Telemedicine Technology Review: *Why Hasn't Telemedicine Taken Off Yet?*

4/15/2003

Dr. Charles Jacobus
Cybernet Medical Corporation
727 Airport Boulevard
Ann Arbor, Michigan 48108

www.cybernetmedical.com

Introduction

It is easily believable that use of advanced networks and telemedicine can (1) make extension of health care to rural and chronically ill home-bound patients more effective and lower in cost; and (2) collect data from populations exposed to biological agents or large scale emergencies to facilitate more efficient treatment (allocating precious medical personnel time to those most likely to recover and serious enough to warrant immediate treatment). In both cases the notion is triage: identifying the most in need of treatment with the likelihood of favorable outcome assuming proper treatment is extended in a timely manner.

If this is so then why is telemedicine so widely underutilized, especially for diagnosis and health maintenance of the chronically ill? Many National Library of Medicine studies have suggested that telemedicine can improve availability, reduce cost, and improve health outcomes. It is important to examine why is it under utilized so that we can propose approaches that support more effectiveness and adoption rates.

The major reasons often cited are:

- ✓ Lack of reimbursement – primarily driven by Medicare payment codes being linked to face-to-face treatment of patients by caregivers.
- ✓ Technology cost and complexity.
- ✓ Lack of acceptance by physicians (related to a lack of reimbursement).

These reasons offset the potential for better emergency response, labor savings, and better patient care. *To this we would add lack of convincingly demonstrated outcome improvement and cost containment or reduction WHICH WOULD MAKE TELEMEDICINE DEPLOYMENT MANDITORY TO REMAIN COMPETITIVE. Notably lacking are large population studies and telemedicine linked to improving particular disease and outcome management. In computer terminology "Where is the telemedicine killer application?"*[1]

Douglas A. Perednia (of the Telemedicine Research Center, Portland OR) in his paper Telehealth's Slow Migration into Mainstream Health Care[2] suggests that slow telemedicine adoption rate can be attributed to health care system fragmentation. By this he means that because there are many payers, providers, and insurers no single entity saves enough from

[1] While it is likely that telemedicine used for disaster relief medicine might be a killer application, the trouble with using this application is that we have to stage a disaster to perform a repeatable scientific study – not something anyone would contemplate doing. Therefore we advocate using a similar problem like treatment of the chronically ill as the testbed so that the study can be realistic and completely beneficial.

[2] Douglas A. Perednia (of the Telemedicine Research Center, Portland OR), Telehealth's Slow Migration into Mainstream Health Care, *presented at the National Library of Medicine sponsored Telemedicine and Telecommunications Options for the New Century Symposium*, March 13-14, 2001. http://collab.nlm.nih.gov/tutorialspublicationsandmaterials/telesymposiumcd/starthere.html.

moving some of its dependents onto a telecare regime. Furthermore he suggests that prior NIH R&D funding in this area is partly to blame because each new telemedicine initiative climbs the same learning curve without much benefit from prior efforts.

Fortunately, consistent with Dr. Perednia's suggestions, Medicare,[3] HIPAA,[4] and competitive pressures are moving some kinds of telecare faster into the mainstream. In the following sections we summarize prior work as a prelude to describing our proposed effort in detail. The goal is to put the new effort into perspective and identify its unique contribution.

Early Telemedicine Work

In Telemedicine: Past, Present, Future,[5] a literature review prepared by Kristine Scannell of the National Library of Medicine covering work from 1966 to 1995, defines telemedicine as being divided into three areas: aids to decision making, remote sensing, and collaborative arrangements for management of patients. She asserts that automated decision making systems, or expert systems in medicine, are the oldest branch. She defines remote sensing as transmission of patient records or data such as EKG signals, X-rays, etc. And finally collaborative arrangements support patient-caregiver or caregiver team communications. In the literature review for work prior to 1995 the vast majority of reported work centered on how new teleconferencing technology will support the collaboration experience.

Only four citations in this period focused on the use of data collection for outpatient triage[6] or diagnosis (not including over 300 references on teleradiology or 45 references on telepathology). While experimentation with AI and knowledge-based systems applied to medical applications began as early at 1980, only about 1% of the total citations (or about 40) report this as their principle contribution. Similarly, while most systems put into practice maintain some kind of patient and/or physician information, only about 200 citations directly pertain to electronic patient record keeping systems. The rest of the work describes general telemedicine themes (approximately 1000 citations), technology and/or communications technology supporting telemedicine (approximately 1200 citations), and use of network and/or web technology for educational purposes (approximately 500 citations) while only about 600 citations describe specific telemedicine applications (which are predominantly two-way video conferencing type applications).

