Alberta Heritage Foundation
for Medical Research

Assessment of telehealth applications

Version 1

David Hailey and Philip Jacobs

October 1997

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This Health Technology Assessment Report has been prepared on the basis of available information of which the Foundation is aware from public literature and expert opinion, and attempts to be current to the date of publication. It has been externally reviewed. Additional information and comments relative to the Report are welcome, and should be sent to:

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Contents

Tables and Figures:

Foreword

This outline of issues in the assessment of telehealth is intended as a resource document for health care funders, providers and administrators. Health authorities and others in Alberta face decisions on the procurement and use of this information and communication technology. Such decisions should be informed by the results of assessment. This publication provides a framework for use when specific telehealth applications are under consideration.

A brief outline is given of general requirements for telehealth applications, bringing together some points which will need consideration during development of a business case. There is then a discussion of a more detailed approach to assessment. This covers specification, performance measures, outcomes, summary measures, operational considerations and other issues related to telehealth applications. Telepsychiatry and teleradiology are used as examples to provide further details of assessment elements. Use of cost analysis and further details on telehealth applications and their assessment are covered in appendices.

This document gives a basic framework for assessment of telehealth applications. Use of the framework will require a commitment to systematic collection of data and to comparison of telehealth applications with alternatives. In applying the approaches given to evaluation of proposals and programs, analysts will need to give further consideration to issues such as the power and experimental design of comparative studies. Involvement of persons with expertise in evaluation will be highly desirable. Input from both managers and evaluators will be needed to provide a useful synthesis of assessment data in the context of the health care system.

It is intended to update the document as further experience is gained in Alberta in the use and assessment of telehealth. Comments and suggestions would be most welcome.

Introduction

Telehealth is often referred to in the literature as 'telemedicine', which has been defined by the US Institute of Medicine as 'the use of electronic information and communications technologies to provide and support health care when distance separates the participants' [6].

Telehealth is not a new idea. For many years, health care information has been sent between persons at different locations using electronic media. Use of older approaches (telephone, fax) is commonplace. Balas et al. have summarised the evidence of benefit from applications based on use of telephone links and computerised communication technology [1]. They conclude that use of these earlier distance medicine technologies enables greater continuity of care by improving access and supporting the coordination of activities by a clinician.

Current and emerging technologies offer new opportunities, but for the most part telehealth is related to the effectiveness and efficiency of existing types of health services.

While telehealth involves the interaction of a variety of information technologies and health services, there has been particular interest in applications which involve the transmission of images for consultations of various types or for sending diagnostic data. The outline given here focuses on these areas, with particular reference to telepsychiatry and teleradiology. Telepsychiatry has been chosen as an example of teleconsultation, with real time communication between the patient and the health care professional. Teleradiology provides an example of exchange of complex diagnostic data through transmission of images.

This outline seeks to provide some general principles regarding evaluation of this technology. Further details of telehealth applications and their assessment, and some sources of further information, are given in the Appendices.

Reasons for assessment

The introduction of telehealth applications will often result in substantial changes to health care practices. The nature of individual telehealth projects, including types of equipment, will vary, and in each case will need to be considered in detail.

There will be a substantial initial financial investment, as well as ongoing operating costs. These financial commitments may exceed those of current practice; or may be less. Further, these investments will be accompanied by changes in patterns of care – in quality of service, time and availability. Resulting from these changes, there may be changes in health outcomes and patient satisfaction.

Administrators and health care professionals will face a good deal of uncertainty as to the effects of these, sometimes very large, changes. When a new technology is adopted, uncertainties exist about the extent of use and the ultimate effects of such changes in practice.

There may be little information available as to the ultimate health effects of telehealth applications. Though these important effects may be difficult to quantify, they should not be forgotten. Further, some issues will be relatively specific to the health authority or other purchaser, so that local data and circumstances will need to be considered.

Assessment of telehealth applications is needed to assist purchasing and planning decisions, approaches to future health services and health education, and also to monitor and modify the use of the technology when it is in place. At the very least, planners, administrators and health care professionals will need a working description of the technology and how it is interacting with the services for which they are responsible.

Given the likelihood that aspects of health care will change and the uncertainties facing those involved with telehealth, it is desirable to consider these changes in a systematic way, to include all important effects. Health technology assessment (HTA) provides a suitable framework to categorize and estimate the various effects resulting from the adoption of telehealth applications, and to provide a synthesis of these as input to future decisions.

Comparison of alternatives

The HTA approach compares alternatives – in this case telehealth versus what would exist in its absence. The planner should never forget the present when planning for the future. Telehealth may have many favorable attributes, but the present system may serve the population well, and also be capable of improvement. Comparison should include the present (non-telehealth) system, the upgraded present system and the telehealth alternative.

The scope of telehealth as a technology is considerably wider than the telecommunications equipment and systems which provide the opportunity for exchange of information at a distance. For the purposes of health technology assessment, telehealth should be regarded in terms of the interaction of the equipment and the information transmitted with the activities of the health care professionals who use telehealth, and the consequences for patients and others who are their clients.

General requirements for telehealth applications

Specification of requirements. The specific health care requirements which are to be addressed should be clearly identified and described. Telehealth and other approaches can then be considered.

Equipment. Introduction of telehealth will raise some general technical issues. There will be a need to obtain assurance that available hardware and software can provide the performance required, at a realistic cost, and that adequate technical support will be available. Major issues are validation of specifications and of performance under local conditions.

Integration with health services. Of great significance to health authorities, individual institutions and health care practitioners is the broad question of how the new technology can be effectively introduced and managed in relation to the services for which they are responsible.

Time elements for various services are likely to be of major significance in considering telehealth applications. Telehealth may lead to cost and administrative efficiencies through reducing the time which is needed to perform various tasks. To realize the potential benefits through time-related gains in efficiency, planners and managers will need to put in place changes to organizational structure and administrative procedures.

Many of the issues related to use of the technology will relate to changes in work practices and routines. Active consultation with all staff who will be affected by introduction of telehealth technology, and use of their expertise in developing programs, should be priorities. Managers will also need to consider the level of telehealth technology that is appropriate for their operations.

Legal issues. Planners will need to be aware of legal issues that may relate to use of telehealth. Areas where clarification may be needed include registration and training of users in different jurisdictions, confidentiality and access to data, and any new responsibilities for health care workers.

Impact on health status. Such administrative considerations are important, but it should always be remembered that the eventual impact of telehealth on health status will be of primary importance. Providers and funders will need assurance that, following the introduction of telehealth, health in the population for which they are responsible will at least be no worse. Health effects of telehealth may take some time to emerge and be difficult to measure. In many cases, at least in the short term, managers will need to make use of surrogate measures of health outcome (for example, changes in use of hospital and other services following introduction of telehealth technology).

Development of a business case

A number of points need to be addressed in making a business case for acquiring telehealth technology. They are important factors which will influence the nature and the success of any assessment.

Coordination

A first point to address is:

Who is to coordinate the telehealth applications and their assessment?

Availability of a person to take responsibility for coordination of telehealth applications and their assessment is an essential. There is little hope that a coherent administrative and technical perspective will emerge unless there is an individual with sufficient status to provide liaison between the many players and interests in a telehealth system.

The proportion of the coordinator's time which must be devoted to telehealth will vary, depending on the requirements of the health service. In many cases, effective coordination will require a full-time position.

There are no specific qualifications for the coordinator; persons with different types of experience and background will be suitable. However, it is essential that the coordinator has a clear understanding of the overall delivery requirements of the health care system and is responsive to the needs of health care professionals and their clients.

Service population and services

Key issues to consider at the early stage are who will be served by the telehealth application, what services (related to telehealth) they are now receiving, and whether there are any gaps between desired and current delivery arrangements. This area includes topics such as distances traveled, waiting and travel times, and the general availability of services. Of critical importance in the planning stage is how the delivery arrangements under telehealth help to address the needs identified.

These points and other questions that should be considered at an early stage are summarised in Table 1.

