored CITL's telehealth taxonomy. For this analysis, we used billing data from Cleveland, OH, as a representative medium-sized US city.

Description of Data

Cleveland was chosen to represent typical patient travel throughout the United States. It has a total population of approximately 480,000, the 33rd largest city in the nation. The greater Cleveland metropolitan area is the 23rd largest in the country with a population of over 2.2 million.[148]

The MetroHealth System (MHS) is the third largest healthcare system in Northeast Ohio. It consists of one central hospital and nine satellite centers throughout urban and suburban Cleveland, comprising over 700 beds, 440 attending physicians, and 360 resident physicians. The MHS conducts over 730,000 outpatient visits and 85,000 emergency department visits annually. CITL examined 2005 billing data from all outpatient encounters. Approval for the use of this data was given under an expedited review from the MetroHealth Medical System Institutional Review Board.

Methods

CITL examined claims data to measure patient travel from the MHS. From the claims data, encounters were categorized into two care types: routine care and consult care. Each encounter was categorized based on its corresponding code in the AMA's CPT code set. CITL's analysis focused on the 131 E&M codes. We assumed that procedures could not be replaced by virtual visits, and thus we eliminated all pure procedure CPT codes from our analysis. The E&M codes were divided into consult care (8 codes) and routine care (53 codes); the remaining 70 E&M codes were discarded because they did not involve true consult or routine outpatient care, such as observation care codes, emergency care inpatient care codes, and newborn care codes. Table G-1 shows the 61 CPT codes used in this analysis.

Table **G-1** ***CPT Codes Used for Type of Care Grouping***

Care Type	Related E&M Codes
Consult Care (8)	New consultation (99241-99245)
	Confirmatory consultation (99271-99275)
	Disability evaluation (99450 and 99455)
Routine Care (53)	New patients (99201-99205)
	Follow-up patients (99211-99215)
	Domicile or rest home visit for new patients (99321-99323)
	Domicile or rest home visit for follow-up patients (99331-99333)
	Home visit for new patients (99341-99345)
	Home visit for follow-up patients (99347-99353)
	Prolonged physician service (99354 and 99355)
	Initial preventative care visit (99381-99387)
	Periodic preventative visit (99391-99397)
	Preventative medicine counseling (99401-99404 and 99411-99412)
Discarded Codes (70)	Emergency care (99281-99285, 99288, 99291 and 99292)
	Observation and inpatient hospital care (99217-99223, 99231-99236, 99238-99239, 99251-99255, 99261-99263, 99295-99297, 99356-99357)
	Nursing home care (99301-99303, 99311-99313, 99315-99316)
	Coordination of care (99358-99359, 99361-99362, 99371-99380)
	Physician standby (99360)
	Newborn care (99431-99440)
	Unlisted E&M (99499)

Using Microsoft Access,[149] the encounters were categorized into consult care and routine care groups. For each group, the patient zip code and the provider zip code for each claim was identified. Each patient-provider zip code pair was then converted, where needed, to 5-digit zip codes. All invalid zip codes, based on the United States Postal Service zip code finder, were removed. Fewer than 0.1% of zip codes were removed based on these criteria.

The one-way distance between each unique patient-provider zip code pair was computed using Google Maps. Google Maps was chosen because it is widely available on the Internet, is considered a standard distance computing software, and creates reproducible distance calculations based on Navteq North American LLC data.[150] The total number of visits for each unique patient-provider zip code pair was used as a weighting factor for the average patient travel analysis for each care type. An overview of characteristics of each care type category of the Cleveland travel market appears in Table G-2.

Table **G-2**

Characteristics of Each Care Type Category

Care Type	Encounters (Percent of Total)	Unique Patient Zip Codes	Unique Provider Zip Codes	Unique Patient-Provider Zip Code Pairs
Consult Care	25,392 (5.0%)	506	14	856
Routine Care	462,518 (95.0%)	1,364	17	2,732

Results

There is a statistically significant difference in patient travel between routine and consult care. This supports the theory that patients typically travel further to receive specialty care than to receive primary care. Patient travel using store-and-forward telehealth would be able to save 35.8 miles of round-trip travel based on the weighted average travel distance, due to the elimination of a consult visit. Real-time video would be able to save 8.6 miles of round-trip travel based on the weighted average, calculated by the difference in travel between the routine and consults visits. Hybrid telehealth technology, which we estimate would be made up of 48.6% store-and-forward encounters and 51.4% real-time video encounters, would save, on average, 21.8 miles of round-trip travel.

