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Tele Oncology for Cancer Care in Rural Australia

Sabe Sabesan[1,3] and Sean Brennan[2,3]
[1]*Departments of Medical Oncology and* [2]*Radiation Oncology*
Townsville Cancer Centre, The Townsville Hospital
Townsville, Queensland
[3]*School of Medicine and Dentistry, James Cook University*
Townsville, Queensland
Australia

1. Introduction

Rural cancer patients in Australia and other countries with significant rural populations face difficulties with accessing various sub specialist services mainly because of shortage of health care work force and long travel distances to access these services(Underhill et al,2009). Partly as a result, their survival is lower than their urban counterparts(Campbell et al,2001; Australian Institute of Health and Welfare,2010; Sabesan and Piliouras,2009).

To improve equity of access and quality of life, clinics and treatment centres should be located closer to homes in rural towns. Currently, there are several models of care exist to address some of the issues as follows(Underhill et al,2009): (1) medical oncologists travel to larger rural towns and chemotherapy is administered there. Frequency of these visits range between weekly to three monthly intervals; (2) patients travel to larger centres for consultation and return to their home towns to receive their chemotherapy; (3) patient's travel to major towns to see the specialists and to receive chemotherapy. These models are often inadequate, expensive and cause problems for patients, specialists as well as rural doctors who would ultimately care for these patients.

There are several problems with the first model. This is only suitable for larger towns with higher patient loads. In between specialist visits, patients who are sick would be transferred to major centres to be treated by the specialists or managed by rural doctors without direct supervision by the specialists who initiated the treatment. It also causes disruption to the routine of specialists who already have a significant work load and a waiting list at their home sites.

Problems faced by patients and families under the second and third models are numerous(McGrath, 2000). They often travel long distances for shorter consultations. They often have to relocate to major centres for extended periods for investigation and treatment which results in significant disruption to family and work routine and incurs significant out of pocket expenses. Patients having chemotherapy face another challenge in that they often travel back long distances after chemotherapy regimens that can make them nauseous. In

addition, these models are expensive because of cost of travel and accommodation for patients and their families and specialists.
This calls for alternative ways of consulting and treating patients from smaller rural centres. Care of cancer patients using videoconferencing is an attractive model to satisfy this call. This technology allows patients, doctors, health workers like nurses and other allied health practitioners and family members to see each other while discussing management options unlike telephone consultations. Centres with established teleoncology services include Kansas, USA; British Columbia, Canada ; Townsville, Australia and many others around the world(Doolittle et al,2001;Taylor et al' 2007; Sabesan et al, 2009).

2. Models of teleoncology outreach care

Technologies in telemedicine like videoconferencing can be used for various purposes in cancer care. These include 1. Discussion between health care professionals about cases in multidisciplinary meetings, 2. Consultation of patients by allied health professionals, 3. Consultations by medical oncologists, radiation oncologists, palliative care physicians and haematologists for ambulatory patients and inpatients in rural hospitals.

2.1 Townsville Cancer Centre model

Townsville Cancer Centre, a comprehensive cancer centre, is located in Townsville in Queensland, Australia and is the tertiary referral centre for a population of 650,000 in the North Queensland. Over the last four years to improve the rural access to specialist medical oncology services, department of medical oncology of the Townsville Cancer Centre has been using videoconferencing technology to oversee the management of medical oncology patients from rural and remote towns of the Townsville and Mt Isa Health Service Districts, approximate area of 1200 x 1200 kms. Initially patients were seen face to face for the first consultation, with subsequent video link consultations and treatment performed in Mt Isa or in alternative nearby towns. In the last 12 months the role of videoconferencing in the Townsville Cancer Centre has expanded, with patients now managed exclusively via videoconferencing from the first consultation to treatment and follow up.
Videoconference consultations are conducted on a weekly basis and patients are allocated a time slot in routine medical oncology clinics, although urgent cases are seen anytime. Prior to initial consultations, informed consent is obtained from patients and individuals declining to be seen via video link would be given the option of travelling to Townsville. In Mt Isa, at the receiving end of the video link, patients and their support persons are joined by a chemotherapy competent nurse, senior medical officer, and allied health workers. Patients are examined by the attending doctors during consultations. If a patient has had a recent CT scan (computer tomography) then physical examination is not performed, except for checking vital signs. Treatment decisions and chemotherapy regimes are decided by the medical oncologists and are administered in Mt Isa by chemotherapy competent nurses, supervised by the local medical team. Any dose modifications are made by the specialists and patients needing urgent chemotherapy for aggressive disease receive their chemotherapy in Mt Isa without delay. Patients who are severely unwell, due to their primary diagnosis or due to treatment adverse effects, are seen more frequently via video link while they are in patients, with the option of transfer to the Townsville Hospital. For other towns in the health services district, where administration of intravenous chemotherapy is not feasible, a nurse and sometimes doctors accompany the patients and

families during consultations. Recently radiation oncology and haematology consultations have commenced on videoconferencing using this model.

