Do teleoncology models of care enable safe delivery of chemotherapy in rural towns?

Abstract

Objectives: To compare the dose intensity and toxicity profiles for patients undergoing chemotherapy at the Townsville Cancer Centre (TCC), a tertiary cancer centre in northern Queensland, with those for patients treated in Mount Isa, supervised by the same medical oncologists via teleoncology.

Design: A quasi-experimental design comparing two patient groups.

Setting: TCC and Mount Isa Hospital, which both operate under the auspices of the Townsville Teleoncology Network (TTN).

Participants: Eligible patients who received chemotherapy at TCC or Mt Isa Hospital between 1 May 2007 and 30 April 2012.

Intervention: Teleoncology model for managing cancer patients in rural towns.

Main outcome measures: Dose intensity (doses, number of cycles and lines of treatment) and toxicity rates (rate of serious side effects, hospital admissions and mortality).

Results: Over 5 years, 89 patients received a total of 626 cycles of various chemotherapy regimens in Mount Isa. During the same period, 117 patients who received a total of 799 cycles of chemotherapy at TCC were eligible for inclusion in the comparison group. There were no significant differences between the Mount Isa and TCC patients in most demographic characteristics, mean numbers of treatment cycles, dose intensities, proportions of side effects, and hospital admissions. There were no toxicity-related deaths in either group.

Conclusion: It appears safe to administer chemotherapy in rural towns under the supervision of medical oncologists from larger centres via teleoncology, provided that rural health care resources and governance arrangements are adequate.

Bryan A Chan
BPharm(Hons), MB BS(Hons), FRACP[1]

Sarah L Larkins
MB BS, PhD, FRACGP[3]

Rebecca Evans
BSp&ExSci(Hons), GCGP&Paff, PhD[3]

Kerrianne Watt
PhD[2]

Sabe Sabesan
BM BS, FRACP, PhD[1,3,4]

1 Townsville Cancer Centre, Townsville, QLD.

2 James Cook University, Townsville, QLD.

3 Anton Breinl Research Centre for Health Systems Strengthening, James Cook University, Townsville, QLD.

4 Tropical Centre for Telehealth Practice and Research, Townsville Hospital, Townsville, QLD.

Sabe.sabesan@health.qld.gov.au

doi: 10.5694/mja15.00190

Even in developed nations, cancer survival rates among patients from rural regions are often inferior to those of their urban counterparts.[1-3] In Australia, these problems are further compounded by the poorer outcomes for Indigenous patients compared with non-Indigenous patients.[4] Reasons that have been proposed to explain this disparity include the differential access of rural and urban patients to various cancer screening and treatment programs.[5] Achieving timely and equitable access to cancer care services for all patients remains a significant challenge, especially in large countries with geographically dispersed populations, such as Australia.

When compared with their urban counterparts, rural patients in New South Wales have different rates of prostatectomy and orchiectomy for prostate cancer,[6] undergo less breast-conserving surgery for breast cancer,[7] and have a lower probability of completing radiotherapy for rectal cancer.[8] Overseas studies have also reported that the uptake of chemotherapy may be lower for patients from rural areas; for example, patients with colorectal cancer living in disadvantaged areas of Scotland were less likely to receive chemotherapy.[9] A Canadian study by the British Columbia Cancer Agency similarly reported that patients from rural areas were less likely to receive adjuvant chemotherapy for rectal cancer than those from larger urban centres.[10]

There are many possible explanations for the differing rates of chemotherapy in rural and urban populations. These include the limited access to chemotherapy closer to home[5] and clinicians being concerned about the potential toxicity of chemotherapy. To explore the latter possibility, the Townsville Cancer Centre (TCC) conducted a study of patients with breast and colon cancer in northern Queensland.[11] Its findings suggested that rural patients with these cancers could be treated safely with the same doses and dose intensity as their urban counterparts; further, complications of treatment could be managed at rural centres, with supervision and partnership shared by rural and urban clinicians.[11]

A possible solution that would provide timely access to chemotherapy closer to home and improve the uptake of chemotherapy by rural and remote patients would be to administer chemotherapy in rural centres, with medical oncology support and supervision provided through teleoncology (telehealth for cancer care). Similar to cancer centres in Kansas (United States) and Kelowna (Canada),[12,13] medical oncologists from our centre, the TCC, supervise the delivery of chemotherapy agents in Mount Isa (a large rural town 900 km from Townsville) using the Townsville teleoncology model that operates under the auspices of the Townsville Teleoncology Network (TTN).[14,15] Patients in Mount Isa are able to receive almost all types of solid tumour chemotherapy. Within the TTN, medical oncologists are able to assess rural patients for fitness to undergo chemotherapy and to use video-conferencing to make decisions about admitted inpatients. This assessment is supported by rurally based doctors and nurses during telehealth consultations. Chemotherapy-proficient nurses administer chemotherapy agents prescribed by TCC-based medical oncologists.