Table 1: Questions to consider in development of a business case for telehealth

Population and services	
What applications are being considered?	By specialty; By administrative task
What are the current delivery arrangements for Each specialty?	Approximate level of demand; Local and remote health care providers; Referral arrangements
Personnel and consumers	
Who is to operate/use the telehealth application(s)?	Local health care providers. Will there be changes in roles and responsibilities? Remote health care providers. Have changes in relationship to remote providers been identified?
Has there been consultation with all health care staff involved? Is there acceptance?	Consider views of all staff.
Should there be wider publicity and consultation regarding the telehealth services?	Consider: - contact with patient groups, general public - level of community acceptance
What training programs need to be put in place?	Consider qualifications and training needs for all staff who will be involved with the telehealth application.
Delivery arrangements	
How many sites will be using telehealth?	Specify the applications at each site Consider sequence/timing of introduction of telehealth at each site. There may be advantages in phased introduction
Has scheduling been addressed, at least at a preliminary stage?	Consider scheduling of teleconsultation sessions within region/service. Check/negotiate availability of remote providers.
Is real-time telehealth essential for local needs, or might store and forward options be adequate?	Consider if immediate availability of information is important for clinical and administrative needs (see Appendix 2). Consider factors which would ensure consistent real time services
What are the storage requirements for data from use of telehealth applications?	Cost and flexibility of storage requirements
What back-up arrangements will apply should the telehealth system fail?	Need to develop contingency plans

Table 1: Questions to consider in development of a business case for telehealth (cont'd)

Specifications and costs	
What are the specifications and projected costs for purchasing and maintaining telehealth equipment? Will they apply fully to the goods which are to be purchased?	Consider how specifications will relate to the application in question and the needs of those using it. Ensure availability of desired equipment. Bear in mind that equipment will need replacement, perhaps after three years. Clarify cost and details of maintenance arrangements.
What are the mode and costs of communication?	How do these relate to expected levels of use of the system?
Will the telehealth application cover all use of the service in question?	If current arrangements are to stay in place for some cases, consider resource and organizational needs, costs
How will changing delivery arrangements affect cost?	Changes to personnel and to supplies will have consequences for costs
Are there other, cheaper telehealth options?	Consider potential for web use, for example in tele-education applications. Older telehealth approaches (e.g., telephone, secure fax, use of e-mail) may be good options for some applications.
Have issues on funding/reimbursement for use of telehealth applications been resolved?	These may involve wider policy matters. Managers and users will require assurance on reimbursement issues.

Overall considerations

Once the preliminary overview has been conducted, the question of whether it is reasonable to proceed further with the telehealth proposal can be addressed.

The most important overall consideration relates to the question of whether any particular telehealth installation is the appropriate one; or, indeed, whether a telehealth installation is needed at all. This question will have to be answered in terms of the service "needs" which are identified by the provider. A telehealth operation should add "value", which means that, considering a combination of cost, user and patient convenience, and patient outcomes, the telehealth operation provides good value.

In the following section, a framework is provided to help answer these questions.

More detailed assessment considerations

In this section, fuller details are provided on some of the issues raised in relation to the business case.

Health technology assessment commonly takes a broad view of a particular technology, providing a synthesis of information of different sorts to provide a detailed description. This information can then be used in helping to decide whether the technology is to be adopted, and if so in what ways.

The general approach suggested for economic and other assessment of telehealth technologies is to take a societal perspective. As far as possible, account should be taken of all costs and benefits. This broad view can be adapted, as necessary, to take account of any narrower focus, for example that which may be sought by funders.

In considering a potential telehealth application the following elements will need to be considered:

- Specification
- Performance measures
- Outcomes
- Summary measures
- Operational considerations
- Other issues

Further details are given in Table 2, together with a brief overview in the text. Usually, telehealth will replace established local services, or those which are being used on a referral basis at other centres. Therefore, there will generally be a need for a description and measurement of the technology which will be in place if the telehealth application is not adopted. Each of these elements should be considered for both telehealth and the alternative technology (often the current service) so as to provide a base case that can then be used in the derivation of comparative costs and benefits.

Specification. First, it is necessary to specify clinical requirements and the technology that is being considered for adoption (or continued support). The specification will include a clear outline of the application that is being considered, equipment, staff and other resources that will be needed and expected transmission time.

At this stage, there should be strong grounds to suppose that the proposed telehealth application will be capable of providing a service continuously, rather than as a demonstration project. Details will be required of the equipment specifications (to eventually be verified under local conditions), the method of transmission maintenance provisions, and training arrangements for those who will use the technology.

Performance measures. In assessing a telehealth application, three types of performance measure are of key importance.

- First, it is necessary to define the effect of telehealth on **time** taken for various tasks. For example, telehealth may reduce the intervals between trauma, diagnosis and appropriate treatment. The technology may have an influence on travel time for patients and health care professionals.
- Next, the effect of telehealth on **'quality'** must be assessed. For the purposes of this outline, 'quality' is defined broadly to include those relevant characteristics, other than time, which influence the experience obtained from use of telehealth. Quality will include comparatively easily defined measures, such as the standard of an X-ray image. However, it may be more ephemeral, and include issues such as the degree of personal contact between a medical practitioner and a patient.
- Thirdly, the **cost** of the telehealth application must be identified. This will include acquisition cost of equipment, transmission costs, personnel training costs and operating costs. Beyond that, there will be interest in the effects on costs of other services and on the overall health care budget.

These attributes will go together to influence outcome variables related to safety, efficacy and effectiveness.

Outcomes. The next category is outcomes. Patient outcomes will be of particular interest, though for some applications there may be purely administrative considerations.

Patient outcomes are more difficult to obtain than measures of operating performance and may only become apparent over the longer term. They are required to indicate whether the technology has had any effect on the target group. Assessments of technologies in terms of health care outcomes typically involve the appraisal of safety; efficacy (performance under optimum conditions); and effectiveness (performance under routine conditions).

- **Safety**, in relation to telehealth, may include issues such as the risk of wrong diagnostic and management decisions as a consequence of using the technology. Data on safety may take some time to emerge. Appropriate planning, consideration of performance measures, and specification of operational protocols will help to minimize potential safety problems. Monitoring of the telehealth service during its introduction and during routine use will be necessary to check for any safety effects with the technology. Appraisal of such effects will need to take account of 'base case' attributes, such as the risk to some patients through delayed treatment if there were no telehealth service.

- **Efficacy,** in the context of introduction of a telehealth service, might be considered as the performance of the technology, after an initial 'learning curve' period, under carefully applied and monitored protocols, such as those used in pilot projects.
- **Effectiveness** is the key for those intending to procure and use telehealth in routine services. This outcome relates to how well the technology will perform after it has been adopted for routine use. The effectiveness of telehealth will emerge if its use is integrated into routine tasks and work flow. Measures may include users' and patients' satisfaction, generalisability of data from pilot projects, support for users and reliability of equipment. Determination of effectiveness will require longer term follow up and appraisal.

With both efficacy and effectiveness, it will be difficult or impossible to determine the impact of telehealth on health status in the short term. Such data must come from longer, more detailed studies and often will not be available to inform decisions when procurement or expansion of a telehealth system is being considered. Longer term studies may prove difficult because of changes to equipment and to the health care system. For practical purposes, effectiveness will often have to be determined through surrogate measures such as length of hospital stay and numbers of prescriptions.

Summary measures. There are several summary measures of performance which can be derived from more basic types of data, but which are useful in obtaining an overview of the functioning of a telehealth application.

One of these is **cost effectiveness**, which refers to the net difference in cost in relation to the net difference in outcome, when comparing telehealth with the alternative technology. A cost effectiveness analysis will indicate what health outcomes will be obtained for the additional investment (if telehealth does not save money). Judgment will still be needed as to whether or not any extra benefits are worth the cost.

A less complete measure is a **cost comparison analysis**, by which only the costs of telehealth and the alternative technology are compared. If the technologies have equal safety and effectiveness, there is need only to compare their costs to determine which is the better buy.