3. Benefits of teleoncology

Telemedicine offers many advantages for patients , their families and rural health workers. Benefits observed by the Townsville Cancer Centre between Jan 2007 and Nov 2010 are described below. Data was extracted from the oncology information system of the Townsville Cancer Centre.

3.1 Ability to provide consultations to patients at their home towns

Since the inception of the project, 150 patients have been consulted resulting in 609consultations. Demographic details are described in table 1 and 2. Of the 77 new patients seen, all were seen for a first new patient consultation via videoconferencing. 60 patients were seen at least once in person when they travelled to Townsville for other medical or social reasons.

Tele Oncology Centres (distance from Townsville)	**Number of Patients**	**Number of Consultations**
Mt Isa(900 km)	123	517
Proserpine/Bowen(275 km)	16	43
Hughenden(385 km)	02	11
Winton(599 km)	04	21
Doomadgee(1200 km)	01	03
Palm Island	01	01
Gulf of Carpantaria(740-1200 km)	04	14
Total	150	609
Gender -Male	69	
-Female	81	
Ethnicity- Indigenous	17	
- Non indigenous	133	
First consultation on videoconference	77	
Seen face to face prior to videoconference	73	

Table 1. Demographic details of patients attending teleoncology clinics

Cancer types	Number of patients	Curative intent	Palliative intent
Breast	55	28	27
Colorectal	31	10	21
Lung	33	00	33
Upper GI Malignancy(stomach, esophagus & pancreas)	13	01	12
Genitourinary malignancy (Testis, prostate, bladder & kidney)	08	02	06
Melanoma	05	02	03
Ovarian cancer	03	03	00
Invasive mole	01	01	00
Mesothelioma	01	00	01
Total	150	47	103

Table 2. Cancer types of patients attending teleoncology clinics

Gulf of Carpentaria comprises a cluster of remote rural and indigenous towns in North West Queensland. This area is frequently cut off from rest of Queensland during wet season and travel by road for face to face consultations are not feasible during this period.

3.2 Ability to provide urgent medical care at their home towns

8 patients required urgent consultation and all were seen via videoconferencing within 24 hours. Table 3 describes the clinical nature of these patients. Prior to the videoconferencing these patients would have required transfer to Townsville hospital for assessment. Of these 8 patients, 2 required transfer to palliative care in Mt Isa after discussion with the family and patient. Treatment was initiated for the remainder within 48 hours. No inter hospital transfers occurred since the project began.

Cancer type	patients	Chemotherapy	palliation
Extensive stage small cell	3	2	1
Non small cell lung	2	2	0
Metastatic Head and neck	1	0	1
Metastatic colon cancer	1	1	0
Invasive mole	1	1	0
Total	8		

Table 3. Clinical nature of patients consulted urgently

3.3 Accommodating indigenous needs

17 indigenous patients were consulted and treated under this model of care. 12 patients were accompanied by 4 or more extended family members for consultations and treatments accommodating cultural family norms.4 were accompanied by their spouses. One patient was accompanied by a traditional healer. Table 3 describes the nature of cancer and the treatment received by indigenous patients.

3.4 Ability to provide cancer treatments closer to patients' homes

81 patients received chemotherapy in Mt Isa. Table 5 shows various chemotherapy regimens and number of cycles administered. Since the project began, no patient has travelled to Townsville for chemotherapy.

Type of cancer	patients	Active treatment	palliation
Breast cancer	3	2 Chemotherapy, 1 hormonal agent	0
Small cell lung cancer	3	2 pts chemotherapy,	1
Non small cell lung cancer	5	2 chemotherapy, 1 targeted agent,	2
Oesophageal cancer	2	1 chemotherapy	1
Metastatic Head& neck cancer	1	none	1
Rectal cancer	1	chemotherapy	0
Metastatic colon cancer	1	chemotherapy	0
Ovarian cancer	1	3 lines of chemotherapy	0
Total	17		

Table 4. Clinical nature of indigenous patients attending teleoncology clinics

Regimens	Number of patients	Median number of cycles(range)
Breast cancer		
TAC	6	6(2-6)
TC	3	4(4)
AC	2	4(4)
Taxol/gemcitabine	3	8(6-8)
FEC100-Taxotere	3	6(6)
Colorectal cancer		
XELOX	8	6(1-13)
FOLFOX	2	10(10-12)
Fluorouracil	3	24weeks
Xeloda	3	8(1-8)
Lung cancer		
Carboplatin /Taxol	6	6(3-6)
Carboplatin/Vinorelbine	4	4(2-4)
Carboplatin/Gemcitabine	8	4(3-6)
Carboplatin/etoposide	5	6(2-8)
Ovarian cancer		
Carboplatin/Taxol	3	6(6)
Germ cell tumour		
BEP	1	4(4)
Invasive mole		
Methotrexate infusion	1	2(2)
Others	20	
Total	81	

Abréviations: T-docetaxel, A-Adriamycin, C-cyclophosphamide.

Table 5. Chemotherapy regimens supervised via telemedicine.

