Computer Telephony in Healthcare

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ABSTRACT

The telephone provides an easy-to-use, reliable and cheap computer interface. We review computer telephony applications for patient care, clinical research and medical education. We describe uses at our academic health sciences centre and discuss strengths and weaknesses of this technology. Until more sophisticated interfaces, for example personal digital assistants with wireless Internet access, are commonplace, we believe computer telephony can play a useful role in electronic healthcare.

INTRODUCTION

The telephone is not just a communication tool but is also a simple, quick and cheap computer interface. The computer telephony system (CTS) combines computer and telephone to receive, process and send information (Edgar 1992), and can either replace or support person-to-person contact. In healthcare, the CTS dates back over three decades (Allen 1969). In this article, we categorize CTS applications found in a MedLine search according to purpose: patient care, clinical research and medical education (Biem et al. 2003). We also describe some uses at our academic health sciences centre (University of Saskatchewan and Saskatoon Health Region).

THE COMPUTER TELEPHONY SYSTEM

Consisting of a computer with telephony card, telephony software and telephone line, a CTS can

- receive and store touchtone telephone keypad data (digit capture).
- discern utterances (voice processing).
- record speech digitally (voice messaging).
- mimic speech by combining prerecorded voice files (voice synthesis).

A CTS can be programmed so that a user can select from a menu of options by keypad or voice processing (interactive voice response), record messages (voice mail) or listen to prerecorded voice files (audiotex). The CTS can also be programmed to dial through a list of telephone numbers (automated diallers) or repeatedly transmit a recorded message until received (message delivery). Programmers develop CTS applications in a cycle of needs assessment, flowcharting, voice file scripting, programming, pilot testing, implementation and evaluation (Edgar 1992).

PATIENT CARE APPLICATIONS

Patient care applications can be subcategorized into health services delivery, preventive care, medical care and psychiatric care (Table 1).

Health Services Delivery

For handling health information, a CTS can collect data from patients by automated questionnaires and provide advice through automated telephone hotlines. A CTS can be linked to electronic medical records. At our centre, we dictate clinical reports over the phone and can access recorded reports awaiting transcription on a searchable database (Weber 1992). Access to radiology reports has eliminated the tiresome task of tracking down routine

Table 1: CTS applications in patient care

Healthcare Delivery

Scheduling:
- Appointment reminder
- Voice messaging

Communication:
- Automated telephone Attendants
- Paging
- Triage
- Telephone prescriptions

Health Information:
- Questionnaire
- Health information lines
- Medical records

Management:
- Employee attendance
- Home care visit tracking
- Residential bed tracking
- Billing

Preventive Healthcare
- Immunization
- Health promotion

Chronic Medical Management
- Monitoring chronic pain, Cardiovascular risk factors Pulmonary symptoms Medication adherence Diabetes symptoms and Glucose results Cancer symptoms Support caregivers of Dementia patients Functional status of seniors

Psychiatric Patient Care

Affective Disorders:
- Depression

Anxiety Disorders:
- Anxiety
- Obsessive-compulsive disorder

Addiction:
- Cocaine
- Alcohol

films and finding a radiologist to read them. Our radiologists appreciate not having interruptions, which makes their work more efficient and pleasant (Merz 1982).

For communication, we rely on CTS-based paging systems, which transmit numeric or voice messages. In our offices, we use automated attendants to triage patient calls. Some automated attendants allow patients to call for prerecorded messages about test results and recommended follow-up. Many pharmacies use automated telephone prescription refilling.

For appointment scheduling, our staff benefit from automated attendants and voice messaging. Several large randomized controlled trials of reminder systems, which call patients before a scheduled visit (Tanke and Leirer 1994; Dini et al. 1995; Tanke et al. 1997), have shown better rates of kept appointments. We are currently developing a system to decrease no-shows in our general internal medicine clinic.

For healthcare management, a CTS can be used for tracking employee attendance. In the hospital, it can help manage patient transport. In the community, it can be used for home care visit verification and billing as well as tracking of residential bed availability.

