FEASIBILITY STUDY OF OUTSOURCED TELERADIOLOGY SERVICE VERSUS TRADITIONAL SUBCONTRACTED RADIOLOGY SERVICE IN COLOMBIA

1. Introduction

Telemedicine may be defined as examination, monitoring and management of patients and education of patients and staff from a distance using systems which allow ready access to expert advice and patient information no matter where the patient or relevant information is located. As such it is a method of improving equity of access, efficiency and quality of health care.

In Colombia, access to medical services is sometimes restricted by geography, topography and transportation as well as by a shortage of medical personnel, particularly radiologists.

Teleradiology is a technique that involves the transmission of radiographs between institutions using a telecommunication network as the transfer medium. The technique enables hospitals both in crowded urban as well as in rural areas to transfer radiographs to a centre where the images are interpreted by a radiologist who returns a report.

An alternative for institutions with X-ray equipment but without a permanent radiologist is to have their radiographs interpreted by a visiting radiologist or to refer the patient to a private radiology center. The combination of the latter two alternatives is currently in use in Colombia in the ISS (Insituto de Seguridad Social) hospitals and clinics. Visiting radiologists service the clinics and major ambulatories during weekdays at normal working hours, and emergency care service is provided only by larger units in densely populated areas. Subcontracting of radiology services is used by primary, secondary and tertiary care in order to meet the demand of services. Because Colombia suffers from a lack of radiologists, one visiting radiologist may have to cover 2-3 locations during a working day, but that rarely guarantees 24 hour service.

ISS Bogota-Cundinamarca pilot teleradiology project:
In mid 1997 a teleradiology trial was commenced in Bogota. ISS Bogota-Cundinamarca contracted a private Colombian company VTG (Vision Technology Group) to provide teleradiology services. The set-up of this teleradiology trial project is presented in Annex 5.

The reasons for starting the trial were
- Need to be able to provide radiology services 24 hours a day, 365 days a year
- Limited funds to subcontract radiologists to a sufficient degree

- Desire to improve the quality of services provided by X-ray departments by shortening the waiting times both in emergency and non-emergency cases
- Desire to test new cost-efficient ways to provide radiology services
- Foreseen future need to have access to specialist radiologists able to examine X-ray images produced through digital imaging methods

VTG has provided 10 ISS health care units (ambulatories) with computers and scanners. Each developed X-ray is scanned, digitized and transmitted using conventional analogue telephone line (28-33 kbit/s modem) to VTG central unit. The staff at the VTG central unit further transmits the images to radiologists that have examination capacity available at each moment. This allows the radiologist to choose relatively freely his/hers working location, and cuts off travelling and incurred costs.

The hospitals and clinics already equipped with X-ray equipment did not have to invest in additional equipment, unless they lacked telefax needed for transmitting referrals and receiving the diagnoses.

VTG offers to perform the radiology services at the rate corresponding to 25 % of the official Annual Tariffs applied by the ISS nationally for any subcontracted services. (Radiology Tariffs are enclosed as Annex 1). The only additional variable costs to be borne by the EPS's are the telecommunications costs.

Simultaneously there are savings accrued through diminished manpower costs when radiologist are no longer needed to the same extent, and also the level of subcontracting has dropped, because only specialist X-ray examinations are currently subcontracted.

After the first 20 months of operations, ISS Cundinamarca now has published indicators of Project's success. The Project was honoured by the Publication "Telemedicine Today" as the best radiology project in 1998.

The improvements in the patient service quality, as well as in the efficiency and quality of working time of radiologists have, along the process, made it possible to overcome the initial resistance met among the radiologists who worried about loss of working opportunities.

2. Objectives of the Financial Feasibility Study

This feasibility study examines the change in resource use in providing the radiology service. The principal aim is to establish the **financial feasibility** of teleradiology, i.e. whether teleradiology is more or less expensive than a standard subcontracted radiologist service. The study also examines the resource consequences of introducing a new service, since introducing new technology in health care is a potential cost-shifting operation. Although the issues related to quality of care and other patients'

benefits are taken into consideration, their financial value has not been used as a variable. Therefore *this study does not fulfill the criteria of a cost-benefit analysis* that would require estimates of the benefit according to the population's health status.

