VITAL SIGNS VIA BROADBAND: REMOTE HEALTH MONITORING TRANSMITS SAVINGS, ENHANCES LIVES

by

Robert E. Litan

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Foreword

Better Health Care Together
A Common Sense Approach to Health Care

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Better Health Care Together (www.betterhealthcaretogether.org) is a coalition of business, labor, and public policy leaders who share the conviction that broad-based health care reform is among the most pressing economic and moral imperatives facing the United States. We are working toward reform that will put a new American health care system in place no later than 2012.

Our effort is guided by four common sense principles for a new health care system.

1. We believe every person in America must have quality, affordable health insurance coverage.
2. We believe individuals have a responsibility to maintain and protect their health.
3. We believe that America must dramatically improve the value it receives for every health care dollar.
4. We believe that businesses, governments, and individuals all should contribute to managing and financing a new American health care system.

As part of that effort, Better Health Care Together is promoting public discussion of promising new directions such as the use of information technology to deliver some health care services through telemedicine applications that can unite patient and caregiver when in person service is impossible or unnecessary.

In that spirit, we are pleased to present Dr. Robert Litan's study **Vital Signs via Broadband: Remote Health Monitoring Transmits Savings, Enhances Lives**. This research illustrates the potential benefits of remote monitoring to improve health care outcomes for those with chronic diseases while also significantly reducing costs to the U.S. health care system. We believe it also demonstrates the need to take a holistic view of our health care challenges and to draw from a range of fields, including communications technology, as we build a better health care system.

VITAL SIGNS VIA BROADBAND: REMOTE HEALTH MONITORING TRANSMITS SAVINGS, ENHANCES LIVES

by

Robert E. Litan[†]

Executive Summary

For the millions of people around the world who have embraced the Internet, the transformational effects of modern communications technologies are well known. Using search engines to access information, attending classes and college lectures online, conducting financial transactions and shopping, and enjoying music, video and games over the Internet are increasingly routine. But other Internet-based activities have yet to reach their full potential; among the most significant is telemedicine – the use of modern communications to deliver a wide range of health care to patients at locations that are physically distant from the caregiver.

By enabling more regular contact between patient and caregiver, the use of IT technologies can mean earlier detection of health problems and better outcomes that enable people to live longer and more satisfying lives. Telemedicine can help those with chronic illnesses to lead normal work and personal lives and enable older Americans to remain in their own homes instead of moving to institutional settings.

Remote Monitoring Detects Problems Earlier; Means Better Outcomes and Less Hospital Time

These benefits of telemedicine, and in particular remote monitoring, are well-documented. Remote monitoring helps chronic disease patients avoid hospitalization and enables those in geographically isolated settings to access specialized and preventive medicine. Distant monitoring has special efficacy for patients with chronic ailments such as diabetes, congestive heart failure, chronic obstructive pulmonary disease, and chronic skin ulcers for which changes in vital signs can signal a need for medical intervention. Remote monitoring technologies can transmit data on a regular, real time basis and prevent hospitalizations by identifying and treating problems by triggering adjustments in care before negative trends reach crisis stage.

The improvements in patient experience can be dramatic. For example, a widely cited study by Meyer, Kobb, and Ryan reports that the combination of home telemonitoring, video visits, and

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coordinated care resulted in substantial improvements in health outcomes among a group of elderly veterans with a variety of chronic diseases. These gains included a 40 percent reduction in emergency room visits, a 63 percent reduction in hospital admissions, and a 60 percent reduction in hospital bed days of care, along with similar reductions in nursing home care.

These types of outcomes also deliver significant savings to the health care system, particularly for the chronic illnesses that account for roughly 80 percent of increases in Medicare costs.

Widespread Remote Monitoring Can Cut Health Care Costs By $197 Billion

Upon examination of existing literature and experience to date, I estimate that a full embrace of remote monitoring alone could reduce health care expenditures by a net of $197 billion (in constant 2008 dollars) over the next 25 years with the adoption of policies that reduce barriers and accelerate the use of remote monitoring technologies. The policy enhancements boost savings by almost $44 billion over the 25-year period, an improvement of almost 29 percent compared with continuation of the current policy baseline.

The savings are largely attributable to better management of chronic diseases because of remote monitoring. Widespread implementation of remote monitoring means key vital signs can be transmitted to a caregiver or a data center in real time and trigger an instant alert when readings change in a medically significant way. Caregivers also say that addition of two-way video to monitoring programs can further enhance the quality of interaction between patient and caregiver and can encourage patients to observe treatment regimens with greater consistency.

When broken down by condition, I estimate the following net savings over the 25-year period:

Congestive Heart Failure	$102.5 billion
Diabetes	$54.4 billion
Chronic Obstruction Pulmonary Disease	$24.1 billion
Chronic Skin Ulcers	$16.0 billion

Savings Can Be Accelerated With Smart Policy in Medical Reimbursement and Technology

Success in translating potential savings into real savings depends in part on public policy decisions that speed the acceptance and penetration of remote monitoring. The realignment of reimbursement policy for telemedicine is among the most critical requirements. For example, Medicare and insurance reimbursement policies that recognize the value of investments in telemedicine equipment and expertise can spread the use of remote monitoring by reducing out-of-pocket costs and encouraging buy-in among practitioners. [For full set of policy recommendations see pages 50-51 and 54-55]

Right now, like other preventive care, telemedicine is only covered by current private and public health insurance plans to a limited extent. For example, remote consultations with physicians are reimbursed if they are conducted over two-way video. However, physicians are not reimbursed for examining remote monitoring data as a preventive measure. Right now, patients and

insurers are capturing many of the quality improvements and cost savings from telemedicine, but paying for few of them. The costs are largely incurred by health care providers, but not fully reimbursed. This circumstance will not encourage optimal levels of investment in and commitment to the provision of telemedicine infrastructure and services. Quite simply, we need policy incentives that ensure that institutions and practitioners who invest in telemedicine are sufficiently compensated for the resulting improvements in both care and costs.

Smart communications policy also can expedite the adoption of remote monitoring and other telemedicine technologies. Policies that increase the public's fluency with advanced communications technology will make telemedicine more effective and easier to implement. Policies that bring broadband technologies into more homes also will help bring in remote monitoring, video visits with providers, and self-care education. Investments in networks provide needed capacity for live video and continuous monitoring, and policies allowing quality-of-service offerings allow doctors to treat their patients without interruption.

In particular, the long-term success of remote monitoring requires telecommunications policies that encourage widespread deployment of broadband and accelerated private investment in "smart networks." Policy should promote network investment and allow operators to tailor services to the needs of telemedicine, including data privacy and reliable real-time connectivity.

I. OVERVIEW

A. The Health Care Opportunity

The health care industry in the United States is characterized by large and growing levels of expenditure.[1] According to the U.S. Department of Health and Human Services, Americans spent $2.1 trillion on health care in 2006, or $7,026 per person. This spending accounted for 16 percent of Gross Domestic Product (GDP).[2] The fraction of the GDP consumed by health will only increase. The growth in the national health expenditure is expected to outpace GDP growth for the foreseeable future.[3]

Important demographic trends will place an increasing strain on the U.S. health care system over the next several decades.[4] The aging of the Baby Boomer generation is expected to lead to an increase of nearly 30 percent in the population over 65 years of age between 2006 and 2017, and nearly 100 percent by 2030.[5] Life expectancy is also expected to continue to grow, representing a significant extension of the lives of the American population.[6] Meanwhile, the percentage of the population living with chronic illnesses and disabilities is expected to continue

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1. Centers for Medicare & Medicaid Services: U.S. Department of Health and Human Services, NHE Fact Sheet, available at http://www.cms.hhs.gov/NationalHealthExpendData/25_NHE_Fact_Sheet.asp#TopOfPage (last visited Apr. 18, 2008) [*hereafter NHE Fact Sheet*].
2. *Id.*
3. *Id.*
4. Centers for Medicare & Medicaid Services: U.S. Department of Health and Human Services, National Health Care Expenditure Projections 2007-2017, at 1, available at http://www.cms.hhs.gov/NationalHealthExpendData/Downloads/proj2007.pdf (last visited Apr. 18, 2008) [*hereafter NHE Projections*].
5. *Id.* at 3. The population over age 65 is expected to rise from 36.7 million to 47.9 million over the study period. *Id.* (citing U.S. Census data).) By 2030, the figure is expected to rise to over 71 million, according to estimates and projections from the U.S. Census. *See* U.S. Census Bureau, Projected Population of the United States by Age and Sex: 2000 to 2050, available at http://www.census.gov/ipc/www/usinterimproj/natprojtab02a.pdf (last visited Apr. 18, 2008).
6. Frederick W. Hollmann, Tammany J. Mulder & Jeffrey E. Kallan, *Methodology and Assumptions for the Population Projections of the United States: 1999 to 2100* (Population Division: U.S. Census Bureau, Jan. 2000), available at http://www.census.gov/population/www/documentation/twps0038.html.

its rise.[7] Accordingly, the annual costs of nursing home and home health care services are expected to increase over 90 percent.[8] Spending on prescription medication is also expected to accelerate.[9] These trends will place an increasing strain on both the private and public health care sectors.

An increasing reliance on health care information technology (IT) could mitigate some of the projected growth in health care spending, and thus help address mounting affordability concerns. Although short run costs may increase because of necessary start-up investments, such investments permit cost savings and quality improvements to be realized over the long run. At its most basic level, IT can be used to improve the information flow between patients and health care practitioners.[10] This enhanced communication can dramatically improve the quality of care and health care outcomes. IT can also make record keeping more efficient, increase the potential for collaboration among disparate providers, and save time and cost for both health care providers and their customers.[11] Finally, the use of IT can expand access to critical services that would otherwise be unavailable to those in need, particularly those in rural or traditionally underserved communities.[12]

The use of IT-related health care technologies also promises to help tap the potential of preventive medicine, shifting the focus of health care away from merely treating illness long

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7. Leslie Harris & Associates, *At A Tipping Point: Transforming Medicine with Health Information Technology: A Guide for Consumers* 13 (Apr. 1, 2005), available at http://www.mehi.org/documents/April12MedStar%20final.pdf [*hereafter Tipping Point*].

8. *NHE Projections* at 4 (estimating that spending in nursing home and home care will increase from $177 million to $336.5 million between 2006 and 2017).

9. *Tipping Point* at 12.

10. Neal Neuberger, *Advancing Healthcare through Broadband: Opening up a World of Possibilities*, 5-7 (Internet Innovation Alliance, Oct. 27, 2004), available at http://www.internetinnovation.org/DesktopModules/iBN%20News%20Articles/Download.aspx?AttachmentID=6.

11. *Id.* at 5-9.

12. *Id.* at 14. ("Broadband-enabled telemedicine can also help mitigate the impact of shortages and mal-distribution of specialty trained physicians, nurses and allied healthcare professionals—a problem that may grow more acute as the current caregiver population grows older.").

after the illness has materialized.[13] Patients can assume greater decision making capacity in the management of their health. As a result, they become more active and better informed consumers.[14] When treatment becomes less episodic and more continuously available, a holistic view of patient health becomes possible. This continuous treatment gives doctors vastly improved information from which to formulate recommendations.[15] Earlier detection of problems becomes possible, allowing for more aggressive treatment and reduced chance of disability. Significantly, preventive and early-warning care can improve outcomes in several leading causes of death, including heart disease, cancer, stroke, chronic obstructive pulmonary disease (bronchitis, emphysema), and diabetes.[16]

Telemedicine capabilities, in particular, hold unique promise to the realization of improved quality of care and lower cost. Telemedicine—the delivery of health care advice and even procedures—overcomes geographical and logistical impediments to care.[17] For patients in rural or traditionally underserved markets, telemedicine capabilities can bring otherwise unavailable expertise to bear on treatment. Studies show that such improved access can dramatically increase health outcomes.[18]

What may have seemed like science fiction only a short time ago is now increasingly a reality, and will become more so, as broadband penetration increases, as health care

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13. Telehealth and Medically Underserved and Advancement Act of 2007, H.R. 1601, 110th Cong. (2007); *see also Tipping Point* at 15.

14. *Tipping Point* at 16. *See also* U.S. Preventive Medicine, available at http://www.uspreventivemedicine.com/ (last visited Apr. 19, 2008).

15. *Tipping Point* at 17.

16. U.S. Preventive Medicine, Why Preventive Medicine, available at http://www.uspreventivemedicine.com/High-Tech%20Diagnostics/Why%20Preventive%20Medicine.html (last visited Apr. 18, 2008).

17. Fran Turisco & Jane Metzger, California HealthCare Foundation, Rural Health Care Delivery: Connecting Communities through Technology (Dec. 2002), available at http://www.chcf.org/topics/view.cfm?itemID=20206.

18. *Id*. at 14-24.

professionals and patients become more comfortable with the use of the technology, and as reimbursement policies recognize and encourage the use of telemedicine:

- Remote consultation and monitoring allows patients and health care practitioners to meet virtually without the patient needing to travel.