Preventive Healthcare

Large randomized controlled trials of CTS reminders (Dini et al. 2000; Lieu et al. 1998; Linkins et al. 1994) have found improved rates of childhood immunization. The CTS has been used to increase immunization rates for influenza in seniors and to assess need for hepatitis vaccine. For health promotion, the CTS-based intervention (weekly calls for diet monitoring, educational messages and behavioural feedback) can improve nutrition (Delichatsios et al. 2001), but has been ineffective for cholesterol reduction (Dutton et al. 1995), weight reduction (Hyman et al. 1996) and physical activity promotion (Jarvis et al. 1997; Pinto et al. 2002).

Chronic Medical Management

The CTS has been used to monitor symptoms and improve health behaviour for a variety of conditions, alerting healthcare providers if responses to automated questions indicate concern. If a patient does not call the CTS as expected, the system can call the patient. A CTS can monitor medication adherence (Leirer et al. 1991). Patient care applications have been used for a variety of conditions:

- For cardiovascular care, a CTS has been used to monitor weight for patients with congestive heart failure and improve medication adherence and blood pressure control in patients with hypertension (Friedman et al. 1996).
- For chronic lung disease, a CTS has been used for monitoring symptoms and medication adherence as well as for providing counselling about vaccination, smoking and exercise (Young et al. 2001).
- For cancer care, a CTS has been used to follow symptoms and determine quality-of-life needs during outpatient chemotherapy (Siegel et al. 1992).
- For diabetes care, the CTS enables patients to transmit blood glucose results regularly to providers. Patients followed by such systems may have better glycemic control, less morbidity (diabetic symptoms, depression and hospital days), higher satisfaction (Piette et al. 2000) and better quality of care (self-glucose monitoring, foot examination and cholesterol testing) (Piette 2001). At our centre, voice messaging is one of a variety of ways we communicate with patients to support diabetic self-management.

Psychiatric Care

A CTS-based psychiatric interview had reasonable accuracy and reliability (Kobak et al. 1997; Kobak et al. 1997). Instruments have been administered by CTS for the diagnosis of depression (Gonzalez et al. 1997; Baer et al. 1995; Mundt et al. 1998), anxiety, obsessive-compulsive disorder (Baer et al. 1993) and substance abuse (Dyches et al. 1999). For management of depression, the CTS has provided psychotherapy (Osgood-Hynes et al. 1998) and improved antidepressant adherence (Stuart et al. 2003). A self-guiding manual combined with CTS has been feasible for assessment, treatment and follow-up using exposure and ritual prevention (Nakagawa et al. 2000). For substance abuse, a CTS has been used to follow patient progress weekly for over a year (Alemi et al. 1994).

CLINICAL RESEARCH APPLICATIONS

The CTS has many research applications: survey, recruitment, allocation, health measurement, longitudinal follow-up and quality improvement (Table 2) (Kobak et al. 2001).

Table 2: CTS Applications in clinical research

Surveys	**Health Measurement**
Difficult-to-reach populations:	SF-12
Substance abuse	Alcohol Dependence Scale
Homeless	Work and Social Adjustment Scale
Sensitive Topics:	**Longitudinal Follow-up**
Drug	Depression
Alcohol	Sexual activity
Marijuana use	Mood
Sexual behaviour	Cognitive function
HIV risk behaviour	Alcohol consumption
Recruitment	**Quality of Care**
Eligibility	Surveys
Allocation	
Randomization	

Surveys

The CTS has been used to administer a variety of questionnaires, helping to reach marginalized groups, e.g. homeless people (Aiemagno et al. 1996), and to broach sensitive topics such as alcohol consumption (Corkrey and Parkinson 2002), substance abuse (Gribble et al. 2000), sexual distress (Bancroft et al. 2003) and HIV risk behaviour (Des Jarlais et al. 1999).

Recruitment

In randomized controlled trials, the CTS can verify eligibility (Silva et al. 1993). By verifying inclusion and exclusion criteria, the CTS may decrease personnel time and save money by avoiding recruitment errors (Silva et al. 1993). We have used a computer telephony system to track new stroke admissions.

Allocation

The CTS can be used to randomize patients (Papaconstantinou and Krischer 1995). Avoiding the limitations of sealed envelopes (Roberts and Torgerson 1998), randomization by a CTS is concealed and independent. Useful not only in multi-centre trials (Krischer et al. 1991), such systems may also make possible allocation algorithms such as balanced randomization (Cheung et al. 1977). As a participating centre in large multi-centre randomized controlled trials, we have used the CTS to register and randomize patients in this way.

