

# Telemedicine and telecare: what can it offer mental health services?

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**Abstract** With new developments in image generation and transmission, researchers have studied the feasibility of using communications technology for remote diagnosis and care delivery. The term 'telepsychiatry' has been used to describe the application of telemedicine and telecare to mental health. This article reviews the development of telepsychiatry and key research findings. Results suggest that service users are more comfortable with mediated services than are professionals. Most work has been done in areas of low population density, where accessibility to conventional services is limited by economics and geography. In urban settings, with distributed community services, telepsychiatry can improve communication between primary and secondary sectors and within secondary services.

Telemedicine has been defined by Wootton as health care at a distance (Wootton & Craig, 1999). In essence, it is the use of communications technology to support health care delivery. It is not new. Researchers across the developed world have examined its feasibility in areas where population density is low, there are problems with transport because of geographical barriers and professional recruitment is difficult. Live pictures and sound have been transmitted between sites to support consultations between professionals and patients when one or other would otherwise have had to travel. Where population density is low, it is usually the clinician who travels, whereas in areas of high population density, with affordable public transport, the service user generally travels. In either case, a cost is incurred simply getting the service user and the service provider together in the right place at the right time.

Telemedicine involves the transmission of data over distance. Often this has been between units providing health care but increasingly it is being used to link the health care provider with the patient's home. In conventional consultations, the physician applies the senses of sight, sound, smell and touch to make a diagnostic formulation and agree a management plan. In telemedicine, the input is limited to sight and sound, although rudimentary electronic 'noses' have been developed. An image or sound is captured from the patient, processed to facilitate transmission over a link, transmitted and then reprocessed to generate sound and images for the health care professional at a remote site. This

process can be either a live exchange, as when a doctor talks to a patient on the telephone (real-time telemedicine), or delayed, as when a digital picture of a skin lesion and a textual clinical summary are e-mailed to a dermatologist, who reviews them and sends back a management plan (pre-recorded or store-and-forward telemedicine). Mental health care relies heavily on interpersonal communication and it is probably one of the most obvious applications for real-time telemedicine.

One of the earliest telephone calls summoned help to an assistant of Alexander Graham Bell after he had spilled acid. Subsequently, television brought the potential to transmit live video pictures to enhance distance communication. In 1955, Wittson & Dutton (1956) used a closed-circuit television system at the Nebraska Psychiatric Institute for live transmission of therapy sessions to students, for educational purposes. They subsequently developed other applications enabling the university's psychiatry department to influence a state mental institution, about 100 miles away. This team ran group therapy programmes and staff supervision over a microwave link. They observed user responses and speculated on how the medium might have altered the content of the interaction and the nature of the relationships which were established. They judged the effect to be neutral. The influence that the medium has on the communication is a recurrent theme and our understanding of this has progressed little in the subsequent 40 years (Baer *et al.*, 1997).

Telemedicine has witnessed many false dawns. In the early 1970s, several pilot projects were

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undertaken. The Logan Airport Project linked the Massachusetts General Hospital to the medical centre at Logan Airport in Boston, USA, via a microwave connection. It was used to deliver primary and specialist care to airport employees and, eventually, to the local community. Evaluation relied heavily on subjective reports.

In the 1980s, the Norwegian government initiated a National Telemedicine Programme to offer citizens in small rural communities an alternative method of care delivery because specialist care was not always available locally. A telemedicine centre was established at the University of Tromsø in northern Norway, and this has spawned many speciality telemedicine projects (Gammon *et al*, 1996) operating over an extensive network. Similar networks developed in Western and South Australia in the early 1990s.

Until the advent of international digital networks such as the Integrated Services Digital Network (ISDN), telemedicine and telecare were limited to isolated pilot projects and restricted to countries with an advanced communications infrastructure. New advanced mobile digital communications may free telemedicine from a reliance on cables and telegraph poles and open opportunities for the developing world, where there is a rapid expansion in the use of mobile telephones.

Such mediated communication also offers greater accessibility. Patients at a remote nurse-led primary care centre in rural America can have more frequent and timely access to a psychiatrist at a teaching hospital using videoconferencing rather than having to wait for a personal visit. With the availability of worldwide communication systems, access to the network can mean easier access to scarce health care resources.

Other specialities in which 'tele' programmes have been developed include teledermatology, teleophthalmology, teleradiology, remote foetal ultrasound and emergency care. The rationalising of accident and emergency services in the UK has resulted in telemedicine being used in nurse-led minor injuries units. Using videoconferencing, these units can have immediate access to other clinicians at emergency centres.

