ASSESSING BENEFITS OF VIDEOPHONE TECHNOLOGY IN INTERNAL MEDICINE

by

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MASTERS THESIS

Presented to the Department of Medical Informatics

and the Oregon Health Sciences University

School of Medicine

in partial fulfillment of

the requirements for the degree of

Masters in Medical Informatics

May 1998

School of Medicine

Oregon Health Sciences University

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ACKNOWLEDGEMENT

I would like to recognize and thank the following individuals for their helpful guidance and support in this project. Advisors from Informatics department, Dr. Paul Gorman, Dr. Paul Sher, Dr. Mark Helfand Dr. Dale Kraemer, Dr. Bill Hersh, Dr. Holly Jimison.

Dr. Dave Phillips, Professor, Public Health Department, for his statistical expertise on the descriptive data analysis part of the thesis.

Dr. Alex Schafir and the physicians at the Internal Medicine clinic, for their cooperation and kindness in providing feedback (data) about the technology.

John Meads, Usability architect, Intel Corporation, for his guidance on Usability Engineering.

Mr. Raman Srinivasan, Senior Software Architect, Intel Corporation, technical consultant, not only for his knowledge in teaching the technical aspect of the project, but he also loaned the systems with the Intel® Videophone, which was the critical tool to complete this project.

ABSTRACT

Study Purpose: To determine the potential benefits of using the Intel® Videophone technology as patient physician communication tool. The main issues of the study are:

(1) How easy is it for the patients and physicians to use the Videophone?

(2) Can the Videophone reduce the utilization of resources?

(3) What are the benefits of using this technology from the physician and patient's perspectives?

Method: The subjects included staff physicians (n=7) and their patients (n=30) at the Oregon Health Sciences University, Internal medicine outpatient clinic. The Intel Videophone was used for the study. A pre and post video session questionnaire was administered to patients and physicians. The concepts of usability engineering and clinical research methodologies were used in this study to collect and analyze the data.

Results: This technology was judged easy to use by 26 of 30 patients and all 7 physicians in the study. Among the 30 patients, 24 accepted the Videophone as a useful means of communication with their physicians compared to the telephone. The patients were willing to use the Videophone to communicate with their physicians, if available in their homes. The physicians felt that the technology provided them with sufficient information for evaluating the patients in 24 of the 30 sessions. The physicians concluded that this technology could potentially replace the need for clinic visits in 11 of the 30 Videophone sessions, when compared to the telephone.

Conclusion: The study showed that there is potential benefit in using the Videophone in outpatient management. The technology is easy to use and is accepted as a useful communication tool, compared to the telephone, by both physicians and patients. The patients would use this tool to communicate with their physicians if it were available at home. The physicians concluded that using of Videophone could potentially reduce the number of clinic visits for some patients compared to the telephone. In many cases, the technology provided sufficient information to the physician to assess the patient.

INTRODUCTION

Telemedicine is the electronic transfer of medical information over a distance between two or more sites. The components of telemedicine include distance, data transmitted, telecommunications, a specialist to interpret and analyze data, and the capacity to affect care as a result of interpreting the data.[1]

Currently, there are telemedicine projects using video conferencing technologies in various stages of development/implementation in at least 33 states.[2] Many of these studies are showing potential benefit in access to health care by patients. They also show a reduction in the number of home visits, for example, the tele-home visits by nurses.[3] The studies have also shown potential reduction in transfer of patients to distant hospitals for care,[4] and videoconferencing technology was used as an effective communication tool among care providers.[5,6,7]

Much of the existing telemedicine literature emphasizes radiology, pathology and dermatology, although many other specialties are being investigated.[4, 7, 8, 9,10] The specialties studied range from dermatology, orthopedics, intensive or critical care, emergency medicine and oncology. Elderly and home health-care applications were also examined. [2, 4,11,12,13] Telemedicine studies have also examined the acceptability of a specific technology, for example, using video conferencing technology for patient and health care provider communications as well as telecommunications among care providers.[3,14,15] Patient care in the hospitals, emergency department, home health care and nursing home care are some areas of health care studied. (*Table 1*)

There are three issues that have not been approached in earlier studies and have been addressed in this study. These include the characteristics of the patients studied, the care providers included in the studies, and the health care environment under consideration.

Patient characteristics: Telecommunication studies have been done in home health care patients, elderly patients, critical care patients, and patients in specialties.[2,4,11,12,13] The general patient population utilizing outpatient clinic visits / doctor offices have not been studied for acceptability of the technology as a communication tool.

Care provider: Nurses and specialists have been the health care providers considered in telecommunication studies.[3,4,5,6,7,10,11] The primary care provider is the main access to health care for patients and studies of patient-primary care physician telecommunication are lacking.

Environment: The studies have been done in the area of elderly patient care, home health care, and remote care situations.[8,9,11] Several technological applications were investigated in other specialties.[4,5, 7,10] However, studies involving the use of the Videophone in the internal medicine outpatient care setting were limited.

Internal medicine is a vast field, encompassing all specialties. Patients are often seen for various problems, chronic and acute, over a period of time. The volume of patients seen in the outpatient care setting is usually more than in the specialty setting. The primary care physician (PCP) is each patient's main care provider. The PCP often has to make decisions on health care management when patients call in (via telephone) with their complaints. The addition of an interactive image could help the physician in better decision making.

This could also potentially reduce the number of clinic visits. Videophone based patient-physician telecommunication, can prove to be an effective and efficient tool for enhancing the quality of care.

This thesis looked at the potential benefits of the Videophone technology in the area of Internal medicine outpatient care. This was based on the scenario of a patient-initiated Videophone conversation with a primary care physician and the discussion of the patient's health problems. The potential benefit of this technology as a patient-provider communication tool was assessed. This study is both a usability study of a technology available in the market today, applied to the dynamic physician-patient environment, and also a usefulness study in the health care setting.

Usability engineering is a new discipline, which has grown during the last ten years in a variety of technical fronts.[16] It is a set of design and development practices one follows that ensures a product's users can succeed in using the product as intended.[17,18] In the case of a technology applied to a new use, acceptability of the technology is largely dependent on ease of product use. Usability testing borrows from human factors engineering, and cognitive psychology.[19] As the product is designed and built, the usability people evaluate the product and analyze the results, to improve the design. The process continues until a satisfactory product is made. Usability testing is a process by which user acceptability and product function can be measured. Common measures of usability are based on user's execution of tasks in a new process.[20] During a usability test, the user performs a specified set of tasks with a version of the product. The product user receives minimal instruction

and is asked to execute the tasks. The tester observes and records user's actions pertaining to the tasks with limited user interaction.[17,20]

The current study applied concepts of the usability engineer to evaluate the Videophone technology as a communication tool in health care environment. However, the usability concept of the product development life-cycle[17,20] is not applicable here, since the product under study, Intel® Videophone, is a commercially available product in market today. This product was not designed as a tool for physician patient communication. However, telemedicine literature supports the use of videoconferencing technologies in various health care settings, which also have acceptability studies.[3,15] Therefore, it would only seem appropriate to apply the concepts of usability engineering as well as clinical research methodologies in evaluating the product's use as a telecommunication tool in health care.