Operational considerations. The quantitative considerations discussed above are only part of the description of a telehealth system from the perspective of HTA. In assessing telehealth applications, there will be a mix of quantitative and qualitative inputs. Both types require documentation and consideration.

- **Access** to the technology is an important consideration. Teleconsultation applications, for example, may reduce travel time and costs for patients in remote regions, making specialty care much more accessible. Increased access may have implications for costs and size of the telehealth service that is being offered. Direct costs to a program may increase; these need to be put in the

context of any offsets through reduction in other services and of benefits achieved.

If telehealth proves expensive to operate, access could potentially become restricted as use of the technology could be rationed.

- **Acceptability** of the technology to patients, health care professionals and managers is a key factor in any telehealth program. Lack of acceptability will imply inefficiencies. Measurement of acceptability through consumer satisfaction surveys should be an important component of any assessment.

Other issues. Finally, other issues which do not fall within the categorization given above will need consideration. These may be critical to the assessment of telehealth. For example, in tele-consultation applications, scheduling of equipment use will eventually need consideration in detail.

Issues of confidentiality and legal requirements will also need to be addressed. Training requirements, practice standards and quality assurance programs will need to be in place and clearly understood. Use of a log book by the coordinator to record difficulties experienced can be a useful aid in evaluation of the system's performance.

There may be significant longer term benefits from telehealth, particularly in remote locations, through its contribution to education of staff and closer liaison with health care professionals at other sites. Telehealth may be an important aide to reducing the sense of professional isolation and improving retention of staff.

Table 2: Elements for assessment of telehealth applications

Element	Attribute	Examples of items for telehealth application and non - telehealth alternative
Specification	Key operating characteristics • Technology description • Assurance of continuity	• Health service description • Equipment, carrier, support • Personnel, time • Performance of equipment, training, maintenance
Performance measures	Time	• Set up and booking time, travel • Consultation, intervention
	Quality	• Image, sound and service quality
	Cost	• Equipment, training, maintenance • Transmission, travel, staff
Outcomes	Safety	E.g. potential adverse effects on patient management decisions and through delayed or missing information
	Efficacy	E.g. Short term measures of timeliness, diagnostic accuracy
	Effectiveness	E.g. Measures of length of hospital stay, numbers of prescriptions, repeat consultations, satisfaction with service
Summary measures	Cost effectiveness	
	Cost comparison	
Operational considerations	Acceptability to: • Patients • Health care professionals • Managers	Ease of use, convenience, cost to budget, time savings
	Access	Availability to population, potential increase in clients, potential decrease in other services
Other issues	E.g. Scheduling of services, confidentiality, educational benefits	

Assessment approaches to specific telehealth applications

As examples of the use of the HTA approach to evaluating telehealth services, lists of important evaluation considerations are given for two specific applications - telepsychiatry and teleradiology. Tables 3 and 4 show details for an assessment approach to these applications. In each case, the attributes listed in Table 2 are addressed in turn, with both telehealth and the alternative technology being considered.

Some of the issues raised in the telepsychiatry example will apply to other teleconsultation applications, while the teleradiology details relate in part more generally to the provision of remote diagnostic services.

Table 3: Assessment requirements for telepsychiatry

Telepsychiatry	Current psychiatric services
Specification	
Base site (e.g. hospital dept.) linked to: (specify number, location of other sites) By: (specify communications carrier) Two way, real time consultation with terminals, associated equipment and appropriate consultation rooms at each site. Specify: - number of telephone lines required - personnel involved - specialist psychiatrist(s), nursing or other health care professionals, general practitioners. - expected transmission time	Psychiatrist travels to individual sites for face to face consultations with patients. Several consultations per session/trip. Appropriate consultation rooms at each site. Specify: personnel involved - specialist psychiatrist(s), nursing or other health care professionals, general practitioners
Arrangements for maintenance, communications, scheduling	Arrangements for travel and scheduling
Performance measures	
Time Time to book consultations, maintain records Psychiatrist time (consultation & preparation) Other health care professional time Patients and families (travel etc.) Number of missed appointments	 Time to book consultations, maintain records Psychiatrist time (consultation, preparation, travel time) Availability of back-up services in absence of psychiatrist Other health care professional time Patients and families (travel etc.) Number of missed appointments

Table 3: Assessment requirements for telepsychiatry (cont'd)

Telepsychiatry	Current psychiatric services
Performance measures (cont'd)	
Quality	
Quality and stability of the image	
Clarity of audio transmission	
Quality of the consultation	Quality of the consultation
- clinical perspective;	- clinical perspective;
- patient perspective	- patient perspective
Cost	
Equipment set up costs	
Training costs	
Communications costs	
Psychiatrists, consultations	Psychiatrists, consultations, travel
Other health care professionals	Other health care professionals
Patient and family travel and lost work	Patient and family travel and lost work
Outcomes	
Safety	
Missed/ incorrect diagnosis; misunderstood advice because of telehealth - related factors	Safety aspects related to unavailability of service,
Consequences of missed appointments	Consequences of missed appointments
Travel accident risks for patients	Travel accident risk for psychiatrists, patients and families.
Efficacy	
Clinical performance in context of pilot project (e.g. with defined protocol.)	Clinical performance with consultation in major centre, no missed appointments, no stress due to travel etc.
Short term measures of: - timeliness of consultation - staff and patient time - quality of consultation - health status	Measures of - timeliness of consultation - staff and patient time - quality of consultation - health status
Effectiveness	
Longer term measures of: - timeliness - participants' time - quality of consultation - length of hospital stay - numbers of prescriptions - numbers of missed and repeat consultations - mental health status	Longer term measures of: - timeliness - participants' time - quality of consultation - length of hospital stay, - numbers of prescriptions, - numbers of missed and repeat consultations - mental health status

Table 3: Assessment requirements for telepsychiatry (cont'd)

Telepsychiatry	Current psychiatric services
Summary measures	
Cost comparison **Overall cost of service** **Cost per consultation, cost per patient**	
Cost effectiveness **Change in cost / change in number of clinically successful cases**	
Operational considerations	
Acceptability to • Patients • Health care professionals • Managers (Use of surveys)	Acceptability to • patients • health care professionals • managers
Access Numbers and distribution of patients consulted Waiting time for consultation	Numbers and distribution for patients consulted Waiting time for consultation
Other issues	
Operational difficulties with telehealth application. Use of qualitative approach (log book) with feedback to eliminate or minimize problems. Training and quality assurance requirements for operations.	Identify (?survey) ongoing operational difficulties with current services.
Consider privacy and confidentiality issues related to consultations and access to medical records.	Review existing arrangements / standards.

Table 4: Assessment requirements for teleradiology

Teleradiology	Current radiology services
Specification	
Centre of expertise (e.g. hospital dept., clinic.) linked to; -specify number, location of other sites. Might be smaller hospitals, community centres by -specify communications carrier (e.g. ISDN used in some services) One way, rapid transmission of image; two way, real time consultation; one way provision of results/ opinion at later stage. Equipment: workstations, film digitizers, terminal adapters, Specify telephone or other communication links required Specify personnel involved - radiologist, radiographers, general practitioners, nursing or other health care professionals, Specify expected transmission time	Local radiological exam, films sent to major centre for further opinion, as necessary and/ or Patients are referred to major centre for radiological exam. and/ or Local radiological exam, patients evacuated to major centre for emergency treatment. and/ or Local radiological exam, infrequent visit by radiologist to report Appropriate consultation rooms at each site. Specify personnel involved - radiologist, radiographers, general practitioners, nursing or other health care professionals, Specify expected transmission time
Arrangements for maintenance, communications, scheduling	Arrangements for travel
Performance measures	
Time Time to book consultations, maintain records Radiologist (consultation & preparation) Other health care professionals, (digitization of films) Patients and families (travel etc.) Time between request for radiological exam and provision of advice relevant to patient management Time between production of image and provision of advice on patient management.	Time to book consultations, maintain records Radiologist (consultation, preparation, travel time) Other health care professionals Patients and families (travel etc.) Time between request for radiological exam and provision of advice relevant to patient management Time between production of image and provision of advice on patient management.
Quality Quality of the image, particularly contrast and resolution compared with film. Quality of the consultation - e.g. accuracy, relevance of advice to management context. -patient perspective	Review radiology quality assurance, film viewing facilities Quality of the consultation - e.g. accuracy, relevance of advice to management context -patient perspective
Cost Equipment set up costs Film and other consumables Communications costs Image storage. Radiologist, consultations Other health care professionals Patients and families	Film and other consumables Communications costs Image storage. Radiologist, consultations Other health care professionals Patients and families