The initial investment required by teleradiology depends on the quality standards applied in each country and/or service provider, and on the purpose the teleradiology services are going to be used for. The images have to have sufficient resolution to preclude erroneous interpretations due to poor image quality. Subtle fracture X-rays in traumatology do not need as high a resolution level as is needed for more specialized radiology services. Ultimately, one depends on the responsible radiologists' ethics to determine whether each image fulfills the criteria for proper image interpretation. Therefore, this study considers two different alternatives based on different uses of teleradiology:

- Case 1: use of existing analogous equipment, with present quality standards set only for the transfer and examination of images
- Digital imaging and transfer of images with latest equipment (Dicom standard)

In order to have a tool for investment feasibility assessment, this study attempts to determine the patient workload that is needed for achieving cost-effectiveness benefits in each of the above cases.

3. Method

Data was collected from the following sources:

1) In the Bogota and Cundinamarca section 10 ISS out-patient service units have used the teleradiology service described above since July 1997, and they have developed financial indicators to verify the cost structure of the teleradiology. These indicators were used where applicable.

2) In Cartagena region the information was collected from a ISS clinic and the local ISS administration.

3) International studies and economic analyses of teleradiology were used to apply similar assumptions about the annual maintenance and about the lifetime of capital items.

4. Costing method

Using the information collected from the sources mentioned above, an average service cost per examination was calculated for

- A subcontracted service
- Teleradiology service provided by VTG

Using the average service costs received through above calculation for a subcontracted service an investment break even point (the threshold value = the number of patients that is required to make the services equally expensive) was calculated for an imaginary case featuring minimum investment in

- Digital imaging and transfer of images with latest equipment (Dicom standard)

Since teleradiology in general is capital intensive and therefore sensitive for patient workload, the fixed and the variable costs are distinguished as carefully as possible.

Fixed costs:

In the current Project using teleradiology services no new fixed costs are introduced, but in the other component where initial investment in digital X-ray equipment is a precondition the capital investment has been converted to an annual costs. The annual interest rate was calculated taking into account that the internal interest rate ISS uses when calculating the opportunity cost of their investments in local currency is 24 - 27 %. When devaluation of 17 % is deducted, the interest rate applicable for U.S. dollars is set between 7 and 10 %. Table in Annex 3 presents calculations applying 5%, 6,7% and 8,5 % respectively, but references in the text are based to the highest, i.e.8,5 % interest value.

The annual equipment maintenance cost of 10 % of the equipment's purchase price was adopted for new investments (based on data derived from both an Austrian[1] and the Norwegian analysis). The maintenance cost for the existing equipment is based on information from ISS Cundinamarca.

The equipment lifetime was estimated to be 6 years. For comparison, calculations in Annex 2 also reflect a case with 6 years' lifetime.

Further assumptions made were related to salaries of the permanent staff: no additional investment in personnel was expected, since the training related to the use of X-ray equipment is assumed the equipment provider's responsibility. Radiologists' salaries were excluded, assuming that those services would be outsourced.

Variable costs:

In order to calculate alternative costs between two forms of service an assumption is made that the subcontracted radiologist has the same efficiency as the radiologists providing teleradiology services, i.e. 700 examinations per month. Therefore it is expected that the human resources (technician, nurse and assistant) *cost per examination* remains the same throughout, even if in the real situation the

[1] Stoeger et al.: A cost analysis of an emergency computerized tomography teleradiology system, Journal of Telemedicine and Telecare 1997; 3

introduction of digital imaging and teleradiology has increased the patient scan volumes[1] by removing the necessity to develop the films.

Based on the financial indicators developed by ISS Cundinamarca and by crosschecking those with values received in Cartagena, the existing data on the fixed and variable costs an average price per examination was calculated. The calcula used and the respective calculations are attached as Annex 2.

5. Considerations of technical quality

Digital imaging offers superior quality and enables direct image transmission in LANs (Local Area Network) and WANs (Wide Area Network). Digital processing of radiological images improves the diagnostic possibilities and thereby offers better quality and enhanced efficiency in diagnostics. Further advantages are reached through the image archiving system (CD-R ROM or DVD) that offers faster and easier access to information, more reliable archiving (through minimized loss of images) and minimized need of physical space.