- Medical imaging applications allow digital images to be captured and transmitted to radiology, pathology, cardiology, and other specialists at disparate locations for evaluation.[19] These capabilities enable members of a medical team to formulate care based on the best possible diagnostic tests, administered without regard to the geographical location of the doctor-diagnostician.[20]

- Electronic prescription capabilities permit doctors to write and transmit prescriptions to pharmacies in digital form.[21] Digitizing prescriptions will dramatically reduce errors and the numbers of calls required to verify prescription details. [22]

- Secure messaging permits safe and robust communication among health care professionals as well as between professionals and their patients.[23]

- Implementation of improved, electronic health record keeping assures that medical teams have a real time, comprehensive view of a patient's medical history, permitting more informed and accurate decision making.[24] Moreover, significant billing improvements are also possible when electronic records are maintained; greater automation lowers administrative overhead and also provides for a reduction in errors.[25]

- Finally, remote surgery or even remote intensive care units may also become viable treatment options in some contexts, provided the right facilities and infrastructure are in place.[26]

19. Turisco & Metzger at 10.
20. *Id.* at 10.
21. *Tipping Point* at 22.
22. *Id.* at 22-23.
23. *Id.* at 28.
24. *Id.* at 28.
25. *Id.* at 18-20.
26. *Id.* at 40-43; s*ee also* Neuberger at 10.

B. Key Patient Groups Benefiting from Telemedicine

Telemedicine capabilities hold particular promise for patients with chronic illnesses,[27] who account for roughly 80 percent of increases in Medicare costs.[28] By improving communication between patients and health care professionals (that is, in terms of quantity of contacts as well as quality of information exchanged), practitioners receive more information, at a greater level of detail, from which they can base treatment decisions.[29] In addition, by expanding the presence of the medical team in a patient's long-term care, tele- and video-visits can improve adherence to prescribed treatment regimens.[30] More successful and closely tailored treatment in turn can significantly reduce morbidity, can improve quality of life, and can decrease admission to hospitals and nursing homes for more aggressive care.[31]

Studies demonstrate the substantial benefits of telemedicine to diabetes patients,[32] whose costs of care contribute significantly to increases in Medicare expenditures.[33] Telemedicine better enables health care professionals to supervise weight management plans, document activity levels, and monitor blood glucose signs—activities of particular importance to

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27. Audrey Kinsella, *Telehealth Opportunities for Home Care Patients*, 21 HOME HEALTHCARE NURSE 661, 662 (2003).

28. Lisa Remington, 2008 MegaTRENDS Predictions and Forecasts Across the Healthcare Delivery System, Remington Report at 9 (Jan./Feb. 2008), available at http://www.remingtonreport.com/toc.asp.

29. Kinsella at 662.

30. *Id*. at 662.

31. Helen Noel, Donna Vogel, Joseph Erdos, David Cornwall & Forrest Levin, *Home Telehealth Reduces Healthcare Costs*, 10 TELEMED. J. E-HEALTH 170 (2004) (concluding that "integrating home telehealth with the healthcare institution's electronic database significantly reduces resource use and improves cognitive status, treatment compliance, and stability of chronic disease."). *See also* Kathryn H. Dansky, Lisa Palmer, Dennis Shea & Kathryn H. Bowles, *Cost Analysis of Telehomecare* 7 TELEMED. J. E-HEALTH 225 (2001) (concluding that telemedicine intervention reduces direct and indirect costs associated with hospitalization by as much as 62.5 percent, and permits full recovery of equipment and personnel costs necessary to operationalize telehomecare services). *See also* Kinsella at 662; *see also* Hebert et al. at 789.

32. Kinsella at 662-64. *See also* Pennsylvania Homecare Association, Telehomecare Research Results (2004), available at http://www.pahomecare.org/teleresearchsum.pdf.

33. Remington at 9.

diabetics.[34] These tasks can all be accomplished on a regularly scheduled basis without the need for in-person care.[35]

Heart patients are also important beneficiaries of telemedicine capabilities. Congestive heart failure (CHF) and coronary artery disease (CAD) account for a large and increasing proportion of health care expenditures.[36] Regular measurement of weight, blood pressure, heart rate, and blood oxygen saturation is critical for providing effective care for these patients.[37] By collecting information on a regular basis, medical teams can get a more complete picture of a heart patient's health and spot dangerous trends such as weight gain due to fluid retention.[38] This information enables physicians to make more informed, timely decisions about further interventions, hospitalizations, and other more aggressive courses of treatment.[39] Studies show that heart patients receiving telemedicine care at home experience lower mortality rates and the duration of hospital admissions is reduced.[40]

Chronic obstructive pulmonary disease (COPD) sufferers form another key patient group that can benefit from telemedicine. COPD is a group of conditions involving decreased lung function such as bronchitis or emphysema. Although the symptoms of COPD are a constant feature of patients' lives, these symptoms can worsen at times, calling for temporary medical

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34. Hebert et al. at 789.

35. Pennsylvania Homecare Association at 2 (comparing improvements in hospitalization rates and emergency care visits for diabetes patients receiving telehomecare). *See also* Dansky et al. 227-31.

36. Remington at 9.

37. John G. F. Cleland, Amala A. Louis, Alan S. Rigby, Uwe Janssens & Aggie H. M. M. Balk, *Noninvasive Home Telemonitoring for Patients With Heart Failure at High Risk of Recurrent Admission and Death: The Trans-European Network–Home-Care Management System (TEN-HMS) Study*, 45 J. AMER. COLL. CARDIOLOGY 1654 (2005).

38. American Heart Association, *Warning Signs to Watch For*, http://www.americanheart.org/presenter.jhtml?identifier=1614.

39. Pennsylvania Homecare Association at 2 (comparing improvements due to telehomecare in hospitalization rates and emergency care visits for coronary artery disease and congestive heart failure patients).

40. Cleland et al. at 1661.

intervention or even hospitalization ("exacerbations").[41] Regular monitoring of lung function and other indicators has been shown to improve COPD patient outcomes and reduce costs, by allowing nurse case coordinators to intervene at earlier stages of exacerbations with inhalers or antibiotics, as necessary, and as a result avoiding some hospitalizations.[42] Telemonitoring can also reduce the frequency of exacerbations in some cases, when interventions are designed to help patients stay on their medication regimes and to make lifestyle changes.[43] Telemonitoring also allows for earlier diagnosis of ancillary conditions such as pneumonia.

Many other patients with chronic conditions may benefit from telemedicine, including AIDS, arthritis, and asthma patients.[44] All of these conditions need the care coordination that telemedicine facilitates. Regular video visits or electronic messages can help with medication compliance and help caregivers learn about, deal with, and prevent exacerbations.[45] Being able to substitute video visits for in-person visits also lets patients avoid difficult and potentially painful travel.

Patients with temporary conditions that require home care or monitoring are also excellent candidates for telemedicine. Women with high-risk pregnancies can benefit from telemonitoring; one study found that using remote monitoring technology to track fetal heart rates reduced subsequent in-patient time and the number of necessary clinic visits.[46] Homebound

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41. Jaap C.A. Trappenburg, Anouk Niesink, Gerdien H.de Weert-van Oene, Hans van der Zeijden, Renée van Snippenburg, Albert Peters, Jan-Willem J. Lammers & Augustinus J.P. Schrijvers, *Effects of Telemonitoring in Patients with Chronic Obstructive Pulmonary Disease*, 14 TELEMED. J. E-HEALTH 138 (2008).

42. *Id*. at 138.

43. *Id*. at 144.

44. Susan L. Dimmick, Carole Mustaleski, Samuel G. Burgiss & Teresa Welsh, A Case Study of Benefits & Potential Savings in Rural Home Telemedicine, 18 HOME HEALTHCARE NURSE 124 (2000), at 127. *See also* Neuberger et al. at 12.

45. Dimmick et al. at 130. *See also* Ren-Long Jan, Jiu-Yao Wang, Mei-Chih Huang, Shin-Mu Tseng, Huey-Jen Su & Li-Fan Liu, *An Internet-Based Interactive Telemonitoring System for Improving Childhood Asthma Outcomes in Taiwan*, 13 TELEMED. J. E-HEALTH 257 (2007).

46. A. Dawson, D. Cohen, C. Candelier, G. Jones, J. Sanders, A. Thompson, C. Arnall & E. Coles, *Domiciliary midwifery support in high-risk pregnancy incorporating telephonic fetal heart rate monitoring: a health technology randomized assessment*, 5 J TELEMED. TELECARE 220 (1999).

patients with pressure sores also can benefit greatly; a study of these patients found that patients who received remote consultations using digital cameras and electronic image transmission subsequently required many fewer emergency room visits and hospitalizations.[47] Not only do these telemedicine interventions result in better health outcomes, but recovery (and thus return to the workforce) is quicker, with less impact on family and other caregivers.

Telemedicine also contributes to maintaining independence for frail elderly patients. Health care for the elderly is a pressing social and medical issue, which the demographic transition underway in the United States will only make more critical. As baby boomers age, care for the elderly will continue to shift from family members to the formal health sector.[48] Millions of the elderly will need to be served through home care, nursing homes, and as a last resort, hospitals. Home care is optimal whenever possible: not only is it significantly cheaper than nursing home care, but patients are more satisfied remaining in their homes.[49] However, home care is most feasible only when patients are capable of living independently.

Many factors contribute to loss of independence among the elderly: osteoporosis and broken bones take away mobility; cognitive decline means previously simple tasks require outside assistance; and chronic illnesses may contribute to mental decline, loss of mobility, and sometimes may require hospitalization, disrupting patients' lives even further.[50] Once very elderly persons lose their independence, their reduced physical and mental activity further contributes to their frailty. Telemonitoring and video visits can prevent illness from reaching serious levels. Regular contact with nurses and other care-givers helps ensure that patients are

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47. Riley S. Rees & Noura Bashshur, *The Effects of TeleWound Management on Use of Service and Financial Outcomes*, 13 TELEMED. J. E-HEALTH 663 (2007).

48. *Id.* at 165.

49. *Id.* at 168.

50. Maria L. Onor, Marianna Trevisiol, Ornella Urciuoli, Shai Misan, Francesca Bertossi, Gabriella Tirone, Eugenio Aguglia & Elisabetta Pascolo-Fabrici, *Effectiveness of Telecare in Elderly Populations—A Comparison of Three Settings*, 14 TELEMED. J. E-HEALTH 164 (2008).

eating nutritious diets and staying on drug regimens. Social contact contributes to well-being and cognitive health. Telemonitoring of various health indicators can help diagnose new conditions before they have a chance to seriously affect the patient's independence.

The ability to conduct medical business at home also benefits disabled patients, for whom mobility may be a serious issue. Telemonitoring and telehomecare save these patients considerable time and trouble getting to appointments. For home-bound patients who must be assisted by nurses and other home care professionals, remote services such as video visits allow more visits per dollar, thereby providing more effective care management and, more importantly, improving patients' sense of security and social connectivity.[51]

Using telemedicine to improve health access in rural areas in the past has been effective but short-lived, as funding for trial programs often has expired.[52] Nonetheless, the benefits of telemedicine to rural patients are clear. *First*, technologies such as video-conferencing and remote monitoring can help patients in rural areas avoid the significant and difficult travel to see health care professionals. Some patients may be monitored at home; other patients may be treated at small local health facilities connected through video and other technologies to doctors at larger facilities in distant cities or counties. *Second*, telemedicine can address the related issue of scarcity of health care services in rural areas. Rural health centers may not have the scale required to justify hiring specialists.[53] Secure communications technologies allow these rural centers to transmit tests such as x-rays to radiologists and other specialists in larger locations. Patient monitoring may be outsourced in a similar way, so that rural hospitals or clinics can afford to maintain specialized services such as intensive care units (ICUs) and cardiac care

51. Dansky et al. at 231 (concluding that telehomecare technology allows a nurse to make contact with 15-25 patients a day, vs. 5.2 patients per day for traditional in-person visits). *See also* Dimmick et al. at 130, 134.

52. Turisco & Metzger at 5.

53. *Id.* at 7.

units.[54] Mental health patients also benefit from access to specialists through video; rural scarcity of behavioral health specialists means that but for telemedicine, treatment may not be feasible.[55]

Children can benefit through telemedicine as well. Because children are quick to learn to use technology, pediatric patients with diseases such as asthma are perfect candidates for telemonitoring and computerized learning. For example, in a Taiwanese study of child asthma patients using Internet-based tools along with home telemonitoring equipment, caregivers closely monitored patients' status and taught them asthma self-management skills. This program resulted in improved patient health outcomes and was well received by patients and caregivers.[56] Another project in Detroit, Michigan combined a similar initiative with classroom activities.[57] Additionally, children's hospitals are using technology to improve parents' access to emergency care information and to increase patient satisfaction with care.[58]

C. From Vision to Reality

Telemedicine has become increasingly feasible in recent years, with the considerable decline in the costs for video and monitoring technologies and the diffusion of new wireless communications technologies. However, there are still significant obstacles to be overcome before the U.S. health care system can fully realize the promise that telemedicine holds for quality and cost improvements in health care.

