

Cardiovascular Disease Prevention for Underserved Patients Using the Internet: Bridging the Digital Divide

MICHELE M. MASUCCI, Ph.D.,¹ CAROL HOMKO, Ph.D.,¹
WILLIAM P. SANTAMORE, Ph.D.,¹ PHILIP BERGER, B.S.,¹
TIMOTHY R. McCONNELL, Ph.D.,² GAIL SHIRK, M.S.,³
FRANCIS MENAPACE, M.D.,³ and ALFRED A. BOVE, M.D., Ph.D.¹

ABSTRACT

For underserved populations, telemedicine can address the high prevalence and suboptimal control of cardiovascular disease (CVD) risk factors. However, Internet access issues may limit the successful application of telemedicine. We tested the hypothesis that computer skills, and not access *per se*, was the main obstacle to using the Internet for health care. After informed consent, 44 participants with little or no computer experience received 2 hours of training covering 14 basic computer use skills, Internet access, and our telemedicine system. The telemedicine system enables reporting blood pressure, weight, physical activity, cigarette use, provider feedback, personal medication information, and educational information about CVD risk factors. The patient population included 12 males and 32 females. Of this total were 23 African Americans. The average patient age was 60.4 ± 3 years, and 64% had annual family incomes under \$25,000. Eighty-two percent of the participants averaged 4 or higher (on a scale of 1 to 5) on basic computer skills. Only 11% had an average score below 3. Thirty-seven of 44 participants reported on their health status from a local Internet access site within 10 days. Participants' successful use of the telemedicine system was not correlated with age, gender, education level, or ownership of a computer. Computer skill score had a positive effect on system use. Underserved populations without computer experience or skills and at increased risk for CVD can be educated to use an Internet telemedicine system to communicate health status to their health care providers. Ownership of a computer was not a factor that predicted system use.

INTRODUCTION

CARDIOVASCULAR DISEASE (CVD) is a significant cause of morbidity and mortality in the United States. For underserved patients with limited access to health care, CVD has even more devastating effects. This population

is at increased risk for CVD and heart failure because of the high prevalence of undertreated hypertension, hyperlipidemia, diabetes, and obesity.¹⁻⁴ New strategies and technologies are required to address the high prevalence and suboptimal control of risk factors if we are to reduce the devastating impact of CVD.

¹Temple Telemedicine Research Center, Temple University, Philadelphia, Pennsylvania.

²Bloomsburg University of Pennsylvania, Bloomsburg, Pennsylvania.

³Geisinger Medical Center, Cardiology Section, Philadelphia, Pennsylvania.

An Internet-based telemedicine system can address chronic disease management in disadvantaged inner-city and rural individuals. However, differential Internet access among social, economic, and racial groups may limit the successful application of telemedicine in this population. Many consider Internet access as the main obstacle to overcome in using telemedicine systems. For instance, NetForAll distributed Web television boxes to Latino communities so they could receive Internet access and interactive programming in English, Spanish, and Portuguese.⁵ However, few community members were using the system one year later. Most people could not remember how to use the system or did not feel they had the skills to use the system. In contrast, after a short training session, adult-elderly African Americans who lived in a public housing development in north Philadelphia were able to use and access the Internet.⁶

Based on our previous studies, we evaluated the effectiveness of our computer and Internet training to enable individuals with little or no computer experience and with known cardiovascular risk to successfully use an Internet-based telemedicine system.⁶

MATERIALS AND METHODS

Telemedicine system

The telemedicine system used in this study (Itsmyhealthfile, Insight TeleHealth, Valley Forge, PA) is a disease-management interactive health care delivery system comprising a secure Internet server and a database. This system provides Internet access to a clinical status database for multiple patients (Fig. 1). The server contains the clinical status database linked to a browser interface accessible through the Internet. This arrangement allows patients to send data directly to their care provider via the Internet, and to receive data for disease management from the database. The website is divided into a patient domain and a provider domain. Access to each domain requires a login identification and password. This system provides Health Insurance Portability and Accountability Act (HIPAA)-compliant 128-bit encryption

with a Secure Socket Layer (SSL), and a Public Key Infrastructure (PKI) so that medical information is safely transmitted via the Internet. The system is designed to optimize function and minimize costs. All off-the-shelf hardware such as a Food and Drug Administration (FDA)-approved sphygmomanometer is approved for patients use at home. No large equipment cost is incurred.