Communications technology has crept almost unnoticed into many areas of health care delivery. The telephone is often used by professionals to follow up patients with whom they have a therapeutic relationship. Simon *et al* (2000) reported a randomised controlled trial on giving general practitioners (GPs) feedback on prescribing for patients with depression: they compared a system of giving feedback alone with giving feedback plus care management advice, including systematic follow-up by telephone. Care management with

### Box 1 Advantages of videoconferencing equipment

- Simultaneous transmission of sound and moving images between sites
- Dial-up access
- Remote camera control for pan, tilt and zoom
- Inset picture ('picture within a picture'), to show the image received at the remote end

telephone follow-up significantly improved clinical outcomes in this sample.

Telephone helplines are extremely popular. Here, users disclose painful or intimate personal details to people they will never meet.

Telemedicine makes care in the home a realistic option for many areas of need. In a retrospective analysis of home nursing charts in the USA, Allen *et al* (1999) estimated that 46% of traditional home health visits could be conducted using telemedicine.

## The technology

It is important not to tie telemedicine and telecare to advanced and expensive communications technology. Before applying an expensive tool, the question should be 'Can an existing tool meet this need?'

Videoconferencing is the tool, or kit, most often associated with telepsychiatry. However, the telephone and postal services are clearly the most widely used communications tools, yet their use is rarely scrutinised by researchers. E-mail is more widely available but is usually reserved for administration.

The term 'videoconferencing', taken from the business sector, is used interchangeably with the terms 'videolink', 'interactive television', 'television link' and 'videophone' (Box 1). They all transmit simultaneous live sound and moving pictures between sites. The quality of the moving picture viewed will be determined by the rate at which the picture on the screen is refreshed (frames per second) and the number of pixels (units of information) which are used to make up the picture (the resolution). These variables are, in turn, determined by the sophistication of the electronic image processing which takes place before and after transmission and the capacity of the channel. An analogue video image can be transformed and transferred into a digital system using either a personal computer (PC) or a standalone unit called a Codec (it *codes* and *decodes*).

A communications channel (Fig. 1) connects the sender and receiver (Coiera, 1997). The most common connection is through a dedicated wire, as in the local telephone network. Here, data are packeted

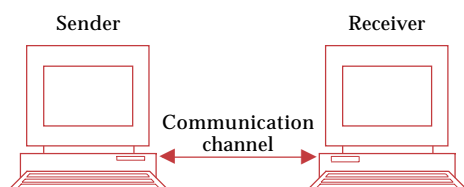


Fig. 1 The communication channel.

and moved along a copper wire between the telephone and the local exchange. Multiplexing combines data packets for transmission along the trunk. Bandwidth, measured in hertz, is one measure of a channel's capacity to carry data.

Telepsychiatry, the use of telemedicine and telecare in the mental health sector, uses either the telephone network's 'Plain Old Telephone Service' (POTS), transmitting at a maximum of 56 kbit/s, or the ISDN. With ISDN, lines can be multiplexed so that capacity is used to its optimum. They operate at 128 kbit/s, probably the most widely studied bandwidth in telepsychiatry, or 384 kbit/s, with three lines operating in parallel. Videoconferencing equipment is usually designed to operate at one of these speeds. The most sophisticated videoconferencing equipment can operate at 128 kbit/s, 384 kbit/s or even higher bandwidths. The higher the bandwidth, the better the quality of the image and sound transmitted from the same equipment. Manufacturing standards were established in the mid-1990s for videoconferencing equipment operating over ISDN or POTS. Equipment from different manufacturers will therefore be able to communicate if it shares the standard protocol. With a commercial videoconferencing unit operating at 384 kbit/s, 'near-TV' quality images and high fidelity audio will be achieved. With 128 kbit/s, the picture will be very sensitive to movement and will fragment or 'pixelate' if this is too rapid. There is also a noticeable delay between the transfer of the sound and the visual image which can interfere with the smooth flow of communication. These effects are magnified on videophones operating over POTS and the picture here is usually displayed on a smaller screen to mask the loss of definition.

Satellite links were, and still are, prohibitively expensive for most health care applications. Radio communication and fibre optic cable are likely to become increasingly important channels for videoconferencing, offering high bandwidth at diminishing cost.