First, health policy must include broadband policy. The growth of telemedicine goes hand in hand with the growth in national communication capability. Any communications policy

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54. *Id*. at 20.
55. *Id.* at 19.
56. Jan et al. at 257.
57. A. Kinsella, *Managing the inner city*, HOME HEALTHCARE DEALER, May/June 1998, at 75-76.
58. S. M. Melzer & S. R. Poole, *Computerized pediatric telephone triage and advice programs at children's hospitals: operating and financial characteristics*, 153 ARCHIVES PEDIATRIC ADOLESCENT MED., 858 (1999).

change that increases the public's fluency with the Internet and advanced communications technology will make telemedicine more effective and easier to implement. Telemedicine, including remote monitoring, delivers benefits even when relying on dialup access to the Internet, but broadband technologies will enable far more robust telemedicine programs. Most significantly, broadband is the core underpinning of initiatives that rely on real-time transmissions to ensure steady data flow and online delivery of the highest quality medical imagery. Policies that bring broadband technologies into more homes (especially into homes of the elderly) will also help bring in remote monitoring, video visits with providers, and self-care education. But we need not just more broadband, but the kind of broadband, or "smart networks."

Policies must permit and indeed encourage investments by telecommunications providers in networks that provide the needed capacity for live video and continuous monitoring, with quality-of-service features to enable doctors to treat their patients without interruption. The continued enhancement of broadband capabilities by the injection of increasingly intelligent technologies can assure uninterrupted transmission of information that cannot tolerate the delays that might otherwise result during periods of congestion on the Internet. Smart networks and effective management also supports heightened security to protect the confidentiality of patient information, which is vitally important for expanded use of telemedicine.

Second, reimbursement policy for telemedicine must be completely realigned. At present, most of the benefits of telemedicine go to patients, and, ultimately, Medicare and insurance companies. However, like other preventive care, telemedicine is only covered by current private and public health insurance plans to a limited extent. For example, remote consultations with physicians are reimbursed if they are conducted over two way video.

However, physicians are not reimbursed for examining remote monitoring data as a preventive measure.[59] Home care agencies are reimbursed for visiting patients and monitoring their vital signs, but are not reimbursed for leaving home monitoring equipment with the patient so that the patient's condition may be viewed more regularly.[60]

In short, patients and insurers are capturing many of the quality improvements and cost savings from telemedicine, but paying for few of them. This is not a circumstance that will encourage optimal levels of investment in and commitment to the provision of telemedicine infrastructure and services. Insurance reimbursement policies need to change to recognize the value of services such as remote monitoring, and to commit to reimbursement for equipment purchase and staff training. In the long run, reimbursement for telehealth needs to reflect fee-for-health, rather than fee-for-service.

On July 16, 2008, Congress passed a new Medicare appropriations bill allowing skilled nursing facilities, in-hospital dialysis centers, and community mental health centers to originate Medicare telemedicine claims, effective at the beginning of 2009.[61] This is potentially a great step forward for telemedicine; it is up to the Centers for Medicare and Medicaid Services to decide how this law will be implemented.[62] Assuming that Medicare begins reimbursing for telemedicine, there is a very real chance that private insurers will follow.

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59. MAX STACHURA, ELENA V. KHASANSHINA, TELEHOMECARE AND REMOTE MONITORING: AN OUTCOMES OVERVIEW 23, available at http://www.advamed.org/NR/rdonlyres/2250724C-5005-45CD-A3C9-0EC0CD3132A1/0/TelehomecarereportFNL103107.pdf.

60. MAJD ALWAN, DEVON WILEY, AND JEREMY NOBEL, STATE OF TECHNOLOGY IN AGING SERVICES, CENTER FOR AGING SERVICES TECHNOLOGIES (CAST) 14 [*hereafter CAST*], available at http://www.agingtech.org/documents/bscf_state_technoloy_phase1.pdf.

61. *See* American Telemedicine Association, "Final Victory for Telemedicine Reimbursement: Congress Overrides Presidential Veto on H.R. 6331," July 16, 2008, at http://www.americantelemed.org/news/policy_issues/LegislativeAlert_16July2008.pdf.

62. *Id.*

D. Making the Case for Telemedicine and Remote Monitoring

A great deal of research has emerged from different sources on the efficacy and cost-effectiveness of telemedicine, and of remote monitoring in particular. However, much of it has heretofore been presented in fragmented form: small patient groups, narrow interventions, and lacking broad comparison of costs.

The goal of this paper is to assemble this valuable but fragmented research and combine it with data on broader medical spending, to make clear that telemedicine is a worthwhile national priority. Remote monitoring makes an excellent case study, because it is well-studied and creates measurable improvements in patient outcomes and reduced need for medical services, which can then be aggregated to give a meaningful measure of benefits. I find that the net benefits are on the order of $12.1 billion per year, even considering remote monitoring costs. Currently, the adoption of these technologies is very limited. This seems anomalous in light of the benefits available, and suggests that regulatory intervention may be warranted to address what seems to be a market failure. Given such a low installed base, appropriate telecommunications and reimbursement policy interventions, net of costs, could be worth a present discounted value of $43.8 billion over the next 25 years

II. Untapped Potential: Broadband Communications and Health Care

A. Communications Requirements for Telemedicine

A wide range of technologies are involved in telemedicine, from simple wireless monitoring devices to extremely sophisticated remote surgery suites. However, a broad group of these technologies depend on Internet access, which is most effectively and reliably provided by always-on broadband connections. For instance, with a broadband connection, remote monitoring devices can transmit live, two-way video side-by-side with vital signs between patients and caregivers. This video capability is very important if telemedicine is to reach its full

potential: if patients are to avoid costly and possibly painful travel, home examinations must offer similar diagnostic capability as in-person examinations; and to realize the full benefits of remote patient nursing visits, remote visits must provide the personal touch that in-person visits do.[63]

Certain telemedicine applications require dedicated and reliable connections, above and beyond those supplied by standard broadband connections. For example, the first telerobotic surgery was performed by doctors in New York on a gall bladder patient in Strasbourg, France; it required the use of a dedicated fiber-optic link to avoid disruptions in service.[64] Because the cost of such connections would make routine remote surgery impossible, practical applications such as rural telesurgery take advantage of Priority Virtual Private Networks (Priority VPNs), in which the surgery-related packets are given priority in transmission to avoid even small interruptions in the signal.[65]

Wireless technologies also have an important place in the implementation of telemedicine. The goal of telemedicine is to use technology to extend medical care into situations where it was not previously feasible; projecting medical expertise and services into rural areas or allowing practitioners to monitor patients when patients are not in medical facilities are two good examples. Wireless technologies allow telemedicine to extend to even more extreme situations. Cellular videoconferencing and monitoring solutions allow medical professionals access to locations where no fixed line service exists. Bluetooth and other personal wireless technologies allow full-time monitoring and emergency service even for mobile patients. Technology now exists to notify caregivers when an elderly person has not taken their

63. Dimmick, et al. 134 (concluding that the Home Touch program was a success among caregivers in part because of the medical value of the video, and a success among patients because of the sense of security and "personalization" allowed by the video).

64. Angela Pirisi, *Telerobotics brings surgical skills to remote communities*, 361 LANCET 1794 (2004).

65. *Id*. at 1794

medicine or has suffered a potentially dangerous fall.[66] By getting patients out of hospital beds and fully back into their lives, these technologies potentially have the greatest overall impact in terms of reduced costs, increased economic output, and improved quality of life.

B. Technical and Resource Requirements for Remote Monitoring

1. Requirements at the patient level

For home monitoring, the first requirement for the patient is some sort of monitoring apparatus. Modern home monitoring devices come in different types. One older but still common type of device consists of a central messaging station which can be connected to a home computer or may have a telephone modem built in. This device allows for text messages, patient condition reports or quizzes, and simple patient educational modules, and serves as a base station for peripheral monitoring devices.[67] Newer devices of this type are broadband-based and can be connected to televisions. These devices allow providers to leave personalized video or text messages for patients, and patients can view educational material delivered as video-on-demand. Their always-on nature also makes possible more intensive real time monitoring.[68] Television interfaces are also designed to be familiar and simple to use for patients and their caregivers.

Further, if home monitoring is to satisfactorily reduce home visits, then video capability in the base station may be necessary. The ability to communicate with care providers without traveling is a key benefit of remote monitoring—especially video transmission, as it adds to the

66. Elizabeth Olson, *Wireless Technologies Keep Elderly Safe From Afar*, N. Y. TIMES, May 25, 2008.

67. *See, e.g.*, the websites of equipment manufacturers Honeywell HomMed at http://www.hommed.com/ (last viewed May 27 2008), and Philips Telehealth at http://www.medical.philips.com/us/products/telemonitoring/products/ (last viewed May 27 2008) [*hereafter Equipment manufacturers*].

68. *See, e.g.,* Philips Telehealth's Motiva platform described at http://www.medical.philips.com/us/products/telemonitoring/products/motiva/index.asp (last viewed May 2008) [*hereafter Motiva Platform*].

provider's ability to assess the patient's condition at pre-critical stages, and contributes to the patient's sense of security.[69]

Peripheral monitoring devices that connect to these base stations are also necessary to provide telemedicine services in the home. These devices are specific to patients' conditions. Congestive heart failure (CHF) patients, for instance, need sphygmomanometers (blood pressure cuffs), pulse oximeters (measuring heart rate and blood oxygen level), scales, and possibly more sophisticated heart-rhythm and clotting-factor measurements.[70] Other conditions may require blood-glucose measurement, peak-airflow measurement, or wound photography. If live video is available and patients are examined by caregivers from afar, stethoscopes and portable cameras may be required.

Many of these peripheral monitoring devices now communicate wirelessly with the base station, making compliance easier for patients and making more frequent or continuous monitoring possible.[71] For example, wearable electrocardiography devices are now available, recording patients' heart patterns around the clock and sending them on to caregivers either through home base stations or through a Bluetooth-enabled cell phone.[72] Many other new monitoring developments are described in a report by three medical specialists: Majd Alwan, Devon Wiley, and Jeremy Nobel.[73]

Finally, the home monitoring apparatus must be able to transmit patient data to the health care provider. Some of the original telemedicine pilot programs relied on telephone visits from nurses and self-contained measurement units that queued up patient data and then dialed

69. Turisco & Metzger at 22-23.
70. Cleland et al. at 1656.
71. *Motiva Platform*.
72. *CAST* at 15.
73. *Id.* at 8-18.

into hospital computers at night on ordinary phone lines, and many systems sold today still do.[74] However, the increased availability and lower cost of broadband access is catalyzing development of more capable products that take full advantage of greater bandwidth. With the advent of widespread broadband access, live two-way video has become feasible on a broader scale, even in the home. Moreover, with always-on connections, patient data can be transmitted to the doctor on a continuous basis. This expands access to continuous monitoring, meaning that patients can be watched by trained professionals even when the patient is at home or at a rural health facility with limited personnel resources. Widespread broadband and household computer use both expands the range of services available, while enabling simpler and cheaper equipment to be employed in patients' homes.

2. Requirements at the medical provider level

For medical providers, the requirements for home monitoring come in two parts: getting patient information and using it. At the very least, providers need computer hardware and software for collecting the information from remote monitoring installations. In the past, for equipment relying only on phone lines (and not IP transmission), dedicated hardware was required for home base stations to dial into and deliver their collected data. Now, since most health care agencies already use computers for billing and payments, e-mail, and the Web, solutions are possible that require a minimum of hardware investment on the provider's end. Larger health care organizations can add remote monitoring onto existing servers; smaller organizations can outsource the collection and storage of health data to third-party providers and simply view patient data via web browsers or software bundled with the monitoring equipment. If video is to be added, health providers will also need to invest in video-conferencing equipment.

74. Noel et al. at 173.

Medical providers also need sufficient connectivity for home monitoring programs. As with computer hardware, larger health care organizations will likely be well-equipped to support home monitoring capability in the form of expanded bandwidth. Smaller organizations, especially home health agencies, may need to move from basic connections (such as dial-up or low-bandwidth Digital Subscriber Line (DSL) or cable modem connections) to more substantial broadband capability. If continuous monitoring or live video are required, health organizations may also want to invest in network options allowing for greater reliability and security.