Videophone was used over Plain Old Telephone System (POTS) line. A Videophone or a video conferencing system is a point-to-point communication between two computers where audio and video images are interactively transmitted.[20] The Videophone uses a desktop video camera and a speaker phone at each end. Users at each end can see their own video and the other person. [21,22] The connection can be over a POTS, ISDN (Integrated Service Digital Network), LAN (Local Area Network) or Internet.[22,23]

This study used Intel Videophone over POTS line. This technology is an accessible product available in the market today. It is being used for telecommunication in business and in general population. Studies in healthcare have been done using the Intel Videophone over an ISDN line (which is more expensive to use and more difficult to install)[5] Most households in America have POTS service[24] and therefore the use of POTS

Videophone has been selected as an appropriate tool for this study. The reasons for using this particular product for the study are because Intel Corporation provided this technology and the product was available.

Based on the above discussion, there were three research questions asked in my study to assess the benefits of this technology as a communication tool among the patients and their primary care providers. The Internal medicine outpatient clinic was the setting for the study. The question of benefit includes the reduction in the utilization of resources, as shown by the potential reduction in some clinic visits from physician's perspective. The usability and acceptability in the health care environment is determined by the ease of using this technology by both the physicians and patients.

Research Questions

- Are there potential benefits of using the Videophone technology in internal medicine outpatient care?
- Can the use of the Videophone replace some visits in the general medical clinic, as judged by the physician?
- Is this technology easy to use by both the physicians and the patients?

Table 1: Literature review

STUDY	Ref.	Patient Characteristic	Caregiver	Technology used	Data Analysis/Results
Kansas: Telemed. In rural Kansas.	[11]	Elderly, home bound & disabled	Nurse	Video/Audio [POTS, ISDN, etc.], interactive.	Only preliminary data available, no conclusions
Kimmel -- Cancer Center	[36]	Cancer patients	Specialists	ISDN based Video Conf. System	No data available.
Mass GH-- Teledermatology	[5]	Dermatology patients	Dermatologist, Clinicians	Image Transfer (IATV cameras) - Store and forward of photos	Still images can substitute for derm. physical exam in upto 83% of cases
Teledermatology in Nursing home, Minnesota	[4]	Nursing home residents with dermatology problems	Dermatologist	Video camera and still image telephone - AT&T	Correct Dx. made for 67% patients given Hx. alone; 85% given image alone & 88% given both.
Medical decision support, UK	[6]	General physicians in community hospitals	Emergency department physicians	ISDN videoconference, teleradiology	Transfer of 70 patients avoided with telemedicine link (of 120 patients)
Orthopedic care, ND	[10]	Orthopedic patients	Orthopedic surgeons	Telemedicine network	Tele consultation - avenue for ortho care where specialists are not available
Critical care	[15]	Patients in hospital	Critical care - Intensivist	Two-way audio-visual link.	Regular consultations provided, acceptable by users and providers, superior to telephone.
Personal telemedicine, Minnesota	[3]	General patient population	Nurse	Personal patient telemedicine unit, POTS video, central nursing station	Reduction in number of home visits in 7of 12 patients.
Current Study		*Adult patients-outpatient population*	*Internists/ PCP*	*POTS based Intel Videophone.*	*30 patients and their physicians. (refer to result section)*

METHOD

Hypotheses

Table 2 below presents the study hypotheses. The study will evaluate these hypotheses based on the methods described in this section.

Table 2: Hypotheses

Patients
1. Patients find the Videophone is easy to use.
2. Patients will use this technology, if available in their homes, to communicate with their physician.
3. Patients perceive the Videophone as a useful tool to communicate with their doctors as compared to the telephone.
Physicians
4. Physicians find the Videophone is easy to use.
5. Physicians perceive this technology as a useful tool in outpatient care and management.
6. Physicians can give better instructions to the patients by using the Videophone as compared to the telephone.
7. Physicians discover that this technology provides them with sufficient information for assessing the patient's need for immediate evaluation, for example, directing the patients to either a clinic visit or the emergency room.
8. Physicians feel this technology is a useful tool to reduce the number of clinic visits as compared to the telephone. (perceived benefit)
9. "Time" of the Videophone call is less than the estimated time of clinic appointment.

Procedure and Setting

The outpatient clinic director's permission and IRB permission was procured to do the study at the Oregon Health Sciences University Outpatient clinic. Then, two Videophones were set up at the clinic and the physicians were briefed on the purpose and procedure of the study. Physicians who volunteered for the study identified patients who could participate, according to the inclusion criteria. Consent was obtained from patients and the pre session interview was conducted. The physicians answered the pre video session questionnaire. During the regular clinic hours and normal workflow, the clinicians discussed current health care issues with their patients over the Videophone. There was no simulation of health issues discussed. The call was made from the patient's room assisted by the investigator (Sara Raman) in the initial part of the call. Then the investigator stepped out of the room and the patients talked to their physicians. The patients were either seen as scheduled, set up for a physical examination, or provided prescriptions as appropriate after the Videophone session was completed. Post session interviews were completed with physicians and patients using a questionnaire (Appendix A).

Scenario

The patient initiated a Videophone call to his/her physician, to discuss current health problem, simulating calling from their homes. The physician answered the call, discussed the health problem, and analyzed the need for the clinic visit as well as care and management of the patient. The patient discussed real life health problems with the physician and thereby avoided potential biases of a simulated physician or patient.

Study Design

This is a cross sectional study, designed with concepts of usability engineering and clinical research methodologies. It determines the ease of use as well as the usefulness of the Videophone technology in an internal medicine outpatient care setting.

Usability Methods Applied to this Study

In this study, usability methods were applied to an existing product in the market, to evaluate the acceptability for effective patient-physician communication.[17,18]

In the case of a technology applied to a new use, acceptability of the technology is largely dependent on the new product's ease of use. Therefore, the "*ease of use*" as applicable to the usability of the product was studied.[16]

Common measures of usability are measures of a user's execution of tasks in a new product.[20] During a usability test; the users perform specified set of tasks with a version of the product. Users receive minimal instruction and are asked to execute the tasks. The tester observes and records the user actions pertaining to the tasks, with a limited interaction with the users.[17,20]

The usability tester (Raman) was present with the patients during the initial part of the session, to instruct the patients of their tasks and observe how well the patients were able to perform the given "tasks" in using the product. The physicians were given the tasks ahead of time. Some of the physicians had more than one Videophone session, but with different patients. So some physicians had to do the tasks more than once and some did the tasks only once.