Table 4: Assessment requirements for teleradiology (cont'd)

Teleradiology	Current radiology services
Outcomes	
Safety Risk of adverse effects due to missed/ incorrect diagnosis or advice; Consequences of delays in providing advice	Risk of adverse effects due to missed/ incorrect diagnosis or advice; Consequences of delays in providing advice or unavailability of service, Travel accident risk for patients and families.
Efficacy Clinical performance in context of pilot project (e.g.) with defined protocol. -X ray quality -response times to requests Short term measures of Timeliness of consultation staff and patient time quality of consultation	Clinical performance with consultation in major centre, no missed appointments, no stress due to travel etc. measures of timeliness of consultation staff and patient time quality of consultation
Effectiveness Longer term measures of timeliness, participants' time, quality of consultation; successful diagnoses and, ultimately, patient health outcomes. length of hospital stay, follow up consultations	Longer term measures of timeliness, participants' time, quality of consultation length of hospital stay, follow up consultations
Summary measures	
Cost comparison Overall cost of service; include exams not covered by telehealth technology. Cost per consultation, cost per patient	Overall cost of service Cost per consultation, cost per patient
Cost effectiveness **Change in costs / change in health outcomes**	
Operational considerations	
Acceptability to • health care professionals • managers • patients	Acceptability to • health care professionals • managers • patients
Access Numbers and distribution of patients using radiology services in region Numbers and distribution of patients referred for radiology exams Waiting time for consultation and advice (health care professionals and patients)	Numbers and distribution of patients using radiology services in region Numbers and distribution of patients referred for radiology exams Waiting time for consultation and advice (health care professionals and patients)

Table 4: Assessment requirements for teleradiology (cont'd)

Teleradiology	Current radiology services
Other issues	
Operational difficulties with telehealth application including factors leading to significant downtime. Use of qualitative approach (log book) with feedback to eliminate or minimize problems. Training and quality assurance requirements for operators.	Identify (?survey) ongoing operational difficulties with current services.
Opportunity to use teleradiology link for educational purposes.	Review existing educational approaches, needs.
Consider privacy and confidentiality issues related to consultations and access to medical records.	Review existing arrangements/ standards.

Stages of assessment

Evaluation will be required over a number of stages in the life of a telehealth project [4] (Figure 1). Not all required information will be available initially, and planning will, in part, be based on estimates and assumptions. Decisions will often be needed before empirical data can be generated.

Assessment should begin at the stage of specifying requirements for the telehealth application, considering the factors outlined previously.

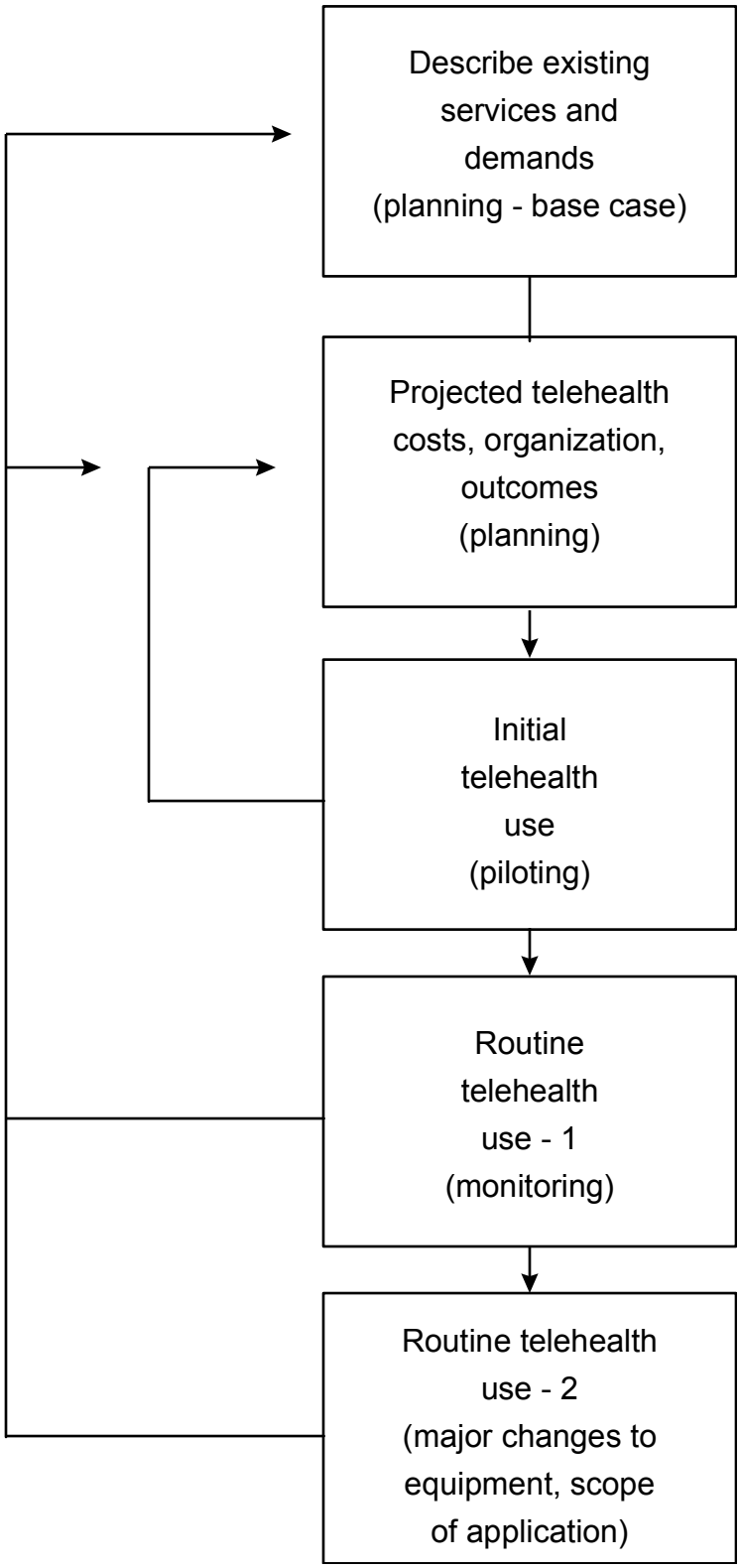
Some further details will be obtained at the pilot or introductory phase, after the telehealth application has been put into operation. During this stage there should be a useful opportunity to review experience and initial information on impact. Surveys of operator and patient satisfaction may provide important indications of areas that require modification. A diary/log book to record experience with the telehealth system can be valuable in identifying difficulties, opportunities and unmet needs. Clearly, there needs to be feedback of such data to the decision-making process.

The pilot project phase will provide much useful information, but is only one stage in the assessment process.

The telehealth application will not be a static technology. Over time, there will be changes to the details and costs of equipment and communication methods. It is likely that the use of telehealth will significantly change the scope of the health services that it supports. Referral patterns, caseload and case-mix may alter appreciably and in ways that are difficult to predict. More efficient use of resources as a result of telehealth might decrease costs for health care programs. On the other hand, access to certain services might increase appreciably, with benefits to population health status but at additional cost.

Such changes mean that it will be necessary to monitor the telehealth application and its effects on an on-going basis.

Figure 1 : Stages of telehealth assessment



Appendix 1: Using cost analysis to compare telehealth with routine care alternatives

In this appendix details are provided of how to measure costs and use them to compare the economic aspects of telehealth and alternative approaches. Telepsychiatry and teleradiology applications are used as examples. The values used in the examples are nominal, though they will approximate to those applicable to Alberta. Recent experience in Norway, Finland and the USA [5, 7, 10] has been considered in developing this outline.