It is our conclusion that the early work prior to 1996 was infatuated with the technology supporting telemedicine more than the specific outcomes the various forms of telemedical technology could implement for the chronically ill or emergency response.

Current and Recent Research

Columbia, Harvard, and Stanford Universities collaborated on a National Library of Medicine funded telemedicine effort[7] that developed and showed a variety of testbed applications based on

---

[3] Solicitation for Proposals for the Demonstration Project for Disease Management for Severely Chronically Ill Medicare Beneficiaries With Congestive Heart Failure, Diabetes, and Coronary Heart Disease, *Centers for Medicare & Medicaid Services (CMS), HHS, Federal Register*: February 22, 2002 (Volume 67, Number 36).
[4] Security and Electronic Signature Standards; Proposed Rule, *HHS, Federal Register*: August 12, 1998 (Volume 63, Number 155).
[5] Scannell, K.M., Perednia, D.A., Kissman, H.M., Telemedicine: Past, Present, Future, CBM 95-4, *National Library of Medicine, HHS*, 1995, http://www.nlm.nih.gov/pubs/cbm/telembib.html.
[6] Gareiss, J.W., Electronic Triage. (computer terminals can help monitor patients at home). *Am Med News* April 1994 24; 37(16): 37.
[7] Green, R.A., Barnett, G.O., Cimino, J.J., Huff, S.M., Shortliffe, E.H., Patel, V.L., InterMed Collaboratory Final Report, Brigham and Woman's Hospital (sub to Massachusetts General Hospital) Contract LM-

shared tools organized around a seven-tiered network model: (1) Network and Services, (2) Vocabulary, (3) Knowledge and Data, (4) Agents and Components, (5) Development Environments, (6) Testbed Applications in clinical care, education, and decision making, and (7) Collaborative Policies. Curiously, the effort used none of the financial support for the project for the actual clinical testbeds that effected various clinical applications.[8] These testbed applications focused indirectly on patient care by providing various collaboration tools and shared information (vocabulary) dissemination tools and as such did not demonstrate in a conclusive way improved outcomes or lowering of practical medical costs. Part of this effort ("HealthAware" by Brigham and Woman's Hospital) did study patient and clinician information seeking behavior and gained strong positive feedback from users indicating that web-based medical information access "empowers" patients to participate in their own health care. Based on patient preference data, this kind of system improves patient-physician interaction. Columbia and McGill demonstrated a system called "PatCIS" which allowed patients to access their own health care records. Again the result was that the patients felt that they had taken "a more active role" in their own treatment, but physician participants were somewhat more neutral in their attribution of the system to improved outcomes. A typical patient characterization was "I wouldn't say [that the system] changes the nature of decisions, because ultimately we are relying on professionals to tell us what to do. But number one I think it creates an environment where you get decisions much more quickly…[because] we have access to more information … we have greater understanding of what's going on."

43512, Columbia Presbyterian Medical Center (sub to University of Utah) Contract LM-43513, and Stanford University (sub to McGill University) Contract LM-4314, May 1, 1994-April 30, 1997, *National Library of Medicine*.

[8] A Selected set of references derivative from the Columbia, Harvard, and Stanford efforts:

Cimino,J.J., Use of the Unified Medical Language System in patient care., *Methods of Information in Medicine;* 1995; 34 (1/2): 158-164.

Cimino, J.J., Socratous, S.A., Clayton, P.D., Internet as a clinical information system: Application development using the World Wide Web. *Journal of the American Medical Informatics Association*; 1995; 2(5): 273-284.

Deibel, S.R.A., Greenes, R.A. Radiology systems architecture: In Greenes R.A., Bauman, R.A. (eds.) Imaging and Information Management: Computer Systems for a Changing Health Care Environment. *Rad Clinics of N. Amer*. Philadelphia: W.B. Saunders. 1996; 34(3): 681-696.

Parker, J.A. Wallis, J.W., Halama, J.R., Brown, C.V., Cradduck, T.D., Graham, M.M., Wu, E., Wagennaar, J., Mammone, G.L., Greenes, R.A., Holman, B.L. Collaboration using Internet: Development of case-based teaching files (Report of the Computer Instrumentation Council Internet Focus Group). *J Nucl Med* 1996; 37(1): 178-184.