The following tasks were given to both the patients and physicians.[20] (*Table 3*).

Table 3: Task Sequence for the Product Usage

Patient		Physician	
Overall Task Establish connection with the physician	**Sub Tasks:** 1. Dial the Physician phone number using the Videophone 2. Once physician answers, initiate video session 3. Hang up the session	**Overall Task** Receive the video call from the patient	**Sub Tasks** 1. Answer the phone call 2. Accept the video session
Communicate with physician using the Videophone	Talk to the physician and adjust video and/or audio as desired	Communicate with the patient using Videophone	Talk to the patient and adjust video and/or audio as desired

In addition to the above tasks, both the patients and physicians were asked to answer the following questions on a 5-point scale to obtain data for objective evaluation. The questions were in reference to the ease-of-use for the technology and the user's perception of the quality of the audio and video, which could influence their acceptance of the technology.[18,20]

Physician Questions Relating to Usability of the Product:

1. *Was it easy to use the Videophone?*
   Definitely Yes Yes Neutral No Definitely No
2. *How was the image quality?*
   Very good Good Neutral Poor Very Poor
3. *How was the audio quality?*
   Very good Good Neutral Poor Very Poor

Patient Questions Relating to the Usability of the Product:

1. *Was it easy to use the Videophone?*
   Definitely Yes Yes Neutral No Definitely No
2. *How was the image quality?*
   Very good Good Neutral Poor Very Poor
3. *How was the audio quality?*
   Very good Good Neutral Poor Very Poor

Hypotheses and Usefulness Study

The study subjects were asked questions and the proportion of answers for each of the questions relating to the hypotheses (stated in *Table 2*) was assessed. The answers were in 5 point Likert scale, to provide the range of answers for each question.

Physician Questions Relating to Hypotheses:

1. *Do you find the Videophone as a useful tool in clinical medicine - outpatient care and management?*
   Definitely Yes Yes Maybe No Definitely No
2. *Did the Videophone conversation provide sufficient information that was valuable in judging this patient's need for immediate evaluation (i.e. office visit or emergency room)?*
   Definitely Yes Yes Maybe No Definitely No
3. *Do you think Videophones would be valuable for giving better instructions to the patient, than over the telephone?*
   Definitely Yes Yes Maybe No Definitely No
4. *Could this patient have potentially avoided this clinic visit today, if you and the patient had talked over the* ***Videophone****?*
   Definitely Yes Yes Maybe No Definitely No
5. *Could this patient have potentially avoided this clinic visit today, if you and the patient had talked over just the* ***Telephone****?*
   Definitely Yes Yes Maybe No Definitely No

Patient Questions Relating to Hypotheses:

1. *If you had a Videophone at home, would you use it to talk to your nurse or physician about your health problems?*
   Definitely Yes Yes Maybe No Definitely No
2. *Do you think the Videophone is a useful means of communication with your doctor or nurse compared to the telephone? (not Llikert scale)*
   Very useful Useful Neutral Useless Don't know

Design of Data Collection Instrument

The draft of the questionnaire was prepared and given to graduate students in Medical Informatics at Oregon Health Sciences University as well as to Physicians attending the Veteran Administration medical center research in progress conference for their input. The feedback from the questionnaire was also received from primary care physicians and specialists in the community. The information was collected and changes were made to some questions to reflect the data to be collected regarding the hypotheses. Using a 5-point Likert scale, the subjects were given questions and asked to select a response that best represented the rank or degree of their answer. Those questions were written at a high school level, to be easily understood by the patients.

The patient questionnaire was designed to get percentages or proportions for each of the hypotheses and also conduct the objective aspect of usability testing. In addition to the questions stated above, data of variables that could influence and affect the hypotheses were also collected. These include patient's age, gender, familiarity with the use of computers, distance to the clinic and traveling time. This was correlated with the hypotheses.

SF 12 form (a short form health survey standardized questionnaire with twelve questions relating to self-assessment of health status by the patients) was used as a means of evaluating the health condition of the patients.

Physician data was collected for usability testing and for testing the hypotheses. Physician data included patient independent data, ease of using the technology, and their familiarity with computer use. The patient dependent data was related to the hypotheses and the

acceptance of the technology in the outpatient care setting. Paired data was collected using the Videophone's perceived number of clinic visits avoided as compared to the telephone. The time taken for the Videophone call and the physician estimated time of the clinic visit was the other collected matched pair data.

For qualitative data analysis, open-ended questions were asked about the technology. Patients and physicians stated their subjective likes and dislikes about the technology. These comments added insight to the opinion of the users regarding the technology and it's use in outpatient care setting.

Study Population

The population of interest was the Internal medicine and family practice physicians and their patients. For feasibility reasons, the study groups were narrowed down to the staff physicians at the Internal medicine outpatient clinic and their adult patients.

Physicians: They were experienced internists and staff physicians, working at the outpatient clinic at Oregon Health Sciences University Hospital. They were all familiar with the use of computers in their workplace and have never used the Videophone.

Patient Selection Criteria

Inclusion criteria - The population studied were the adult patients at the Internal medicine outpatient clinic who agreed to volunteer.

Exclusion criteria - Patients who were unable to use the system due to physical/mental limitations.

Videophone Set up

Two Videophones were set up in the Internal medicine outpatient clinic. Two Intel® Pentium® processor-based PC's were used in this set up. The systems had a32 MB system memory and a Lucent H.324 ready internal Modem. (H.324 is the videoconferencing standard.[23]) The system also used a Desktop Video camera, with analog output and a Universal Serial Bus (USB) camera with digital output of the image captured.

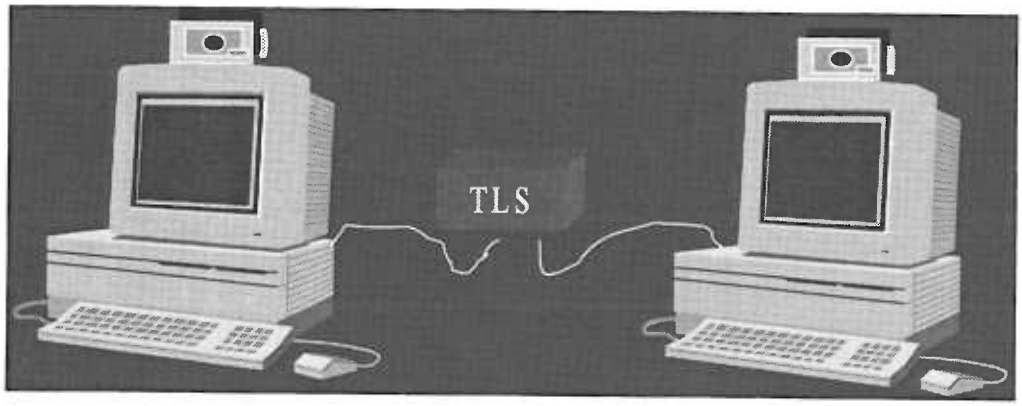

Figure 1: Videophone set up

The USB camera did not require the expensive video capture internal add-in card hardware for digital conversion of the images, the other camera needed this hardware.[25]

The Intel Videophone 2.0 version of the software, which is available in the market today, was used for the study. The systems were connected using a telephone line simulator (TLS), as POTS telephone lines were not available in the clinic rooms. The telephone line simulator acts like a POTS line, providing simulation of the POTS analog connection. (*Figure 1*). This simulator was programmable to introduce noise to simulate the real time POTS connection.