3.5 Discussion

Results from analysis of our project demonstrate that provision of equitable cancer care to the rural and remote towns and indigenous patients can be achieved using videoconferencing. The model facilitates equitable and immediate access to medical oncology specialist services and allows reviews on an urgent basis within 24 hours without the need for costly inter hospital transfers and inherent delays in transfer. Disturbance to family and work routine is minimised, Inter hospital transfer costs are reduced and disruption to health systems and patients and their families is minimised. Under our model, immediate consultation is possible, with investigation initiated and treatment commenced within 48 hours.

The system is simple to operate and efficient in its ability to dial into different towns in one sitting allowing greater geographical access than that allowed by attending a limited number of prescribed peripheral clinics. Feedback regarding investigations and post treatment assessments are possible without delays incurred by clinic schedules.

17 indigenous patients and their families from Mt Isa, Lake Nash, Doomadgee and Mornington Island were seen in clinics. Special attention to cultural norms and community involvement in patient care is facilitated by allowing patients to remain located within their immediate communities whilst accessing specialist advice and management. On average, indigenous patients were accompanied by 4-6 family members. Explaining to the family members about the illness and clarifying questions from community members contributed significantly to patient care. Improved treatment acceptance and compliance is observed. Attendance of local traditional healers with patients at their consultation offers the opportunity of education and acknowledgement of cultural values. An unanticipated potential opportunity has developed from many separate families asking questions regarding the causes of cancer and in particular smoking related malignancy. An educational component to extended families during the interview could be incorporated into video linked clinics in addition to the patient focus.

A major benefit of this system is the ability to treat patients with chemotherapy closer to their homes. Mt Isa provides all solid tumour chemotherapies, both oral and intravenous, whilst smaller towns can safely supervise oral agents. Since the project began, no patients from Mt Isa had to travel to Townsville for chemotherapy. A further advantage is that patients may be reviewed immediately for complications and appropriate advice discussed with the physician responsible at the remote centre.

Initial challenges to the successful implementation of the project were overcome with staff training on relevant technology. Hearing and visual impairment in patients presented no greater impediment to successful communication than it did in face to face clinics. Accompanying nurses, doctors and patient family members ensured the correct message was passed on to the patients.

The benefits this project offered to rural patients has resulted in clinicians from other departments within Townsville Cancer Centre (including Radiation Oncology, Haematology and Palliative Care) introducing the technology in selected rural patient consultations. The model has potential wide applicability within medicine. Adoption of the model will require specific tailoring to the unique needs of the medical subspecialty clinicians and their patients.

In conclusion, medications have changed, health technology has advanced but the way we deliver health care services has not changed over the last 100 years. Videoconferencing is an alternative and /or complimentary technology to enhance the rural access not only to specialist oncology services but also for all fields of medicine and could become part of day to day business of all departments involved in care of rural patients. This would be one of

the first few steps in closing the gap between rural and urban health outcomes and indigenous and non indigenous health outcomes, not only in Australia but also in many other countries with significant rural population.

4. Measurement of outcomes

In addition to the overall benefit of teleoncology described above, it is useful also to measure and document other outcomes to promote this model of care among other health workers and patients. They include level of patient and health workers satisfaction, safety of chemotherapy supervision and delivery and cost effective analysis.

4.1 Satisfaction of patients and health care workers

4.1.1 Introduction

Studies executed with smaller patient numbers suggest both patients and physicians are satisfied with videoconference consultations. A regional cancer centre in Victoria Canada compared satisfaction levels between 60 sequential patients, 30 consulted via videoconferencing, and 30 seen face to face(Weinerman et al;2005). Results demonstrated patients were very satisfied with teleconsultation, particularly as it saved travel time. However, the oncologist involved in this study was reported to feel that video consultation was less effective. Another study from British Columbia also revealed a high level of satisfaction, with greater than 90% of the patients involved in agreement with the highest offered positive questionnaire options(Taylor et al;2007). The consulting physicians in this study demonstrated slightly less satisfaction, with 80% or more cumulative agreement. One question however scored lower for both the patients and physicians and concerned the absence of a physical examination by specialists. Our aim was to examine the level of satisfaction among patients and health workers in relation to the Townsville model.

4.1.2 Methods

At Townsville Cancer Centre(TCC), a questionnaire based survey was conducted by telephoning patients, following informed consent (Sabesan et al;2011),. Questionnaires addressed the following: (a) demographic details (age, gender, educational level, difficulties with hearing and vision, cancer types, (b) type of consultation (new vs reviews) and (c) 16 statements regarding satisfaction levels in various aspects of telemedicine(figure 1). Responses to each statement were recorded on a 5 point Likert scale with 5 indicating strong agreement, 3 agreement and 1 strong disagreement. Question 17 allowed patient suggestions for future improvement of the service.

The first 13 questions were extracted from the study discussed earlier by Taylor *et al*, (2007), for ease of future comparisons between Townsville and British Columbia models, with town name changes as necessary. The last 3 questions were added to assess overall satisfaction and safety. These 3 questions were not validated but piloted on a smaller sample before use in the main study. Q17 was added to obtain further qualitative input regarding this model of care . Interviews were conducted in 2007/8 in the first consecutive 27 patients, when the service began, and in 2009/10 in 28 consequent patients, after the service was fully established.