Patient use of telemedicine system

Patients access the Internet telemedicine system with a user ID and password. The system presents the patient with several Web screens, including message from practice, input, medications, and education. The input Web screen prompts data entry of weight obtained with a scale, blood pressure, heart rate obtained with a manometer, physical activity, and number of cigarettes smoked. The patient can enter data daily or several days of data can be entered at one time. When data entry is complete, the patient submits the information to the system, and receives a confirmation that the server has received the data. In addition, the patient can review these data by trend charts as well as access educational information.

Subjects

Forty-four subjects with little or no computer experience and who had hypertension, hyperlipidemia, diabetes, or who smoked, were recruited from the medical practices at Temple University Hospital and the Geisinger Medical Center. Clinical characteristics of the study participants are shown in Table 1. Informed written consent was obtained from all participants after explaining the nature, purpose, and potential study risks. The Institutional Review Boards for Human Research at Temple University School of Medicine and at Geisinger Medical Center approved this study and consent form.

Experimental design

Each participant received a manual blood pressure monitor (Omron, Model HEM-432-C, Vernon Hills, IL) and was instructed on its use by a registered nurse. The participants received

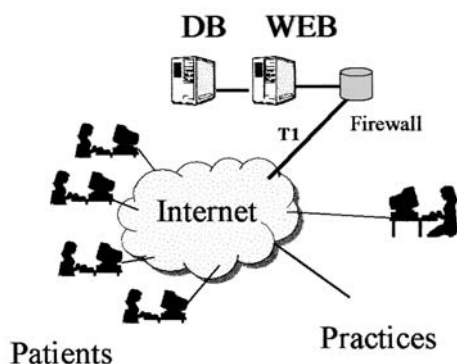


FIG. 1. Schematic of telemedicine system.

a logbook in which to record their daily blood pressure, weight, and cigarette consumption. Nurses helped the participant measure his/her blood pressure and recorded these values in the logbook for later transmission via the telemedicine system. The participants were provided login identification names and passwords to gain access to the telemedicine system.

All participants received computer training. The design of the computer training was based on studies of similar populations in North Philadelphia conducted by Temple University's Information Technology and Society Research Group.^{7,8} The training protocol anticipated the needs of underserved populations for basic computer training and orientation to the Internet as an integral part of using the telemedicine system. The 2-hour training was divided into three basic components: (1) determination of initial computer experience, (2) computer training, and (3) assessment of specific skills gained. Initial computer experience was determined through a questionnaire. The basic computer use component of the training included: (1) an orientation to the computer, (2) instruction on how to use a mouse, (3) an explanation and orientation to MS Windows Operating System (Microsoft, Redmond, WA), (4) an orientation to specific applications, (5) an introduction to the use of MS Windows Explorer, and

TABLE 1. DEMOGRAPHICS AND CARDIOVASCULAR RISK FACTORS

	<i>Inner city</i>	<i>Rural</i>	<i>Totals</i>
Age	52.6	68.6	60.4
Gender	15 F, 9 M	17 F, 3 M	32 F, 12 M
Race			
White	1	20	21
African American	23	0	23
Other	0	0	0
Educational level			
Some high school	4	1	5
High school	12	9	21
Graduate			
Some college	7	3	10
College graduate	1	7	8
Income			
Did not specify	2	1	3
Under \$15,000	13	2	15
\$15,000–24,999	6	7	13
\$25,000–34,999	1	3	4
\$35,000–44,999	0	5	5
\$45,000–54,999	1	2	3
Over \$55,000	1	0	1
Employed	6	5	11
Owned computer	13	14	27
Smoker	6	0	6
BMI	34.2 ± 5.3	26.3 ± 6.7	30.3 ± 7.2
Systolic BP	138.0 ± 16.0	135.5 ± 18.9	136.9 ± 17.2
Diastolic BP	84.4 ± 8.9	75.4 ± 7.1	80.3 ± 9.3
Diabetes	11	5	16
HTN	16	11	27
Hyperlipidemia	13	8	21

BMI, body mass index; BP, blood pressure; HTN, hypertension.