Using remote monitoring data to its fullest extent will also require significant organizational investment and leadership, in much the same way that productivity has been enhanced by IT elsewhere in the economy. In health, the first necessary investment is in care coordination. The Veterans Administration has been a leader in this area, both because of its vertically-integrated structure (the organization captures almost all of the future cost improvements created by its investments in preventive medicine) and because of its patient mix. A widely quoted study by Meyer, Kobb, and Ryan reports that the combination of home telemonitoring, video visits, and coordinated care resulted in substantial improvements in health outcomes among a group of elderly veterans with a variety of chronic diseases. These gains included a 40 percent reduction in emergency room visits, a 63 percent reduction in hospital admissions, and a 60 percent reduction in hospital bed days of care, along with similar reductions in nursing home care.[75] Meyer, Kobb, and Ryan conclude that it is the synergy created by supporting care coordinators with the best possible telemonitoring and communication technology that has achieved these results and kept patients at home.[76]

75. Meyer et al. at 87.
76. *Id.* at 93.

Telemedicine would be more effective to the extent that providers also had access to electronic patient records and other technologies that were interoperable between different health providers.

Investment in training is also crucial at the individual caregiver level, especially when doctors and nurses are used to monitoring patients in person. One telehomecare study documented that nearly 25 percent of video visits were unsuccessful for technical reasons; however, this level fell over time, as the nurses (who previously had little computer experience) became more familiar and comfortable with the equipment.[77]

Finally, health organizations must acquire the technical expertise to set up and maintain these systems. For larger hospitals and health systems, adding this ability may involve increased cost or the establishment of a new telemedicine division or related corporation; for smaller hospitals, clinics, and home health agencies, the necessary expansion of technical scope may be a difficult requirement, requiring cooperation with other health providers and support from state and local agencies (some of which may need to be created).

3. Requirements for provider-to-provider remote monitoring

Thus far, I concentrated on the requirements for home health care monitoring. Another type of remote monitoring takes place between medical facilities, for example between a rural clinic or hospital and a larger hospital usually located in a distant city. Rural facilities with small patient populations suffer from poor economies of scale. In particular, they often cannot support full time intensive care unit (ICU) monitoring staff, whereas at larger facilities trained personnel can watch sensitive patients' vital signs around the clock. The solution has been to outsource monitoring from the rural hospital to the urban hospital, via broadband internet links, whereby

77. Dansky et al. at 228.

staff at the larger hospital monitor ICU patients' vital signs and contact on-duty physicians and nurses whenever necessary.[78]

The technical requirements for ICU monitoring are similar to those for home monitoring, with two main differences. First, while continuous monitoring is a beneficial but somewhat uncommon feature in home monitoring, in ICU monitoring continuous, high-quality monitoring is absolutely necessary. Second, ICU data needs to be available on a real-time basis, as opposed to home monitoring data, which is often collected several times a day or more and then aggregated so that caregivers can spot trends. Thus, the monitoring equipment needs to be extremely reliable, the network connections extremely robust and free from delays and disruptions, and the computer hardware on the monitoring end needs to make patient status visible in real-time.

C. State of Remote Monitoring Adoption

1. Adoption of Remote Monitoring in General

Remote monitoring is beginning to take hold among home care providers. The home care industry, according to the US Economic Census of 2002, consisted of 17,666 establishments and employed 777,128 people. Expenditures on home care were $52.7 billion in 2006 and are projected by the US Department of Health and Human Services to grow at over 7 percent a year for the next 10 years.

A study conducted in 2007 by the National Association for Home Care and Hospice (NAHCH) provides the most up-to-date information on these providers' adoption of telemonitoring. It shows that telemonitoring has established a beachhead in the industry, especially among large health agencies. Overall, 17.1 percent of the sampled agencies use some form of telemedicine, but adoption is uneven: agencies with Medicare budgets below $1 million

78. Turisco & Metzger at 20.

have only a 9 percent adoption rate vs. a 32 percent adoption rate for agencies with Medicare budget sizes above $6 million.[79]

The NAHCH study also makes clear where more work and support are needed. The number of telemonitoring units in adopting organizations remains low, with 10-25 units the most common survey response among adopters even among the largest organizations; only 12 percent of adopting organizations have more than 100 telemonitoring units.[80] Utilization is also lower than optimal; 43.4 percent of adopting organizations reported at least 75 percent of units were in use at any one time, but 14.5 percent of adopters reported that less than 25 percent of units were in use at any one time, meaning that a substantial portion of organizations may need additional support beyond purchase grants.[81] Meanwhile, video-based telemonitoring is still an under-utilized opportunity; only 18 percent of those agencies using telemonitoring use systems with video capability, or 3.1 percent of all sampled home care agencies.[82]

The state of adoption of remote monitoring in hospital and nursing home settings is somewhat less clear. A survey of California rural health care providers in 2003 found that 5.4 percent of health clinics and 8.9 percent of hospitals were using remote patient monitoring.[83] According to a report to Congress by the Joint Advisory Committee on Communications Capabilities of Emergency Medical and Public Health Care Facilities (JAC), as of the beginning

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79. NATIONAL ASSOCIATION FOR HOME CARE AND HOSPICE, PHILIPS HOME HEALTHCARE SOLUTIONS, AND FAZZI ASSOCIATES, INC., PHILIPS NATIONAL STUDY ON THE FUTURE OF TECHNOLOGY AND TELEHEALTH IN HOME CARE, 31, (2008) [*hereafter NAHCH*]

80. *Id.* at 39.

81. *Id.* at 39.

82. *Id.* at 33.

83. FRAN TURISCO ET AL., FIRST CONSULTING GROUP AND CALIFORNIA STATE RURAL HEALTH ASSOCIATION, TECHNOLOGY USE IN RURAL HEALTH CARE: CALIFORNIA SURVEY RESULTS, April 2003 [*hereafter California Survey*], available at http://www.chcf.org/topics/download.cfm?pg=hospitals&fn=RuralHealthCareSurvey%2Epdf&pid=91475&itemid=20206.

of 2008 there were over 200 currently operating telemedicine networks in the US, connecting over 3000 health facilities ranging from hospitals to prisons.[84]

Overall, both home care agencies and rural health care organizations seem to be taking first steps into remote monitoring, especially where grant funds are available. However, there are indications that more support is needed; usage levels within agencies remain low in some cases, and video adoption has been very slow. Additionally, purchases seem to be heavily dependent on grants: the NAHCH study found that the majority of agencies bought rather than leased their equipment, and that 90 percent of small agencies bought their equipment.[85]

There will continue to be impediments to the adoption of telemedicine until significant changes are made in Medicare and insurance reimbursement policies making home monitoring financially feasible for small agencies.

2. Adoption of Specific Remote Monitoring Capabilities

The monitoring of patients' status and vital signs is the most widely employed ability of telehomecare at present. The three most common sensors in the NAHCH survey (each employed by over 90 percent of the agencies using telemonitoring) are blood pressure monitors, pulse oximeters, and scales.[86] These are non-invasive sensors that are easy for patients or family members to use and which, together, provide remote care providers a powerful tool for care management and for early diagnosis of chronic disease exacerbations. The sensors are used both for chronic disease patients and for patients at home following hospitalizations or surgeries.

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84. JOINT ADVISORY COMMITTEE ON COMMUNICATIONS CAPABILITIES OF EMERGENCY MEDICAL AND PUBLIC HEALTH CARE FACILITIES, REPORT TO CONGRESS, 25 (2008).

85. NAHCH at 35. Purchasing vs. buying is relevant because most grants prohibit ongoing lease commitments.

86. Pulse oximeters measure the oxygen saturation of the patient's blood. *See* the MedLinePlus Health Dictionary at the National Institutes of Health, http://www2.merriam-webster.com/cgi-bin/mwmednlm?book=Medical&va=pulse%20oximeter (last viewed May 27, 2008).

For example, all these sensors are involved in cardiac care after heart attacks. One study of post-attack heart patients shows that patients' twice daily self-measurement of weight, blood pressure, heart rate, and rythym with automated devices linked to a cardiology center can play a valuable role in maintaining an effective therapy regimen and in detecting deterioration in patients' condition. The home monitored patients in the study subsequently spent less time in the hospital than control patients (6 days fewer per hospitalization) and had lower one-year mortality (29 percent vs. 45 percent).[87] Other general sensors used by telehomecare providers include stethoscopes (33.3 percent of agencies) and thermometers (58.9 percent).

A related use for these sensors is in properly monitoring medications. Blood sensors are more condition-specific, and slightly more intrusive. Blood glucose (used by 58.5 percent of agencies using telemedicine) and PT/INR (26 percent) testing help caregivers monitor diabetes and the level of coagulants in the blood, respectively. Combined with the other sensors above, these help doctors adjust dosages and monitor patients' self-medication compliance. One study of rural diabetes patients found that a telemonitoring program was effective both in controlling blood glucose levels and in teaching patients how to manage their condition themselves based on the home monitoring results.[88] In the case of diabetic patients, glucose monitoring can also tell caregivers when patients may be straying from dietary guidelines.

What the NAHCH survey also reveals is that video monitoring is presently underused. Video-equipped home monitoring equipment has great potential both for clinical benefit and for increasing the productivity of home care providers. In one study that added video-assisted televisits by home care nurses to a normal course of home care, the ability to examine the patient

87. Cleland et al. at 1660 (both of these results were statistically significant at the 95 percent level).

88. Susan Dimmick, Samuel Burgiss, Sherry Robbins, David Black, Bertha Jarnagin & Mary Anders, *Outcomes of an Integrated Telehealth Network Demonstration Project*, 9 TELEMED. J. E-HEALTH 13 (2003) [*hereafter Dimmick 2*].

and perform triage whenever convenient or necessary reduced hospitalization costs relative to a control group by 44 percent. In another study, video visits were substituted for some in-person visits for a set of rural home care patients; 98 percent of patients reported satisfaction with the video-supplemented care, and all patients found the equipment easy to use.[89] As with the above study, the ability to receive care when needed by the patient was highly valued by both patients and caregivers. Additionally, the reliability of the video system was a substantial advantage in the rural setting, because in-person visits were subject to traffic and weather problems.[90]

Finally, newer home monitoring technologies, such as motion/fall detectors and medication monitors, are available but not yet widely used. This is because Medicare and most insurers will not reimburse patients or caregivers for their use, and there is at present limited research into their effectiveness.[91]

A Case Study: Montefiore's Population-Based Telemonitoring Strategy

Montefiore Medical Center in New York City is the university hospital and academic medical center for the Albert Einstein College of Medicine. With 4 hospitals and 21 ambulatory medical facilities located throughout the Bronx and Westchester, Montefiore is one of the 50 largest employers in the state of New York. The Care Management Company ("CMO"), a subsidiary of Montefiore, contracts with medical insurance plans at varying levels of capitation to manage care for 100,000+ plan members in the area. According to internal estimates, 20 percent of CMO's Medicare population accounts for 84 percent of its Medicare costs. Whether high utilizing patients belong to Medicare, Medicaid, or commercial plans they are often frail, have chronic diseases, and many have substantial social support needs. CMO's telemedicine

89. Dimmick et al at 131.
90. Dimmick et al, at 130.
91. Olson, *High Tech Devices*. *See also* Alwan et al at 9.

strategy has been focused on identifying these patients, who they believe can most benefit from telemedicine.

To test the efficacy of various telemonitoring strategies for improving outcomes and reducing costs, CMO employs various care management efforts. CMO's initial foray into telemonitoring began in 2003 with a telemonitoring program for heart failure (HF) patients, and continues to this day. Members who agree to participate (~50% of the eligibles) receive a CardioCom Telescale that connects to a phone outlet in the home. The patient is asked to stand on the Telescale daily (the scale has a LCD display and speaks). The scale weighs the participant and asks a series of questions. For example, each participant is asked, "Are you taking all your medication?" The device is intended to overcome a patient's natural inclination *not* to bother a doctor when she is experiencing minor discomfort. The device's output is monitored by a nurse, who can call the patient and/or the patient's physician if necessary when they detect significant changes from their baseline, such as a sudden change in weight. The results of this program have shown that, over 5 years and 125 participants, patients who answer the questions and use the scale regularly see a 25 percent reduction in hospital utilization.

The Care Connect program grew out of the telemonitoring experience provided by the heart failure (HF) patients. CMO personnel noted that the sense of connection fostered in the HF program was applicable to patients in general, and could be of particular use in patients with chronic conditions, especially the frail elderly. Care Connect is aimed at keeping frail elderly patients connected with health professionals and identifying situations where early interventions are warranted. Care Connect provides frail elderly patients (average age 80) with a specially developed Cardiocom Frail Elderly (FE) device which has similar question-based messaging capability with questions targeted to this population. The goal of the project is to catch patients

before they “fall off the cliff”—in other words, to keep patients who are not “sick” from becoming sick. As with the earlier weight monitoring program, when patients respond to questions regularly nurses are able to get a picture of the patient’s health and communicate with patients when care is needed.

CMO’s experience with Care Connect has been very positive. Over the first year of the program, the 100 or so patients who joined and stayed for at least 6 months have enjoyed reductions of 38% and 55% in inpatient admissions and emergency room visits respectively. CMO’s costs for these patients have fallen from $23,000 per patient per year to $15,000 (-35%). This more than offsets the costs of providing the devices and managing the program (about $2,000 per patient per year).