Although this model has been shown to be accepted by both patients and health professionals,[16] and facilitates timely provision of medical oncology services in rural towns,[17] it is not known whether the safety and quality of treatment received by Mount

Isa patients (as indicated by dose intensity and toxicity profile) are comparable with those for Townsville patients. The aim of this study was therefore to determine whether there were any differences between the quality and safety of chemotherapy received by patients treated in person at the TCC and those treated at the Mount Isa Hospital by the same oncologists via teleoncology.

Methods

Data collection

Retrospective chart audits were conducted at both the Mount Isa Hospital and the TCC for patients who received chemotherapy. The data collected included:

- demographic details, including age, sex and cancer type;
- types of chemotherapy regimen, dose intensity (actual and planned doses) and number of treatment cycles;
- intent of treatment: curative (chemotherapy was the primary therapy or an adjunct to surgery that aimed to cure cancer) or palliative (chemotherapy that aimed to prolong survival and to improve or maintain quality of life); and
- rates of severe side effects (grade 3 and 4 toxicities according to National Cancer Institute Common Toxicity Criteria [NCI CTC], version 4)[18] and of admissions to inpatient facilities linked with the side effects of cancer therapy.

Patient selection

The Mount Isa audit included all chemotherapy administered from the inception of the Townsville teleoncology model of care from 1 May 2007 until 30 April 2012. The TCC audit was conducted during two separate 3-month periods: March – May 2009 and June – August 2010. These two periods were chosen for two reasons. First, from 2010 many patients were enrolled in clinical trials at the TCC, a tertiary centre, and these trials were not available at Mount Isa; including these TCC patients would make comparing the data difficult. Second, referral patterns at the TCC fluctuate during major holiday seasons according to the availability of surgical theatres; the end-of-year holiday period was excluded from our study because of the unusual patient profile at the TCC at this time of year. The two unrelated time periods for data collection were thus selected to avoid tumour selection bias in the study population. As Mount Isa does not have radiotherapy facilities, patients undergoing chemoradiotherapy at the TCC were also excluded from the study.

We also attempted to match the sample population for patient comorbidities, but chart data on minor comorbidities tend to be incomplete. It was therefore assumed that both patient populations were fit for chemotherapy, based on the usual practice that patients with severe comorbidities and poor performance status would not be offered chemotherapy.

Statistical analysis

The SPSS program (IBM) was used for all analyses. Between-group differences for categorical variables were analysed with χ^2 tests; where the expected cell count was less than 5, the Fisher exact test was instead used. Between-group differences for numerical variables were analysed with t tests; where data were not normally distributed or the sample size for each group was less than 30, Mann–Whitney U tests were used instead. Statistical significance was defined as $P < 0.05$. Sample size calculations indicated that a total of about 160 participants was required to detect a between-group difference of 20% in the rate of side effects, assuming a base side effect rate of 10% (previously determined at Townsville Hospital), with 90% power and $\alpha = 0.05$.

Ethics approval

This study received ethics approval from the human research ethics committees of the Townsville Health and Hospital Services (HREC/12/QTHS/29) and the James Cook University (H4602).

Results

During the period May 2007 – April 2012, a total of 89 patients received chemotherapy at Mount Isa Hospital under the supervision of TCC medical oncologists through the teleoncology model. The comparison group included 117 eligible patients from Townsville. Demographic details are summarised in Box 1. The three most common cancer types were breast, colorectal and lung cancers, although most solid tumour types were treated at both sites. There were no significant differences in the characteristics of the patients at the two sites with respect to sex, age, cancer types or treatment intent ($P > 0.05$ for each comparison). However, significantly more Indigenous patients were treated at Mount Isa than in Townsville (χ^2 [1] = 11.66, $P < 0.001$).

Chemotherapy doses and side effects

A total of 626 and 799 cycles were respectively administered at the Mount Isa and Townsville hospitals. All chemotherapy regimen types (lines) used in Townsville were also available to patients in Mount Isa, but as the number of patients receiving each regimen type was small, no comparison between Mount Isa and Townsville was attempted in this regard. Data on the chemotherapy cycles and toxicity rates are summarised in Box 2 and Box 3; the side effect profiles at the two hospitals are summarised in Box 4.