Health Measurement

Some instruments administered by CTS have been studied for validity. In a comparison of a CTS vs. in-person administration of the SF-12 health status survey of patients with low back pain, although the physical scales were similar, patients were more likely to report emotional concerns, lower mood and poorer overall health with the CTS (Millard and Carver 1999). The CTS has been used to assess cognitive function after anesthesia (Girdler et al. 2002), cognitive assessment with chronic fatigue syndrome (McCue et al. 2002), alcohol dependence using the Alcohol Dependence Scale (Mundt et al. 2002a) and social functioning using the Work and Social Adjustment Scale (Mundt et al. 2002b).

Longitudinal Follow-up

The CTS can be useful for longitudinal follow-up during cohort studies and randomized controlled trials, since patients may not adhere to paper diaries (Verschelden et al. 1996; Mazze et al. 1984; Stone et al. 2002). A CTS can monitor patients by conducting repeated simple interviews. The CTS has been used to monitor a variety of symptoms (Marshall et al. 1993) and behaviours including mood (Mundt et al. 2001), sexual activity (Minnis and Padian 2001) and binge eating (Bardone et al. 2000). For alcohol intake, the CTS may be more accurate than timeline feedback questionnaires (Searles et al. 2002), since retrospective questionnaires underestimate alcohol consumption, especially in heavy drinkers (Perrine et al. 1995; Searles et al. 2000; Searles et al. 1995). The CTS method has been used to follow temporal trends in intake (Mundt et al. 1995b) for as long as two years (Helzer et al. 2002). Adherence has been reasonable in studies lasting a few months (Mundt et al. 1995A). Compared to a paper-based diary, a CTS accessed by cellular telephone may be easily integrated into daily routine and has the additional advantage of time-stamped data entry (Collins et al. 2003). At our centre, we have used the CTS to monitor patients during a randomized controlled trial of labour induction, during which patients called every four hours to record ratings of pain, anxiety and satisfaction (Biem et al. 2003d).

Quality of Care

For evaluating quality of care, health services researchers need standardized measures of access, process, satisfaction and outcome (Cella 1995). A CTS has been used to evaluate access to health services among patients with diabetes (Piette 2000). Automated performance assessment may help providers improve healthcare (Wulff et al. 1997). A CTS has been used for patient rating of visit satisfaction (Isenberg et al. 2001) and to evaluate programs (Singhal et al. 2001). At our centre, we have developed a CTS to measure patient satisfaction among patients in our new urgent care clinic (Biem et al. 2003a).

MEDICAL EDUCATION APPLICATIONS

The CTS has been used to provide timely educational information for healthcare providers and to evaluate

healthcare trainees (Table 3). A CTS has been described to answer questions in infection control (Manangan 1996) and another to access educational resources at the Center for Disease Control (Friede and O'Carroll 1996). A voice mail educational program has been described for helping nurses appropriately collect administrative data (Narayan 2001).

Table 3: CTS Applications in Medical Education

Educational Resources	Trainee Evaluation
Voice mail educational program	Competency of resident physicians
Infection control information	Evaluation of medical students
Educational resources line	

The CTS has been used to evaluate competency of physician trainees (Fung Kee Fung et al. 1997). We have been using a system to track the training experience of senior medical students. Faculty members call the system to record student evaluations after observing patient assessments and procedures. To test management skills, faculty can use it to quiz students on common clinical scenarios (Biem et al. 2003c).

PROS AND CONS OF COMPUTER TELEPHONY

Although CTS healthcare applications are diverse, the evidence for the effectiveness of CTS-based interventions based on randomized controlled trials is limited (Biem et al. 2003a). Some CTS applications (e.g., health information, communication, office management) do not lend themselves to randomized controlled trials. Many trials have been small (Dutton et al. 1995; Jarvis et al. 1997; Mahoney et al. 1998; Leirer et al. 1991) or had loss to follow-up (Jarvis et al. 1997). The duration of the intervention has usually been less than a year. Perhaps due to loss of novelty, the effect may not be sustained (Pinto et al. 2002). Few applications, except for appointment reminders, have been replicated in multiple settings. Cost-effectiveness has only rarely been estimated (Franzini et al. 2000; Rask et al. 2001).