Detmer, W.M., Shortliffe, E.H., A model of clinical query management that supports integration of biomedical information over the World Wide Web. In Gardner, R.M., ed.: *Proceedings of the Nineteenth Annual Symposium on Computer Applications in Medical Care*; New Orleans; Oct-Nov, Hanley & Belfus, Philadelphia, 1995; 898-902.

Kohane, I.S., van Wingerde, F.J., Fackler, J.C., Cimino, C., Kilbridge, P., Murphy, S., Chueh, H., Rind, D., Safran, C., Barnett, G.O., Szolovits, P., Sharing electronic medical records across multiple heterogeneous and competing institutions. *Proc of the 1996 AMIA Annual Fall Symposium*, 1996; 608-612.

Liem, E.B., Obeid, J.S., Shareck, P., Sato, L., Greenes, R.A., Representation of clinical practice guidelines through and interactive WWW interface. Proc Nineteenth Annual Symposium on Computer Applications in Medical Care, New Orleans, Nov 1994, Philadelphia: Handley & Belfus. 1995: 223-27.

Zeng, Q., Cimino, J.J., Linking a clinical system top heterogeneous information resources. Proc of the 1997 AMIA Annual Fall Symposium, Nashville, TN, Philadephis: Hanley & Belfus, 1997; 553-7.

Cimino, J.J., Li, J., Mendoca, A., Sengupta, S., Patel, V.L., Kushniruk, A.W., An evaluation of patient access to their electronic medical records via the World Wide Web. *Proc 2000 Fall AMIA*.

Cimino, J.J., Patel, V.L., Kushniruk, A.W., What do patients do with access to their medical records? *2001 MedInfor Conference*.

Georgetown University Medical Center developed a telemedicine system to support outpatients suffering with end stage renal disease ("Project Phoenix").[9] These patients require routine dialysis and if they do not get this treatment on regular intervals they will become quite sick. It was hypothesized that using telemedicine to increase the quantity and quality of interaction between the physicians and patients and provide more comprehensive patient data to the physicians would improve patient outcomes. Improved outcome was defined as lower numerical Kt/V values for the patient. The telemedicine approach used was to provide PC-based two-way video links from the dialysis center, a physician's office, and the physician's home. Two control groups were established (one having telemedicine intervention and the other under conventional care guidelines), and Kt/V, quality of life (QoL), and patient satisfaction surveys were collected. Based on these studies there was no statistically significant difference in Kt/V, QoL, or satisfaction values between the groups making one suspect that telemedicine simply as a means for better physician patient interaction might be of low value.

Northwestern Memorial Hospital developed the NetReach Project[10] to (1) develop a methodology for identifying the information needs of physicians and health-care teams in outpatient settings, (2) assess these needs in diverse outpatient settings, (3) implement test sites, and (4) evaluate the impact of these information solutions. The project provided connectivity to seven different clinical sites chosen to reflect diversity of practices on the Northwestern campus. Needs were assessed by observation, time allocation studies, semi-structured interviews, and surveys. The results indicated that information support included: (1) access to patient information, (2) summarization of information, (3) communication between the members of the health-care team, (4) patient instruction, and (5) convenient access to information terminals. Interestingly, these studies included neither two-way video conferencing, nor direct data collection from patients. This, in part, is explained by the practices chosen to connect to the network. They primarily (by patient load) provide medical care to the generally healthy (i.e. those sick with treatable/curable illnesses as opposed to the chronically ill). Much of the effort revolved around providing connectivity to the practices and helping the medical staff achieve a comfort level with PC-based information technology (mouse point and click, authentication, remote access, etc.). Additional effort was spent providing extensions to the existing patient record system to include simple decision support to the practices.

While the Northwestern experiment was probably informative to the medical practitioners involved, as reported, a significant amount of the effort seemed to be consumed with fighting computer daemons – things like computer workstation usability, e-mail incompatibility due to poor mail infrastructure, and the complexity of heterogeneous computer systems integration (which now are substantially improved due to more vendors adhering to the most common standardized Internet technology). The effort had little effect on outpatient management or care and reported no quantitative results improving outcomes or reducing costs. The effect of technology deployment primarily showed as clinical staff reporting (during survey) that communications was improved and documentation was better. One interesting observation was that in spite of labor saving information technology deployment, the time spend by the clinician with patients actually continued its trend downward in 1998 as compared to 1995 when the effort