## Telepsychiatry research (Box 2)

The first use of the term 'telepsychiatry' in the literature was by Dwyer (1973). In spite of pilot

### Box 2 Telepsychiatry research methods

Observational pilots  
Qualitative studies  
Controlled studies  
Satisfaction studies  
Reliability of standardised rating scales  
Reliability of diagnosis and management planning

projects and prophets foretelling dramatic benefits from technology for more than 40 years, telepsychiatry has made little impact on mental health care outside of some parts of rural Australia and the USA. Most studies have been descriptive and, in controlled studies, sample sizes have been small and methodology weak. Potential applications of telepsychiatry (Box 3) are discussed below.

### Telepsychiatry in primary care

Telemedicine has been proposed as a means of improving communication between primary and secondary care. Harrison *et al* (1996) have highlighted the advantages of a joint consultation model in which the GP participates in the patient's consultation with the remote expert. It has been argued that this is a valuable educational experience for the GP as well as offering support and reassurance for the patient. Videoconferencing has been piloted

### Box 3 Applications of telemedicine in mental health

Pilot studies have shown that a wide range of clinical tasks can be completed using interactive television:

- Discharge planning with primary care teams participating by videolink
- Remote psychiatric consultation with outpatients by videolink
- Remote joint assessment with primary care teams: videolink assessment with the GP present with the service user
- Remote psychiatric assessment in prison
- Remote support of psychiatric patients admitted to GP hospitals
- Linking acute psychiatric wards with psychiatric intensive care units: facilitating transfers and maintaining therapeutic relationships with the staff on the referring ward
- Psychotherapy: supervision of psychodynamic and cognitive-analytic therapy; delivery of psychoanalysis and cognitive-behavioural therapy

as a means of involving GPs in care planning and running remote out-patient services (McLaren *et al*, 1999). Patient responses in this study were generally positive but one refused to be interviewed by videolink, having used it on two previous occasions. Involving GPs in discharge planning meetings for patients on an acute adult psychiatric ward was highly valued by both patients and professionals.

May *et al* (2000) set up a pilot telepsychiatry service for patients in the north-west of England who had anxiety or depression. Low-cost videophones operating at 128 kbit/s linked a psychiatrist to two general practice surgeries. A rigorous qualitative analysis was performed on data collected from professionals and service users. The authors examined the responses of 22 patients and 13 professionals through semi-structured informal interviews. The professionals were not telemedicine proponents and were more ambivalent about the system than were the patients (Box 4). One of the GPs stated:

'I don't think there is [a need], to be honest, I mean, not here anyway ... I can see it being used where the population is not so intense – here the accessibility of the service is not a problem.'

GPs were also concerned about the impact that the medium would have on the patient–doctor relationship. Patients echoed these concerns. One stated:

'The thing that came over to me was that you don't sort of interact in a face-to-face way because it's difficult to pick up expression, facial expressions – as to whether he [the psychiatrist] was pleased with what I was saying, or whether he understood what I meant.'

One of the psychiatrists said:

'I think what has been difficult for those people who have found it difficult is that they [did so] because they seemed to be aroused and anxious. When you are with someone face-to-face for an hour, most people settle by the end of the hour, they would feel more relaxed – I would be able to help them feel more relaxed. But on occasion it has been difficult in these conditions.'

D'Souza (2000) reported on the use of videoconferencing to support the treatment of psychiatric

#### Box 4 Professional concerns about telemedicine

- It makes patients anxious
- It makes professionals anxious
- You cannot use your acquired skills to reassure patients
- You cannot have a proper professional–patient relationship using a television
- You might miss important non-verbal communication
- Confidentiality could be compromised

#### Box 5 Patients' responses to telepsychiatry

- Most find the experience acceptable
- The reduced need for travel is attractive
- Treatment at a general practitioner clinic or site near home is attractive
- The medium upsets them less than professionals expected it to
- Higher-quality images are preferred

patients in small rural hospitals staffed by GPs, as part of the Rural and Remote Mental Health Service based at Glenside Hospital in Adelaide, Australia. Videoconferencing was used to assess 28 patients. Six had to be transferred to the psychiatry facility in Adelaide as they could not be managed in the local hospital either for reasons of their own safety or in the interests of the other patients. The mean stay for the patients supported in the rural hospital by videoconferencing was 10 days, significantly shorter than the average for psychiatric patients in Adelaide.