The object is to give an outline of a methodology, rather than to demonstrate actual operational situations. The cost analysis will need to be adapted to meet particular circumstances. For example, in a teleradiology application there might be a need to consider costs of ultrasound examinations, image storage, radiologist's travel and transport of films, none of which have been included in the scenario given here.

Some basic concepts

Cost is one aspect of any intervention. There are a number of different types of questions and viewpoints which might be illuminated by cost analysis. There is no one single measure of cost that can be used for all purposes. The cost measure must be tailored to the argument that is being established.

Perspective

The first basic concept is the perspective to be taken in the study. There may be a wish to take the **provider's perspective**, which focuses on the interests of the regional health authority or whoever is responsible for providing resources for the telehealth application. If this perspective is taken, there will be a need to capture all of the resources which are the responsibility of the provider.

Alternatively, there might be a wish to focus on the **patient / caregiver perspective**. In this case, the costs borne by the patient / caregiver as a result of the use of the telehealth application would be determined.

The broadest perspective is the **societal perspective**, which encompasses the interests of all members of society - providers, patients and caregivers. This perspective is often taken in economic studies, as it gives the best overall picture of the resource implications of interventions.

What are costs?

The cost of an intervention is the value of the services provided by the resources which are used in the intervention. Resources include labor, equipment, supplies, power, and communications services. The value of resource services can often be determined by what the resource owner is paid. In some instances the resource owner may use resources without pay: there is still a "cost" in the

sense that the resource owner gives up something by using these resources. In order to put unpaid and paid costs on an even playing field, cost is usually defined in terms of what is given up by using one's resources in a certain way.

There are several distinctions which are made when using costs in analysis. One distinction is between **resource costs** and **transfer payments**. A resource cost is the value of the services of economic resources which have alternative uses, such as labor time, equipment and supplies.

A transfer payment is a one-way payment of money without services flowing back. Examples provided by unemployment insurance and social disability payments. Transfer payments are not costs, from a societal viewpoint. However, if a narrower perspective is taken, such as that of a Workers' Compensation Board, disability payments are viewed as "costs" by the Board. On a societal level, transfer payments are made with no resource services generated; on a global or societal basis, they cancel out (payments = receipts), and are not considered as costs. But if the perspective taken is that of an individual, or a provider, transfer payments will be considered as "costs".

A second distinction is between **direct costs** and **indirect costs**. Direct costs are those for which payments are made (in return for the services provided). A psychiatrist who travels to provide a consultation at a remote location is incurring direct costs, which include travel expenses and payment for the psychiatrist's time.

Indirect costs are those costs which result from giving up work or leisure-time. When an individual takes off time from work to travel for medical treatment, there is a reduction in productivity and perhaps in earnings. Income is given up, and so the trip has a cost associated with it which is over and above the paid expenses of travel. Such costs would arise when a patient travels to a remote site for an x-ray examination, giving up work. Teleradiology might reduce both paid travel and indirect costs by cutting down on the amount of time spent traveling.

Costs can also be broken down into **operating costs** and **capital costs**. Capital costs are the costs which are associated with equipment whose useful life exceeds one year, such as cameras and transmission equipment. Current operating costs are those related to personnel, supplies and transmissions which are routinely incurred.

Capital costs are often spread out over several years, as the equipment use occurs over several time periods. On an annualized basis, the capital costs consist of depreciation of equipment and interest which the owner gives up by "investing" in capital equipment. For example, assume that transmission and receiving equipment for a teleradiology application has a life of 5 years and costs $120,000. Annual depreciation would be $24,000 (=$120,000/5 years). If the interest rate which could have been earned on the amount which was invested was 5 per cent,

then there was an annual interest earning that was foregone of $6,000. Annual capital costs would then be $30,000 - the interest forgone plus the depreciation.

If the timing of costs or benefits extends over a time horizon which is longer than one year, then an appropriate discount rate should be applied to future period costs and benefits. Weinstein and Stason [11] provide further information on this topic.

Telehealth costs

In the telehealth context, costs can be broken down into sender and receiver capital costs, sender and receiver transmission costs, fixed overhead and variable operating costs for senders and receivers, provider's travel costs, and travel and indirect costs for patients and caregivers [5, 7].

Cost behavior

It is important to consider how costs change when the volume of services changes. The concept of **fixed and variable costs**, which is relevant for this analysis, is very important from the viewpoint of telehealth applications. Costs can be fixed and variable, with regard to the volume of output. A fixed cost is a cost which does not change when the volume of output changes. Once a provider purchases cameras and digitizers for radiological applications, these fixed costs have been incurred. As the volume of x-ray exams increases, such costs remain the same (within certain bounds).

Sometimes costs are fixed within given ranges; for example, one might hire a technician for a telehealth application. Within a certain range of volumes, only one technician would be needed. Within that range, the technician can be considered as a fixed resource.

Variable costs are those which increase when volume of use increases, such as those associated with film and transmissions.

Applications of cost analysis to telehealth

In this section some examples of cost analysis to teleradiology and telepsychiatry are presented. The intention is to show how costs might be used in several different applications. It should be noted that different dimensions of cost are used in these examples, depending on the purpose of costing.

Example 1: Telepsychiatry - a provider perspective: break-even analysis (psychiatrist travels to patient)

Break-even analysis is a tool which is used by managers to determine the volume of output at which the total cost of two alternative interventions will be equal. In the present example, it is assumed that under conventional psychiatric services, **the psychiatrist will visit the patient**. This requires one hour of travel each way, and a one hour consultation.

The psychiatrist's time is valued at $80 per hour, or $240 for three hours. Travel costs (gasoline and mileage) are $10 each way, or $20 per consultation. Variable costs are therefore $260 per consultation. Fixed costs in this case are office space, valued at $5,000 per year and a full time secretary, valued at $15,000 annually. Total fixed costs are therefore $20,000 annually.

The relationship between total costs and the volume of consultations is shown in Figure 2. Fixed costs are $20,000 (regardless of volume of service). Variable costs increase with volume at a rate of $260 per consultation. Total costs are equal to $20,000 in fixed costs plus the volume-determined variable costs.

The assumptions regarding telepsychiatry are also shown in Table 5. Under telepsychiatry, fixed costs consist of equipment cost, office space, and staff. The fixed cost for office space is $5,000 annually. Equipment costs for the telepsychiatry application are $30,000 in total and the life of the equipment is 3 years. Annually, depreciation will be $10,000 (=$30,000/3 years) while the foregone interest at an assumed interest rate of 5% on the capital investment is $1,500. Thus, equipment costs are $11,500 annually. Maintenance costs are assumed to be 10 per cent of the value of equipment, or $3,000. The technician and secretary cost $20,000 per year. They will be assumed to be fixed within the relevant range. In total, fixed costs are $39,500 per year. Variable costs are $80 per consultation for the psychiatrist and $20 for transmission charges; in total, variable costs are $100 per consultation.

Costs for both conventional psychiatry and telepsychiatry are listed in Table 5.

Breakeven analysis shows the volume at which the two applications have equal total costs. Telepsychiatry has $19,500 more fixed costs per year. However, because of the savings in travel, each [additional] consultation costs $160 **more** under conventional psychiatry. If 122 consultations were made, the two sets of costs would be the same (=$19,500/$160). This is the break-even point. Any volume above this would result in lower costs for telepsychiatry.