(6) demonstration of and practice using the telemedicine system. After the training, patient performance on 14 specific basic computer skills, shown to be essential in learning how to use the telemedicine system, were assessed.

The participants were also provided with information related to additional training support services provided by the medical centers where they received initial training on the system. Participants were asked to discuss the likelihood that they would use the system and to share their plans for submitting data once training was completed.

The participants made their first time data entry with coaching by a member of the research team. The participants were instructed to monitor their blood pressures at home on a daily basis and send data sets (blood pressure) 1 week posttraining. Participants were given the locations of free Internet access points in their community. Once the training was complete, database activity was monitored by study researchers (1) to determine length of time between training and data submission, (2) to conduct follow-up phone calls related to technical difficulties and accessibility issues that may be affecting specific participants, and (3) to determine whether or not participants are successful in transmitting data into the database.

DATA ANALYSIS

Correlation scores for factors related to successful use of the Internet-based telemedicine system were determined by a multivariate logistic regression using factors shown in Table 1, and the dependent variable, the presence or absence of a data transmission within 10 days of training.

RESULTS

Cardiovascular risk factors

Table 1 provides a summary of participant demographics and cardiovascular risks. A total of 44 participants were trained on the telemedicine system, 24 at Temple University and 20 at Geisinger Medical Center. Reflecting

the general populations around each center, the vast majority of participants were African American (96%) at Temple University, all of whom lived in inner city neighborhoods located in north Philadelphia. Conversely, 100% the subjects at the Geisinger Medical Center were Caucasian. Seventy-three percent of the subjects were female and 27% were male. The income levels were lower in the Temple University group; 54% had annual family incomes of less than \$15,000 and an additional 25% earned between \$15,000 and \$24,999 annually. In the Geisinger group, 50% had incomes greater than \$25,000 per year.

Regarding cardiovascular risk factors, 14% smoked, 36% had diabetes, and 48% had hyperlipidemia. Mean systolic and diastolic blood pressures were 136.9 ± 17.2 and 80.3 ± 9.3 mm Hg, respectively. The mean body mass index was 30.3 ± 7.2 .

Previous computer experience

Fifty percent of the participants had none, or less than 5 hours, prior computer experience. Most subjects (66%) had no prior experience using the Internet, and 61% did not have e-mail accounts. At Temple University, 46% of the subjects did not have computer access in the home, while at Geisinger, only 30% of the subjects did not have computer at home.

Skill attainment

The goal of training was to provide sufficient instruction so that participants with little or no prior computer experience would be able to use the telemedicine system. Performance of the ability to do 14 basic computer skills, use the Internet, and use the telemedicine system was measured using a Likert scale. Thirty-two percent of the participants achieved the highest level (5 on a scale of 1 to 5) across all 14 skills, and 82% of those trained averaged 4 or higher across all skills. Only 11% had an average score below 3.

Response rates

Thirty-seven subjects (84.1%) successfully transmitted their data within a mean of 6.9 ± 7.2 days after training. Three additional sub-

jects tried, but failed to successfully transmit their data. Of the 37 participants who submitted data using the telemedicine system, all but two averaged 4 or higher on all 14 skills. Only 29% of those who successfully submitted data once they had completed the training required a follow up reminder to use the telemedicine system.

Participant success in using the telemedicine system (i.e., sending data) was not correlated with age, gender, ownership of a computer or educational level, while high (4) or very high (5) scores on all computer skills had positive effects on successful use of the telemedicine system (Table 2). Ownership of a computer and education level did not appear to be an impediment to participation in this program.