The user interface of the computer based Videophone technology is seen in this actual screen shot of the active Videophone session in progress with both the host as well as the remote video displayed. (*Figure 2*) The size of the remote or host video can be increased or decreased as needed. The volume can be adjusted and are other features like sending freeze shot photographs during the active session, fax transmission and other data sharing tools.

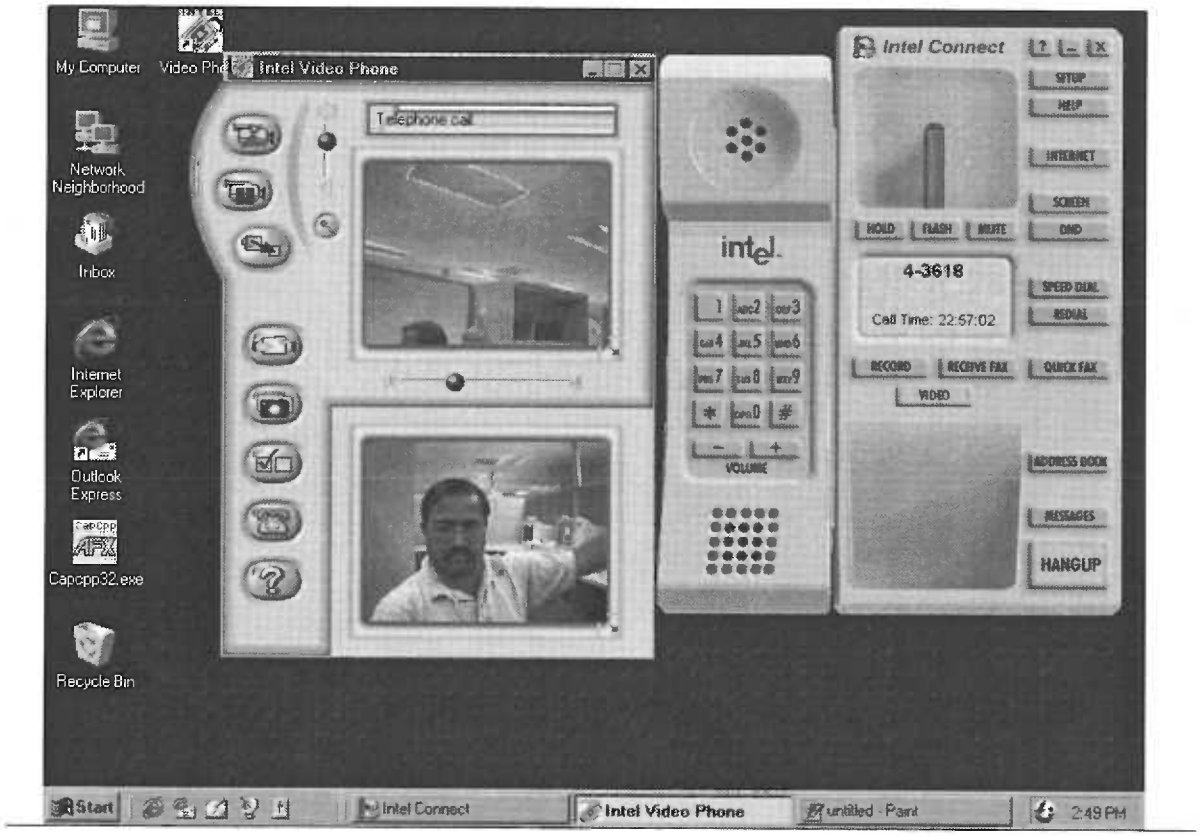

Figure 2: Intel Videophone 2.0 Screen Shot (session in progress).

Statistical Methods Used

The mean, median, and range for distribution of the variables were computed, which describe the characteristics of the study population. Percentages by category were calculated for the non-continuous data. Confidence intervals were calculated for the proportions or single percentages. For 95% confidence interval, the range of values would not differ from the estimate provided by the study, at statistical significance level of 0.05.[26]

A non parametric McNemar test was done for analysis of paired binary data.[27] A non parametric Wilcoxon signed rank test was used to determine differences among paired data (ordinal and continuous).[27] The mean of the difference in scores was used for computing differences in matched pair data. The non parametric measure of correlation, Spearman's Rho was used for computing correlation among ranked scale data, continuous, and ordinal values of the variables.[27] The *p* value (probability) was set at 0.05.

Since multiple hypotheses were tested in this study, the likelihood that at least one will achieve statistical significance on the basis of chance alone increases. The Bonferroni adjustment was made to keep the over all probability of accepting any one of the alternate hypotheses, (when all the findings are due to chance) at the specified level.[28] This was done by dividing the significance level (α of 0.05) by the number of hypotheses (k) tested (α/k).

Power analysis and calculation of the number of subjects needed (N) for study were calculated.[29] N is the number of subjects required for the study, for the magnitude of correlation coefficient, ρ detected.

Data Collection and Analysis

The data was collected from the pre and post video session questionnaire, given to physicians and their patients, and was analyzed and summarized. (Table 4) JMP statistical software was used for analyzing descriptive data and graphical representation of the results. Correlation among the variables was done for the physician and the patient data.

Table 4: Results classification

Descriptive data		
Patient data	Distribution of variables	
	Proportions, CI	Hypotheses #1, 2, 3
Physician data Patient independent data		Hypothesis #4
Patient dependent data	Proportions, CI	Hypotheses #5, 6, 7
	McNemar test	Hypothesis #8
	Wilcoxon signed rank sum	Hypothesis #9
Qualitative data		

Patient data	Liked about Videophone	
	Disliked about Videophone	
Physician data	Liked about Videophone	
	Disliked about Videophone	

CI - Confidence Interval. Refer Table 2 for hypotheses studied.