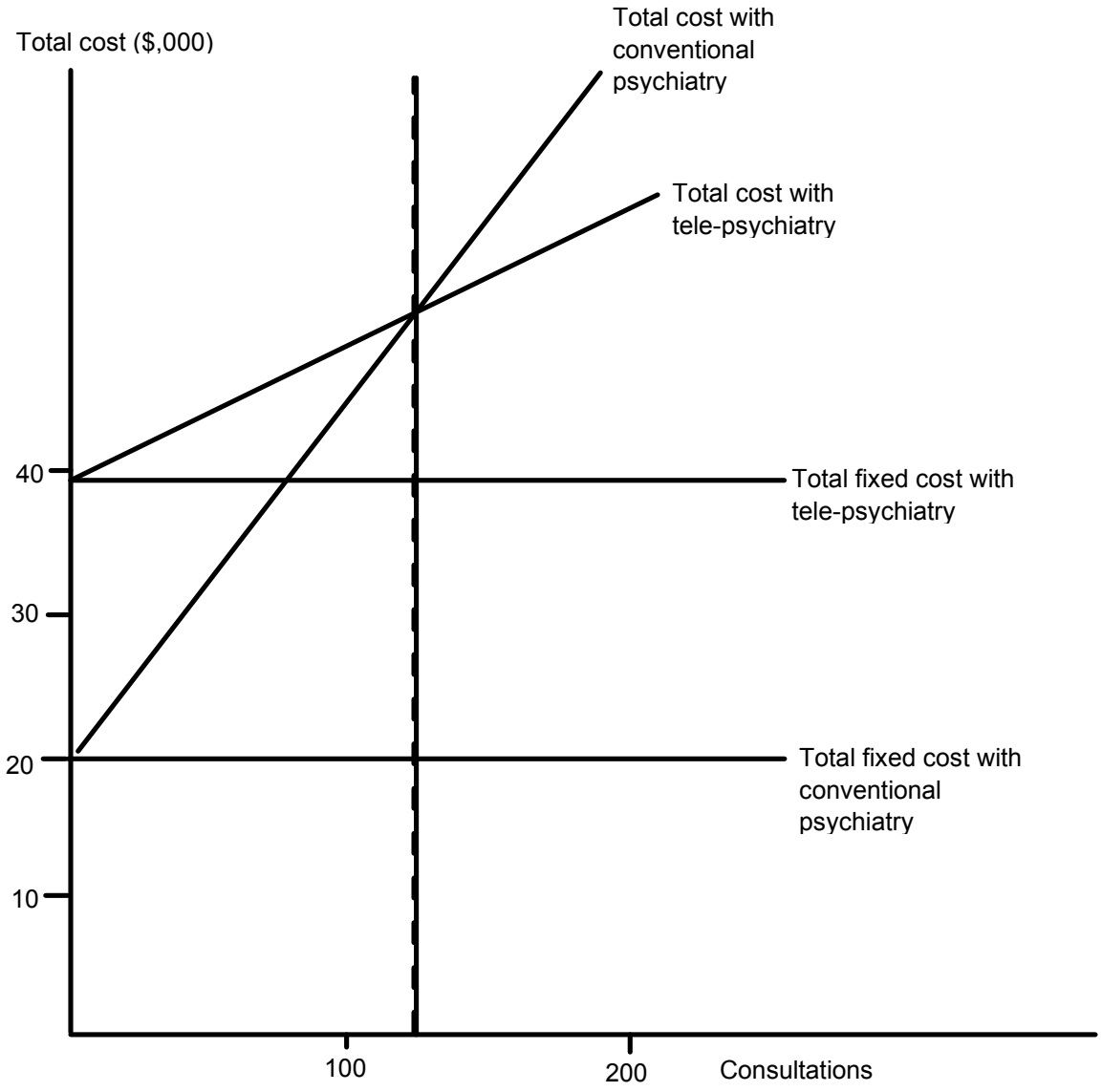
This analysis, it should be stressed, is from the **provider's** viewpoint. It is a convenient management tool, but it leaves out the patient's costs. In this example, patient costs are for one hour under each alternative, and so these cancel out. There is little harm done from excluding them in this instance.

Table 5: Cost assumptions in telepsychiatry, break-even analysis (provider perspective)*

	Telepsychiatry	Conventional psychiatry (psychiatrist travels to patient)
Fixed cost	Office space at $5,000 p.a. Equipment costs $30,000, lasts 3 years, straight line depreciation, foregone interest is 5%. Maintenance costs assumed to be 10% of value of equipment. Technician costs $15,000/y and part-time secretary costs $5,000/y. Fixed costs are $39,500.	Additional office space costs $5,000 p.a. Full-time secretary costs $15,000 p.a. Fixed costs are $20,000.
Variable cost	One consultation costs $80 per hour and takes one hour. Communications costs are $20 per hour. Patient indirect costs are $20/hour. Provider costs are $100 per consultation.	One consultation, with psychiatrist travel. Psychiatrist fee costs $240 (3 hours). Psychiatrist travel cost is $10 each way ($20 in total). Patient indirect costs are $20 per hour. Provider costs are $260 per consultation.
Total cost	$39,500 + $100 per consultation.	$20,000 + $260 per consultation.

* Psychiatrist travels to patient in conventional psychiatry alternative

Figure 2: Total cost under conventional psychiatry and telepsychiatry, in relation to the volume of consultations



Example 2: Telepsychiatry - a provider perspective: break-even analysis (patient travels to psychiatrist)

In the second example, all the assumptions from Example 1 are retained, except that with conventional psychiatry the patient travels to the psychiatrist, rather than the other way around. The only thing that changes for the provider in the analysis is that the variable cost to the provider under conventional psychiatry is $80 per consultation. However, the patient now has to travel for two hours, one hour each way. The patient's costs are the (direct) out-of-pocket travel cost and the indirect cost of time. Travel costs are $20 for a return visit, and $20 per hour for indirect time costs. For each consultation under telepsychiatry, patient costs are $20 (one hour indirect costs for the treatment); under conventional psychiatry, they are $80 for the consultation, including travel.

If the provider's perspective is taken, the fixed costs are the same as in the first example. Variable costs are $100 for a consultation, under telepsychiatry, and $80 for a consultation under conventional psychiatry (because the psychiatrist's travel is eliminated). In this case, both capital and operating costs are more under telepsychiatry, and so there is no break-even point. On cost grounds alone, from the provider's perspective, conventional psychiatry is the preferable alternative. This ignores the costs which are imposed on the patient. In this example, such costs are of a considerable magnitude.

Example 3: Telepsychiatry - a societal perspective: cost per patient analysis (patient travels to psychiatrist)

The analysis in Example 2 is repeated, but taking a broader, societal perspective. An appropriate type of cost analysis to use is to calculate the overall per consultation cost under each alternative. Societal cost per consultation includes fixed per consultation costs, variable provider costs per consultation, and variable patient costs per consultation.

The specification of fixed costs per consultation requires calculation of annual total fixed costs, and then selection of a volume of output to calculate fixed costs per consultation. The selection of a target volume is arbitrary, and will affect the cost per consultation. Therefore, managers should be sensitive to changes in volume and use sensitivity analysis (see below) to determine by how much the per consultation fixed costs can be influenced by the choice of volume.

In this example a volume of 100 consultations is selected.

The cost per consultation for telepsychiatry is summarized in Table 6. Under telepsychiatry, the fixed and variable cost for the provider and the indirect time cost for the patient are added, giving a value of $495 per consultation. Under conventional psychiatry, the cost per consultation is $360. It should be emphasized that patient costs have a considerable bearing on the total cost

picture; they should not be ignored in those instances where a substantial burden is incurred by the patient.

Table 6: Cost assumptions in telepsychiatry, cost per case analysis (societal perspective)*

Cost category	Telepsychiatry	Conventional psychiatry (patient travels to psychiatrist)
Fixed provider cost per consultation	Annual equipment, rent, maintenance and personnel costs ($37,500) per consultation (100) = $375 per consultation.	Annual rent and personnel cost ($20,000) per consultation (100) = $200 per consultation
Variable provider cost per consultation	Psychiatrist, one hour ($80) and transmission ($20) = $100 per consultation	Psychiatrist, one hour ($80)
Variable patient cost, direct and indirect	One hour - no direct travel costs and $20 for one hour indirect cost = $20 per consultation	Travel ($20 direct travel costs per round trip) and three hours indirect time cost (20 x 3=$60) = $80 per consultation
Total cost per consultation	**$495**	**$360**

* Patient travels to psychiatrist in conventional psychiatry alternative

Sensitivity analysis

Sometime arbitrary or uncertain assumptions are used in an analysis. In order to test for the reliability of the conclusions reached, a sensitivity analysis can be applied. This involves changing the values of individual variables in order to determine how much the results change in response to changes in the assumptions made.