DISCUSSION

Prevalence of CVD among underserved populations

CVD is a significant cause of morbidity and mortality in the United States. Underserved populations develop risk factors including glucose intolerance, hyperlipidemia, and hypertension at higher rates than the population as a whole. African Americans have a 40% greater prevalence of hypertension compared to whites. Roughly 1 in 3 adult African Americans has hypertension. Additionally, African Americans have a higher rate of multiple risk factors, this group has the highest overall coronary disease mortality rates and the highest out-of-hospital coronary death rates of any ethnic group in the United States, particularly at younger ages.^{3,9,10}

For African American women, the figures are particularly troubling: nearly half of African-

American women are considered obese, and more than 15% of African-American women between the ages of 40 to 59 are extremely obese (body mass index [BMI] ≥ 40).⁴ Moreover, obesity and abdominal obesity are twice as common in African American women compared to white women. While the prevalence of hypercholesterolemia is similar in African Americans and whites, fewer African Americans (26%) than whites (47%) are aware of their hypercholesterolemia.¹¹ African Americans also have a higher prevalence of diabetes: 19% for African-American women compared to 7% for white women, and 16% for African American men compared to 8% for white men.¹ Reflecting the interrelationship between economic and CVD risk factors, when compared with white women, African American women are more likely to live in poverty, have less education, experience greater weight gain during childhood, and have lower resting metabolic rates, physical activity energy expenditures, all of which are correlated with a greater risk of obesity.^{12,13}

Internet telemedicine and CVD

Telemedicine can address many of the problems, concerns, and barriers for chronic disease management, such as: (1) risk reduction strategies can be built into the system, (2) patient compliance can be documented and (3) feedback can be provided to the physician. Furthermore, an Internet-based telemedicine approach can do this in a cost-effective manner. Our study findings add to an emerging discussion of the potential benefits of Internet-based telemedicine.

Bondmass et al.¹⁴ found in their study that African Americans ($n = 33$) treated for but not

TABLE 2. CORRELATION SCORES FOR FACTORS RELATED TO SUCCESSFUL USE OF THE INTERNET INFORMATION SYSTEM

<i>Factor</i>	<i>Coefficient</i>	<i>CI</i>	<i>P</i>
Age	0.06	-0.08-0.21	0.381
Gender	0.88	-1.78-3.54	0.518
Ownership	-0.29	-0.55-0.54	0.983
Score	2.30	0.22-4.38	0.030
Education	-0.29	-1.91-1.34	0.731

Analysis by logistic regression.

Coeff, regression coefficient; CI, confidence interval of Coeff; *p*, significance level.

achieving blood pressure control for 1 year or more, benefited from the use of a transtelephonic monitoring device. Within 1 month, the patients' mean, systolic, and diastolic blood pressure measurements were significantly reduced. Friedman¹⁵ compared usual care to an automated telephone monitoring system in which subjects called an interactive computer-based system on a weekly basis and reported their blood pressures, knowledge, and medication adherence. This information was sent to their physicians. Antihypertensive medication adherence improved and blood pressure decreased more for the telephone system users.

In another study, African Americans in the telemonitoring group (adhering to a protocol of weekly telephone counseling and transmission of blood pressure records) had significant reductions in systolic and diastolic blood pressure, while blood pressure was unaltered in the usual care group.¹⁶ Rogers et al.¹⁷ conducted a study in which patients transmitted blood pressure data by telephone to their physicians. Among African Americans ($n = 26$) in this study, mean arterial pressure decreased by 9.6 mmHg in the telemonitoring group and increased by 5.3 mm Hg in the usual care group. The blood pressure decrease was partially the result of more frequent changes in type or dose of antihypertensive medication.

Several studies of Internet monitoring systems to control diabetes have also shown benefits including better self-management of their diabetes, blood sugar, and HbA_{1c}.^{18,19} In 12 patients, Bellazzi²⁰ showed that an automatically downloaded blood glucose monitoring system allowed physicians to analyze and make decisions concerning the patient's clinical status, thereby improving blood sugar control. In another study, 11 patients had better control of their blood glucose when using computerized blood glucose records transmitted to a central database than when the same patients used the traditional record books.²¹ Ahring et al.²² assigned 42 patients to either a weekly modem transfer of blood glucose value or a usual care group.²² The telemedicine system motivated the patients to keep closer control of blood glucose levels with resulting lower levels of HbA_{1c}.