#### Discharge planning

A Finnish group has analysed the cost of using videoconferencing for discharge planning (Mielonen *et al*, 2000). Their analysis covered 14 discharge planning consultations to 2 municipalities, one 229 km and the other 160 km from the base hospital. The costs of the 14 videolink assessments were compared with those from 20 conventional discharge planning consultations. The videolinks used three ISDN lines offering a total bandwidth of 384 kbit/s. Only 6 of the 48 primary care workers and 1 of the 13 relatives would have preferred a conventional meeting at the psychiatry department. The most important reasons given for preferring videoconferencing were the participant's reduced need to travel and the ease and speed of the consultation. Responses suggested that support for videoconferencing tended to be lower in locations where it was not available than in those where it was. The videoconferencing equipment cost around US\$14 500 and the authors concluded that if it was used in 30 consultations a year and also put to other uses, it was slightly less expensive than for a nurse to travel to a meeting. The responses of their patient subjects suggested that videoconferencing produced almost as good an outcome in care planning consultations as do conventional meetings (Box 5).

#### General adult psychiatry

Zaylor (1999), working in Kansas, USA, reported the largest series of telepsychiatry consultations with outcome measurement. Chae *et al* (2000)

reported an evaluation of a telemedicine system in South Korea operating over the ordinary telephone network at 33 kbit/s. Thirty subjects were randomly selected from 198 attendees at a community mental health centre. The system was used to assess 15 patients, and 15 others were assessed face-to-face using the Brief Psychiatric Rating Scale (BPRS). The reliability of the BPRS was established by a doctor and nurse simultaneously rating the patients. In the telemedicine situation, a doctor at the community mental health centre scored the BPRS over the link while a nurse with the patient at the remote site carried out a simultaneous rating. Using intraclass correlation to compare the 18 rating items between the two groups, agreement was similar for 3 items, higher with telemedicine than in face-to-face for 8 items and lower for 7 items. The agreement correlation for the BPRS total score (0.82) was significantly higher for telemedicine than for face-to-face interviews (0.67). This might have been due to a practice effect, as the telemedicine ratings were made after the face-to-face ratings. The anxiety reliability was very low for telemedicine (0.22), which might indicate that it was difficult to assess this item using the medium. The total acceptance score for telemedicine was higher than for face-to-face assessments. A multiple regression analysis using total acceptance score as the dependent variable showed that telemedicine was more acceptable to patients whose illness was less severe.

Kavanagh & Yellowlees (1995) suggested that telemedicine may be less threatening because patients feel that they can walk out of the room without offending the interviewer.

Zarate *et al* (1997) compared the reliability and acceptability of a telemedicine system using ISDN at 128 kbit/s and 384 kbit/s for patients with schizophrenia and found that the lower transmission rate could be used reliably for administering psychiatric rating and screening scales. They found intraclass correlation for total BPRS scores of 0.96 for face-to-face interviews, 0.84 for telemedicine at 128 kbit/s and 0.90 at 384 kbit/s. Telemedicine exhibited losses in reliability in detecting the presence of negative symptoms. The assessment of total score on the Scale for Assessment of Negative Symptoms (SANS) was less reliable at the lower bandwidth, as were several specific negative symptoms of schizophrenia that depend heavily on non-verbal cues. Patients in the group using the high bandwidth were more likely to prefer the video interview to a live interview.

Although such work is generally reassuring as to the reliability of assessments by videoconferencing it is unlikely that variation in reliability of simultaneous rating scale measures is a sensitive enough paradigm to detect clinically meaningful distortions introduced by the medium. These results are

insufficient to confirm that videoconferencing is a reliable way to practice psychiatry.

### **Psychiatric intensive care**

Haslam & McLaren (2000) reported on the use of a videolink, operating over 128 kbit/s, to facilitate communication between a psychiatric intensive care unit (PICU) and a referring general adult ward on another site. In one case, nurses from the referring unit were able to maintain contact while the user was in the PICU.

### **Obsessive-compulsive disorder**

At Harvard, USA, Baer *et al* (1995) demonstrated the reliability and acceptability of telemedicine, using an ISDN bandwidth of 128 kbit/s, for patients with obsessive-compulsive disorder. They found near-perfect reliability (intraclass correlation of 0.99) for both video and in-person agreement on the Yale-Brown Obsessive Compulsive Scale. These authors later re-rated videotapes of the interactions based on the soundtrack alone. They found the same high correlation between the conclusions of the face-to-face and remote interviewers, suggesting that the visual aspect of rating might not be important with these scales.