CMO has recently begun working with the Health Hero Network’s Health Buddy device, also a telephone supported system, which reinforces self-maintenance behaviors by providing directed feedback around a broad array of topics, including why to take your medications and why to eat regularly. A clinician reviewing the results of these interactions continues to be integral to the success of these programs.

Montefiore and CMO are also managing Care Guidance, a program launched in June 2006 when CMO/Montefiore was selected by the Centers for Medicare and Medicaid Services (“CMS”) as one of the six demonstration sites for the High Cost Beneficiary demonstration project. Care Guidance is designed to improve the care and lower the costs of high risk beneficiaries participating in the original Medicare fee-for-service program. A multidisciplinary team of RNs, MSWs, pharmacists, LPNs, physicians, and case workers provide care coordination and social support to 3800 elderly and disabled Medicare beneficiaries living in the

Bronx. Telemonitoring is felt to be an important tool in managing this population, with over 200 patients benefiting directly. This demonstration will end in May 2009.

CMO's experience in telemonitoring, while generally successful, has underlined several practical complications in telemonitoring implementation. First, participant attrition and non-compliance are major challenges. One goal of any telemonitoring program is to enhance communication with patients and increase self-participation in care. However, no program can force patients to keep using a device or communicate with care providers. Until methods of engagement are improved, compliance will continue to be an issue that prevents the benefits of telemonitoring programs from reaching some subset of patients.

Second, identifying patients who can benefit from telemedicine programs may be difficult, but measuring whether patients have benefited from those programs is even more difficult. Some of the above programs may have shown improvements partially because many participants' needs for extra monitoring and reinforcement were apparent. However, CMO believes that the untapped potential benefits of telemonitoring lie with maximizing and maintaining the health of populations, rather than keeping relatively sick patients from getting sicker. Identifying the appropriate subpopulations, establishing what constitutes a successful outcome, and defining the success in terms of a workable business model remain the challenges. New statistical methods and study designs to help health administrators effectively implement telemonitoring programs and promote them to payers, health professionals, and patients would be extremely welcome.

III. LIFE QUALITY AND REMOTE MONITORING

A. General Benefits of Home-Based Care and Monitoring

Home monitoring has tremendous potential for increasing patients' quality of life. Some benefits accrue regardless of the patient's condition or age.

For example, one obvious benefit is reduced (or avoided) travel and waiting time. Depending on patients' and caregivers' location and condition, travel to clinics or hospitals can range from a minor annoyance to a serious hardship. One rural telemedicine study estimated the distance savings from a set of 444 telemedicine visits to be over 27,000 miles, an average of over 60 miles for each round trip.[92] Once at the doctor, the appointment time (an average of 20 minutes, according to the 2005 National Ambulatory Health Care Survey) may be extended by waiting for the doctor to be free.[93] If patients are not easily moved, the expense may be much higher than the patient's mileage and time. A 2007 study of the benefits of provider-to-provider telemedicine found that the average cost of transporting a patient from a nursing home to the doctor's office was $76, and this cost will rise to the extent fuel prices increase.[94]

Avoiding delays in care can be equally valuable to treatment. A 2005 survey of adults with health problems within the last two years (*Patients' Experiences Survey)* found that only 47 percent of U.S. respondents had been able to get appointments by the next day, and that 23 percent of patients either could not get an appointment at all or had to wait at least a week to obtain one.[95] Telehomecare with home monitoring is designed for care to be regular or continuous, and allows the patient to receive triage (medical assessment of patient condition and need for further attention) whenever necessary. Some home monitoring systems even have

92. Dimmick et al. at 129.
93. National Center for Health Statistics, *National Ambulatory Health Survey: 2005 Summary* 37 (2007).
94. *See CITL* at 45.
95. Cathy Schoen, Robin Osborn, Phuong Trang Huynh, Michelle Doty, Kinga Zapert, Jordon Peugh & Karen Davis, *Taking The Pulse Of Health Care Systems: Experiences Of Patients With Health Problems In Six Countries*, HEALTH AFFAIRS (Web exclusive) W5-509 (2005) [*hereafter Patients' Experiences Survey*], available at http://content.healthaffairs.org/cgi/reprint/hlthaff.w5.509v3?ijkey=10nPOyqgRXKAM&keytype=ref&siteid=healthaff.

condition questionnaires built into the user interface, to overcome patients' natural reticence to ask for help.[96]

Similarly, telehomecare allows patients to get care outside of typical office hours. According to the *Patients' Experiences Survey*, 60 percent of patients seeking care after hours found it somewhat or very difficult to get care, and 26 percent of emergency room visits were for care that could have been provided by a regular doctor if available.[97] Visits to the emergency room involve the same travel-related costs and inconveniences as physician visits, and wait times can be much longer. The *Patients' Experiences Survey* reports that 47 percent of patients waited at least an hour for care and that 12 percent of patients waited over four hours.[98] Moreover, many patients value the sense of security afforded by the ability to reach a care provider (especially when their telemonitoring equipment allows video examinations with attached diagnostic equipment).[99]

Most importantly, home based care and monitoring creates a relationship between providers and patients that is by nature proactive rather than reactive. Although home based care is often only prescribed after heart attacks or other adverse health events, once in place the home monitoring data enable nurses and physicians to treat exacerbations much sooner than they otherwise could. In particular, telehomecare with home monitoring reduces both the incidence and duration of hospitalization for patients with chronic conditions, including COPD and CHF. [100] In one study in the Veterans Administration system the total hospital bed days of care (BDOC) fell by 55 percent.[101] Although I discuss the financial costs of hospitalization later in

96. *Equipment Manufacturers*.
97. *Patients' Experiences Survey* at W5-519.
98. *Id*.
99. Dimmick et al. at 130.
100. Cleland et al. at 1661 *or* Johnston et al. at 44.
101. Meyer et al. at 87.

this paper, avoiding hospitalization is clearly a quality of life improvement for patients as well as for family and caregivers. Similarly, any care that telemonitoring provides on an out-patient, non-emergency basis will be more pleasant for patients than the alternatives, regardless of the financial savings.

B. Seniors

Senior citizens greatly value remaining in their homes. A series of surveys by AARP (formerly the American Association of Retired Persons) of AARP members in various states shows that a majority of seniors prefer long term care at home to care in other settings such as residential assisted living facilities or nursing homes. In Connecticut, 59 percent of respondents preferred home care, as opposed to 21 percent who preferred assisted living and 1 percent who preferred nursing home care.[102] In New Mexico, 90 percent of respondents thought that long term care that enabled them to stay at home was very or extremely important.[103]

In some cases remote monitoring technology can help home care substitute for more intensive settings (such as nursing homes).[104] More importantly, however, remote monitoring keeps patients home by producing better health outcomes. A 2006 study in rural Minnesota evaluated the long-term effects of the addition of remote monitoring and video visits to a program of skilled home nursing care. After six months, 42 percent of the control group patients had been discharged from the program to a higher level of care such as a hospital or nursing home, while only 18 percent of the patients receiving the tele-homecare intervention were

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102. AARP Knowledge Management, Long Term Care in Connecticut: A Survey of AARP Members 2, April 2008, available at http://assets.aarp.org/rgcenter/il/ct_ltc_08.pdf.

103. AARP Knowledge Management, Health Care Reform and Long Term Care: A Survey of AARP Members in New Mexico 9, January 2008, available at http://assets.aarp.org/rgcenter/il/nm_hcr_ltc_08.pdf.

104. *See* Onor et al. at 165.

discharged to a higher level of care.[105] Many studies described elsewhere in this paper also find improvements in health outcomes that reduce the need for care away from home.[106]

Health needs are not the only problem that can force seniors out of their homes into residential care facilities. Seniors also must be able to live independently to remain at home, and remote monitoring helps keep seniors independent. Video visits and interactive monitoring devices are excellent ways to help seniors learn self-management techniques for their chronic health conditions. A study of elderly diabetics who were given weekly video and telephone visits by nurses over a period of several months demonstrated substantial improvements in patients' ability to manage their blood glucose levels, both through diet and insulin control.[107] Access to diagnosis and advice around the clock, without having to travel to the doctor's office or hospital, is an important source of security for seniors who live alone or are unable to drive; it also reduces the burden on their caregivers.[108]

Above and beyond helping seniors perform tasks for themselves, however, telemonitoring helps seniors avoid the serious illnesses and exacerbations in chronic conditions that can destroy their independence. In order to remain at home, seniors need the strength and endurance that comes with physical and social activity. Yet as seniors age, their physical reserves decline, and after serious illnesses or hospitalizations, they may be unable to resume their former activities.[109]

Regular monitoring and other proactive care can keep frail, elderly patients from losing their independence. Passive sensors in the home or health alarm devices enable patients to

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105. Stanley M. Finkelstein, Stuart M. Speedie & Sandra Potthoff, *Home Telehealth Improves Clinical Outcomes at Lower Cost for Home Healthcare*, 12 TELEMED. J. E-HEALTH 28 (2006).

106. *See e.g.* Cleland et al. at 45, *and* Dansky et al. at 225.

107. *See Dimmick 2* at 21-22.

108. *See* Dimmick et al. at 130.

109. *See* Onor at 164.

receive help as quickly as possible following falls and other dangerous events.[110] Regular video visits and remote vital signs monitoring let caregivers monitor patients' diets and medication usage, and more importantly let them spot signs of general decline. A coordinated approach is very important since many frail, elderly patients have multiple chronic conditions, and even small problems in one area such as diet can quickly result in major health problems.[111]

The cost of traditional health care is an especially important issue for senior citizens on fixed incomes. Nursing home care is extremely expensive. A national survey by the MetLife Mature Market Institute (MMMI) found that the national average yearly rate in 2007 was $77,745 for nursing home care, and $35,628 for assisted living care.[112] Medicare does not cover long term nursing home care, but only short term care when medically necessary, usually following hospitalizations. Medicaid does cover long term care when medically necessary, but it requires that patients spend all their income and assets first, leaving only a small stipend if a spouse is still living in the community.[113]

Home care is very affordable by comparison. Another survey by the MMMI studied the costs of home care services, finding that the national average hourly rate for home health aides in 2007 was $19.[114] Over the course of a year, even if a home health aide were to spend 4 hours in the home each day, the total annual cost would be $27,740, below the cost of assisted living care, and substantially less expensive than nursing home care. Although some seniors receiving home

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110. *See* Alwan at 9-10.

111. *See* Onor at 164.

112. Metlife Mature Market Institute, The MetLife Market Survey of Nursing Home and Assisted Living Costs, 4, October 2007 [*hereafter MMMI Nursing Home Costs*], available at http://www.metlife.com/FileAssets/MMI/MMIStudies2007NHAL.pdf. These costs vary by region of the country. At the upper end of the scale, for example, nursing home care in Anchorage, Alaska currently costs $180,000 annually.

113. Kaiser Family Foundation, Medicaid and Long-Term Care Services 2006 Fact Sheet, 1-2, July 2006, available at http://www.kff.org/medicaid/upload/Medicaid-and-Long-Term-Care-Services-PDF.pdf.

114. MetLife Mature Market Institute, The MetLife Market Survey of Adult Day Services and Home Care Costs, 4-5, September 2007 [*hereafter MMMI Home Care Costs*], available at http://www.metlife.com/FileAssets/MMI/MMIStudies2007ADSHCCStudy.pdf.

health care might also need occasional skilled nursing care, keeping seniors in their homes improves their quality of life and allows them to retain at least a portion of their assets.

C. Reduced Impact on Patient and Caregiver Work Schedules

Illness has significant impact on patients' and their families' work schedules. Patients must go to or be taken to appointments, often at inconvenient times. Critical conditions may require emergency care at any time. One study estimated that employers nationwide lose $10 billion each year in reduced productivity due to caregivers' workday interruptions and crises in care.[115] Remote monitoring, by allowing continuous and preventive care, reduces the time patients and their caregivers must spend procuring all kinds of health care, and reduces the disruption to their jobs and work schedules.

Telemonitoring also can help patients who need regular monitoring maintain regular work and social lives. For instance, portable monitors are now available that communicate through a Bluetooth wireless connection to a cellular phone, which sends health data on to a patient's care provider.[116] Other available peripherals include cardiac event monitors, blood pressure monitors, pulse oximeters, spirometers (breathing function testing devices), and scales.

IV. Economic Benefits of Remote Monitoring

A. Mechanisms for Direct Cost Savings

Although telemonitoring has many indirect and quality-of-life benefits, its most measureable, tangible benefits will be realized through reduced health care costs. This will be accomplished by improving health outcomes and reducing health care utilization.

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115. MetLife Mature Market Institute, The MetLife Caregiving Cost Study: Productivity Losses to U.S. Business, 14, July 2006, available at http://www.metlife.com/FileAssets/MMI/MMIStudiesCaregiverCostStudy.pdf. Caregiver refers to a spouse, a child, or other private individual who takes responsibility for a patient's health.

116. *See e.g.* LifeWatch Corporation's LifeStar line of wireless vital signs monitors, at http://www.lifewatch.com/LWTpo_vsm.html.