For example, there might be uncertainty about the value of the capital equipment, which could be $60,000 rather than $30,000. If this were the case, annual capital costs would be $20,000 for depreciation and $3,000 for foregone interest, or $23,000 annually. This is $11,500 more annually than when the capital equipment cost $30,000. Total fixed cost under telepsychiatry would then be $49,000 (=$37,500 + $11,500).

If there were 100 consultations, the fixed cost per consultation of Example 3 would become $490, and the total cost per consultation would be $610. This is quite different from costs under the previous assumption. If the value of capital equipment was not known, sensitivity analysis should be used to check for the effect which different values have on the outcome.

Cost per consultation will be sensitive to a number of variables. One of the most important is the projected volume of output. If the number of consultations doubled, for example, to 200, then the fixed cost per consultation for telepsychiatry would fall to $187.50 and that for conventional psychiatry would

fall to $100. These changes in per unit fixed costs do not have any economic meaning, because the costs have already been committed. One should therefore exercise caution when generating conclusions based on changes in unit **fixed** cost.

Example 4. Teleradiology - a societal perspective: cost per consultation

In the final example, the societal cost per patient will be calculated for a teleradiology application. The scenario is that, without teleradiology, patients have an initial x-ray examination and, if complicating conditions are expected, they are then referred to a larger medical centre. They will travel by car to the centre or, if there is an emergency, they will travel by air, via dedicated medical evacuation services. In this example, it is assumed that each year there are 3,000 patients in the remote setting who receive 4,500 x-rays (1.5 per patient). This assumption will hold under both teleradiology and conventional radiology. Under teleradiology, x-rays can be read at the referral medical center by a specialist. This will result in a decrease, but not elimination of, patient travel for referrals.

The initial x-ray examination may indicate a need for further diagnoses. Under conventional care, 150 patients per 1,000 (450 in total) will require referral by road travel, and 8 per 1,000 (24 in total) will require emergency referral by air travel. A teleradiology application will reduce these numbers by half, so that there will be 225 road referrals and 12 air referrals. Because patient costs (time and travel) seem significant, the analysis of the cost per case will take the societal perspective. In the analysis, the per patient cost under teleradiology will be compared with that under conventional care.

Assumptions and values for this example are summarized in Table 7. Patients travel under conventional case arrangements, rather than radiologists. For those patients who are very sick, and are candidates for air transport, indirect costs per case are the same under either type of radiology; the only differences in the indirect costs between the two types of radiology occur because of the frequency with which trips are taken.

Given these assumptions, the annual fixed costs per case (based on a volume of 3,000 patients per year) and variable costs per case are calculated. The variable costs include direct and indirect patient costs. The final result is expressed in terms of the average cost per patient, with all the costs factored in.

Under teleradiology, cost per patient is $80, while under conventional radiology, cost per patient is $91. Under teleradiology, fixed costs are much higher, but in this example, these costs are more than offset by reduced utilization and associated travel costs. As well, indirect patient travel costs are reduced.

The robustness of the conclusions might be checked by conducting sensitivity analyses. These can be done on the cost of equipment, the numbers of referrals in each instance, the travel expenses, and the medical expenses of referred

patients. Most important, however, is the volume of x-ray examinations over which the fixed costs are averaged. In general, average **variable** cost per patient will not change with volume: patients will still be x-rayed and referred. However, as volume changes, fixed cost per case will change as well. Analysts should therefore pay attention to the range of volumes of services of patients, over which the fixed costs are averaged. As indicated in the telepsychiatry example given previously, changes in fixed costs should be interpreted cautiously.

Table 7: Societal cost per case for teleradiology

	Teleradiology	Conventional radiology	Assumptions
Fixed cost per case			
Teleradiology equipment	**$16.67**	**N/A**	Total cost of equipment is $200,000, with a life of five years and interest rate of 5%. Annual cost is $40,000 (depreciation) plus interest ($10,000). Annual cost per patient is $50,000/3,000.
Equipment maintenance	**$6.67**	**N/A**	Annual cost is 10% of value of equipment ($20,000). Per patient is $20,000/3,000.
Health care professionals who prepare and forward radiographs	**$3.33**	**$0.67**	Teleradiology technician equal to 0.5 FTE at $20,000. Current radiology equal to 0.1 FTE at $20,000 p.a. Both expressed on a per patient basis.
Total fixed cost per case	**$26.67**	**$0.67**	
Variable cost per case			
Radiologist fee	**$8.28**	**$8.28**	$5.52 per x-ray (provincial fee) x 1.5 x-rays per patient
Patient road travel - direct costs	**$13.50**	**$27.00**	Teleradiology: 30 cents /mile x 600 miles x 0.075 trips per patient Conventional radiology: 30 cents / mile x 600 miles x 0.150 trips per patient.
Patient air travel - direct costs	**$19.20**	**$38.40**	Teleradiology $8/mile x 600 miles x 0.004 trips per patient. Conventional radiology $8/mile x 600 miles x 0.008 trips per patient.
Communica-tions	**$3.50**	**N/A**	5 minutes per transmission x 70 cents per minute
Diagnosis costs following transit to referral center	**$7.90**	**$15.80**	Teleradiology - referral to medical center at $100 x 0.079 trips per patient. Conventional radiology - referral to medical center at $100 x 0.158 trips per patient.

Table 7: Societal cost per case for teleradiology (cont'd)

	Teleradiology	Conventional radiology	Assumptions
Indirect costs - patient (road and air travel)	**$11.85**	**$23.70**	Teleradiology - Travel costs of $15/hour x 10 travel hours per trip x 0.079 trips per patient (road and air) Conventional radiology - Travel costs of $15/hour x 10 travel hours per trip x 0.158 trips per patient
Total variable cost per case	**$64.23**	**$113.18**	
Total cost per case	**$90.90**	**$113.85**	

Changes in the cost of telehealth to health services

As suggested previously, there are likely to be changes to caseload, case-mix and operational costs over time for both the applications considered here. It will be necessary to keep the situation under review and to update the analysis of cost and other effects of telehealth from time to time so as to provide information for future administrative and policy decisions.

In practice, costs to the health system following introduction of telehealth may vary in a complex fashion. For example, the conventional approach may be continued for a period after the introduction of telehealth. Costs could be expected to increase sharply as telehealth comes into use, with the rate of increase in total costs declining after use of the conventional approach is phased out.

Appendix 2. Further details on telehealth applications and their assessment

Assessment approaches

In general, assessment of telehealth has been relatively limited, other than in regard to appraisal of equipment performance. The available literature is growing, but will often indicate potential or possibilities rather than giving clear answers that are applicable to particular circumstances. There is general guidance, but little specific that can assist local decisions. Economic studies, as is the case with other health information technologies, are few and usually not generalizable. There is useful information from some pilot studies, including those carried out in Alberta.

As would be the case with many other types of health technology, a definitive assessment of a telehealth application may be a demanding in terms of resources, data and expertise. Some of the more comprehensive approaches to assessment are difficult to contemplate in the context of a health authority or other agency with few assessment resources and limited time within which to make decisions on the technology. Nevertheless, more detailed evaluations are highly desirable. These will be needed both for single telehealth applications and for provision of services with a telehealth network. In all cases, the same HTA principles should apply, with appropriate links to development of a business case. A staged approach to assessment, as suggested by De Chant et al. [4] may be helpful.

An outline of evaluation questions suggested by the U.S. Institute of Medicine [6] is shown in Table 8. The broader questions and additional methodological demands suggested by this list provide an important perspective for those who are using or funding telehealth. At some stage, details additional to those referred to in the approach given in this report may need to be considered.