Perspective of health workers:

This study collected responses from a range of 18 health care workers who accompanied patients during videoconferencing sessions, including: 5 registered nurses, 9 doctors (2 resident medical officers, 4 senior medical officers, 2 registrars, 1 physician), 1 breast care

nurse, 1 social worker and 2 indigenous health workers. Since there are no validated questionnaires to assess the views of the health workers in relation to teleoncology, open ended questions were asked to explore the following themes: (1) safety of chemotherapy delivery, (2) comparison between face-to-face and videolink, (3) major benefits for patients, (4) benefits staff, (5) potential problems that could arise for this model of care, and (6) medico legal concerns. This study was approved by the ethics committees of the Townsville and Mt Isa Hospitals.

1. I could talk to the specialist easily and openly.
2. I felt I could ask my specialist questions.
3. I did not feel that anything important was missed during my visit with my doctor.
4. I understood what the specialist told me.
5. I felt that the doctor and the nurse answered all my questions and concerns.
6. I felt the specialist was able to understand my situation and provide satisfactory care.
7. I felt my privacy and confidentiality were preserved during my first visit with my doctor.
8. I felt it is important for the specialist to examine me.
9. It is important to have the local doctor or nurse with me when my specialist is consulting.
10. I would rather travel to Townsville to
11. I had no difficulty seeing and hearing the doctor through the video link system.
12. I would rather video consult with my doctor now than have to wait for a few weeks to see him/her in person.
13. I felt that being able to video consult with my doctor was convenient and/or saved me time and money.
14. I was able to develop a friendly relationship with my specialist.
15. I am getting satisfactory care from the specialist on video link with the help of doctors and nurses locally.
16. I was able to take medications safely after the consultation with the specialist
17. Anything you feel important that we need to address to improve?

Fig. 1. Statements regarding patient satisfaction

4.1.3 Results

Between June 2007 and June 2010, 113 patients were seen in the telehealth clinic. A total of 55 patients were approached, 27 from the first period and 28 from the second period. 2 patients from the first period and 3 patients from the second period declined for personal reasons. Demographic details of the consenting patients were summarised in table 6. Subjective hearing and vision impairment were reported in 4% of the patients, who were able to complete consultations with the help of their families and accompanying nurses and doctors. The majority of consultations were for pre-chemotherapy visits and routine follow up after being seen initially face-to-face in Townsville. All 8 patients seen for their initial consultation belonged to the second period, after which all patients were cared for without being seen face-to-face first.

Patient satisfaction survey:

A response of the patients to the questionnaire statements is shown on figure 2. Except for questions 8 and 9, the majority of the responses were in agreement or stronger agreement with the score of 3 or more on the Likert scale. For Question 8, which refers to the need for a specialist physical examination, 76% of the patients thought it was necessary, though they

were examined by local doctors or had imaging scans. For Question 9, which refers to the need for local doctors and nurses to accompany them, 24% were in agreement. In Q10 22% were willing to travel to TSV rather than attending the videoconference but were happy to have chemotherapy in Mt Isa. Nine of these patients were from the initial period. In contrast to this in Q12 over 82% preferred to receive care via the videolink than travel to a larger centre for a consultation.