1. Impact on Physician Visits

Telemonitoring may both increase or decrease physician visits, depending on the patient's condition and the particular telemonitoring program. This is because physician visits can be proactive as well as reactive. Although monitoring and video visits may be able to substitute for some physician visits, the early warning afforded by telemonitoring may also help physician visits substitute for emergency room visits or hospitalizations. Table 1 below describes the results of available studies measuring the effect of telemonitoring programs on physician visits, indicating both negative and positive impacts.

TABLE 1: STUDIES MEASURING CHANGE IN PHYSICIAN OFFICE VISITS WITH TELEMONITORING

Authors	Intervention	Disease Groups	Result
Cleland et al. (2005)	Physiological monitoring, telephone visits	Heart disease	Office visits increased by 71%
Johnston et al. (2000)	Video visits	Heart disease, lung disease, diabetes, chronic wounds	Outpatient costs (including ER visits) increased by 12%
Meyer, Cobb, and Ryan (2002)	Physiological monitoring, video visits, messaging	Heart disease, lung disease, diabetes, chronic wounds	20% fewer visits relative to control
Noel et al. (2004)	Physiological monitoring, remote wound camera	Heart disease, lung disease, diabetes, chronic wounds	10% more visits relative to control
Trappenburg et al. (2008)	Remote messaging	Lung disease	17% fewer outpatient visits relative to control

2. Reduced Emergency Room Visits

In contrast to its ambiguous effects on physician visits, telemonitoring most likely reduces emergency room visits in most telemonitoring programs. This is for several reasons.

First, video visits and home monitoring allow nurses or physicians to perform the same sort of diagnostic care as would occur in the emergency room. Second, by enhancing the ability of medical staff to monitor a patient's medication compliance and teach them effective self-care

techniques, telemonitoring keeps patients' condition more stable. Third, videoconferencing and other communications devices give patients access to care outside of normal office hours and without waiting for appointments. As shown in Table 2, four of five recent studies document that telemonitoring reduces emergency room visits.

TABLE 2: STUDIES MEASURING CHANGE IN EMERGENCY ROOM VISITS WITH TELEMONITORING

Authors	Intervention	Disease Groups	Result
Johnston et al. (2000)	Video visits	Heart disease, lung disease, diabetes, chronic wounds	Outpatient costs (including ER visits) increased by 12%
Meyer, Cobb, and Ryan (2002)	Physiological monitoring, video visits, messaging	Heart disease, lung disease, diabetes, chronic wounds	Reduced ER visits by 29% vs. control.
Noel et al. (2004)	Physiological monitoring, remote wound camera	Heart disease, lung disease, diabetes, chronic wounds	Reduced ER visits by 19% vs. control
Rees and Bashshur (2007)	Wound camera	Chronic wounds	Reduced ER visits by 59% vs. control
Strategic Healthcare Programs, LLC (2004)	Physiological monitoring	Heart disease, lung disease, diabetes	Reduced ER visits by 49% for CHF patients, 66% for COPD patients, and 83% for diabetes patients

3. Reduced Hospitalizations

Numerous studies have found a clear reduction in hospitalization, both in admissions and in total days of care, when caregivers are able to monitor patients' heart rythym, blood pressure, blood sugar levels, and other indicators on a daily or hourly basis. Table 3 presents a wide range of studies examining telemedicine's impact on hospitalization: the reduced hospitalizations and bed days of care (BDOC) range from 20 percent to 75 percent.

TABLE 3: STUDIES MEASURING CHANGE IN HOSPITALIZATIONS AND BDOC WITH TELEMONITORING

Authors	Intervention	Disease Groups	Result
Cleland et al. (2005)	Physiological monitoring, telephone visits	Heart disease	Reduced BDOC by 20% vs. control.
Dansky et al. (2001)	Video visits	Heart disease, lung disease, diabetes, chronic wounds	Reduced hospitalizations by 64% vs. control
Finkelstein et al. (2006)	Physiological monitoring, video visits	Heart disease, lung disease, chronic wounds	Hospital and nursing home admissions reduced by 58% vs. control
Johnston et al. (2000)	Video visits	Heart disease, lung disease, diabetes, chronic wounds	Reduced hospitalization expenses by 44% vs. control
Meyer, Cobb, and Ryan (2002)	Physiological monitoring, video visits, messaging	Heart disease, lung disease, diabetes, chronic wounds	Reduced BDOC by 52% vs. control.
Montefiore Care Connect (interview, 2008)	Physiological monitoring, telephone visits, messaging	Heart disease, lung disease, diabetes	Reduced hospitalization and ER costs by 40%
Noel et al. (2004)	Physiological monitoring, remote wound camera	Heart disease, lung disease, diabetes, chronic wounds	Reduced BDOC by 19% vs. control
Rees and Bashshur (2007)	Remote wound camera	Chronic wounds	Reduced BDOC by 45% vs. control
Strategic Healthcare Programs, LLC (2004)	Physiological monitoring	Heart disease, lung disease, diabetes	Reduced hospitalizations by 39% for CHF patients, 51% for COPD patients, and 75% for diabetes patients
Trappenburg et al. (2008)	Remote messaging	Lung disease	Reduced hospitalization by 41% vs. control

4. Reduced Nursing Home Care

Telemonitoring reduces the need for nursing home care both by allowing home care to substitute for some nursing home care and by keeping patients healthy and thereby avoiding the need for such a high level of assistance. Both studies presented in Table 4 take the latter approach, and find that a significant percentage of patients can be kept out of nursing homes with the help of remote monitoring.

TABLE 4: STUDIES MEASURING CHANGE IN NURSING HOME ADMISSIONS AND BDOC WITH TELEMONITORING

Authors	Intervention	Disease Groups	Result
Finkelstein et al. (2006)	Physiological monitoring, video visits	Heart disease, lung disease, chronic wounds	Hospital and nursing home admissions reduced by 58% vs. control
Meyer, Cobb, and Ryan (2002)	Physiological monitoring, video visits, messaging	Heart disease, lung disease, diabetes, chronic wounds	Reduced nursing home BDOC by 68% vs. control.

B. Potential Health Care Expenditure Savings of Remote Monitoring for Various Sub-Populations

I now break down the potential savings from the telemonitoring of different patient populations by the expense items discussed in the previous section. Estimates from the Agency for Healthcare Research and Quality (AHRQ) and from the National Center for Health Statistics identify the total number of emergency room visits, hospitalizations, and nursing home stays. Cost figures from the AHRQ and from the MetLife Mature Market Institute (MMMI) indicate the amount that can be saved by reducing the need for these services.

The research literature listed in the previous tables provides a range of estimates of the ability of telemedicine to improve patient outcomes and reduce resource utilization. The estimates cover a wide range of chronic conditions and diseases. Many patients, however, suffer from more than one condition at once. Moreover, most of the available studies on the effect of telemedicine on chronic disease management patients focus on groups served by particular hospitals or health organizations, rather than particular disease groups.

To the extent possible, therefore, I have identified the studies that include patients with particular conditions or diseases, and averaged the reported effects of telemedicine for each cost item. The one exception is physician office visits, where the studies differ on the impact (some indicating that telemedicine substitutes for outpatient visits, while others indicate that

telemedicine promotes outpatient visits as a substitute for inpatient stays). In particular, health organizations that are reimbursed per patient rather than per service provided tend to consider physician office visits to be inexpensive substitutes for emergency room visits or hospitalizations, as does the Montefiore Medical System (discussed in a case study above). Physician office visits and other claims on providers' time are broken down below, as part of a discussion of telemonitoring costs.

Another issue that is not well addressed by the existing literature is how many emergency room visits and hospitalizations are preventable. Some patients may only be diagnosed upon their first visit to the emergency room (and subsequent hospitalization). To be conservative, I assume that only half of these urgent events are preventable, and the estimates below are adjusted accordingly.

Because the surveys that this section draws upon range in time from 2004 to 2007, all costs are adjusted to 2008 dollars. Again, to be conservative, the numbers of medical events (ER visits, hospitalizations, and so on) are left as they are reported by the surveys. I discuss in later sections the impact of demographic changes on future utilization.

1. Diabetic Patients

As already discussed, telemedicine can help diabetes patients better manage their disease and thereby keep them out of hospitals and emergency rooms. Diabetic patients visited emergency rooms approximately 472,000 times in 2006.[117] The average charge for such a visit was $1,770,[118] resulting in total preventable expenditure of $377 million per year. On average,

117. Estimate created by the Healthcare Cost and Utilization Project (HCUP) based on the State Emergency Department Databases (SEDD) 2005, Agency for Healthcare Research and Quality [*hereafter SEDD*]. Note that only 23 states report data to the SEDD; I extrapolate these estimates to the entire United States based on the population of the reporting states. A database is available for web-based queries at http://hcupnet.ahrq.gov.

118. *Id.* (in 2008 dollars).

the studies above show a 30 percent decrease in emergency room use for diabetic patients as a result of telemedicine. This translates into potential savings of $113 million.

Diabetes also was responsible for an estimated 540,000 hospitalizations in 2006.[119] Since the average charge for these visits was $26,000,[120] diabetes-related hospitalizations cost $14 billion in that year. The mean reduction in diabetes-related hospitalization expenses or BDOC as a result of telemonitoring is 49 percent, based on the studies that measure the change in hospitalization rates of diabetic patients. Accordingly, telemedicine could generate $3.5 billion (2008 dollars) in savings from reduced hospitalizations.

In 2004, there were 57,500 patients in nursing homes whose primary diagnosis at admission was diabetes.[121] The studies cited above suggest that 63 percent of these patients could avoid nursing home care through home care and remote monitoring, Conservatively, I assume that all of these patients would require home care, at $28,000 a year; this is a saving of nearly $41,000 from the national average cost for a year in a semi-private nursing home room.[122] Applied to the entire population of nursing home patients with diabetes, telemedicine could lead to savings of as much as $2.5 billion a year (2008 dollars) in nursing home costs.

In sum, telemedicine promises very substantial benefits for diabetes patients – over $6 billion annually (see Table 5 below).

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119. Estimate created by the Healthcare Cost and Utilization Project (HCUP) based on the Nationwide Inpatient Sample (NIS) 2006, Agency for Healthcare Research and Quality [*hereafter NIS*]. A database is available for web-based queries at http://hcupnet.ahrq.gov.

120. *Id.* (in 2008 dollars)

121. National Nursing Home Survey (NNHS) 2004, National Center for Health Statistics (NCHS), Current Resident Tables – Estimates: Table 33 [*hereafter NNHS*]. Available at http://www.cdc.gov/nchs/data/nnhsd/Estimates/Estimates_Diagnoses_Tables.pdf#Table33.

122. *See MMMI Home Care Costs* at 4-5, *and see MMMI Nursing Home Costs* at 4.

TABLE 5: POTENTIAL ANNUAL SAVINGS FROM TELEMONITORING FOR DIABETES PATIENTS

Estimated Savings For Diabetes Patients	Emergency Care Expenses	$0.1 billion
	Hospitalization Expenses	$3.5 billion
	Nursing Home Expenses	$2.5 billion
	Total:	$6.1 billion

2. Congestive Heart Failure Patients

Among its other benefits, telemedicine allows care providers to observe deterioration in a CHF patient's condition much earlier than would otherwise be possible, thus shortening or avoiding emergency room visits and hospital stays. About 175,000 emergency room visits were made in 2005 because of congestive heart failure (CHF), and each visit cost an average of $2,746, resulting in total preventable expenditure of $240 million per year.[123] On average, the studies above show a 33 percent decrease in emergency room use as a result of telemedicine. This results in potential annual savings of $50 million (2008 dollars).

CHF was the primary diagnosis for 1.1 million hospitalizations in 2006, and each visit was billed at over $32,000.[124] The mean reduction in hospitalization expenses or BDOC as a result of telemonitoring is 42 percent based on the studies that measure the change in hospitalization rates of CHF patients. This means that a total of $7.4 billion (2008 dollars) could be saved on hospitalization costs.

123. *See SEDD*.
124. *See NIS* (in 2008 dollars).

In 2004, there were 63,800 patients in nursing homes whose primary diagnosis at admission was CHF.[125] The studies above suggest that 63 percent of these patients could avoid nursing home care through home care and remote monitoring, Conservatively, I assume that all of these patients would require home care, at $28,000 a year; this is a saving of nearly $41,000 from the national average cost for a year in a semi-private nursing home room.[126] These figures imply annual savings of $2.7 billion a year (2008 dollars) in nursing home costs.

As shown in the table below, the potential savings from telemedicine for patients with congestive heart failure is even greater than for diabetes—over $10 billion per year.