However, traditional imaging technologies are still acceptable in many fields of radiology. Especially in the cases when the equipment and imaging routines can produce high quality X-ray images which offer reliable diagnostics new investments in the digital imaging need to be carefully considered. In some cases digital and analogue X-ray images can offer almost equal diagnostic results, e.g. in basic traumatology.

Since the initial investment in digital imaging system is very high one has to carefully consider the appropriateness (expected lifetime and expansion capability of the equipment and techniques) and the expected advantages. When calculating the real value of the investment and comparing it to the expected financial benefits (cost-benefit) the latter is more complicated to define. There are very few published internationally valid cost benefit analyses that could estimate the economic value of such variables as:

- Improved diagnosis
- Monitoring of clinical changes
- Change in health related quality of life
- Change in health care process
- Improvement in proficiency at a primary health care centre
- Savings accrued through shortened treatment time

However, the accuracy of the diagnosis when using teleradiology services has been largely studied internationally. Several studies in which both digital and analogue radiographic images from the same patients were diagnosed by different radiologists

[1] M C Davis: Teleradiology in rural imaging centres, Journal of Telemedicine and Telecare, 1997:3

have shown no significant differences between the two methods. Any variations found were clearly attributable to differences between the observers. [1]

This is supported by, for instance, a recent Finnish assessment[2] carried out in the Northern Ostrobothnia (a region with low and highly scattered population with long distances to secondary health care facilities). In the assessment the use of teleradiology in emergency cases and in consultation between central hospitals was studied. In emergency care teleradiology consultations were considered useful in 94 % of the cases, the original diagnosis altered in 27 % of the cases, treatment changed in 17 % of the cases and the patient transfer was avoided in 12 % of the cases. The inter-hospital consultation changed 13 % of the diagnoses and 25 % of the treatment plans. It also prevented unnecessary treatment in 26 % of cases and 50 % of the cases could be treated without transferring the patient. The results reflect the reality where highly developed radiological imaging procedures need specialized knowledge for interpretation, and without teleradiology it would be difficult to provide the specialized manpower required for interpretation of examinations 24 h a day seven days a week.

6. Comparison of the cost structures:

6.1. Subcontracted radiology services

Information on subcontracting is based on ISS statistics from the last 6 months, according to which 109 250 patients were examined by subcontracting radiology services of the primary care. The total costs of the services amounted to COP 2 843 100 000, which equals to USD 1.834 258.

A sample of more than 100 000 patients can be considered large enough to provide a reliable average cost of the service, i.e.

	COP	**USD**
Average service tariff per patient, *Fsub*	**26 023**	**16,79**
Average service cost per examination, *ASCsub*	**18 571**	**11,98**

Where
ASC sub= average service cost per examination of a subcontracted radiology service

[1] Trine S. Bergmo: An economic analysis of teleradiology versus a visiting radiologist service, Journal of Telemedicine and Telecare 1996; 2
[2] Ohinmaa and Reponen: Assessment of Telemedicine in the Northern Ostrobothnia health care district

ASCsub = Fsub:1.4

where
Fsub is the average service fee per patient
and
1.4 is an indicator of the number of examinations carried out per patient
Compared with information collected in Cartagena this average cost is even lower than the one based on Cartagena statistics between February-October 1998 that indicate an average cost of approximately 12,50 USD per examination. In order not to exaggerate the eventual savings ***the ASC sub value of 12,00 USD is applied in this study***.

6.2. Current VTG-ISS teleradiology service network and its cost structure

The type of teleradiology service contract that ISS Bogota-Cundinamarca has had with VTG does not cause any additional fixed expenses for the health service provider, because the service is based on the use of existing X-ray equipment. The computer with communications software as well as the scanner in this case do not cause extra costs for the health service provider either, since all the related costs, including maintenance and training, are included in the VTG service package.

The average cost per examination was calculated as follows.