No statistically significant differences between the hospitals were observed with regard to the numbers of treatment cycles, of cycles per line, of lines per patient, of side effects, or of hospital admissions ($P > 0.05$ for each comparison). Although neutropenia was reported more frequently in Mount Isa, this did not cause more hospital admissions or dose delays. There were no deaths in either group caused by toxicity. Further, there were no statistically significant differences in dose intensities between sites, regardless of treatment intent. Due to the higher proportion of Indigenous patients in Mount Isa, the analysis comparing sites was stratified by Indigenous

1 Demographic characteristics of the patients treated in Mount Isa and Townsville

	Mount Isa	Townsville
Number of patients	89	117
Sex		
Male	43 (48%)	60 (51.3%)
Female	46 (52%)	57 (48.7%)
Ethnicity*		
Indigenous	20 (22%)	7 (6.0%)
Non-Indigenous	69 (77%)	109 (94.0%)
Age, years (median, range)	58 (18–82)	59 (20–86)
Treatment intent		
Curative/adjuvant	34 (38%)	56 (47.9%)
Palliative	55 (62%)	61 (52.1%)
Cancer type		
Breast	24 (27%)	33 (28.2%)
Colon	10 (11%)	12 (10.3%)
Lung	21 (24%)	22 (18.8%)
Prostate	1 (1.1%)	2 (1.7%)
Rectal	7 (7.9%)	2 (1.7%)
Oesophagus/gastric	4 (4.5%)	2 (1.7%)
Neuroendocrine/gastrointestinal stromal tumour	1 (1.1%)	1 (0.9%)
Head/neck	0	2 (1.7%)
Other	21 (24%)	41 (35.0%)

* Indigenous v non-Indigenous: $P < 0.001$; there were no other statistically significant differences. ◆

status; no site differences in any parameters related to dose intensities and rates of serious adverse events were detected after this stratification.

Discussion

Teleoncology models enable many types of chemotherapy to be administered in a timely manner closer to home for rural patients, with close supervision by medical oncologists from urban centres.[14,17] This model of remote chemotherapy supervision has been shown (a) to reduce the need for rural patients to travel long distances; (b) to be accepted by both patients and health professionals; and (c) to reduce health care system expenses.[12,19] However, it is also imperative to ensure that safety is not compromised, and that the quality of care provided through these models is of at least the same standard as that experienced by patients receiving their care from oncologists in person.

2 Chemotherapy doses and toxicity rates, by site

	Mount Isa	Townsville
Number of patients	89	117
Cycles per line (mean ± SD)	5.38 ± 3.84	5.07 ± 4.80
Total number of cycles	626	799
Number of treatment lines (mean ± SD)	1.30 ± 0.65	1.36 ± 0.66
Rate of serious side effects (per patient)	4.4%	9.5%
Inpatient hospital admissions		
Total number	30	50
Proportion of patients	28%	35.3%

$P > 0.05$ for all between-group comparisons. ◆

It had previously been reported that thrombolysis could be safely and effectively performed on stroke patients at remote centres using telehealth techniques.[20] Our study has shown that, in comparable populations, there were no statistical differences in safety parameters between an urban, traditional model of care and a rural teleoncology model. Similar numbers of treatment cycles and lines and dose intensities indicate that the administration of therapy was comparable for the rural and urban patient groups. Although the Mount Isa group included a greater number of Indigenous patients, it did not affect our results, as chemotherapy treatment decisions are based on medical comorbidities and not on ethnic background.

Our study is the first to show that many types of chemotherapy can be administered in rural centres, without compromising safety and quality, by teleoncology models of care. These results, together with those of an earlier study that compared the safety of chemotherapy for rural and urban patients with breast or colon cancer,[11] may reassure many urban clinicians that high-quality cancer care can be provided at rural centres by teleoncology models. It is important to note, however, that these models require appropriate governance, and that adequate health care system resources be directed to rural centres.