CONCLUSIONS: THE DIGITAL DIVIDE AND IMPLICATIONS FOR TELEMEDICINE

One of the challenges facing Internet telemedicine approaches for patients to monitor their health is to mitigate the effects of differential access to the information technology among social economic and racial groups. Gilbert and Masucci⁸ note that the National Telecommunications and Information Administration (NTIA) studies showed that households with the highest family incomes had significantly greater access to computers and the Internet than homes with the lowest income levels.^{8,23} Disparities between African Americans and Hispanics compared to white households also increased during the past decade. Nearly half of all white households compared to one fifth of African Americans and Hispanic households had computers and Internet access.²³

Several studies suggest that Internet-based telemedicine approaches can be effective among underserved populations. These show that interest and training are two factors that have a significant impact on compliance among underserved populations. For example, Finkelstein et al.²⁴ conducted an asthma telemedicine study in which 74% of the participants were African Americans or Latinos living in inner cities, 71% had no previous experience in using computers, and 58% had never used an ATM. They found that the vast majority (83%) of patients were able to use computer-based self-monitoring techniques to transmit asthma data to physicians after just one 40-minute training session.²⁴

The success of the training protocol indicates that additional measures could produce even better results for those facing the most significant barriers to accessing information technologies. These may include: (1) providing assistance in obtaining computer technology resources, (2) identifying appropriate settings where additional technology training is available and (3) supporting patients to participate in programs made available through their social networks such as churches, schools and libraries, community centers, and

health facilities. For example, we are currently conducting a clinical study to determine if a telemedicine system can help to reduce cardiovascular risk in underserved patient population. To increase Internet access, we are distributing computers with Internet access to participating churches.

Our study indicates that training is an essential element needed to address the challenges that will be faced by underserved patients to benefit from Internet telemedicine approaches for managing health. With training, underserved populations were able to access the Internet and successfully use the telemedicine system. An important implication is that telemedicine system holds promise for improving a patient's ability to self-monitor chronic conditions, even among groups who face challenges to accessing information technologies.

ACKNOWLEDGMENTS

This study was supported, in part, by a grant from the Pennsylvania Department of Health and by the National Institutes of Health HL 065073. The Pennsylvania Department of Health specifically disclaims responsibility for any analyses, interpretations, or conclusions.