[9] Mun, S.K., Project Phoenix: Scrutinizing a Telemedicine Testbed, *National Library of Medicine* Contract N01-LM-6-3544, June 30, 2000.
Winchester, J.F., Telecommunications and the dialysis patient, *Amer Journal of Kidney Diseases*, 34: xxxvi-xxxvii.
Winchester, J.F., "Telemedicine in the Dialysis Unit, *Renal Physician's Association*, Washington, DC March 27, 2000.
[10] Tang, P.C., NetReach: A Clinical Information Infrastructure for Heath-Care Teams in Ambulatory Care, *National Library of Medicine* Contract N01-LM-4-3509.

started. A short study of why this might be was conducted by reviewing patient-physician interactions for physicians who still used paper records as compared to the group more tightly tied to computer record keeping. The surprising result was that the computerized records tended to separate the physician from the patient more that paper-based records did. Overall the clinician group reported the computerized systems as improved over prior paper-based systems.

The National Laboratory for the Study of Rural Telemedicine of the University of Iowa conducted a study for the National Library of Medicine that focused on the effect of telemedicine applications to support populations in a rural setting.[11] The following areas were covered: (1) Pediatric EKG – EKGs from a limited number of sites were transmitted from the collection site to EKG experts, (2) Emergency Department support for Vascular Ischema – data collected in the Emergency Departments to be sent to cardiac experts, (3) Telepsychiatry – allowing the psychiatrist to communicate with patients through remote connections, (4) Home delivery of diabetes education, and (5) Consultation for aid to disabled children. All of these experiments except (4) focused on bringing the remote patient to the core medical establishment-based physician through a virtual or tele-remote physician consultation or visit. The primary care giver-to-patient application was (4) or providing diabetes education, a primarily passive activity not requiring substantial patient/physician direct interaction. This study focused on direct uses of the most commonly considered telemedicine, i.e. two-way video to provide direct patient remote patient interaction modeled after the conventional patient visit. Broadly speaking, the University of Iowa experiment showed that more sophisticated medicine can be extended at acceptable cost to rural communities via the telemedicine technology used in this study. The benchmark was not to improve outcome or reduce overall cost, but to extend service at comparable cost and quality to rural patients. Based on these criteria the experiments were successful and continue as operational services now after NLM funding has ceased. Cost saving primarily accrues to the patients who do not have as much travel and lodging expenses (from travel to core health care centers).

Problems cited in the University of Missouri-Columbus School of Medicine final report on the Rural Telemedicine Evaluation Project[12] (RTEP) included: (1) Lack of HCFA[13] (now CMS[14]) reimbursement – indicated as a problem but perhaps not the most significant because may private payers will reimburse telecare; (2) Legal issues – again, these issues were noted but not paramount; (3) Physician resistance to change – an issue but also not an insurmountable problem; (4) Telemedicine systems are not user-friendly enough – again this factor was ruled out as a significant barrier to telemedicine adoption; (5) Firm evidence of value – while indicating that this may be part of the issue the report cites many new medical technologies that have been rapidly embraced with less evidence of effectiveness than telemedicine; and (6) Provider involvement – this too was dismissed as not being that significant a factor to adoption.

So what did this study attribute slow telemedicine adoption rate to? The study suggests that it is less a matter of barriers to adoption, but rather incentives. Providers have no substantial incentive to use telemedicine because they: (1) get no special financial incentive, (2) except for certain specialists, no substantial improvement in convenience[15], (3) there is only limited evidence of any

---

[11] Zollo, S. (director), Final Report from the National Laboratory for the Study of Rural Telemedicine, The Telemedicine Resource Center, The University of Iowa, *National Library of Medicine* Contract N01-LM-6-3548.
[12] Rural Telemedicine Evaluation Project, Final Report for National Library of Medicine Contract N01-LM-6-3538, University of Missouri-Columbus School of Medicine, January 2000.
[13] Health Care Finance Administration
[14] Centers for Medicare & Medicaid Services
[15] Patients get improved convenience by avoiding travel to medical centers but this does not affect the physician specialist very much.

outcome improvements due to the use of better clinical decision making resources, and (4) limitations on physician time per patient which are not improved. In light of limited incentives to adopt the technology, even small barriers like those described above limit technology use. Thus, integration of the technology into the fabric of day medical practitioner usage patterns, lowering disincentives to the minimum, and smoothing adoption was the goal of the Columbus study. Part of the difficulty in this effort was supporting two-way video in rural areas.