Figure G-1 shows the consult care and routine care travel routes, based on patient and provider zip codes, on a map of the United States and for Northeast Ohio.

Figure **G-1**

US Maps of Consult Care and Routine Care for Cleveland (1:50,000,000 and 1:10,000,000 scales)

Cleveland Routine Care Routes

CITL used the estimated distances to extrapolate travel savings to the nation by applying mileage reimbursement rates to avoided travel distance. To calculate patient travel costs, CITL used the General Services Administration 2007 reimbursement rate of \$0.445.[124] Patient travel savings are based on the following equations:

Patient travel saving from teleconsults = (Total number of consult visits) X (usage percent) X (success rate percent) X (round-trip mileage saved by teleconsult)

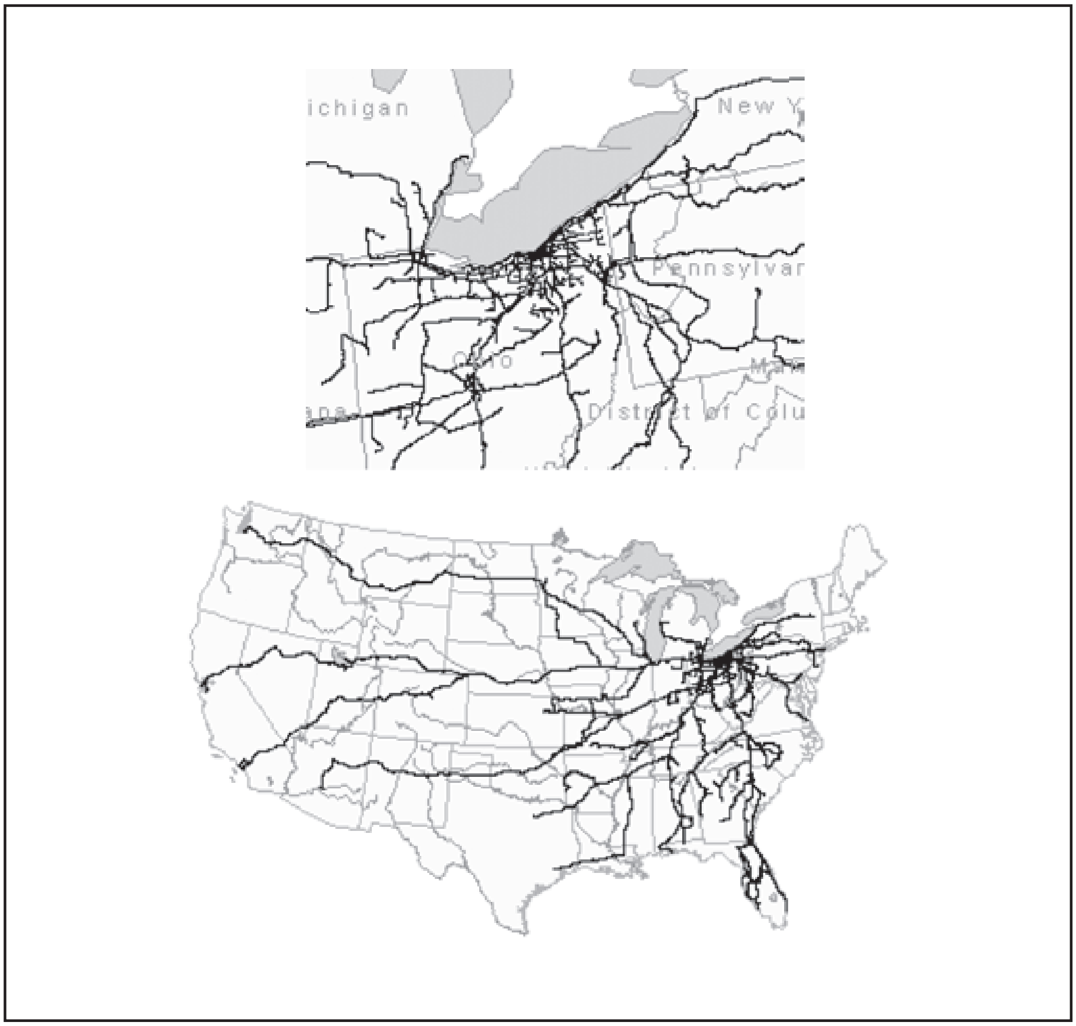
Patient travel costs from unsuccessful teleconsults = (Total number of consult visits) X (usage percent) ((1-success rate percent) X (round-trip mileage of face-to-face consult visit)))

Net patient travel savings = Mileage saving from teleconsults – Mileage costs from unsuccessful teleconsults

US Maps of Consult Care and Routine Care for Cleveland (1:50,000,000 and 1:10,000,000 scales)

Figure **G-1**

Cleveland Consult Care Routes



The total number of consult visits used was 142 million, based on data from CDC's 2004 National Ambulatory Medical Care Survey (NAMCS), of ambulatory medical care services provided by office-based physicians.[73] The usage percent and success rate percent were those used in the main telehealth model and were 38.2% and 89.9% for store-and-forward telehealth, 56.2% and 87.3% for real-time video telehealth, and 78.6% and 73.1% for hybrid telehealth respectively.