TABLE 6: POTENTIAL ANNUAL SAVINGS FROM TELEMONITORING FOR CHF PATIENTS

Estimated Savings For CHF Patients	Emergency Care Expenses	$50 million
	Hospitalization Expenses	$7.4 billion
	Nursing Home Expenses	$2.7 billion
	Total:	$10.1 billion

3. Chronic Obstructive Pulmonary Disease Patients

The key benefit of telemedicine for patients with chronic obstructive pulmonary disease (COPD) is the ability it gives care providers to medicate patients using inhalers or other treatments before their conditions require urgent care or hospitalization. COPD resulted in approximately 1.2 million emergency room visits in 2005, and hospitals charged an average of $1,227 per visit, resulting in total preventable expenditure of $720 million per year.[127] On

125. *See NNHS.*
126. *See MMMI Home Care Costs* at 4-5, *and see MMMI Nursing Home Costs* at 4.
127. *See SEDD* (in 2008 dollars).

average, the studies above show a 33 percent decrease in emergency room use as a result of telemedicine, implying potential annual savings of $184 million (2008 dollars).

COPD was also the cause of 600,000 hospitalizations in 2006.[128] Charges for these visits averaged just over $20,000 per visit.[129] The mean reduction in hospitalization expenses or BDOC as a result of telemonitoring is 46 percent for those studies that include COPD patients and include a measure of the change in hospitalization. Based on these figures, telemedicine could save $2.9 billion (2008 dollars) in hospitalization costs annually.

In 2004, there were 42,200 patients in nursing homes whose primary diagnosis at admission was COPD.[130] The studies above suggest that 63 percent of these patients could avoid nursing home care through home care and remote monitoring, Conservatively, I assume that all of these patients would require home care, at $28,000 a year; this is a saving of nearly $41,000 from the national average cost for a year in a semi-private nursing home room.[131] These figures imply annual savings of $1.8 billion a year (2008 dollars) in nursing home costs.

In total, as shown in the table below, telemedicine therefore could generate savings of approximately $5 billion annually for those patients with COPD.

TABLE 7: POTENTIAL ANNUAL SAVINGS FROM TELEMONITORING FOR COPD PATIENTS

Estimated Savings For COPD Patients	Emergency Care Expenses	$0.2 billion
	Hospitalization Expenses	$2.9 billion
	Nursing Home Expenses	$1.8 billion
	Total:	$4.9 billion

128. *See NIS.*
129. *See NIS* (in 2008 dollars).
130. *See NNHS.*
131. *See MMMI Home Care Costs* at 4-5, *and see MMMI Nursing Home Costs* at 4.

4. Chronic Skin Ulcer Patients

As discussed above, wound care patients benefit from regular follow-up care and monitoring by specialists to avoid surgery and hospitalization. Telemedicine can help these patients by enabling nurses and physicians to review digital images of a patient's wounds on a daily or weekly basis.

Almost 47,000 emergency room visits were made in 2005 for treatment of chronic skin ulcers, and each visit cost an average of $916, resulting in total preventable expenditure of $21 million per year.[132] On average, the studies above show a 33 percent decrease in emergency room use as a result of telemedicine, which translates into potential savings of $5 million (2008 dollars) per year.

Although emergency care is less of a burden for chronic skin ulcer patients than for the other chronic conditions discussed here, hospitalization is a more serious problem. Chronic skin ulcers resulted in 79,000 hospitalizations in 2006.[133] Charges for these visits averaged just under $43,000 per visit.[134] The mean reduction in hospitalization expenses or BDOC as a result of telemonitoring is 47 percent for those studies that include wound care patients and include a measure of the change in hospitalization. This means that a total of $800 million (2008 dollars) could be saved on hospitalization costs for chronic skin ulcer patients through the use of telemedicine.

In 2004, there were 6,500 patients in nursing homes whose primary diagnosis at admission was a chronic skin ulcer.[135] The studies above suggest that 63 percent of these patients could avoid nursing home care through home care and remote monitoring,

132. *See SEDD* (in 2008 dollars).
133. *See NIS.*
134. *See NIS* (in 2008 dollars).
135. *See NNHS.*

Conservatively, I assume that all of these patients would require home care, at $28,000 a year; this is a saving of nearly $41,000 from the national average cost for a year in a semi-private nursing home room.[136] These figures imply annual savings from telemedicine for chronic skin ulcer patients of $280 million a year (2008 dollars) in reduced nursing home costs.

In total, as shown below, telemedicine promises $1.1 billion in annual savings for patients with chronic skin ulcers.

TABLE 8: POTENTIAL ANNUAL SAVINGS FROM TELEMONITORING; CHRONIC SKIN ULCER PATIENTS

Estimated Savings For Chronic Skin Ulcer Patients	Emergency Care Expenses	$5 million
	Hospitalization Expenses	$800 billion
	Nursing Home Expenses	$270 million
	Total:	$1.1 billion

5. Summary of Current Annual Benefits from Remote Monitoring

Telemonitoring and telehomecare are only a small part of the scope of telemedicine, but they have great potential to improve patient outcomes and thus reduce the cost of emergency, hospital, and nursing home care. For these chronic diseases, these studies indicate that the potential reductions in these costs from the use of remote monitoring and visiting technologies total $22.2 billion per year (2008 dollars).

V. FROM VISION TO REALITY

A. Policies Required for Investments and Technical Developments to Achieve Potential Benefits

At bottom, telemonitoring provides a way for doctors and patients to communicate more effectively and more frequently, despite the hurdles of time and distance. Internet technology

136. *See MMMI Home Care Costs* at 4-5, *and see MMMI Nursing Home Costs* at 4.

enables this contact, and disruptions in service can greatly reduce its effectiveness—if patients do not feel the "telepresence" of the provider (as one study put it),[137] then they will not accept telemonitoring and will not use it, and if providers do not get the information they need, then they will not adopt telemonitoring in the first place.

To this end, appropriate policies must be in place to encourage the *technical environment* necessary for enabling telemonitoring and other telemedicine applications:

- *Remote monitoring products must be interoperable, safe, effective, and easy for patients or caregivers to use. Many individual companies offer products that are safe, effective, and easy to use, but interoperability is still far from a reality. Continua Health Alliance is an example of an industry effort toward several common standards for hardware and information sharing.[138] Commitments from Medicare to provide preferential reimbursement for interoperable products (as part of the broader changes to Medicare reimbursement discussed below) would accelerate interoperability.*

- *Widespread broadband connections allow for rich patient data exchange, video visits, and patient education via the internet and video-on-demand. However, seniors tend to be late adopters of technology and at the same time benefit disproportionately from more effective chronic disease care. For telemedicine to achieve its promise in both service improvements and cost reductions, policymakers should encourage adoption (especially among seniors) by several means: investments in internet education; incentives for rural broadband infrastructure investment; and telecommunications policies that allow broadband providers to experiment with different offerings that attract marginal users without sacrificing profits on other users.*

- *While broader broadband penetration is clearly desirable, the right kind of broadband is just as important. Effective remote monitoring requires "smart networks", those which ensure that patients' critical data and communications are not disrupted. As with ambulances on the road, communications essential to patients' survival should take priority over other traffic on the network. The resulting reliability and quality of service is crucial to the ability of providers to supplement virtual care for in-person care. Policy must therefore ensure that network providers retain maximum flexibility to assure the quality of service necessary for effective and reliable telemedicine services.*

- *The critical and personal nature of the health data involved in remote monitoring calls for network infrastructure that allows for extremely reliable and secure transmission of patient communications and data. Although some stop-gap*

137. *See* Dimmick et al. at 48.
138. Continua Health Alliance, www.continuaalliance.org

technologies have been employed in trial applications, wider adoption will require investment and support of innovation in network capabilities.

- *Given the sensitivity of personal health information, privacy rules are essential. At the same time, privacy rules for telemedicine should be no more burdensome than those that apply to non-electronic environments. Furthermore, providers of telemedicine services must not be subject to unreasonable liability rules that could chill their provision of such services.*

- *To take full advantage of the available data and communications capabilities, providers need hardware and software (managed either by the health organization or by a third party) that allow health professionals to quickly access relevant patient data, communicate with patients, and track patients' health conditions. In particular, integrated systems that feature interoperability between and among hardware and with health IT infrastructures, and between and among multiple providers are necessary to accomplish these objectives. The Consolidated Health Informatics (CHI) Initiative is one example of such an effort.*[139] *As with hardware for patients, Medicare clearly should provide preferential reimbursement for products that allow care to be coordinated across providers.*

Other investments and policy changes need to be made in the *health arena* in particular. Without knowledge of telemedicine capabilities, expertise and training, and integration into care, the data gathering and communications capabilities of telemonitoring will fall short of their potential.

- *Health boards and associations should adjust their accreditation procedures to include professionals specialized in various aspects of telemedicine and remote monitoring. In particular, telecare coordination specialists and monitoring specialists are two important new professions necessary for taking full advantage of the data from home monitoring.*

- *Hospitals and health organizations need to invest in IT infrastructure. HIMSS Analytics projects health IT spending to account for about half of hospitals' total capital spending for 2008, but this investment is building on a low base: for example, computerized physician order entry systems (CPOEs) and clinical decision support systems (CDSSs) were used in less than five percent of hospitals as of the end of 2007.*[140] *Many investments, including CDSS and CPOE systems as well as electronic health records, are complementary with telehomecare and telemonitoring.*

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139. *See* Consolidated Health Informatics (CHI) Initiative, http://www.hhs.gov/healthit/chi.html.

140. *See* HIMSS Analytics. Essentials of the US Hospital IT Market – 3rd Edition, 2007, at iv-vi. Available at http://www.himssanalytics.org/docs/iIntro.pdf

- *Increased grant funding for telemedicine-specific health IT investments such as video-conferencing equipment, remote exam rooms, and remotely monitored ICUs is vital at this early-adoption stage, when the external benefits of "joining the network" are at their smallest. Similarly, funding for technology training makes adoption easier for providers, and the increased awareness encourages providers to embrace telemedicine programs. Special attention may be required to the needs of small (less than $1 million billed per year) health agencies and organizations, based on their current low adoption rates.*

- *Care coordination is complementary to telemonitoring, and some of the most successful telemonitoring demonstration programs (both in terms of clinical outcomes and physician and nurse buy-in) are centered on chronic-disease management programs.*[141] *Along with accreditation for telecare-coordination specialists, grants for the development of new care coordination programs help establish institutional expertise at new locations and encourage provider buy-in.*

- *Preventive medicine also has synergies with telemonitoring. Policymakers should consider creating incentives at the national level for physicians to enter preventive medicine, which is one of the 24 specialties recognized by the American Board of Medical Specialties (ABMS).*

Finally, although all providers must be aware of some forms of telehealth and health IT, the low adoption rates of telemonitoring to date indicate that there is still a need to inform providers of its capabilities and potential benefits. This study is one step, but new programs and support for existing organizations such as the American Telemedicine Association will also bring widespread telemonitoring closer to fruition.

B. Reimbursement Practices

1. Costs of Telemonitoring

In this study, I focus on the most important costs involved in a telemonitoring implementation—equipment and monitoring costs. Other cost factors are more difficult to predict. For instance, it is possible, as in a few of the studies above, that a given telemedicine program will result in an increased level of outpatient services provided, when early intervention replaces acute care. However, as the studies demonstrate, the structure of the program may also

141. *See for example* Meyer et al. and *Montefiore*.

reduce the need for additional care. For example, telemonitoring may reduce the need for regular check-ups, since two of the major purposes for check-ups are for the patient to communicate any health issues they have to their medical provider, and for the provider to record vital signs.

Telemedicine equipment costs are substantial. While a few programs, such as remote asthma monitoring using web-based technology,[142] have been implemented using only patients' existing computers and spirometers (devices testing breathing function), most telemonitoring programs require dedicated equipment including base stations, peripherals, cameras, and so on. A report on provider-to-provider technologies from the Center for Information Technology Leadership (CITL) gives examples of costs for different types of equipment.[143] This equipment can range in cost from several hundred dollars to several thousand dollars for more complex systems that include cameras and broadband capabilities.

Monitoring costs can likewise be significant. All telemonitoring requires some sort of communication infrastructure so that the data collected by telemonitoring devices can be viewed by health providers. However, the data must subsequently be reviewed, either by a person or by some sort of monitoring software. Monitoring costs can also vary depending on the program and the hardware used, from monthly costs near zero to over $50 per month.

In the past, many telemonitoring programs relied on start-up grants to pay for equipment, and then monitored the equipment using specialized staff and network hardware. To simplify the financing and implementation of telemonitoring programs, equipment providers are increasingly packaging telemonitoring equipment with monitoring services on a per-patient, per-month subscription basis. Currently, for example, joint prices from third party providers for the

142. *See* Jan et al at 257.
143. *See* CITL at 99-102.

kinds of equipment and services that CMO buys for its telemonitoring programs (see case study above) average between $75 and $100 per patient.

For the purposes of this paper, I will use an estimated average cost of $1000 per patient per year for the cost of implementing telemedicine. This would be equivalent to purchasing a $2500 system and amortizing it over 5 years, and incurring a monitoring cost of slightly more than $40 a month. Alternatively, on a subscription basis, this would be equivalent to an $87-per-month payment. This should allow for the purchase of a middle-of-the-road system at current prices. The total expense of chronic disease management programs may exceed this figure. However, as discussed above, some of the costs of such programs are clinical and outpatient services that are not necessarily part of the incremental cost of telemonitoring.