### **Child and adolescent psychiatry**

Straker *et al* (1976) described the use of a videolink between a child guidance clinic in New York's Harlem and the academic department at the city's Mount Sinai School of Medicine, and proposed that the link allowed service access by families who were otherwise inhibited from coming into the teaching hospital. They proposed videoconferencing as a way of making services more accessible to patients who were reluctant to visit a hospital, perhaps through fear or because of stigma.

Elford *et al* (2000) evaluated a personal-computer-based videoconferencing system used to conduct remote psychiatric assessments in Newfoundland. Two assessments were completed by 23 patients, aged 4–16 years. One used videoconferencing and the other was face-to-face. The order of assessments was randomised and one of five participating psychiatrists was randomly assigned to each assessment. Diagnosis and treatment were discussed with the patients only after the second assessment and this was conducted face-to-face. An independent evaluator compared the primary diagnosis and treatment recommendations made after a videoconferencing assessment and one conducted face to face. Of the 34 patients enrolled, only 24 participated.

None of those that refused had specific concerns about the technology. Before the study, two or more psychiatrists expressed concerns about 'missing something', being unable to interact and equipment failure. Afterwards, all five said it was an acceptable alternative but that they would prefer to assess face to face. None felt that it hindered them from making a diagnosis. The independent rater concluded that in 22 of 23 cases, the diagnosis and treatment recommendations made using videoconferencing were clinically the same as those made face to face. In the remaining case, the order of primary and concurrent diagnoses was reversed. The users liked videoconferencing and many preferred it to face-to-face interviews.

### Forensic services

State prisons in Texas and Ohio, in the USA, are currently providing psychiatric services using telemedicine. Zaylor *et al* (2000) established a pilot telepsychiatry project between the Kansas University Medical Centre and the Lyon County Jail. The system used personal-computer-based videoconferencing at 128 kbit/s, with 17-inch monitors. Only one inmate refused to take part. The demand for consultations was five times greater than projected and rose to 34 consultations per month. Psychotropic medicine was prescribed as a result of 74% of the consultations.

### Psychotherapy

Psychoanalysis by letter is, by Wootton's definition (Wootton & Craig, 1999), an example of telemedicine. Kaplan (1997) reported on their use of a videophone for psychoanalysis of two patients who had to relocate while in therapy. In psychoanalysis, the therapeutic relationship develops through the mirroring of the patient by the therapist and through the patient's fantasies about the analyst. It could be postulated that technologically mediated psychoanalysis, where contact between therapist and patient is even more limited, might facilitate more intense fantasy and exploration of the perceived relationship. Earlier workers used the telephone to maintain contact with clients who moved during therapy. Cognitive-behavioural therapy has been piloted and psychotherapy supervision delivered in psychodynamic therapy (Gammon *et al*, 1998) and cognitive-analytic therapy by videolink.

### Neuropsychological assessment

Kirkwood *et al* (2000) studied the consistency of cognitive assessments of individuals with a history

of alcohol misuse. Assessments were performed on 27 participants in two equivalent forms, one via videoconferencing and one face-to-face. They found that the mean time taken for consultations by videoconferencing was about 7 minutes longer than for face to face. Similar results were obtained for most of the measures. Cognitive assessment by mediated communication has been reviewed by Ball & McLaren (1997), who found that old age is no bar to participation in telemedicine services.

## Understanding differences between media

The early 1970s saw the beginning of a theoretical interest in differences between communication media, with the anticipation of widespread use of mediated communication in commerce. This work was summarised by Short *et al* (1976), who proposed three hypotheses to explain the effects of different media on human communication.

The first, the 'efficiency hypothesis', follows from the assumption that the lower number of cues available in a telephone conversation will reduce the efficiency of the interaction. Greater cooperation and more rapid problem-solving are expected from bargaining face to face rather than via a telephone. However, because of the level of redundancy in human communication, efficiency could actually be improved by the loss of cues that may be distracting. Businessmen have reported that they prefer to use the telephone for situations of high conflict or embarrassment.