RESULTS

Patient data: Distribution of the variables

Table 5: Distribution of Patient Data Variables

Age distribution (near normal distribution)	Mean = 54, Median = 56, Standard deviation = 14.78	Maximum age - 81 years Minimum - 27 years
Distance from the clinic (miles) (Skewed distribution)	Mean = 20.63, Median = 10.5, Standard deviation = 24.83	Minimum of 2 miles Maximum of 100 miles
Travel time (minutes) (Skewed distribution)	Mean = 37.16, Median = 30, Standard deviation = 26.54	Minimum of 10 minutes Maximum of 120 minutes
Gender	16 men (53%)	14 women (47%)
Familiar with the use of computers	12 of 30 - yes or definitely yes 6 of 30 - maybe	12 of 30 - no and definitely no

Of the 33 patients who were asked whether they would to participate in the study, 30 participated. The SF 12 questionnaire that was used to evaluate patient's perception of their health was difficult to administer. The data from this part of the study was not used, as some of the patients had difficulty in understanding the questionnaire and some refused to answer.

Table 6: Distribution of Patient Data Variables

Video quality	25 /30 -very good/ good	2/30 (7%) - neutral	3/30 - poor/very poor
Audio quality	24 /30 -very good/ good	3/30 (7%) - neutral	3/30 - poor, very poor

Patient Data: Hypotheses

Table 7 - Patient Hypotheses

Hypothesis #1

Patients find the Videophone easy to use.

Proportions - 26/30 = 87%

Confidence Interval = 71% - 95%

Hypothesis #2

Patients will use this technology to communicate with their physician if available in their homes.

Proportions - 24/30 = 80%

Confidence Interval = 64% - 91%

Hypothesis #3

Patients perceive the Videophone as a useful tool to communicate with his doctor compared to phone.

Proportions - 24/30 = 80%

Confidence Interval = 64% - 91%

Patient Data Correlation

Table 8: Patient Data Correlation

Variables	Hypotheses		
	Ease of Use	Useful tool	Will use the VP
Age	r = - 0.0017 p = 0.9928	r= -0.2303 p = 0.9928	r = -0.0237 p = 0.9928
Familiarity using computers	r = 0.1572 p = 0.4069	r = 0.0584 p = 0.7594	r = 0.0417 p = 0.8267
Video quality		r = 0.3386 p = 0.0672	r = 0.2024 p = 0.2834
Audio quality		r = 0.2393 p = 0.2029	r = 0.3716 p = 0.0432
Distance traveled to clinic		r = - 0.0422 p = 0.8247	r = 0.1857 p = 0.3259
Time for travel		r = - 0.0878 p = 0.6445	r = 0.0105 p = 0.9562
Ease of use		Correlation r =**0.6008** **p=0.0004**	Correlation r =**0.6228** **p = 0.0002**
Useful tool			Correlation r =**0.7574** **p < 0.0001**

The significant p value after Bonferroni adjustment (α/k = 0.05/17) is 0.0029.

There are three correlations that are significant in above table: "Ease of use" and "Useful tool," "Ease of use" and "Will use the Videophone" and "Useful tool" and "Will use the Videophone."

Physician Data: Distribution of the variables

Table 9 - Distribution of Physician data variables

Video quality	7/30 -very good/ good	12/30 - neutral	11/30 - poor, very poor
Audio quality	10 /30 -very good/good	8/30 - neutral	12/30 - poor, very poor
VP call time	Mean = 8.16, Median = 8.0	Standard deviation = 3.15	Maximum = 18 minutes Minimum = 5 minutes
Time of estimated clinic visit	Mean = 15.16, Median = 15	Standard deviation = 5.6	Maximum = 30 minutes Minimum = 5 minutes

Table 10- Physician video sessions

Physician participants (n=7)	#1	#2	#3	#4	#5	#6	#7
Patients sessions done with each physician (n=30)	6 patients	7 patients	10 patients	1 patients	1 patients	3 patients	2 patients

Of the 8 physicians available, 7 participated in the study. One physician had patients (geriatric) who were excluded due to physical or mental limitations and did not participate in the study. Some physicians (#4 and #5) did only one Videophone session, others (#1, #2, #3, #6 and #7) had two or more sessions with different patients.

Physician Hypotheses

Table 11- Physician Hypotheses

Hypothesis #4

Physicians find the Videophone easy to use

Proportions - 7/7 = 100%

Hypothesis #5

Physicians perceive this technology as useful tool in outpatient care and management.

Proportions - 10/30 = 33%

Confidence Interval = 18% - 52%

Hypothesis #6

Physicians can give better instructions using the Videophone compared to the telephone.

Proportions - 6/30 = 20%

Confidence Interval = 9% - 36%

Hypothesis #7

Physicians perceive that this technology provides them with sufficient information for assessing the patient's need for immediate evaluation, i.e. clinic visit or to emergency department.

Proportions - 24/30 = 80%

Confidence Interval = 64% - 91%

Hypothesis #8

Physicians perceive this technology as useful tool to reduce the number of clinic visits compared to the telephone. (perceived benefit)

McNemar test (discussed below)

Hypothesis #9

"Time" of the Videophone call is less than the estimated clinic visit by physician.

Wilcoxon signed rank sum test (discussed below)

Hypothesis #8

Clinic visits avoided by using the Videophone compared to the telephone:

Table 12: Avoidable clinic visits

Level	Using Videophone	Using Telephone
1 (Definitely Yes)	0	0
2 (Yes)	11	4
3 (May be)	5	6
4 (No)	14	20
5 (Definitely No)	0	0
Total	30	30

The above table shows that the clinic visits avoided (as perceived by the physician) by using the Videophone are 11/30 or 37%. However, as compared to using the telephone, 7 visits, or 23% more visits are avoided by using the Videophone. A conservative approach has been taken to compare the proportion between those who said "yes" and to all responses.

To test this hypothesis, the non-parametric test for repeated measures, McNemar test was done to find the difference between the two sets of data.

Table 13: McNemar test

Clinic Visits Avoided	Videophone Yes	Videophone No
Telephone Yes	4	0
Telephone no	7	19

For the McNemar test, conservative values of the data were used. The $\chi^2 = 5.14$ (table value for degree of freedom=1 & α=0.05 is 3.84). This shows that there is significantly

more clinic visits potentially avoided by using the Videophone compared to the telephone.[27]

Hypothesis #9

Comparison of the time taken for the Videophone calls versus the estimated time of the clinic visit. The non-parametric test, Wilcoxon signed rank sum, was used to calculate differences for matched pair ranked data that are ordinal values.

Null hypothesis – The time of the Videophone call is equal to the estimated time of clinic visit for the patients. The mean of the difference between the time taken for the Videophone call and estimated time for clinic visit is -7. The calculated value of Z is 2.91, (two tailed table value for a $p \leq 0.05$, is $\pm$ 1.96) therefore, the null hypothesis is rejected. Therefore, there is significant difference in the time taken for the Videophone call versus the estimated time of the clinic visit.

Mean of the difference in scores: Sum of VP time – estimated clinic visit time (difference in clinic visit time and Videophone call time) and the mean is -120/30 = -4. The negative value of the mean of the difference indicates that, there are more clinic visits avoided by using the Videophone compared to the telephone.