Within the TTN, the quality of care provided through teleoncology is closely related to the adequacy of the rural workforce and strict governance of chemotherapy management.[15] Workforce requirements and governance of chemotherapy administration are the same for all sites. Medical oncologists from the TCC provide their outpatient services regularly and on demand via videoconferencing, and are also able to review and make decisions for admitted inpatients.[14] These are the

3 Chemotherapy doses and rates of side effects, by treatment intent and hospital

	Palliative (116 patients)		Curative/adjuvant (90 patients)	
	Mount Isa	Townsville	Mount Isa	Townsville
Number of patients	55	61	34	56
Cycles per line (mean ± SD)	4.37 ± 2.41	4.47 ± 5.20	7.0 ± 5.02	5.70 ± 4.29
Number of lines (mean ± SD)	1.44 ± 0.76	1.45 ± 0.75	1.08 ± 0.29	1.27 ± 0.55
Total number of cycles	367	388	259	411
Rate of serious side effects (per patient)	5.4%	15%	2.9%	3.6%
Hospital admissions				
Total number	24	33	6	17
Proportion of patients	36%	43%	15%	27%
Dose intensity, percentage* (mean ± SD)	97.4 ± 24.0	98.2 ± 16.1	84.4 ± 25.9	88.1 ± 25.9

* Actual dose, compared with planned dose. $P > 0.05$ for all between-group comparisons. ◆

same medical oncologists who provide face-to-face care in Townsville. TCC-based oncologists are supported by general physicians, nurses, allied health professionals and pharmacists in the rural centres. These multidisciplinary services undertake initial consultations, monitoring and management of toxicity in ambulatory care, and inpatient settings and follow-up until the completion of a treatment program or referral to palliative services for end-of-life care. As part of this network and throughout our study, the Mount Isa Hospital was adequately resourced to provide services locally through a teleoncology model of care.[15] As the scope of practice broadened and the complexity of cases increased over time, clinicians successfully lobbied for increased resources for Mount Isa to expand its rural service capabilities. The results of our study should therefore be applied with caution to centres with more limited resources.

Our study was designed to detect differences in toxicity profiles and dose intensities for treatment delivered by teleoncology (Mount Isa) or in person (Townsville). None were detected. However, further research is required with larger sample sizes to assess the statistical equivalence of these treatment modalities. Although our study was statistically powered for the analysis of differences in dose intensities associated with teleoncology and face-to-face models of care at the two hospitals, comparisons for individual tumour types would not be meaningful because of the small patient numbers for each tumour type. Selecting a matched patient sample at the TCC was considered, but it was difficult to compile a complete history of patient comorbidities because of the retrospective nature of the audit and the incomplete chart data. In reality, however, patients with severe comorbidities would not have received chemotherapy at either hospital, and lack of matching probably had only a minimal impact on the outcomes of our study.

As our data were not collected prospectively, it is possible that some adverse effects and other relevant data, including quality-of-life information, were not recorded and captured by the audit. However, serious adverse effects (NCI CTC grades 3 and 4) usually result in admission to hospital, and this would have been captured by admission records. In addition, any omission or delays in chemotherapy are likely to be documented in patient charts.

4 Side effect profiles (National Cancer Institute Common Toxicity Criteria, grade 3 and 4 toxicity) for patients treated at Mount Isa and Townsville hospitals

	Overall (206 patients)		Palliative (116 patients)		Curative (90 patients)	
	Mount Isa	Townsville	Mount Isa	Townsville	Mount Isa	Townsville
Neutropenia*	29%	18%	21%	23%	34%	13%
Nausea and vomiting	0	1.7%	0	0	0	3.3%
Diarrhoea	1.1%	6.9%	0	12%	1.8%	1.7%
Neuropathy	3.3%	1.7%	8.8%	0	0	3.3%
Fatigue	0	4.3%	0	1.8%	0	6.7%
Other	16%	26%	8.8%	21%	16%	30%

* More neutropenia was reported in Mount Isa, but this did not result in more hospital admissions. ◆

In conclusion, our results, together with those of telestroke studies and our earlier rural chemotherapy study,[11] provide initial reassurance that high-quality and safe cancer care, including a variety of complex medical therapies, can be provided to rural patients closer to their homes by teleoncology and other telehealth models of care. By expanding the scope of practice and capabilities of rural health care systems through the use of telehealth models, rural patients may gain access to chemotherapy and other complex medical therapies similar to that of urban patients. To ensure a high level of safety and quality, centres embarking on providing chemotherapy and complex medical therapies in rural areas using telehealth models need to ensure that rural resources are adequate and that governance arrangements are strict.

Competing interests: No relevant disclosures. ■

1 Australian Institute of Health and Welfare. Cancer survival and prevalence in Australia: cancers diagnosed from 1982 to 2004. Canberra: AIHW, 2008. (AIHW Cat. No. CAN 38; Cancer Series No. 42.) http://www.aihw.gov.au/WorkArea/DownloadAsset.aspx?id=6442454567 (accessed Apr 2015).