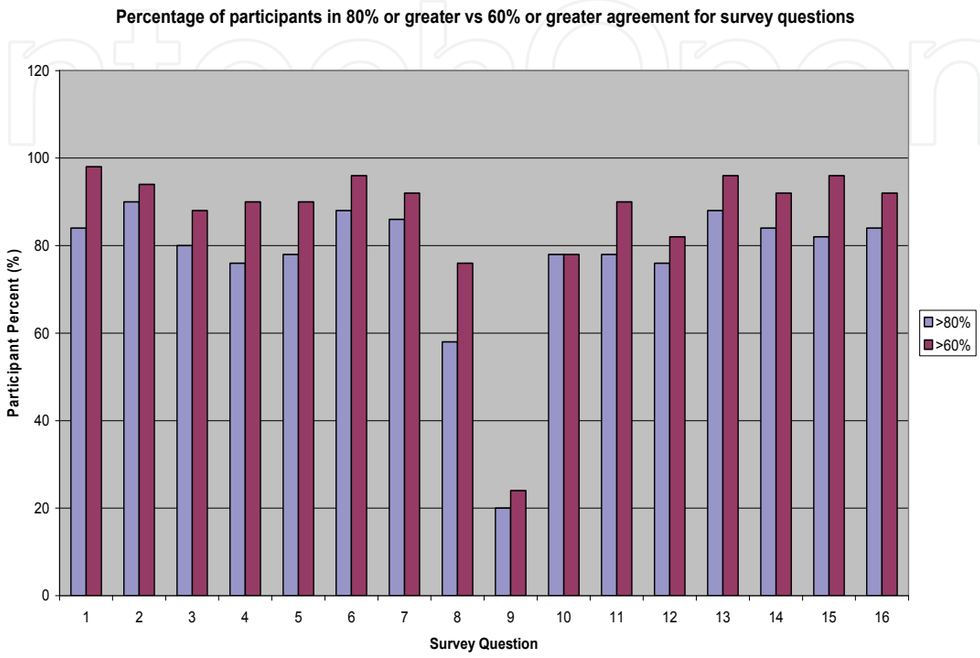

Fig. 2. Responses to satisfaction statements by patients

Age	Mean 58y(range 28-83)	
Total number participating	50 patients	
Gender	Male Female	24% 76%
Educational level	University TAFE High school Less than high school	20% 10% 46% 24%
Hearing and vision impairment		10%
Cancer type	Breast Colorectal Lung Other	42% 18% 10% 30%
Prognosis	Curable Incurable	30% 70%
Type of visit	New Pre chemotherapy Follow up	8% 48% 44%

Table 6. Demographic details of participating patients

Views of the health workers are collated under corresponding themes as follow.

Safety of chemotherapy delivery

1. It is safe as long as procedures are followed and events documented properly,
2. Mutual trust between local doctor and specialist is important and specialist have to be vailable and contactable easily,
3. If patients are too complicated, they could be flown to Townsville,
4. Since health workers are present during consultations and hearing the discussions and instructions, there would be less chance of communication break down.
5. Since we go to TSV for up skilling, we are comfortable with skills and feel safe in administering chemotherapy.
6. Since chemotherapy scripts are done by medical oncologists and they follow the patients up. It can't be less safer than in face to face.

Comparison between face to face and videoconferencing

1. Consultation on videoconferencing looks smooth and spontaneous,
2. Rapport and relationship is easily established, since patients are in their own environment with family members present with local health workers accompanying them, they are relaxed enough to be engaged in discussion regarding their illness.
3. Of course rapport would depend on personalities of the specialists. But here, I can not see any difference between face to face and videoconferencing,
4. I can't believe how effective it is. Face to face still the best for rapport but falls just behind. But patients seem to like it and the conversation is natural and smooth.

Major benefits for patients

1. Less travel for patients
2. Complex services are available locally including chemotherapy delivery
3. Less disturbance to family life,
4. Convenient for patients,
5. Saves money for system and patients
6. Excellent innovation, if it is replicated everywhere, Angel care flight advertisements would need to be modified,
7. Patients appreciate it and expect it and community can not afford to not embrace this technology.

Benefits for doctors, nurses and allied health workers

1. Continuing education,
2. Ready support by specialists,
3. It is like having staff medical oncologist in our town,

Potential problems that could arise for this model of care

1. Coordination is important for smooth running,
2. Minor hearing difficulties could arise, but attending team members could fill in the gaps
3. Doctors with lack of communication skills will find it difficult to engage with patients and would need specific training.
4. Technical difficulties could be frustrating but easily rectified these days.

Medico legal concerns

1. Since patients are seen in a team setting and discussions are documented, no difference between face to face and video link. It may even be safer via videolink because in face to face, patients are seen without other health workers present.
2. Since medical oncologists are involved in all aspects of the care with close follow up, risk of litigation would be similar to that of face to face.
3. Because we follow the procedures and policies that are ratified by the hospital, no cause for concern.

4.1.4 Discussion

Based on favourable patient satisfaction and positive health care workers responses, this study further strengthens the argument for implementing videoconferencing as part of routine medical oncology clinics. Our study evaluates a model of care where chemotherapy regimes and dosing decision is part of the telehealth service, unlike models where videolink is mainly employed for consultations and reviews.

Main themes receiving approval were the following; ease of communication and ability to form rapport, ability to save time and money as the result of reduced travel, medication safety, and the opportunity to receive specialist services closer to home. Of the participating 50 patients, more than 80% were in agreement with satisfaction statements except for Questions 8, 9, and 10. The first 7 Qs relate to the quality of consultations and satisfaction levels proved high. Question 15 examines the overall perceived satisfaction of the medical oncology service, including videoconferencing and local administration of treatment, and demonstrated 96% in agreement with the satisfaction statement, and 82% in stronger agreement. Interestingly Q8 scored highly, indicating patients' desire for physical examination by the medical oncologists. However this appeal reduced once the results of imaging investigations were discussed during consultations. We expected patients to find it important for local doctors and health workers to participate in the videoconferencing yet our results indicated otherwise. However, we believe it is important for the health workers to join patients during consultations since local health care workers have the ability and opportunity to facilitate and fill in the gaps of communication between specialists and patients. In addition, health workers also gain educational benefits for themselves. It is somewhat unexpected that 22% of the patients would rather travel to Townsville than videoconference however the majority were from the first period when the service was in its initial stage. In the later cohort, when our model was operating smoothly, only 2 patients preferred to travel.