Using this approach, the net steady-state patient travel cost savings for the store-and-forward telehealth scenario is projected to be $736 million per year. Similarly, the patient travel cost savings for real-time video and hybrid telehealth scenarios are projected to be $160 million and $912 million per year, respectively. CITL assumed that a successful store-and-forward telehealth encounter would not require a return visit to the routine care or consult care physician, unlike a real-time video teleconsult in which a patient typically is scheduled to return in the future for this virtual visit. As a result, the store-and-forward scenario avoids more patient travel than the real-time video scenario. The hybrid scenario assumes some consultations will be provided in a store-and-forward manner and some in a real-time video manner, and thus reflects a combination of the two modalities. Table G-3 shows the net steady-state savings from patient travel due to telehealth.

Table **G-3**

Table G-3: Estimated Annual Net Patient Travel Savings by Telehealth Technology

	Store-and-Forward (Level IIa)	Real-Time Video (Level IIb)	Hybrid (Level III)
Baseline Routine Patient Visits	1.11 billion		
Baseline Referral (Consult) Patient Visits	142 million		
Net Steady-state Patient Travel Savings	$736 million	$160 million	$912 million

In this analysis, we estimated savings in patient travel time by assuming a conservative two minutes per mile in our travel market so that a large percentage of patients traveled at least 30 minutes (based on 35.8 miles for a round trip consult visit) each way to their appointments. This time would not include parking, registration, and waiting time before the actual appointment, which could potentially double the time involved in traveling to a provider's office. The typical estimated time of a standard provider established visit (99213) is 15 minutes. Therefore, from this perspective, most patients spend 4-6 times more time traveling to and from their appointment than they do seeing their provider. With 1 billion visits per year, of which 142 million are referral visits, this accounts for upwards of 70 million hours per year in patient travel or approximately 36,000 full-time equivalent employees per year.

Store-and-forward telehealth technology has the potential of eliminating the majority of this travel time because a successful teleconsult eliminates the patient's need to travel for the virtual visit. With real-time video, patients need to return to their routine provider for their virtual visit; however, patient travel is still reduced. The typical travel to the routine provider is about 25.0% less than the typical travel to their consult provider; therefore about 25.0% of the patient travel cost is eliminated. As long as an average of 3 out of 4 teleconsultations are successful, the patient travel costs saved through real-time video would break even with the added costs associated with an unsuccessful teleconsult. This analysis is based on the idea that an unsuccessful real-time video consultation would result in patients still needing to travel to the consultant for their consultation. Using a similar analysis, hybrid telehealth technology, which we estimate would be made up of 48.6% store-and-forward encounters and 51.4% real-time video encounters, would break even, with respect to patient travel costs, as long as 3 out of 8 teleconsultations are successful.

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About the Book

The Value of Provider-to-Provider Telehealth Technologies examines the value proposition for implementing a subset of telehealth technologies: those in which providers are involved in both the near, or patient side, and the far side of the encounter.

This analysis looks at the cost-benefit of using telehealth technologies in a variety of care settings, including:

- Reducing emergency department transfers
- Reducing transfers from correctional facilities to emergency departments and physician offices
- Reducing transfers from nursing home facilities to emergency departments and physician offices
- Replacing in-person consults with virtual consults
- Reducing redundant and unnecessary laboratory tests

In addition, this analysis examines three levels of system costs as well as a summary of the other potential value of telehealth in provider-to-provider encounters, including a side analysis on avoiding patient travel.

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The Center for Information Technology Leadership (CITL) in Boston is a not-for-profit research organization chartered by Partners Healthcare System and supported by a strategic alliance with Healthcare Information and Management Systems Society (HIMSS). Using a rigorous analytic approach, CITL assesses clinical information technologies and disseminates its findings to help provider organizations maximize the value of their IT investments, help technology firms understand how to improve the value proposition of their healthcare products, and inform national healthcare IT policy discussions. For more information, visit www.citl.org.

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