Physician Data Correlation

Table 14: Physician's Data Correlation

Variables	Hypotheses			
	Useful tool in outpatient care	Better instructions	Sufficient info. provided	Avoided clinic visits
Video quality	r = 0.1464 p = 0.4401	r = 0.0586 p = 0.7584	r = 0.1022 p = 0.5911	r = - 0.0782 p = 0.6812
Audio quality	r = 0.2072 p = 0.2720	r = 0.1411 p = 0.4571	r = 0.2394 p = 0.2026	r = - 0.1562 p = 0.4097
VP call time	r = - 0.0701 p = 0.7130	r = 0.2356 p = 0.2102	r = 0.1224 p = 0.5194	r = 0.1057 p = 0.5784
Sufficient information	**r = 0.5804** **p = 0.0008**	r = 0.3256 p = 0.0791		r = 0.2663 p = 0.1548
Useful tool		r = 0.0931 p = 0.6245		r = 0.3599 p = 0.0508
Instruct pt.				r = 0.1980 p = 0.2943

The significant p value after Bonferroni adjustment ($\alpha/k = 0.05/18$) is 0.0027.

There is one significant correlation in above table. Videophone providing sufficient information and being a useful tool in Internal medicine outpatient care is correlated. (r = 0.5804 and p = 0.0008)

Qualitative data analysis

Qualitative Data on what the patients liked about the technology.

1. Seeing the doctor:

Among the 30 patients, 12 of the patients (40%) who used the Videophone liked the fact that they could see the person they were talking to. For example, patients said, "It is nice to see the face you are talking to" and "I can see the doctor and he can see me."

2. Comparison to telephone:

Among the 30 patients, five of them felt that this technology was better than the telephone. Patients said, "I had a sense that I was more connected than talking over the phone"; "Not as impersonal as telephone."

3. Remote use, Travel distance and time factor saving:

Of the 30 patients, two also felt that this would be useful for remote situations and six of them (20%) felt this technology would save time and the effort of traveling to the clinic.

4. Seeing the doctor often:

One patient felt this technology could help her see the doctor more often.

5. Ease of use:

One patient said that this was not stressful and it was easy to use.

6. Cost saving, novelty:

One patient felt that this could potentially cut down on cost of health care and the futuristic novelty of the technology was interesting.

7. Not easy to use:

One patient quoted that "When I get used to it, I think it will be great."

Qualitative Data on what the patients disliked about the technology.

1. **"Nothing":**

When asked what they did not like about this technology, 40% (12/30) said "*nothing*."

2. **Direct contact:**

Of the 30 patients, four, (13%) said that they prefer "direct contact" with their physician.

3. **Impersonal:**

Two of the 30 patients felt that this was impersonal.

4. **Cost factor:**

Two worried about cost factors.

5. **Comparison to telephone:**

Four among the 30 patients (13%) felt that this technology was no better than the telephone. One patient quoted "Feeling self conscious about being seen. Telephone is better because no one can see me."

6. **Audio/video quality:**

Three patients said the audio was discomforting. Three others said the video was "distracting" and was "jerky."

Qualitative Data on what the physicians liked about the technology.

1. Eye contact:

Of the 30 Videophone sessions with patients, physicians liked eye contact in 4 sessions.

2. Patient assessment:

Of the 30 Videophone sessions, physicians liked seeing of the patients in 6 sessions. Physicians answered, "Could see patient, she appears well, not ill."

3. Patient reassurance:

Two of the physicians said that patient was reassured about their condition.

4. Communication:

Two of the physicians said that they could communicate well to the patient. One physician quoted "Less personal, somewhat easier to ask confronting questions." (Note: When investigator asked the physician what particular questions they were, she replied that she could confront the patient about substance abuse over the Videophone, she could not really see if he was lying when questioned over the telephone.)

5. Potential uses in clinical medicine:

One physician said that this technology might be useful in remote setting. This "might prevent clinic visit, cut down on time spent with patient" and "potential for efficiency." One physician noted that "same information was gained as a regular clinic visit, able to see patient's face, though not good eye contact." One other comment was that there was more information than telephone.

6. Novelty:

One physician repeated that novelty was likeable after Videophone calls with his patients.

Qualitative Data on what the physicians disliked about the technology.

1. **Patient assessment:**

There were 5 comments on the inability to examine patient as required by the condition.

2. **Patient reassurance:**

Two physicians said the call was impersonal and "not as reassuring to patient as direct contact."

3. **Communication:**

One physician noted that there is "better discussion in person for psychiatric issues, unable to adequately assess patient's mood." Another said "patient was concerned about talking about sensitive issues without me in the room."

4. **Audio/video quality:**

Physicians did not like the restricted image seen. They could not see the entire body or body language, only "head shot" was seen. The quality of the image was also not satisfactory for seeing patient's facial expressions clearly, noted five physicians. The audio quality was also not satisfactory in three Videophone call sessions. The audio/video synchrony, voice delay, and "choppy" image were also disliked features.

DISCUSSION

Patients

The patients found this technology was easy to use. This information was correlated with their acceptance of the technology. However, there was no correlation to their ages or the distance traveled by the patients. In this study, age of the patients did not correlate with acceptance of the new technology. It may prove that, either the elderly are more accepting to the newer technologies or this sample is unusual and may not reflect the characteristics of the general population.

The patient data also revealed that they would use this technology for communicating with their physicians if available in their homes. This data correlated with their perception of the ease of using the technology as well as their view that this was a useful tool for communication compared to the telephone. Though the design of the study was to assess patient's acceptance influenced by audio and video quality, this did not seem to affect their acceptance.

The travel time or the distance to the clinic did not modify this and further studies can be done to assess the problems associated with traveling to see if this would be the affecting factor. There may be inaccurate data collected since patients may have given approximate information for the travel time and distance to the clinic. The earlier studies have focused on remote health care and home health care. This study shows that there is no significant correlation for patient's acceptance with the distance traveled or time taken for travelling. Further studies should be done to evaluate the advantage of using this technology as a

communication tool for remote health care as well as care for patients who live adjacent to the clinics. The acceptance of the technology did not correlate with the patients' familiarity of the use of computers. This is the evidence of the usability and the usefulness of the Videophone as perceived by the patients.

The patients commented that they liked seeing the image of their doctor and talking to him or her. This direct communication with their physician, rather than leaving a message with the nurse, could have influenced their acceptance. However, one patient did state that this would be a useful tool for communicating with the care line nurse. Some (2 of 30) raised the issue of cost, but one patient said there is possibility of potentially cutting back on the health care costs. The cost factor was not raised in this study but could be a potential factor in acceptance of the technology in the real world. The effort of travelling and the time of travel being saved by this technology were also pleasing the patients. Twelve of the thirty patients had nothing negative to state about the technology. This again reflects the acceptance of the Videophone.