Results of our survey are not dissimilar to other surveys indicating overall satisfaction with this model of care(Weinerman et al, 2005; Taylor,2007). Major benefits include travel time saved and improved access to specialist services. The need for physical exam continues to be a concern among the few studies that examined this aspect of care. In a Kansas study 9 of the 22 patients expressed concern about the role of the nurse as a proxy for the doctor in performing certain parts of the physical examination(Mair et al,2000). In the British Columbia study 35% of participants showed the same concern and yet when the physical exam was performed by the specialist within 60 days, no change in treatment decision was reported(Taylor et al,2007). Our study reported 76% of the participants proposed it was necessary, despite examination by local doctors. Unlike the Kansas study, where a nurse was the examiner, the patients are examined by a senior medical officer. In the future this concern could be alleviated by case-by-case explanations at the time of consent demonstrating why an examination by the medical specialist is not required.

After the initial set up period, following adequate training of staff and development of work instructions, technical difficulties were minor and infrequent. The speed and clarity of videoconferencing has greatly improved with advanced technology, simplifying installation and day to day operation.

Satisfaction levels of health care staff involved in videoconferencing have not clearly been established in literature. Currently available study populations include only the specialists and local doctors and study numbers are small, preventing statistically significant conclusions. Similarly our health care worker cohort consisted of few nurses, social workers, and indigenous health workers. Nevertheless this model of care is seemingly welcomed and appreciated by rural health workers due to the benefits to the patients and their treating teams. Unlike many face-to-face consultations, where the specialist consult only with patients and their support persons, in this model medical staff accompanying the patients receive ongoing case-based education and support from the specialists. This study revealed no concerns with litigation and in reality all our videoconference patients are seen personally by medical oncologists, unlike major teaching centres where a significant proportion of patients are seen by trainees with instructions handed down from the specialist following a verbal handover. The risk of litigation, therefore, would be not higher than face-to-face consultations.

Despite being the second largest study focused on this model of care in oncology, our participants' number was still limited. Telehealth is commonly used for smaller rural towns, where patient numbers are small, and consequently randomised controlled studies are unrealistic and subgroup analysis is not meaningful. While we had 2 cohorts, overall responses were similar in terms of satisfaction, with less participants in the second group querying the need of specialist physical examination. This illustrates improved acceptance and satisfaction over time.

In conclusion patients and health workers approve of this model of care due to its many benefits to rural and remote patients. Videoconferencing allows oncology patients to be cared for closer to home without costly long distance travel. From our experience we believe this technology can be complementary to any models of care in looking after rural and remote patients, in all fields of medicine. Since the results of patient satisfaction surveys are consistent and rural health workers approve of this model, telehealth could become a part of standard practice.

4.2 Safety of chemotherapy and medication administration

4.2.1 Introduction and methods

Currently there are no studies in the literature examining the safety of supervision of chemotherapy administration at remote sites via videoconferencing. Therefore a prospective and retrospective chart audits in Townsville and Mt Isa hospital were conducted in patients between January 2007 and November 2010 to examine side effects and admission rates. Results of this audit were to be compared with data from Townsville hospital chemotherapy unit using t-test on SPSS version17.

4.2.2 Results

81 patients received a total 431 cycles of chemotherapy in that time period. 13 patient admissions occurred, 12 patients for treatment related complications and 1 for a

methotrexate infusion in Mt Isa. Reasons for admission included neutropenic sepsis (6 patients), bowel obstruction or diarrhoea (2 patients), pulmonary embolism (1 patient), cardiac arrest(1patient) and pain (2 patients). One patient died after one cycle of capecitabine from severe pneumonia. This patient was on long term prednisone for chronic obstructive pulmonary disease. One patient with gastric cancer suffered a cerebro vascular accident after 4 cycles of EOX (epirubicin,oxaliplatin and capecitabine). Xelox (oxaliplatin and capecitabine) regimen had to be ceased after one cycle in one patient because of severe anaphylactic reaction to oxaliplatin. Rates of side effects were similar to the rates in Townsville ($p = 0.108$).

4.2.3 Conclusion

Our data shows that, using videoconferencing, it is safe to supervise chemotherapy administration by chemotherapy competent nurses at remote sites. It would prudent to document side effects in a prospective manner to enhance the validity of these results. It is also important to ensure that the staffing levels, competencies and training and infrastructure are adequate for achieving and maintaining safety at remote sites.

4.3 Cost effectiveness

4.3.1 Introduction and methods

Cost effective analysis of telemedicine in cancer care is reported only in few studies(Doolittle et al,1997). Along with these studies, many other studies in telemedicine reveal savings to the health systems and families by embarking on telemedicine(Smith et al, 2003;Stalfors et al,2005;Smith et al,2007). All these studies compare cost of out patient clinics or multidisciplinary meetings performed via telemedicine with face to face consultations and fail to include other factors that could potentially increase the financial benefits of telemedicine. Cost effective analysis incorporating many other factors was performed in our center and the methods and results are described below(Thaker and Sabesan,2010).

Data on teleoncology clinics between March 2007 and May 2010, run by TCC between Townsville medical oncology and its satellite centers (Mt Isa, Proserpine, Hughenden, Doomadgee and Winton) was gathered from the Oncology Information Management system.

Crowe's model was used to calculate cost effectiveness which includes project establishment, equipment, maintenance, Communication and Staffing costs (Crowe,1998). Benefit was calculated based upon following factors: prevention of air/road travel and accommodation of patients and relatives from satellite centres to Townsville, prevention of urgent air transfer of patients and prevention of visits of specialists to these centres.