The University of Southern California[16] performed an effort investigating the sufficiency of telemedicine imaging technology. This study began with considering film technology being supplanted by digital imaging as the gold standard. The findings of the study in the areas of general image quality, imaging to support eye care, and videoconferencing were that then-current technology was satisfactory for screening out specific pathology but may not always be suitable for diagnosis of specific diseases. Furthermore videoconferencing was deemed problematic over lower speed digital lines (POTS and ISDN). Ease of implementation and use were considered critical barriers for applications like eye care.

The University of Washington performed a project for the National Library of Medicine, ending in 2000,[17] which evaluated the future impact of digital communications over the five state Washington, Wyoming, Alaska, Montana, and Idaho region. The goal was to go beyond two-way video by providing access to a full range of reference and decision aiding tools. The project also included access to archival images. The project results are summarized as follows:

Acceptance of relatively low bandwidth, affordable network access was high. In these wide-open regions, reduced travel was a significant benefit especially when remote access to the specialist was augmented by the presence of the local caregiver in specialist-patient interactions. Use of XML and web-based data access and e-mail were widely accepted. Access to a wider array of reference materials was in high demand among rural providers. Generally the effort focused on integration of network services for data and image material. This component of the effort appeared to be fairly conventional by today's standards.

The West Virginia University Research Corporation Concurrent Engineering Research Center conducted a project to provide Secure Collaboration Technology for Rural Clinical Telemedicine.[18] This effort developed an architecture and applications to support intensive care

---

[16] Beecher, J., Briggs, R.P., Chiesa, J., Flowers, C., Jackson, C., Lim, J., Relles, D., O'Brien, R., Stumpf, S.H., Zalunardo, R., Investigations of Sufficiency in Telemedicine Applications: Standards in Context of Populations and Technologies, Final Report for *National Library of Medicine* Contract RFP-NLM-96-105/MVA, September 15, 2000.
Flowers CW, Baker RS, Khanna S, et al. Teleophthalmology: rationale, current issues, future directions. *Telemedicine Journal* 1997; 3: 43-52.
Li HK, Telemedicine and ophthalmology. *Survey of Ophthalmology* 1999; 44: 61-72.
Lee, PP et al. Evaluation of Telemedicine Image Quality for Interpretation of Diabetic Retinopathy, in Investigations of Sufficiency in Telemedicine Applications: Standards in Context of Populations and Technologies, *National Library of Medicine*, 2000.

[17] Benchmark to Bedside and Beyond: Building and Testing a Regional Telemedicine Testbed, Final Report to the *National Library of Medicine* Contract N01-LM-6-3545, December, 8, 2000.

[18] Secure Collaboration Technology for Rural Clinical Telemedicine, Final Report for the National Library of Medicine Contract N01-LM-6-3549.
Jagannathan V, Reddy R, Srinivas K, et al. An Overview of the CERC ARTEMIS Project. Proceedings of the 19th Annual Symposium on Computer Applications in Medical Care (SCAMC); 1995. p. 12-16.
Reddy S, Niewiadomska-Bugaj M, Reddy YV et al. Experiences with ARTEMIS – An Internet-Based Telemedicine System. Proceedings of the 1997 AMIA Annual Fall Symposium. 1997. P 759-763.
Computer Science and Telecommunications Board, National Research Council. For The Record: Protecting Electronic Health Information. Washington, DC: National Academy Press; 1997.

providers, mid-level providers, and home care patients. The communications systems used SSL,[19] PPTP,[20] and RSA encryption[21] technology. The project deployed telemedicine communications systems in a phased manner at each pilot site followed by evaluation of its use. Evaluation included cost savings modeling, but because of the small patient sample sizes and the diversity of telemedical applications spanned, the evaluation was not statistically significant. Generally the reception to the technology in the region of service was similar to that for other concurrent telemedicine projects.

A telemedicine project primed by BDM Federal (division of TRW Systems and Information Technology Group) demonstrated the use of real time transmission of vital signs from patients in ambulances to the trauma center at the Maryland Brain Attack Center at the University of Maryland at Baltimore. The project goal was to speed treatment of patients who could benefit from recombinant human tissue plasminogen activators (t-PA) where this was appropriate. Speeding t-PA treatment in patients with blood clots in the brain to within a 3-hour window of symptom onset substantially improves patient recovery. However, if the patient is suffering from a hemorrhage rather than a clot (similar external symptoms), t-PA treatment may be adverse to good patient outcome. Thus, moving proper diagnosis out to the first point of emergency treatment supports speedy treatment, but requires patient vital signs to be forwarded to the trauma care center for proper medical consultation. The project technology (based on cellular telephones) worked. The project discovered the following interesting result. *A patient that is difficult to diagnose in person is also difficult to diagnose remotely*. Based on the small number of patients treated so far, linking the use of telemedicine to support this treatment methodology to improved outcomes is still not proven.