The second, the 'non-verbal communication' hypothesis, relies on extrapolation from known media qualities and the known functions of non-verbal cues. This approach lists cues which are lost in different media; the functions of these lost cues are discovered and deductions made about the effect of their absence on the outcomes of the conversation. For example, an audio-only medium does not transmit facial expression. Since facial expression is important in face-to-face conversation for communicating emotional need, it will be difficult to transmit or receive indications of emotional need in a telephone conversation. One problem with this approach is that a non-verbal cue is not transmitted in isolation, but is always combined with other non-verbal cues and usually with a verbal message. A range of verbal and non-verbal cues is used to signal which person should speak next. This might be expected to be less efficient on the telephone. Research suggests, however, that there are fewer interruptions on the telephone. Human communication is highly adaptive and loss of one channel will lead to compensatory changes in another. Analysis

**Box 6 Key issues in telepsychiatry**

The following questions demand clinical effectiveness studies in real services, but such studies have yet to be reported:

- Communicating by telephone and by video-conferencing differ. Does this matter in clinical psychiatry?
- Which medium is best suited to which clinical task?

of the Watergate transcripts found that the telephone transcripts contained more verbal expression of agreement or disagreement with the other's opinion than those of the face-to-face interactions (Short *et al*, 1976). This provides evidence of the interchangeability of non-verbal cues (head nods and facial expressions) and verbal messages.

The third hypothesis is based on the construct of 'social presence'. This is a quality of the medium as perceived by the user. Cukor *et al* (1998) proposed that the added value of the video channel in low-cost videoconferencing is that it allows the creation of social presence. They define social presence as 'permitting participants to share a virtual space, to get to know the conferencing partner better and to feel comfortable discussing complex issues'. Some non-verbal cues may occur too rapidly and be lost in data compression and signal-processing delays. The low-cost videophone is considered to provide adequate social presence for telepsychiatry (Box 6).

**The future?**

Wootton (Wootton & Craig, 1999) has described the art of telemedicine as being able to choose appropriate situations where its application can be useful. He also says that systems and programmes should be as simple as possible to meet the health needs of the population of interest. Telepsychiatry needs to widen its focus away from videoconferencing to study communication processes in mental health care in order to answer the question 'Which medium should I use for which clinical task?' Human and organisational factors are likely to be the main determinants of how successfully telemedicine and telecare can be applied (Box 7).

**Further reading**

The main journals covering this subject are the *Journal of Telemedicine and Telecare*, which has a worldwide focus, and *Telemedicine Journal*, which focuses on North America. Wootton & Craig (1999) is a good introductory text, and Wootton *et al* (2003)

**Box 7 Potential benefits and drawbacks of telemedicine and telecare***Benefits*

Improved access to information  
 Provision of care not previously deliverable  
 Improved access to services and increasing care delivery  
 Improved professional education  
 Reduced health care costs  
 Improved knowledge about clinical communication

*Drawbacks*

Compromised relationship between health professional and patient  
 Compromised relationship between health professionals  
 Issues of the quality of clinical information  
 The need for major organisational changes in the way that health care is provided, to maximise its potential

offer an overview of the subject. Coiera (1997) covers the technical aspects well and puts telemedicine into a wider telematics context.

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## Multiple choice questions

### 1 Telemedicine:

- a is about the use of the latest communications technology in health care

- b requires satellite connections
- c was first reported in the 1950s
- d requires technical expertise
- e includes use of the telephone.

### 2 Telemedicine and telecare:

- a should only be used for communication between professionals
- b tend to make professionals more anxious than patients
- c can facilitate the continuing professional development of remote health care providers
- d alter the communication in a consultation
- e have only been used in remote areas of the developed world.

### 3 The following applications have been reported for telepsychiatry:

- a linking an acute ward with a psychiatric intensive care unit
- b psychoanalysis
- c psychiatric assessment of prisoners
- d assessments in adolescent psychiatry
- e assessment in old age psychiatry.

### 4 Service user responses to telepsychiatry:

- a most find it acceptable
- b most get persecutory ideas about being filmed
- c tend to be less upset by the experience than professionals expect
- d miss the ambience of the out-patient department
- e get flustered by the technology.

### 5 In the technology of telemedicine:

- a a multiplexer generates multiple images
- b POTS is an imaging device
- c bandwidth is calculated in hertz
- d ISDN is restricted to 128 kbit/s
- e the higher the bandwidth, the better the image transmitted.

### MCQ answers

1	2	3	4	5
a F	a F	a T	a T	a F
b F	b T	b T	b F	b F
c T	c T	c T	c T	c T
d F	d T	d T	d F	d F
e T	e F	e T	e F	e T