4.3.2 Results

Total of 409 consultations were performed for 110 patients over a period of 38 months from Townsville cancer centre to five satellite centers. Cost of travel, air medical retrieval and accommodation vary between towns depend on distance and road services. During flood, only available mode of transport is by air for some rural towns. For the purpose of this analysis, cheapest available travel cost was used, but in reality, in most cases fares are two to three times higher due to last minute requirements.

Total cost of telemedicine taking into account most of the clinical and technical factors is tabulated in table 7 and the expenses prevented is tabulated in table 8.

Four patients from Mt Isa were consulted urgently on the day of referral or within 24 hours during the period of analysis. These cases would have required transfer to Townsville

Cancer Centre prior to the commencement of the tele oncology services. Our calculations allow for only one escort to accompany patients when they travel to Townsville and does not allow for ideal circumstances. For example, many indigenous patients and some non indigenous patients were accompanied by more than 5 family members and friends during tele consultations. If the government has to pay for travel and accommodation for all the family members, then the expense would be even greater. These calculations do not include out of pocket expenses incurred by patients and families. Other factors like sick leave for patient and a family member, loss of income resulting from long travel and overnight stay would further add to the financial strain faced by patients.

Type of cost	Cost per centre	Cost for all centres for three years	Total
Project establishment	6000	6000 X 6	36000
Equipment	23,726	23,726 X 6	142,356
Maintenance	3558 per centre per year	3558 X 6 X 4	85392
Communication	0.00	0.00	0.00
Staffing	50,000 per year for all centres	50,000 X 4	200,000
Total cost over four years			463,748 AUD

Table 7. Total cost of telemedicine

Description of expenses prevented		Total
Return travel cost for patient and one relative to Townsville	Mt Isa: 516 X 2X 600 $ = 619,200 Proserpine: 40 X 2 X 150 $ = 12000 Hughenden: 11 X 2 X 260 $ = 5720 Winton: 21 X 2 X 320 $ = 13440 Doomadgee: 3 X 2 X 1150 $ = 6900 Normanton: 8 X 2 X 480 $ = 7680 Mornington Island: 4 X 2 X 580= 4640 $ Palm Island: 1 X 2 X 110 = 220 $ Karumba: 1 X 2 X 480 = 960 $	670,760 AUD
Overnight accommodation at Townsville	100 $ X 605	60500
Urgent Aero Medical Retrieval of four patients from Mt. Isa	13,100 $ X 4	52,400
Specialist/Registrar travel once a week for three years	500 $ X 48 X 3	72,000
Total savings over four years		855,660 AUD

Table 8. Expenses prevented by telemedicine.

Another analysis reveals that the cost is higher during establishment period and the savings become greater with time. For example, total cost was 113,006 AUD (Australian dollar) in the first year and the savings was 82820 AUD. In the second year, running cost was 53,554 AUD and saving was 180,320 AUD. In the third year, as many other centres were open, total cost was 229,399 AUD while the benefit was 188,420 AUD. In 2010, running cost was 67,789 AUD and the benefit was 404,100 AUD.

4.3.3 Conclusion

It is clear that teleoncology is cost effective to the patients and the health systems. It seems that the cost is higher than the benefit at the establishment phase because of capital investment and the benefit becomes greater with expansion of services to many other centres with increase in number of consultations and other clinical services like urgent reviews and preventing inter hospital transfers.

5. Factors to consider before embarking on teleoncology

Many factors need to be considered and issues addressed prior to establishing tele oncology clinics in order to avoid conflicts in the future(Sabesan et al,2010). Most of these factors are related to models of care, funding issues, staff level and competencies and service level agreements between provider and receiver of these services. These are discussed below.

5.1 Models of care

It is important to decide on the model of care at the outset that determines the requirements for the clinics. Technical and staffing requirements to provide comprehensive and complex services would differ from that of basic and limited services as discussed below.

5.2 Staff level and competencies

This aspect of telehealth depends on the extent of the services provided via videoconferencing. To provide a comprehensive cancer care including chemotherapy delivery, chemotherapy competent nurses, chemotherapy waste disposal mechanisms, medical officers to supervise and deal with acute complications, administrative support officers to coordinate services and allied health workers are necessary at the receiving end. If simple chemotherapy regimens are administered in rural towns, it would be unrealistic to expect chemotherapy competent nurses and oncology pharmacists in small rural towns. Tele nursing and tele pharmacy could be alternatives. If the service is limited to consultations and short reviews, however, then there may not be a need for a multidisciplinary team. It is important that attendance of rural doctors is not requested unnecessarily given the lack of medical workforce and their clinical work load in rural towns.

Pathology turn around time is another factor to consider and for most chemotherapy regimens, turn around time of 24-48 hours should be adequate. Lastly, oncologists and administrative support officers are needed to run these services at the providing end. When these specialists are busy at their home site, it might be more convenient to have smaller weekly clinics than larger clinics at less frequent intervals. This also allows patients and rural health workers to have regular personal contacts with specialists.