Other National Library of Medicine projects[22] on telemedicine have included: (1) a Beth Israel Deaconess Medical Center study focused on using telemedicine to improve care for high-risk

---

Raman R, Reddy R, Jagannathan V et al. A Strategy for the Development of Secure Telemedicine Applications. Proceedings of the 1997 AMIA Annual Fall Symposium. 1997. P 344-348.
Gagliano D, Xiao Y. Mobile Telemedicine Testbed. Telemedicine Applications. Proceedings of the 1997 AMIA Annual Fall Symposium. 1997. P 383-387.
Raman R, Kannan S, Baker DV, Reddy R. Security for Collaborative Telemedicine. Proceedings of Health Cards '97. Ed. L. van den Brock and A.J. Sikkel. Studies in Health Technology and Informatics. Vol 49. IOS Press.1997. P 346-354.
Markwell, David (Ed.). G7 GII SP6 Healthcards. Interoperability of Healthcard Systems. G7 Interoperability Specification. 1996. [http://clinicalinfo.co.uk/euhci.htm] Trusthealth 1. Guidelines for Implementation of Security Services and Interfaces. Appendix B. Guidelines for Implementing the Card Terminal Manager 1996. [http://www.ehto.be/projects/trusthealth/deliver.html
W. Hunt, R. Raman, R. Reddy, V. Baker, et al: "Theater-style Demonstration: Secure Collaborative Telemedicine Applications" in C.G. Chute (ed.) Proceedings of the American Medical Informatics Association (AMIA'98) Annual Symposium; Hanley and Belfus, Inc. (Publisher) p. 1119, 1998.
Sima C, Raman R, Reddy R, Hunt W and Reddy S. Vital Signs Services for Secure Telemedicine Applications in C.G. Chute (ed.) Proceedings of the American Medical Informatics Association (AMIA'98) Annual Symposium; Hanley and Belfus, Inc. (Publisher) p. 361-365, 1998.
Andrew Cameron, MBA, Rashid Bashshur, PhD, and Kevin Halbritter, MD. A Simulation Methodology for Estimating the Financial Effects of Telemedicine in West Virginia. In Proceedings of The American Telemedicine Association ATA/DOD Annual Telemedicine Conference. 1998.
Mahmud, K. and Lenz, J. The personal telemedicine system. A new tool for the delivery of health care. Telemed Telecare 1995; 1 (3): 173-7.

[19] Secure Socket Layer

[20] Internet protocols over point-to-point links

[21] Public/Private key encryption and virtual private networks

[22] www.nlm.nih.gov/research/initprojsum.html, NLM National Telemedicine Initiative Summaries of Awards Announced October 1996 (and September 1997).

newborns; (2) Indiana University School of Medicine and the Regenstrief Institute for Health Care, Indianapolis, are implementing the means to allow rapid access to patient record data in its area of service supporting and improve care at clinical labs, pharmacies, emergency rooms, and other healthcare providers; (3) a Science Applications International Corp (SAIC), La Jolla CA, project, "PCASSO," is implementing the means for patients, health care providers, and medical researchers securely over the World Wide Web; (4) The University of Alaska Applied Science Laboratory, Anchorage, is exploring the use of telemedicine technology to reduce the need for transportation of patients over long distances; (5) a University of California, San Francisco, study is focused on electronic distribution of radiology imagery; (6) the University of Pennsylvania School of Dental Medicine, Philadelphia; is pursuing an innovative approach to dental care delivery through telemedicine, and (7) the University of Pittsburgh Medical Center, Pittsburgh, is evaluating the clinical utility of multimedia workstations at the University of Pittsburgh Cancer Institute.

Why Further Work?

While telemedicine has been perceived as having substantial value, the majority of the funded projects reviewed have demonstrated this value through patient and caregiver preference studies and have failed to show substantial outcome improvements.[23] The primary cost savings modeled are attributed to patient travel expenses that do not substantially motivate the provider community. The convenience of remote access to specialists and even electronic patient record information has often been offset by computer integration difficulties, which hopefully are less for current technology.

To convincingly demonstrate outcome improvement and cost containment or reduction, the telemedicine project must identify the particular disease states or frequently exercised emergency procedures that will be improved through the application of routine remote monitoring or other telemedicine technology. It is important to identify a larger scale concentrated set of enriched populations who will more readily and quickly show the medical outcome improvements needed to drive the technology into widespread practice. We need to focus the project around the "telemedicine killer application."