ASCtr (Averige Service Cost for a teleradiology service) = F + W + Py + L
where

F tr = average service tariff of a teleradiology service

W = W tech + W aux + W rec + Wsoc

where
W tech = Wage for the technician calculated per service at the current frequency of 700 monthly examinations

W aux = Wage for the auxiliary nurse calculated per service at the current frequency of 700 monthly examinations

W rec = Wage for the receptionist calculated per service at the current frequency of 700 monthly examinations

Wsoc =Extras and social costs

P y = film processing cost per service (includes chemicals, films and losses)

L = average charge for using the communication lines

At the current personnel cost (1998 salary level) an average price for each examination carried out using VTG services consists of the following variable costs:

	COP		**USD**	
Average service tariff, *Ftr*	2 600		1,68	
Film processing cost, *Py*	2 257		1,46	
Human resources, *W*	2 500		1,61	
Telecommunication, *L*		570		0,36
Average service cost per examination, *ASCtr***:**	**7 927**		**5,11**	
Average service tariff per patient: [1*]	**11 098**		**7,16**	

6.3. Investment break even point for fully digital X-ray equipment

Using the purchase value of the sample equipment presented in the Annex 4 and assuming 6 years' equipment lifetime, with annual maintenance costs corresponding to 10 % of the purchase value the **annual capital** charge for equipment purchase (including 2500 USD estimated for ISDN line rental) would be **68 017 USD** at a 8,5 % annual interest rate.

The following calculation of an average cost for examination when using fully digital system includes the following preassumptions:

- *Availability of ISDN lines*
  In practice the use of fully digital X-ray equipment is currently realistic only in three major cities of Bogota, Medellin y Cali because of the limited availability of ISDN lines elsewhere. Because even in those cities there are still technical problems with ISDN lines the introduction of ISDN connections in rural areas is not a practical solution at this stage. As the calculations show, the required patient workload to make the investment feasible also supports the introduction of this new technology starting in the major cities.

- *Exclusion of network requirements*

[1] Assumption: 1,4 examinations per patient

[*] Using the indicator of 1,4 examinations per patient

Because the existence of LANs or WANs is not a precondition for using digital imaging systems and transmitting digital data, the eventual installation costs of networks have not been included in the calculation.

- *Investment in personnel and patient awareness raising and staff retraining has a separate budget*
  Introduction of new technologies always causes major changes in the working environment, working methods and in the required capability profiles of the personnel[1]. In a country like Colombia introduction of filmless examination of X-rays means breaking fundamental and complicated cultural barriers. One of the success factor of VTG-ISS network has been the continuous awareness raising and on-the-job training of staff members at all levels and in both ends of the network. As the pioneers of teleradiology VTG has provided the training as part of their service package, but it the teleradiology is to be more largely introduced the healthcare units themselves have to be ready to invest in the continuous retraining of their staff. This cost has not been taken into account in the following calculations, but any healthcare unit planning an investment shall be prepared to additional personnel costs of this kind.

- *ISS fixed personnel costs remain the same*

- *The costs of archiving remain at the same level*
  The extra archiving costs due to purchase of CD-R ROMs or DVDs may be compensated by the need of less physical space for archiving and by easier access to old records.

- *Radiologists' services provided by VTG according to current conditions, i.e. at a rate corresponding to 25 % of the ISS annual tariffs for respective subcontracted services*

Taking into consideration the above preassumptions the average cost per service may be calculated using the fixed and variable costs of the teleradiology service provided by VTG, and deducting only the film processing costs. (The costs of archiving the information have been left outside this calculation.) The average cost per examination thereby received is USD 3,65.

In order to attain a cost structure that could compete with subcontracted services, i.e. cost per examination should be less or equal to 12 USD, the equipment should be used to examine the minimum of 8 146 images per year. The calculus used to determine this investment threshold value in comparison with subcontracted services, Xsub, is as follows:

$$Xsub\ (ASCsub - (ASCtr\text{-}Py)) = 68\ 017$$

[1] Reponen et al: Digitaalitekniikan aikakausi (The era of digital techniques), Suomen Laakarilehti, 1995; 31

Similarly one can calculate the annual number of examinations needed to make the investment feasible in comparison with the present services of VTG-ISS radiology network. Since the only expected saving then would be the excluded average film processing cost, i.e. USD 1,46 per service, the calculus is:

$Xtr * Py = 68\ 017$

The simplified calculus shows that with the minimum volume of 46 587 examinations per year the average cost for an examination would be close to that of the present service provided by VTG-ISS network, provided that VTG would be able to continue to offer radiology interpretations at the same rate, i.e. at a rate corresponding to 25 % of the tariffs published by ISS. At a daily level this would mean that approximately 130 examinations per day, 360 days per year should be taken. In a healthcare service unit operating only during normal hours on working days this would correspondence to approximately 230 examinations per day, which is far more than for instance the average patient and examination load of e.g. the Cartagena clinic[1] that currently operates with one single X-ray equipment only.