The second part of the calculation of telemonitoring costs is to determine how many patients should be monitored. Finding the patients that will benefit most from telemonitoring support is itself a significant implementation challenge, as described in the Montefiore/CMO case study earlier in this paper. The reality that not every hospitalization can be avoided is already built into my calculation of benefits; part of the reason behind this is that physicians do not know who to monitor. In practice, they are most likely to monitor patients who are most clearly on a path to needing acute care. While perfect measures are not available for this population, the National Health Interview Survey (NHIS) includes estimates for the number of patients with chronic diseases who are functionally impaired by their conditions. Table 9 presents the numbers of patients of the four chronic conditions discussed in the above sections, calculated from the results of the 2006 NHIS.[144] These totals have been adjusted to reflect 2008 population and to avoid counting patients multiple times for multiple conditions.

144. National Center for Health Statistics (2007). *Data File Documentation, National Health Interview Survey, 2006 (machine readable data file and documentation).*The number of patients is calculated by identifying patients in

TABLE 9: ESTIMATED NUMBER OF PATIENTS TO RECEIVE TELEMONITORING AND TOTAL EXPENSE, BY CONDITION AND ADJUSTED FOR POPULATION GROWTH TO 2008

	Number of Patients	Expense
Heart Patients	3.8 million	$3.8 billion
Diabetes Patients	2.8 million	$2.8 billion
COPD Patients	3.4 million	$3.4 billion
Chronic Wound Patients	0.1 million	$0.1 billion
Total:	10.1 million	$10.1 billion

Data Source: National Center for Health Statistics (2006).

At a per-person, per-year cost of $1000, the total incremental costs of full telemonitoring implementation would be $10.1 billion dollars per year.

2. Potential Changes in Reimbursement

A number of important changes need to be made in reimbursement policy. Policymakers can change Medicare and Medicaid policies directly; private insurers will be more difficult to affect, but they should hopefully follow the example of the public insurers, especially once the benefits become obvious in practice.

- *Reimbursements for remote services should mirror in-person reimbursement. The studies described above show that remote monitoring and video visits can result in equal or better outcomes than traditional home care. Thus, when a remote visit accomplishes the same goal as an in-person visit, health insurers should reimburse accordingly. Currently, Medicare allows reimbursement for some telemedicine services, notably remote consultations, but many services are not covered and*

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the NHIS who are reported as having some functional limitation caused by the listed conditions. Because the data measures lung problems but also includes asthma, I remove patients who are identified as still having asthma but not emphysema or bronchitis. These patients are then restricted to those whose condition is chronic. Furthermore, the numbers are corrected for multiple diagnoses. Patients are allocated evenly between their conditions; a patient with heart problems and diabetes, for example, counts as 1/2 of a patient for each group. The number of chronic wound patients is calculated not from the NHIS but directly from the hospitalization and emergency care totals in section (IV)(B)(4) above—since any bed-ridden patient can develop chronic wounds, it is assumed that only patients once hospitalized for chronic wounds will be sent home with a telemonitoring solution specifically for chronic wound care.

currently reimbursement is at the discretion of individual states, although this may change following the passage of H.R. 6331 (discussed below).[145]

- *Telehealth equipment must be a reimbursable cost, and telemonitoring should be included as part of the Medicare home health care benefit. It is also important to allow telehealth equipment to be capitalized over multiple years of use, for purposes of grants and other one-time funding mechanisms.*

- *Policymakers need to expand eligibility for home monitoring technology. Even if telehealth reimbursement were to mirror in-person reimbursement, home monitoring would be limited to patients eligible for the Medicare Part A home health benefit; to achieve the maximum benefit, home monitoring technology needs to be extended to helping patients remain healthy and in their own homes, either via clinically monitored equipment or medically appropriate self-care technology. This could be achieved either by adding a benefit within existing public or private insurance schemes or by creating tax breaks for individual purchase of equipment and monitoring services.*

- *Eligibility also needs to be wider among rural patients. Telemonitoring is very important to rural patients, both because of the distances that patients or providers must otherwise travel to receive care, and also because patients are more vulnerable if their conditions become acute, especially if they require access to specialists. Adding a rural home monitoring and video visit benefit to the Medicare schedule would be cost effective and would help address the inequity in access to care that presently exists for rural patients.*

- *Incentives also need to be realigned for the use of telemedicine, so that practitioners who invest in telemedicine are sufficiently compensated for the resulting improvements in care quality. Remote monitoring has the potential both to reduce costs and improve outcomes. At present, providers have incentives to invest in telemedicine when it will reduce costs, such as substituting remote monitoring for some in-person visits. However, providers currently are not reimbursed for the higher level of monitoring and patient communication described in many of the studies seen in this paper.*

In short, Medicare and Medicaid must lead the way in encouraging and reimbursing care coordination, physician review of patient monitoring data, supplemental video visits, preventive monitoring, and so on. Outside Medicare and Medicaid, the presence of many different privately operated health insurance and health plan networks (each with its own reimbursement policy) creates a coordination problem. Medicare and Medicaid can lead by example and thus elevate

145. Alan Naditz, *Medicare's and Medicaid's New Reimbursement Policies for Telemedicine*, 14 TELEMED. J. E-HEALTH 21 (2008).

attention among private insurers to the benefits of changing their reimbursement practices to include payment for telemonitoring and broader telemedicine services. The passage in July 2008 of H.R. 6331, the new Medicare appropriations act, creates an opportunity for change, allowing skilled nursing facilities, in-hospital dialysis centers, and community mental health centers to originate Medicare telemedicine claims, effective at the beginning of 2009.[146] The details of implementation, however, are yet to be worked out by the Centers for Medicare and Medicaid Services. But once Medicare begins reimbursing for telemedicine there is a very real chance that private insurers will follow.

C. Estimated Value of Communications and Health Policy Enhancements

As a result of reduced emergency room visits, hospitalizations, and nursing home care, I find that remote monitoring and video visits have a potential net benefit, in 2008 dollars, of $12.1 billion per year. This reflects the foregoing estimates of the value of potential reductions in hospitalizations and other charges of $22.2 billion per year, set against additional estimated telemedicine costs of $10.1 billion per year. This number will change over time, due to the United States' changing demographics. For purposes of this study, I assume that telemedicine will be adopted eventually, but that the correct policies can help us realize the benefits years earlier. This allows me to calculate the present value, through cost savings and quality improvements, of the above telemedicine policy changes.

1. Changes in Costs and Benefits over Time

Both the costs and benefits of telemedicine will change over time, due to changes in technology and changes in the number of chronic disease patients. To be conservative, I assume that the average per-patient benefit remains the same, and that the costs of telemedicine do not

146. *See* American Telemedicine Association, "Final Victory for Telemedicine Reimbursement: Congress Overrides Presidential Veto on H.R. 6331," July 16, 2008, at http://www.americantelemed.org/news/policy_issues/LegislativeAlert_16July2008.pdf.

decrease (although continued technological improvements in fact are likely to both increase benefits and reduce costs). Forecasts are readily available for demographic change: according to the United States Census Bureau, the population of Americans 65 and over is expected to grow from 38.7 million in 2008 to 74.5 million in 2033.[147] Demographic forecasts are not a perfect proxy for growth in the number of chronic disease patients, but the majority of chronic disease patients are 65 years or older, and there is no reason to believe that disease rates are falling drastically. In fact, the rate of diabetes among 65-74 year-olds has risen from 9 percent to 18 percent since 1980.[148] Therefore, Census forecasts of the number of Americans 65 and over will be incorporated into the net benefits calculated below.

2. Adoption With and Without Policy Action

Currently, the adoption of remote monitoring technology is at a very low level. The National Association for Home Care and Hospice (NAHCH) study described above found in 2007 that only 17 percent of home care agencies were using some form of telemonitoring, and of those agencies that were using telemonitoring technology, many had a small number of units or did not use the units they had intensively. Because of this low baseline, there are large gains to be achieved through policy action, including the investments and reimbursement policy changes described above. To be conservative, I assume that 17 percent of the potential benefits have already been captured, and that adoption without any policy changes would occur naturally over the next 25 years. This is the baseline case. With the right policy changes, full adoption would occur over only 15 years. This is the policy case. The benefits are phased in linearly; for

147. U.S. Census Bureau, "U.S. Interim Projections by Age, Sex, Race, and Hispanic Origin: 2000-2050," http://www.census.gov/ipc/www/usinterimproj/.

148. Centers for Disease Control and Prevention, "Prevalence of Diagnosed Diabetes by Age, United States, 1980-2005," http://www.cdc.gov/diabetes/statistics/prev/national/figbyage.htm.

example, an additional 1/25th of the potential benefit is achieved each year between 2008 and 2033 in the baseline case.

To quantify the benefits of these policy measures, I first calculate the difference in adoption rates between the policy case and the baseline case for each year. Then, I multiply this figure by the total potential savings from remote monitoring. The gross savings in hospital, ER, and nursing home expenses are $22.2 billion, but the direct costs of telemonitoring equipment and labor amount to $10.1 billion leaving potential annual net savings of $12.1 billion. I then adjust for the growth in the patient population, according to Census Bureau estimates. Finally, I discount all future savings at an annual rate of 4 percent. This is necessary because a dollar saved today is not the same as a dollar saved 20 years from now--a dollar today can be invested and earn interest over 20 years. Government agencies are encouraged by the Office of Management and Budget to use a 2.8 percent rate of interest when discounting future benefits and costs.[149] I use a 4 percent interest rate in order to capture the greater risk involved in the private sector. Although half of all health care expenditures come from Medicare and Medicaid and thus carry a government guarantee, the other half is private and thus carries some risk.

3. The Net Benefits of Policy Enhancements

The above research makes clear that telemedicine is far too beneficial to be ignored, and I am confident that remote patient monitoring and video visits will eventually be adopted. However, achieving the full $12.1 billion dollars a year in potential savings, as well as the qualitative improvements in millions of chronic disease patients' lives, depends on the speed of that adoption. The policy measures outlined above can ensure that remote patient monitoring takes hold as quickly as possible and is as successful as possible.

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149. See Office of Management and Budget, "Discount Rates for Cost-Effectiveness Analysis of Federal Programs," 73 Fed. Reg. 5599, available at http://www.whitehouse.gov/omb/fedreg/2008/013008_discountrate.pdf.

Based on the medical research described earlier, making conservative estimates when necessary, and adjusting for the effects of demographic change, I estimate that the net total benefit from the policy measures above, in present value, is on the order of $44 billion per year. This estimate accounts for the costs and benefits per patient as they stand today; it does not account for the innovations in technology and medical practice that will surely follow as remote monitoring and other telemedicine technologies become more widely adopted.

TABLE 10: ESTIMATED GAIN FROM TELEMONITORING UNDER BASELINE AND POLICY CASES

Net Present Value of Savings, Baseline Case	**Net Present Value of Savings, Policy Case**	**Gain From Policy Implementation**	**Average Gain From Implementation Per Year**
$153.2 billion	$197.0 billion	$43.8 billion	$1.75 billion

TABLE 11: ESTIMATED GAIN FROM POLICY IMPLEMENTATION, BY CONDITION

	Baseline Savings	**Policy Savings**	**Gain from Policy Change**
Heart Patients	$79.7 billion	$102.5 billion	$22.8 billion
Diabetes Patients	$42.3 billion	$54.4 billion	$12.1 billion
COPD Patients	$18.7 billion	$24.1 billion	$5.4 billion
Chronic Wound Patients	$12.5 billion	$16.0 billion	$3.5 billion
Total:	$153.2 billion	$197 billion	$43.8 billion

GLOSSARY OF TERMS

Monitoring

Also known as remote monitoring, vital signs monitoring, or telemonitoring, monitoring refers to the use of remote sensors to measure vital signs such as blood pressure, heart rate, breathing function, and blood glucose levels. The resulting data is sent via the internet to health providers. Data may be viewed live as part of a remote exam, stored and used to create a patient history, or set up to alert providers and caregivers to sudden degradations in a patient's condition.

Telehomecare

Telehomecare is the use of communications technology, including video visits and remote monitoring, in the care of patients in their homes. Telehomecare often complements traditional home nursing care provided by professional home nurses. Telehomecare can also substitute for a limited number of nursing visits through video visits, in situations where transportation is a major obstacle to home care.

Telemedicine

Telemedicine, as defined by the American Telemedicine Association, is "the use of medical information exchanged from one site to another via electronic communications for the health and education of the patient or healthcare provider and for the purpose of improving patient care." In practice, telemedicine also frequently serves as a more limited term referring to the practice of conducting clinician visits or procedures from remote sites. An example would be a psychologist at a large city hospital treating a patient at a rural clinic using a two-way live video link.