We believe that two-way video is not normally that valuable, and that web-based information dissemination/education is a proven technology that can be applied to medical care readily (i.e. needs no further study), but that the key to the killer application is objective collection and review of chronically ill patient data remotely collected on an outpatient basis. The potential savings possible for CHF, Diabetes, and COPD patients by emergency hospitalization avoidance enabled by automated compliance to treatment regime assessment is quite large. Furthermore, when a patient knows that his/her compliance with treatment is objectively on the record, fewer patients will rationalize lax behavior. Such an application also optimizes caregiver effort by quickly identifying the portion of the patient population that is at risk due to non-compliance or emerging complications. Many hospitals currently manage recently discharged CHF patients through phone communications by RNs. Using technological means for collection of critical vital signs data (weight, blood pressure, blood sugar levels, respiration data, etc.), the RN staff can cover more patients in less time for longer recovery periods. Since it is a given that next year caregivers will cover more, especially elderly, patients per care giver than they did last year, this improvement in caregiver efficiency ultimately will pull the necessary telemedicine technology into mainline deployment.

[23] See Jacobus, C, "Current Bibliography in Telemedicine" [1996-May 2002] Cybernet Medical, www.cybernetmedical.com and Scannell, K.M., Perednia, D.A., Kissman, H.M., Telemedicine: Past, Present, Future, CBM 95-4 [1966-March 1995] *National Library of Medicine, HHS*, 1995, www.nlm.nih.gov/pubs/cbm/telembib.html.

When this technology is available because of a routine use, it can become a strong contributor in less frequently arising situations such as emergency care in support of major disaster relief or detection/response to biological terrorism events. In both of these cases the problem is also one of triage – finding early trends in large populations, identifying patients needing treatment versus patients that can receive reduced levels of care (either because they are less acute or because they cannot be helped effectively). While these applications may not solely justify widespread telemedicine system deployment, they can substantially leverage such a system when they are in place due to normal use economic justifications.

Consider the case of the outbreak of airborne anthrax or a smallpox epidemic. In the early stages (first 3-14 days) these illnesses mimic the symptom set[24] of a wide array of metabolic, circulatory and respiratory diseases as benign as the common cold, chickenpox, or ordinary influenza. However, shortly they progress to fatal proportions in a significant percentage of the infected population. On a case-by-case basis, the health care community will be unable to identify individual patient symptoms as part of a larger bio-terrorism event until a substantial number of patients have progressed to the deadly period of disease symptom presentment.