5.3 Equipment

Main issues for consideration are clarity of the images and sound. But the type of technology required depends on the model of care and the purpose of the clinics. For

example, if the purpose of the consultation is to discuss issues, then a videophone or internet based systems like skype is adequate. If the clinic is to talk, examine patients and show scans, then a different system with remote control capacity and duovideo systems would be necessary. For example, Queenland health in Australia uses Tandberg 990 codecs and Sony Bravia 32 inch LCD monitors. The codec can be connected to a computer, to show radiology images to the patients. Standard bandwidth for consultations is 256 kbps over IP(internet protocol). Once every one involved is trained on how to operate the technology, consultations would be faster and smoother.

5.4 Medico legal issues and service level agreements

These are usually related to patient consent, documentation of decision making and safety of administration of toxic chemotherapy. Queensland Health's patient consent form, which the patients sign prior to the tele oncology consultations, is designed to protect staff and patients participating in telehealth clinics and use of the Telehealth Patient Information brochure helps ensure that consent is informed. Documentation is similar to that required for an outpatient consultation. Drugs are prescribed by medical oncologists or other oncologists and then checked by nurses and pharmacists as per hospital policies. Adhering to these precautions, we have demonstrated that it is safe to administer and supervise chemotherapy for most cancers in Mt Isa using this technology.

Service level agreements between providers and receivers need to include discussions regarding ownership and allocation of responsibilities when patients become acutely ill. Hospital policies on admission process and care of the admitted patients should be determined early to avoid conflicts over responsibility for the admitted patients. In Mt Isa, patients are admitted under senior medical officers and resident physicians when patients have chemotherapy. The treating specialists can also review inpatients via videoconference. Issues related to funding and remuneration for services are matter for hospitals and health departments to sort out.

5.5 Inability of the specialist to perform a physical examination

This issue can be overcome by having a doctor sitting with patients during consultations and perform physical examination when necessary. If a patient has had recent CT scans of visceral organs, then a physical examination is not always needed. It is also important to explain to patients why physical examination by specialists is not always required. In studies by Mair et al and Taylor et al, nearly one third of the patients were concerned about lack of physical examination by specialists but when physical examinations were performed within 60 days by the specialists, no change in management was made (Taylor et al, 2007).

6. Conclusion

In conclusion, we have demonstrated that telemedicine is an excellent tool for addressing the issue of lack of access to specialist services among rural, remote and indigenous communities. Ability to give urgent medical advice also reduces the need for inter hospital transfers and resulting unexpected and sudden relocation of family members to major centres. Other social benefits for the patients are many. This model of care also allows the specialists to care for many towns in one setting without wasting time on travel. Patients seem to appreciate and accept this model of care and health workers find it beneficial for professional reasons. Level of rapport formed between specialist and patients is difficult to

measure, though the overall patient satisfaction is high. Safety is always a concern in medicine and we have shown that it is safe to supervise chemotherapy using videoconferencing. Teleoncology seems to be cost effective for the patients and the health systems. By embarking on telemedicine, valuable funds could be used for infrastructure development instead of wasting on travel. We could also contribute to the climate change agenda by significantly reducing travel.

7. Future

Use of telemedicine in the future is not going to be limited to ambulatory care alone. When patient are admitted to the in patient facilities in rural towns, further support to the local medical and nursing staff could be given via this technology. With enthusiasm among doctors in medical and radiation oncology, palliative care and haematology, this model of care could be applied across all the sub specialities in cancer centres as part of core business to create a concept of "cancer centres in cyber space". Education for rural and remote communities on smoking prevention and other life style issues are not usually the focus of many tertiary cancer centres mainly because of lack of access to these communities. Telemedicine could facilitate regular educational events, in an interactive format, to these isolated communities. Lastly allied health consultations and nursing interventions could be achieved via videoconferencing. One attractive idea is chemotherapy administration by non chemotherapy competent nurses in remote communities, supervised and mentored by chemotherapy competent nurses from tertiary centres using videoconferencing. It would be a dream come true, when the entire medical oncology services including patient consultations, chemotherapy delivery and follow up are one day provided to remote and indigenous patients using telemedicine.

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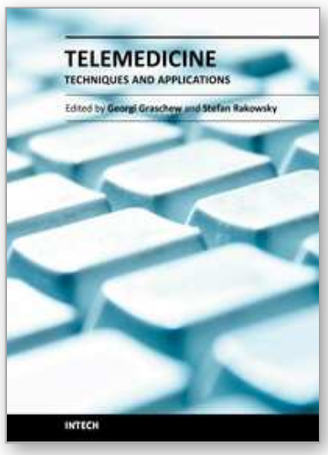

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Telemedicine is a rapidly evolving field as new technologies are implemented for example for the development of wireless sensors, quality data transmission. Using the Internet applications such as counseling, clinical consultation support and home care monitoring and management are more and more realized, which improves access to high level medical care in underserved areas. The 23 chapters of this book present manifold examples of telemedicine treating both theoretical and practical foundations and application scenarios.

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University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
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