REFERENCES

- Hutchinson RG, Watson RL, Davis CE, Barnes R, Brown S, Romm F, Spencer JM, Tyroler HA, Wu K. Racial differences in risk factors for atherosclerosis. The ARIC Study. *Atherosclerosis Risk in Communities. Angiology* **1997**;48:279–290.
- Weinsier RL, Hunter GR, Zuckerman PA, Redden DT, Darnell BE, Larson DE, Newcomer BR, Goran MI. Energy expenditure and free-living physical activity in black and white women: Comparison before and after weight loss. *Am J Clin Nutr* **2000**;71:1138–1146.
- Gillum RF, Mussolino ME, Madans JH. Coronary heart disease risk factors and attributable risks in African-American women and men: NHANES I epidemiologic follow-up study. *Am J Public Health* **1998**;88:913–917.
- Mokdaad AH, Serdula MK, Dietz WH, Bowman BA, Marks JS, Koplan JP. The spread of the obesity epidemic in the United States. *JAMA* **1999**;282:1519–1522.
- Batista, E. 2000. TVs aren't PCs for Latinos. *Wired News*. June 1, 2000.
- Liu JC. Interoperability realization: A case study on Harrison Plaza housing development project [master's thesis]. Temple University, Philadelphia, PA: **2001**.
- Gilbert M, Masucci M. Feminist praxis in university community partnerships: Reflections on ethical crises and turning points in Temple-North Philadelphia IT Partnerships. In: Fuller D, Kitchin R, eds. *Radical theory/critical praxis: making a difference beyond the Academy*, Okamagen, IR: Praxis (e) Press, **2004**:147–158.
- Gilbert M, Masucci M. Moving beyond "gender and GIS" to a feminist perspective on information technologies: The impact of welfare reform on women's IT needs. In: Seager J, Nelson L, eds. *A Companion to Feminist Geography*, Oxford: Blackwell Publications, **2005**:305–321.
- Becker LB, Han BH, Meyer PM, Wright FA, Rhodes KV, Smith DW, Barrett J. Racial differences in the incidence of cardiac arrest and subsequent survival. *N Engl J Med* **1993**;329:600–606.
- Potts JL, Thomas J. Traditional coronary risk factors in African Americans. *Am J Med Sci* **1999**;317:189–192.
- Prisant LM, Thurmond C, Robinson VJ. Treating hyperlipidemia in African Americans. *Ethn Dis* **2000**;10:334–342.
- Gannon B, DiPietro L, Poehlman ET. Do African Americans have lower energy expenditure than Caucasians? *Int J Obes Relat Metab Disord* **2000**;24:4–13.
- Weyer C, Snitker S, Bogardus C, Ravussin E. Energy metabolism in African Americans: potential risk factors for obesity. *Am J Clin Nutr* **1999**;70:13–20.
- Bondmass M, Bolger N, Castro G, Avitall, B. The effect of home monitoring and telemanagement on blood pressure control among African Americans. *J Telemed e-Health* **2000**;6(1):15–23.
- Friedman RH, Kazis LE, Jette A, Smith B, Stollerman J, Torgerson J, Carey K. Telecommunications system for monitoring and counseling patients with hypertension: Impact on medication adherence and blood pressure control. *Am J Hypertens* **1996**;9:285–292.
- Artinian NT, Magnan M, Sloan M, Lange MP. Self care behaviors among patients with Heart failure. *Heart Lung* **2002**;31:161–172.
- Rogers MA, Small D, Buchan DA, Butch CA, Stewart CM, Krenzer BE, Husovsky HL. Home monitoring service improves mean arterial pressure in patients with essential hypertension. A randomized, controlled trial. *Ann Intern Med* **2001**;134:1024–1032.
- Schultz EK, Bauman A, Hayward M, Holzman R. Improved care of patients with diabetes through telecommunications. *Ann NY Acad Sci* **1992**;670(1):141–145.
- Biermann E, Deitrich W, Standl E. Telecare of diabetic patients with intensified insulin therapy: A randomized clinical trial. *Stud Health Technol Inform* **2000**;77:327–332.
- Bellazi R, Larizza, C, Montani S, Riva A, Stefanelli M, d'Annunzio G, Lorini R, Gomez EJ, Hernando E, Bragues E, Cermeno J, Corcoy R, de Leiva A, Cobelli C, Nucci G, Del Prato S, Maran A, Kilkki E, Tuomi-

- nen J. A telemedicine support for diabetes management: the T-IDDM Project, *Computer Methods Programs Biomedicina* **2002**;69:147–161.
21. Billiard A, Rohmer V, Roques MA, Joseph MG, Suraniti S, Giraud P, Limal JM, Fressinaud P, Marre M. Telematic transmission of computerized blood glucose profiles for IDDM patients. *Diabetes Care* **1991**;14(2):130–134.
 22. Ahring KK, Ahring JP, Joyce C, Farid NR. Telephone modem access improves diabetes control in those with insulin-requiring diabetes. *Diabetes Care* **1992**;15: 971–975.
 23. National Telecommunications and Information Administration. Falling through the Net: Defining the digital divide. A report on the telecommunications and information gap in America. Washington DC: NTIA, July **1999**.
 24. Finkelstein J, Cabrera MR, Hripcsak G. Internet-based home asthma telemonitoring: Can patients handle the technology? *Chest* **2000**;117:148–155.

Address reprint requests to:

Michele M. Masucci, Ph.D.

USB 111

Information Technology and Society

Research Group

Institute for Public Affairs

Temple University

1601 North Broad Street

Philadelphia, PA 19122

E-mail: masucci@temple.edu