The CTS has some drawbacks. Similarly to other types of automation, a CTS is impersonal. Person-to-person contact seems more appropriate in some situations, for example, support of caregivers of patients with dementia (Mahoney et al. 1998; Mahoney et al. 2001). The CTS has been found feasible for management of obsessive-compulsive disorder, but in-person therapy was more effective (Greist et al. 2002). Combining CTS with personal contact has been better (Piette et al. 2000; Piette et al. 2001; Siegel et al. 1992). For automated questionnaires, while subjects prefer in-person interviews, for sensitive issues, subjects reported less embarrassment with a CTS (Kobak et al. 1999).

A CTS may be annoying. "Voice mail jail" from long voice menus, ambiguous instructions and repeated transfers can be avoided by giving common menu options first so that users can quickly move from menu to menu. Rapid, poorly recorded or synthetic speech can be annoying. However, newer technology and careful recording can eliminate these problems. The CTS can be tailored to older persons and to speakers of different languages (Marcellini et al. 2000; Maxwell et al. 2001).

Although CTS applications require special equipment and programming, software and user-friendly applications are becoming available (Janda et al. 2001). Both inexpensive and sophisticated products are available to run on personal computer systems and larger computers. Telecommunications companies offer computer telephony services. Although a CTS application is generally reliable, technical difficulties can occur (Mahoney et al. 1998).

Because of the ubiquity of the telephone, the CTS is ideal for many types of information handling. However, not surprisingly, such systems are ineffective in populations without telephone access (Maxwell et al. 2001; Stehr-Green et al. 1993). Although hand-held computers are increasingly available, the telephone remains cheap and familiar, especially for older persons unfamiliar with hand-helds (Marcellini et al. 2000) or lacking Internet access (Gimenez-Perez et al. 2002).

Although the cellular telephone, personal digital assistant and audio/video player are converging into a single, multifunctional, voice-activated device (Starren et al. 2002), it may be some time before most people have these units. Advances in speech recognition, synthetic speech and natural language processing are enabling voice control without need for touchtone keypads. Shortages of healthcare personnel will make automation increasingly attractive (Noell and Glasgow 1999). Ideally a CTS should not only save personnel costs (Hall and Huber 2000; Alemi et al. 1996) but also improve patient outcomes.

CONCLUSION

The CTS has many applications in patient care, clinical research and medical education. Some applications are supported by strong randomized controlled trial evidence, for example reminders for scheduling; other applications are self-evident by common use, for example telephone dictation, automated attendants and health information lines. In our centre, we have applications spanning the spectrum of potential uses. Given the omnipresence of the telephone, the CTS should be part of the electronic healthcare toolbox for appropriate applications (e.g., simple, serial, longitudinal, and/or high-volume data collection, processing, transmission), especially when it can be integrated with health information systems (e.g., transcription, reminders, disease management).

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Online Stats

A recent study by Forrester research reports: 73% of clinically depressed consumers look up health information online; this tops other disease groups. 8% of consumers diagnosed with a disease or medical condition say they have participated in a clinical trial. 6% of consumers indicated that they had visited their doctor's website. (*Source: Forrester Research*, June 10, 2004)

E-mails at a Standstill

Patient-physician communication over e-mail has remained fairly stagnant in the past two years despite the fact that nearly 85% of physicians use e-mail for professional purposes. One analyst states that "the future of online communication looks bright with 51 million consumers enthusiastic about the possibility of using e-mail with their physicians, but barriers hindering supply on the physician side remain." (*Source: Manhattan Research*, June 17, 2004.)

E-mail Concerns Put to Rest

For physicians who are still sitting on the sidelines when it comes to e-mail communication with their patients, an article from the University of Michigan puts to rest some of the most common concerns. Most messages (82%) addressed a single issue, and messages overall were "concise, formal, and medically relevant." Only 5.1% included sensitive content and none concerned truly urgent health issues. Less than half (43.2%) required a physician response (messages were triaged by content). (*Source*: White et al., *Journal of the American Medical Informatics Association*, 11:260–267, July/August 2004.)