The French HTA agency CEDIT has outlined a framework for analysis of telehealth applications in the context of hospital services [2]. Consideration of technical, medical, economic/cost, organizational and legal aspects is recommended. As suggested in the overview presented here, all these areas will require attention in planning and operating a telehealth system.

The Finnish Office for Health Care Technology Assessment has published a report on a model for assessment of telemedicine, with particular reference to projects in teleophthalmology, telesurgery, teleradiology, telepsychiatry and telepathology [7]. The report notes that effects should be assessed on the basis of the functionality (changes in processes), fluency (savings in time, speed of diagnosis, speed of treatment) and efficiency (cost-effectiveness) of each telemedical project. The impact of the new activity on cost structures and people's quality of life should be estimated. The list of variables for

consideration for the five project areas includes costs, effects, technical properties, satisfaction/quality, study design, assessment method and sensitivity analysis.

Table 8: Categories of evaluation questions in comparing telehealth to alternative health services

1) What were the effects of the application on the clinical process of care compared to the alternative(s)?
2) What were the effects of the application on patient status or health outcomes compared to the alternative(s)?
3) What were the effects of the application on access compared to the alternative(s)?
4) What were the costs of the application for patients, private or public payers, providers, and other affected parties compared to the alternative(s)?
5) How did patients, clinicians, and other relevant parties view the application and were they satisfied with the application compared to the alternative(s)?
Each question assumes that results will be analyzed controlling for or taking into account severity of illness, comorbidities, demographic characteristics, and other relevant factors.

Source: Reference 6

Summaries of monetary and non-monetary factors

As indicated in the discussion on assessment approaches, appraisal of telehealth will need to consider a range of both quantitative and qualitative factors.

Tables 7 and 8 illustrate areas of impact for the two applications considered earlier, telepsychiatry and teleradiology. Monetary and non-monetary factors in different areas of impact can be brought together for comparison, with additional detail and values being included as assessment results become available.

An approach which has been suggested for assessment of computed radiography applications is social audit analysis [3], and can take account of a range of issues.

With this approach, a matrix of data on monetary items plus information on non-monetary benefits is produced. Particular benefits which apply to each group of major participants in the telehealth application can then be considered, taking care to avoid double-counting of benefits achieved. In the case of computed radiography, this analysis would include costs and benefits to specialists, referring physicians, health care professionals, patients and their families, and to health care administrators and funders.

Table 9: Summary of impact for a telepsychiatry application

Area of impact	Effect on consumer (patients & family)		Effect on psychiatrist		Effect on referring physician/local service provider		Effect on payer (provincial government)	
	Monetary	**Non-monetary**	**Monetary**	**Non-monetary**	**Monetary**	**Non-Monetary**	**Monetary**	**Non-Monetary**
Treatment/ outcomes	Effects through changes in length of treatment	Effect on health status Increased access to care; increased support	Psychiatrist can treat more patients	Intervention before severity of illness increases (identify cases earlier) ? Increase in consultation for patients whose conditions would resolve? Effects through decreased travel	More patients can be treated	Assistance/ education in management Ability to clarify information	Increased treatment costs	Improved coverage of population
Travel	Decreased travel expenses	Inconvenience and stress of travel		Decreased travel, foregone professional tasks			Decreased travel costs for psychiatrists	
Waiting	Potential decreased costs through lost work time, etc.	Potential for more rapid help/ support, decreased severity of illness	Uncertain	Uncertain	Uncertain	Shorter-term management prior to consultation. Faster decisions on treatment.	Possible influence on costs of services.	Potential for improved health status.

Table 10: Summary of impact for a teleradiology application

Area of impact	Effects on Consumer/family		Effects on Radiologist		Effects on physician/local service provider		Effects on payer (provincial government)	
	Monetary	**Non-monetary**	**Monetary**	**Non-monetary**	**Monetary**	**Non-monetary**	**Monetary**	**Non-monetary**
Treatment / Outcomes	Consequences of decreased time between diagnostic and management decisions	Potential faster return to normal activities Consequences of being treated close to home, prompt care	Uncertain. Potential increase in number of services	Faster and more effectively targeted service	Effects on numbers of local consultations and services	Potential educational role of technology Reassurance, availability of support for local decision	Uncertain. Potential decrease in unit service costs, increase in number of consultations	Effects on population health status
Travel	Effects of avoiding referral to major centre or emergency evacuation	Decrease in disruption to normal lifestyle		More appropriate use of professional's time	Increase in number of cases treated locally	Greater continuity of patient care	Avoid cost of radiologist travel and emergency evacuations	

Technical aspects of telehealth applications

A useful description of various technical considerations in the application of telehealth is given by Reid [9]. Such points have not been discussed in the present paper, other than to note that purchasers and operators of telehealth system will need assurance that the technical characteristics of the equipment and infrastructure will be adequate to meet routine operational needs. The parameters listed by Perrault and Wiederhold [8] in discussing computer system design for health care still provide a useful guide to some key points:

- **Quality and style of the interface:** the system should be user-friendly and present an appropriate level of information.
- **Convenience:** users must have easy access to the system.
- **Speed:** hardware must have sufficient capacity to handle users' demands for information during peak hours, and software must allow users timely access to the data in the correct form.
- **Reliability:** the system must be reliable in terms of results and also have minimal downtime so that users are not forced to use manual backup.
- **Security:** confidentiality of medical, personal, and cost data is essential.
- **Integration:** it is necessary for the system to integrate with other computers or elements in the hospital information system.

As noted in Section 2, an important issue for those planning to implement a telehealth application is whether real time communication is a necessity. Table 9 presents a comparison of real-time and store and forward options given by Reid [9].

Reid points out that "the life span of most microprocessor-based technologies is no greater than three years. The products themselves last longer, but in that short time they become painfully obsolete. Some telemedicine technologies are more capable than others of being upgraded as improvements become available. "Face lift" upgrades, where the "old box" is physically and completely replaced with a "new box" are to be avoided. This is a very expensive undertaking. Those systems that can be upgraded by loading new software are the most desirable."

Many vendors represent their products as being "scaleable". This usually means that they can be installed in component sections to meet a customer's needs at the time of purchase and then added to as needs change. Expansion capability is a valuable quality, particularly in telecommunication transmission equipment.

Table 11: Real-time vs. store and forward options for telehealth

	Real-Time	Store and Forward
Interactive	Yes	No
Bandwidth requirement/telecommunications costs	Higher	Lower
Technology cost	Higher	Lower
Provides multimedia transmission of data (images, sounds, video, data)	Yes	Yes
Response time	Immediate	Delayed
Consultant can expand on patient's history and physical findings	Yes	No
Impact on patient/consultant relationship	High	Low
Instructional potential for primary care providers	High	Lower
Convenience of use for both providers	Lower	Higher
Ease of scheduling	Difficult	Unnecessary
Referring provider must anticipate consultant's information needs	No	Yes
Resembles face to face consult	Yes	No

Source: Reference 9

Applications

Some telehealth applications which are already implemented or under development are listed in Table 12.

The scope and impact of these applications varies. Some are still at the developmental stage, or have not been applied routinely in health care systems. Also, there are variations in the status of such applications between countries and between specialties. All require assessment in the context of local decisions on procurement and operation.

Table 12: Some telehealth applications

Consultation

- Teledermatology (specialist consultation)
- Teleoncology (patient counseling and education)
- Telepsychiatry (consultation with patients and their carers)
- Telespeech pathology (remote / multiple site consultations by specialist staff)
- Teleophthalmology (remote site consultation)

Monitoring

- Telecardiology (e.g., provision of advice on ultrasound data on an outreach basis)
- Telenursing (e.g., information for home-based patients)

Diagnosis

- Teleradiology / tele-mammography (includes potential links to libraries and registries)
- Picture Archiving and Communication System (PACS)
- Telepathology (e.g., transmission of histological, cytological images for urgent advice; link to registries)

Procedure guidance

- Teleaccident and emergency support services (expert advice for remote sites)
- Telepresence surgery
- Prosthesis design

Education

- Continuing medical education
- Interactive seminars
- Patient/consumer information

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