2 Liff JM, Chow WH, Greenberg RS. Rural-urban differences in stage at diagnosis. Possible relationship to cancer screening. *Cancer* 1991; 67: 1454-1459.

3 Jong KE, Smith DP, Yu XQ, et al. Remoteness of residence and survival from cancer in New South Wales. *Med J Aust* 2004; 180: 618-622. https://www.mja.com.au/journal/2004/180/12/remoteness-residence-and-survival-cancer-new-south-wales

4 Condon JR, Barnes A, Cunningham J, Armstrong BK. Long-term trends in cancer mortality for Indigenous Australians in the Northern Territory. *Med J Aust* 2004; 180: 504-507. https://www.mja.com.au/journal/2004/180/10/long-term-trends-cancer-mortality-indigenous-australians-northern-territory

5 Underhill C, Bartel R, Goldstein D, et al. Mapping oncology services in regional and rural Australia. *Aust J Rural Health* 2009; 17: 321-329.

6 Hayen A, Smith DP, Patel MI, O'Connell DL. Patterns of surgical care for prostate cancer in NSW, 1993-2002: rural/urban and socio-economic variation. *Aust N Z J Public Health* 2008; 32: 417-420.

7 Kricker A, Haskill J, Armstrong BK. Breast conservation, mastectomy and axillary surgery in New South Wales women in 1992 and 1995. *Br J Cancer* 2001; 85: 668-673.

8 Armstrong K, O'Connell DL, Leong D, et al. The New South Wales colorectal cancer care survey. Part 1: surgical management. Sydney: The Cancer Council NSW, 2004. http://www.cancercouncil.com.au/wp-content/uploads/2010/09/Surgical-Report-Final-2007.pdf (accessed Apr 2014).

9 McLeod A. Variation in the provision of chemotherapy for colorectal cancer. *J Epidemiol Community Health* 1999; 53: 775-781.

10 Javaheri KR, Moghaddamjou A, Speers C, Cheung WY. Causes of urban-rural disparities in adjuvant chemotherapy (AC) for rectal cancer (RC). *J Clin Oncol* 2013; 31 Suppl: abstract e14603.

11 Pathmanathan S, Burgher B, Sabesan S. Is intensive chemotherapy safe for rural cancer patients? *Intern Med J* 2013; 43: 643-649.

12 Doolittle GC, Spaulding A. Providing access to oncology care for rural patients via telemedicine. *J Oncol Pract* 2006; 2: 228-230.

13 Weinerman B, den Duyf J, Hughes A, Robertson S. Can subspecialty cancer consultations be delivered to communities using modern technology? A pilot study. *Telemed J E Health* 2005; 11: 608-615.

14 Sabesan S, Larkins S, Evans R, et al. Telemedicine for rural cancer in North Queensland: bringing cancer care home. *Aust J Rural Health* 2012; 20: 259-264.

15 Sabesan S, Allen DT, Caldwell P, et al. Practical aspects of telehealth: establishing telehealth in an institution. *Intern Med J* 2014; 44: 202-205.

16 Sabesan S, Simcox K, Marr I. Medical oncology clinics via videoconferencing: an acceptable telehealth model for rural patients and health workers. *Intern Med J* 2012; 42: 780-785.

17 Sabesan S, Aiken P, Roberts L, Larkins S. Timely access to specialist medical oncology services closer to home for rural patients: Experience from the Townsville Teleoncology Model. *Aust J Rural Health* 2014; 22: 156-159.

18 National Cancer Institute Common Toxicity Criteria for adverse events. Version 4. Bethesda: US Department of Health and Human Services, 2009. http://evs.nci.nih.gov/ftp1/CTCAE/CTCAE_4.03_2010-06-14_QuickReference_8.5x11.pdf (accessed May 2015).

19 Thaker D, Monypenny R, Olver I, Sabesan S. Cost savings from a telemedicine model of care in northern Queensland, Australia. *Med J Aust* 2013; 199: 414-417. https://www.mja.com.au/journal/2013/199/6/cost-savings-telemedicine-model-care-northern-queensland-australia

20 Jhaveri D, Larkins S, Sabesan S. Telestroke, tele-oncology and teledialysis: a systematic review to analyse the outcomes of active therapies delivered with telemedicine support. *J Telemed Telecare* 2015; 21: 181-188. ■