6.4. Uncertainty factors:

Salaries as well as ISS service tariffs are checked once a year. According to the latest information the salaries will increase by 18-19 percent in December 1998. The service tariffs that ISS establishes annually for any subcontracted service and that are valid from 1st April to end of March were criticized for being too low and therefore there might be a heavy pressure to increase them as well. If the increase in service tariffs will be higher than the salary increase, the difference between average service cost for teleradiology and the average service cost for a subcontracted service will be even greater, and vice versa.

Although presented as a preassumption, it is not possible to guarantee that VTG will be able to maintain their present cost ratio. The salaries in the private sector have the tendency to rise more rapidly than those in the public sector, and particularly in highly specialised professions the demand of labour is causing competition that will further increase the personnel costs.

The sample equipment price was received through an international dealer of X-ray equipment operating mainly in Europe. Therefore the price quotations for similar equipment in Colombia might vary up to +/- 30 %.
Each of the “preassumptions” included in the calcula are practically uncertainty factors, and the biggest of them in this particular case is the unavoidable cost of

[1] Interview of Ms. Rosario Anaya, Tecnica rayos-X, Clínica de Enrique de la Vega, Cartagena

personnel retraining and awareness raising. The user training is normally offered by the provider of new equipment, but changing working environment may call for other types of investments in the personnel.

In most of the articles referred to in the footnotes it was mentioned that initial technical problems during the first months following the introduction of new equipment were common and increased the costs directly and indirectly. One of the problems most commonly referred to was related to unreliability of ISDN lines due to teleoperators' lack of experience, which problem has also been recognised by VTG, part of whose radiologists already are connected to the network through ISDN.

7. Conclusions

Even if it will not be necessary nor reasonable to provide several ISS healthcare units with digital imaging equipment, teleradiology services themselves in the form they are currently offered by VTG should be further incouraged and developed.

The future scenario is that digital equipment will gradually replace the analogue equipment. In USA and Europe this development is already ongoing, and for instance in Finland the regional and central hospitals are using latest imaging systems, but at the same time they are lacking the necessary experience to interpret the images. In many cases that is more due to economic limitations than to availability of trained personnel. In either case, teleradiology applications are essential to guarantee timely diagnostics even in the remote rural areas.

According to calculation presented above, fully digital imaging system requires a rather high patient workload to be feasible. However, the prices of digital equipment are expected to decrease as they become more common. In a case where investment in digital imaging system is an *alternative cost* to an investment in analogue imaging system the investment break even point is far lower than the one used here.

In Colombia the human resource costs compared to cost of new equipment are still very low in proportion, and therefore the threshold value, i.e. the number of examinations needed to attain cost-effectiveness is higher than for instance in Europe. However, since no additional investment in equipment is needed in the current VTG-ISS radiology network the savings achieved are remarkable: If 95 % of the subcontracted radiology examinations could be implemented using teleradiology services, approximately 256 000 patients could be treated with the same budget that was used to subcontract radiology services for 109 250 patients between May-November 1998. In terms of capacity that would mean 130 % increase, and in terms of savings the average saving per examination is currently 6,89 USD, corresponding to 57 % of the average price of a subcontracted examination.[1]

[1] Benitez, Helena, ISS Cundinamarca, Colombia: Informe Teleradiologia de 7.12.1998

Further savings and improvements in quality could be sought through close cooperation of health authorities and the telecommunication operators. If teleoperators could offer preferential prices to healthcare units and if the improvements in the quality of telecommunication lines and availability of ISDN lines could be expected, the teleradiology option would yield even higher benefits.

Even if the economic consequences of societal values have not been considered in this study, the importance of the benefits accrued to the patient should not be ignored. Improved correctness of diagnoses leading to shortened treatment times and absences from work, and avoidance of unnecessary transport of patients are benefits generally related to use of telemedicine.

The additional market value that a company may gain through improved quality of services is as difficult to calculate as the societal values. Nevertheless, although ISS currently is the largest social insurance provider operating in Colombia, the quality of the services they can provide remains a crucial factor in the competition between them and other private insurance providers.