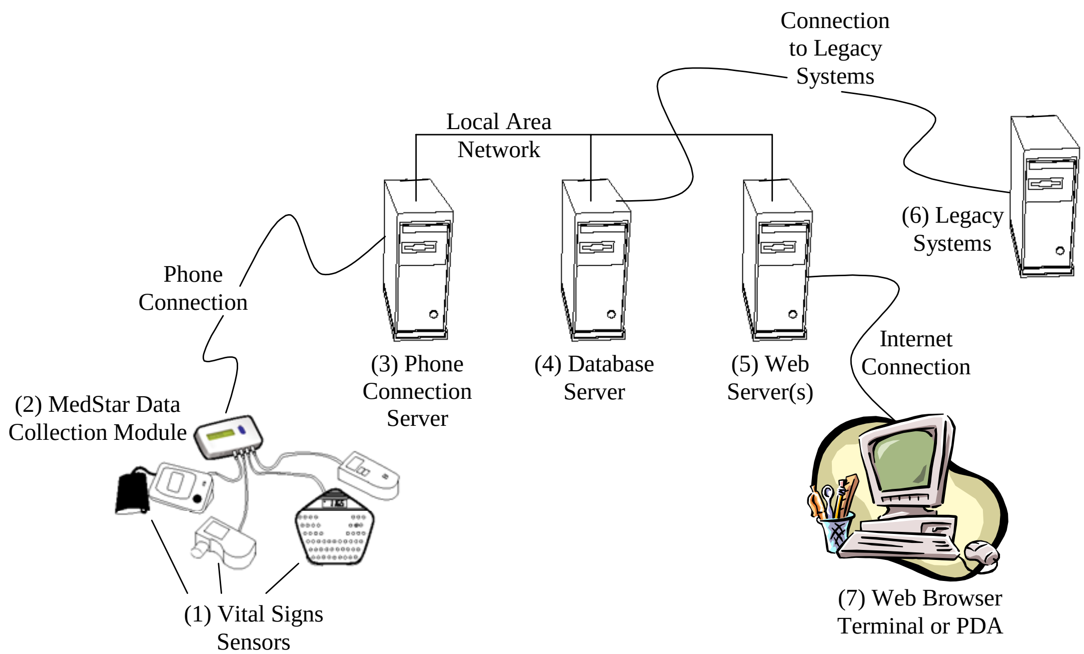

Figure 1. The MedStar System Block Diagram

With a widely deployed telemedicine system which routinely reports simple vital signs like temperature, respiration parameters (peak flow and total lung volume), and blood pressure and pulse rate,[25] for instance, the healthcare system operator will know that a large number of people in the monitored population have begun symptom presentment virtually simultaneously. This

[24] Per D. A. Henderson, Smallpox: Clinical and Epidemiologic Features, Johns Hopkins Center for Civilian Biodefense Studies, Baltimore, Maryland, USA, http://www.cdc.gov/ncidod/EID/vol5no4/henderson.htm, early smallpox symptoms include fever leading to febrile seizures and may also include muscle ache typical of early influenza. Later the early onset of pox mimics chicken pox. Per CDC, http://www.cdc.gov/ncidod/dbmd/diseaseinfo/anthrax_g.htm, the initial symptoms may resemble a common cold – fever, congestion, runny nose, etc.

[25] We assume that this would be economically justified for management of the chronically ill or for wellness/health maintenance through employers, health clubs, or by the consumer in his/her home.

would be highly correlated with the early stages of a major health emergency.[26] Significantly, such a system offers the prospect of detection of an emerging event at the early stages where large-scale treatment options will still be viable (anthrax – large scale deployment of antibiotics; smallpox – large scale vaccinations; etc.).

Introducing the MedStar System

The MedStar system (Figure 1) is composed of seven (7) primary technical components: (1) consumer vital signs devices (scale, blood pressure, glucose meter, temperature, peak flow and total lung volume, pulse oximetry, trans-telephonic EKG), (2) a small MedStar data collection module (one-way from data source to the web or two-way which also includes messaging to/from the patient through a phone connection or through a DTMF compatible cellular phone), (3) scalable phone server (which reads MedStar data and mediates two-way message flow), (4) scalable SQL database system (for storing patient's electronic data records), (5) scalable web server (which allows the patient or health care professional to authenticate, access and annotate data records to which they have access, and control messaging), (6) interfaces to external patient data systems (in the practice, lab or hospital), and (7) the health care professional's standard web browsing system (which can be an ordinary PC, PDA, webTV, or other web terminal). Figure 1 shows the basic components of the system and how data flows. Each component is self-scalable by either adding more patients (and patient collection systems), adding more health care professionals (and their browser-based data access points or PCs), or adding more and larger servers (to handle more web traffic and to store more patient record data).

This approach keeps the cost of deployment to a minimum by leveraging existing consumer grade medical equipment designs and substantially reducing communications module cost.

Furthermore it provides wider area accessibility by utilizing the normal consumer's phone line for uplink communications. This also reduces equipment losses because under normal conditions the systems is tethered.[27]

This is coupled to wide data access for the health care provider or caregiver through virtually any available web terminal or PC. Because the web access is through secure SSL connections the system technology maintains HIPAA compliance assuming the health operator is compliant in his normal operations. Data uploaded through the phone are also compliant because the patient's name or personal identification is not associated with the measurement data until received at the secured servers (where MedStar unit number is used to index to patient assignment data).

For for more information on the MedStar system please contacts us at:

Cybernet Medical Corporation

www.cybernetmedical.com

---

[26] The alternative approach would be widespread deployment of specialized and sensitive biohazard sensors, connected using communication technology identical to that suggested for patient monitoring in this effort. This is viable, but must be completely justified based on the bio-terrorist threat alone and not also through routine use in normal medical care. Furthermore, specialized sensors detect only what they are designed to detect, but human subjects can detect any human pathogen in use now or in the future. The deployment population must be chosen to reflect how the pathogen is transmitted – for instance, the house-bound elderly might not be a good population for airborne spores like anthrax, which is spread through subway tunnels. The population of health club users might be better for detection in this case.

[27] Note the individual measurement devices, BP, EKG, Glucometer, etc., are all portable and so it the MedStar battery powered communication module. This means that the patient can take measurements over a prolonged period away from the tether location and upload data upon returning home or front a hotel or office phone set-up while on the road.