The comparison to the telephone brought both favorable and unfavorable viewpoints. Some patients remarked that this was not as impersonal as the telephone and others said this was no different than a regular telephone.

The comparison to the direct contact with their physician again had favorable and unfavorable responses. Some patients thought this was as good as being in the same room with the doctor but others preferred direct contact.

Physicians

There were seven physicians who participated in the study and some of them had many Videophone sessions with different patients and some had a single session with one patient only (*refer Table 9*). It is unlikely that data for multiple patients observed by physicians is completely independent. Further studies with fixed patient numbers for each physician can explore the differences between the physicians. This sample size is small and the study is not designed to look at this.

The physicians did accept that this technology was a useful tool in Internal medicine outpatient care and management. They also acknowledged that the Videophone conversation provided sufficient information which is valuable to them in judging the patient's need for immediate evaluation. This correlated with the physician's opinion that the Videophone was useful tool and were the only two correlating factors.

One of the significant aspects of the study was the physician's opinion that a number of the clinic visits could have been avoided by using this technology compared to the telephone. This shows potential for future application in area of health care for physician – patient communication. There is potential for reduction in utilization of resources because of the reduction in clinic visits. The effect of the avoidance of the clinic visit may or may not be significant in affecting the patient's health and follow up studies should be done to assess this. Factors such as the audio and video quality as well as the time spent on the Videophone call did not affect the decision on avoidable clinic visits.

The health status or the disease condition of the patients may influence this hypothesis. However, this could not be assessed in the study. This was tried by using the SF-12 health

survey questionnaire administered to patients. The patients complained that they did not understand the questions. They quoted answers that were not part of the answer choices and this data could not be used in the study. Other studies have been done using the SF -12 questionnaire successfully and this result was unusual.

Physicians had difficulty interpreting the question of "giving instructions better over the Videophone compared to telephone." This would have been more appropriate for nurses providing interactive instructions in the case of chronic wound infection (for example, wound care) or providing instruction for self-injection of insulin in diabetic patients. This could also be applicable in other instances like rendering instructions to use inhalers for asthma patients or when specific instructions have to be given to patients or their families. Other media such as using compact discs or videotapes for instructions are not customized to the patient's needs and are not interactive.

Physicians remarked that they could see the patients well and steadily and they were able to reassure the patients. Some said that there was potential for remote use and could cut down the time they spend with their patients. The time taken for the Videophone call was consistently less than the estimated time of clinic visit for all of the patients in this study. When physicians were questioned about this, they stated that the physical examination, whether required or not, is an expected part of every clinic visit and this would always increase the time of clinic visit.

The main limitation that the physicians mentioned were not being able to physically examine the patients when required. The physicians may have to see the patient in the clinic after the Videophone conversation and time/cost saving with this technology cannot

be fully determined. One can only compare the Videophone to the current telephone, where physicians talk to the patients and still see them in the clinic.

Usability Inferences

The usability aspect for this study was to understand the usability of this technology (Videophone) in the clinical environment. However, for the reasons of Patient-Physician confidentiality, the tester could not observe beyond the initial start up of the conversation. Therefore, the scope of the usability observation and subjective part of the test was limited. The objective part of the usability testing was derived from the subjects' responses to the questionnaire.

One can argue on the value of the question relating to the ease of use at the end of session. No user would like to admit that they were not at ease to use the system, retrospectively. However, the usability data based on the observation by the tester on completion of the given tasks successfully corroborated their answers to this question.

As there was only one tester, the physician side could not be observed. The mere fact that they were able to establish the video session promptly proved that they were at ease in using the system.

Power Analysis

The study was designed to be a pilot study. The correlation values were significant for patient variables of ease of using the technology and willing to use the technology if available in their homes and prefer this compared to the telephone. (*Refer Table 8*)

Table 15: Power analysis

ρ	N
0.3	104
0.4	57
0.5	31
0.6	26
0.7	18

Hypothesis for power calculation:

$$H_0 : \rho_0 = 0 \quad \text{vs.} \quad H_a : \rho > 0$$

Then calculate N, for different ρ_0 values. (*Table 15*)

N – is the number of subjects required for the study, for the magnitude of correlation coefficient - ρ values that we would like to detect. For significant correlation of 0.5 or more the number of subjects needed is 31.

For power analysis, with a power of 80%, the study will detect that the value of $\rho > 0$, with 30 subjects given a ρ value of 0.50 or above. [29] This turned out to be a full-scale study for the significant correlation values obtained after calculating the number of subjects needed.

Limitations

Some issues of the limitations in the study have been alluded to in the discussion section. The limitations of the study include the four sources of ***variations***: the *patient*, the "*disease*," or health problem of the patient, the *physicians* in the study, and the *technology* itself.

This is a pilot study and not a definitive study. The validity and the reliability of the data collection instrument were not evaluated, as this is a pilot study. However, this is often the goal of a pilot study. The data collected gives feedback on the questionnaire and the methods used for future applications. However, the difficulty of traveling, the health status, and the nature of the health condition could have provided some insight of the patient's situation. The physician question regarding "giving instructions" may not be applicable here.

Feasibility issues such as the number of subjects who would be available (small sample size) and the number of physicians who would volunteer to participate in the study, are also limitations of the study. To explore the issue of completely independent observations made by physicians; fixed number of patients and more physicians should have been studied for variations within the physicians and among the physicians.

The study was conducted in an academic environment at the Oregon Health Sciences University Internal medicine outpatient clinic and the population of patients who visit the clinic. Other limitations include potential investigator's bias influencing the patients during interviewing. This study also does not have control group for comparison. There

could be selection bias due to the subjects being volunteers and were not randomized. Patients who were seeing the physicians for the first time - the new patients, were not selected for the study as the physicians felt that they had to meet with these patients in person. Physicians selecting the patients for the study could be a potential selection bias although they were acceptable under the inclusion criteria. The standardized SF-12 health questionnaire could not be used since patients found the questions were difficult to understand.

Full-scale usability study with tester observations during the whole process of communication on both the patient and physician ends could not be done, because there was only one tester. The issue of cost of the technology versus cost savings was beyond the scope of this study.

The technology is available in the market today but newer versions are being released every day, with better image quality and frame rates that could affect the responses of the subjects.

CONCLUSION

The study was done to assess if there were any benefits of using the Videophone as a communication tool between the patient and their primary care physician, in Internal Medicine outpatient care and management.

The three main issues of the study are to evaluate how easily is the technology used by the patients and physicians, can this reduce the utilization of resources as suggested by the reduction in clinic visits and the benefits of using this technology from the physician's and patient's perspectives.

The study suggests that this is a technology that is easy to use by both the physicians and the patients. The study evaluated from both, the patient and physician's perspectives, the use of this technology, for better and effective communication compared to the current telephone. The conclusions from this study suggest that patients accept the Videophone as a useful means of communicating with their physician compared to the telephone. This technology saves time and effort of travelling for many patients. The patients would use this technology to communicate with their physicians if available in their homes.

The physicians concluded that the use of Videophone in clinical medicine outpatient care could potentially reduce the number of clinic visits for some patients compared to the telephone. The technology provides sufficient information to the physician for assessing the patient's need for immediate evaluation – clinic visit or to emergency department. Clinicians find this a potentially useful tool in internal medicine outpatient care. The time taken for the Videophone call was less than the estimated time of clinic visit.

FUTURE STUDIES

Future studies should focus on validating the results of this study using larger number of subjects. Studies can also be done using a control group with the telephone as communication tool and compare them to patients using the Videophone for patient and physician communication.

Follow up of patients whose clinic visits were avoided by using this technology can be done to determine any effects due to the missed visit. The health condition or disease, the nature of the disease process and the condition of the patient where this technology could be more useful, can be determined in subsequent studies.

This study was done in an academic hospital; further studies can also be done in community hospital setting or in private outpatient clinic setting. This can determine if the Videophone could be useful in different environments and for different patients. Although the study did not find a correlation between the acceptability of the technology and the distance traveled by the patients, studies can be done to assess the use of Vide Phones in remote situations, where access to care can be inadequate or infrequent.

Studies can also be done using the Videophone instead of the existing telephone for patient and the care-line nurse telecommunication to see if this is more beneficial and efficient. Studies can compare the efficacy of the Videophone as a communication tool among the patients and the physicians in comparison with the telecommunication between the patients and the care-line nurses. Acceptability of this technology can be assessed among the two groups.

This study looked at one aspect of the health care communication between the patient and their primary care physician. Future studies can look at the usefulness of the Videophone as a communication tool among physicians, specialists and health care teams involved in patient care and management.

The usability aspects of the study can be done with more complex tasks assigned to the patients and physicians. Two observers can be present at all times during the patient and the physician encounters, each assigned to the patient or physician using the Videophone. They can record their subjective findings and corroborate this with the objective results.

Other Videophones available in the market can be tested for product variability. Using higher bandwidth and better frame rate with larger size of the image in future study can also be done. The bandwidth can be considerably increased using ISDN or cable lines and the benefit of this can be assessed as clearer images can be seen. This can be particularly helpful for physicians. Other aspects of the technology, such as data sharing tools, and/or sending freeze shot photographs, can be studied along with interactive video /audio telecommunication. Other features of the technology such as video store and forward can be studied for situations requiring second opinions or consultant input.

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APPENDIX A: DATA COLLECTION INSTRUMENTS

Previdео session Questionnaire

Physician Questionnaire

1. *Do you use computers at home or at your workplace?*

   Always Usually Sometimes Rarely Never

2. *Are you familiar with the use of computers ?*

   Definitely Yes Yes Maybe No Definitely No

3. *Have you seen or used a Videophone system? If **no**, do not answer the following two questions.*

   Yes No

4. *How was the image quality?*

   Very good Good Neutral Poor Very Poor

5. *How was the audio quality?*

   Very good Good Neutral Poor Very Poor

Patient Questionnaire

1. *How old are you?*

   Write your age in years. _____

2. *Please answer if you are:*

   Male Female

3. *How is your health condition today?*

   Excellent Very Good Good Fair Poor

4. *How many times have you seen your physician in the past year?*

   Write the number of visits. _____

5. *How often have you see your physician in the past year?*

   More than once a month

   Once a month

   Every other month

   More than once in six months

   Once in six months

6. *In the past year, how often have you seen your doctor for the problem that you have today?*

   Write the number of visits. _____

7. *Do you talk to your nurse/ primary care physician over the telephone, before going to the clinic visit?*

   Always Usually Sometimes Rarely Never

8. *Do you use computers at home or at your workplace?*

   Always Usually Sometimes Rarely Never

9. *Are you familiar with the use of computers ?*

   Definitely Yes Yes Maybe No Definitely No

10. Would you like to learn about new technology?

Definitely Yes Yes Maybe No Definitely No

11. Have you seen or used a Videophone system? If ***no****, do not answer 12 & 13.*

Yes No

12. How was the image quality?

Very good Good Neutral Poor Very Poor

13. How was the audio quality?

Very good Good Neutral Poor Very Poor

14. How far do you live from this clinic?

_____miles

15. How long does it take for you to travel to the clinic from your home?

_____hours.

Postvideo session Questionnaire

Physician Questionnaire

1. *Is it easy to use the Videophone?*

   Definitely Yes Yes Neutral No Definitely No

2. *How was the image quality?*

   Very good Good Neutral Poor Very Poor

3. *How was the audio quality?*

   Very good Good Neutral Poor Very Poor

4. *Do you find the Videophone as a useful tool in clinical medicine - outpatient care and management?*

   Definitely Yes Yes Maybe No Definitely No

5. *Did the Videophone conversation provide you with sufficient information to be of value to you, in judging this patient's need for immediate evaluation (i.e office visit or emergency department)?*

   Definitely Yes Yes Maybe No Definitely No

6. *Do you think Videophones would be valuable for giving better instructions to the patient, than over the phone?*

   Definitely Yes Yes Maybe No Definitely No

7. *Could this patient have potentially avoided this clinic visit today, if you and the patient had talked over the* ***Videophone****?*

   Definitely Yes Yes Maybe No Definitely No

8. *If yes, What information was gained? <u>OR</u> if no, What information was lacking?*

_____

_____

_____

9. *Could this patient have potentially avoided this clinic visit today, if you and the patient had talked over just the* ***Telephone****?*

Definitely Yes Yes Maybe No Definitely No

10. What did you like about the Videophone?

(Please write your comments:)

_____

_____

_____

11. What did you not like about the Videophone?

(Please write your comments:)

_____

_____

_____

12. How long was the Videophone call with this patient?

_____

13. How long would be the estimated time of this patient's clinic visit?

_____

Patient Questionnaire

1. *Is it easy to use the Videophone?*

   Definitely Yes Yes Neutral No Definitely No

2. *How was the image quality?*

   Very good Good Neutral Poor Very Poor

3. *How was the audio quality?*

   Very good Good Neutral Poor Very Poor

4. *If you had a Videophone at home, would you use it to talk to your nurse or physician about your health problems?*

   Definitely Yes Yes Maybe No Definitely No

5. *Do you think the Videophone is a useful means of communication with your doctor or nurse compared to the phone?*

   Very useful Useful Neutral Useless Don't know

6. *What did you like about the Videophone?*

(Please write your comments:)

_____

_____

7. *What did you not like about the Videophone?*

(Please write your comments:)

_____