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RESEARCH

Evaluating telehealth for the education and monitoring of lymphoedema and shoulder dysfunction after breast cancer surgery

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Abstract

Purpose The primary aim of this study was to compare the attendance rates at a group lymphoedema education and same-day individual surveillance appointment between telehealth (TH) and in-person (IP) care for participants following breast cancer (BC) surgery. Secondary aims included evaluating participant satisfaction and costs between the two service models, while also determining the extent of technical issues and clinician satisfaction towards TH.

Methods Participants following axillary lymph node dissection surgery attended a group lymphoedema education and same-day 1:1 monitoring session via their preferred mode (TH or IP). Attendance rates, satisfaction and costs were recorded for both cohorts, and technical disruption and clinician satisfaction for the TH cohort.

Results Fifty-five individuals participated. All 28 participants who nominated the IP intervention attended, while 22/27 who nominated the TH intervention attended an appointment. Overall reported participant experience was positive with no significant differences between cohorts. All TH appointments were successfully completed. Clinicians reported high satisfaction for delivery of education (median = 4[IQR 4–5]) and individual assessment (median = 4[IQR 3–4]) via TH. Median attendance costs per participant were Australian $39.68 (Q1–Q3 $28.52–$68.64) for TH and Australian $154.26 (Q1–Q3 $81.89–$251.48) for the IP cohort.

Conclusion Telehealth-delivered lymphoedema education and assessment for individuals following BC surgery was associated with favourable satisfaction, cost savings and minimal technical issues despite lower attendance than IP care. This study contributes to the growing evidence for TH and its potential applicability to other populations where risk for cancer-related lymphoedema exists.

Keywords Lymphoedema · Breast Cancer · Telehealth · Telerehabilitation · Education

Introduction

Breast cancer-related lymphoedema (BCRL) is a well-known complication of breast cancer (BC) surgery and presents as regional swelling of the arm and/or the associated upper trunk in response to lymphatic impairment [1, 2]. The incidence of reported BCRL can vary according to the extent of axillary intervention. A meta-analysis by Di Sipio et al. [1] reported a 19.9% incidence following axillary lymph node dissection (ALND) and a 5.6% incidence after sentinel lymph node biopsy. While there is a lifelong risk for BCRL [3], it commonly presents within the first two years post-surgery [1]. BCRL may be reversible if treatment is commenced at a sub-clinical stage [4–7]; however if left untreated, severity of symptoms can worsen and subsequently impact on quality of life and physical

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function [8]. The associated burden of BCRL is related to its severity [9]; hence, there is a need for prospective lymphoedema surveillance and early intervention models of care. Such care models have been implemented across several countries and have demonstrated the ability to prevent the progression of the condition [3–5, 10–14].

Standard clinical practice for all individuals with BC undergoing ALND at the Royal Brisbane and Women's Hospital (Brisbane, Australia) aligns with contemporary prospective lymphoedema surveillance models of care. Prior to surgery, patients complete a baseline physiotherapy assessment [5, 11–14] and are then subsequently reviewed 4–6 weeks post-surgery. These appointments are traditionally conducted in-person (IP) in the hospital setting. The purpose of this post-operative appointment is to observe for lymphoedema signs and symptoms, assess recovery of shoulder range of motion (ROM) and provide lymphoedema education. Tailored management plans are then established, taking into consideration both post-operative progress and planned adjuvant cancer treatments, particularly those treatments with concomitant lymphoedema risk (e.g. taxane-based chemotherapy and radiation to regional lymph nodes) [1, 5, 15–18].

Attendance at these post-operative appointments can be difficult, particularly for those undergoing concurrent cancer treatments who may be limited by associated side effects as well as the burden of attending multiple medical appointments [19]. Additionally, accessing care in Australia may involve potentially long travel distances. The failure to be assessed at this timepoint can reduce the likelihood of early detection of BCRL and other musculoskeletal sequelae of BC treatment, leading to a poorer prognosis and long-term functional outcomes [8, 11, 20]. An alternative method is to provide these assessments via telehealth (TH) which has been demonstrated to provide similar or superior clinical outcomes when compared to IP care for a variety of clinical conditions routinely managed by physiotherapy [21, 22]. Telehealth (specifically videoconferencing) has also been successfully validated for the assessment and diagnosis of lymphoedema in a BC population [23]. What is yet to be established is the feasibility of providing early post-operative physiotherapy surveillance, care and education via TH to individuals with BC.

As such, the primary aim of this study was to compare the attendance rates at a group lymphoedema education and same-day individual surveillance appointment delivered via TH or standard IP care for participants following BC surgery. Secondary aims were to evaluate participant satisfaction and participant-related costs for the two service models, while also determining the impact of technical issues and clinician satisfaction towards TH.

Methods

This study used a cross-sectional quasi-experimental study design. Ethical approval was obtained from the institutional Human Research Ethics Committee (HREC/18/QRBW/249), and the study was registered on the Australian New Zealand Clinical Trials Registry (#375513). All participants provided informed written consent prior to entering the study.

Participants

Participants were recruited while attending their post-operative breast clinic appointment (approximately 10–14 days post-surgery) at a quaternary public hospital facility (Brisbane, Australia) between November 2018 and March 2020. Eligible participants included those who were ≥ 18 years of age and had undergone either a wide local excision or mastectomy, and ALND for BC. Participants were required to have access to an Internet-enabled computer device to be eligible to attend the TH intervention. Individuals who required an accredited interpreter, or those with significant visual, hearing and/or cognitive impairments who were considered by the referring clinician to preclude a safe examination via TH, were excluded from this study.

Intervention

At the time of recruitment, participants were able to self-select their preferred mode of service delivery either IP (control cohort) or via TH (experimental cohort). The intervention for both cohorts included attending a lymphoedema group education session followed by an individualised assessment. Both appointments were conducted on the same day, approximately 4–6 weeks following surgery (Fig. 1).

The 60-min interactive group lymphoedema education session was delivered by a physiotherapist experienced in BC rehabilitation and lymphoedema management. Content delivered during this session included explanation of BCRL, risk minimisation practices and instruction in the progression of post-operative upper limb exercises to optimise recovery of shoulder ROM and strength. Additionally, participants received lymphoedema education materials "Understanding lymphoedema—a guide for people affected by cancer" fact sheet [24] and "Lymphoedema—fact sheet" [25] in hard copy by mail prior to the session for the TH cohort and at the session for the IP cohort. Following the group session, participants completed a 30-min individual assessment with the same physiotherapist where the purpose was to examine the at-risk upper limb and trunk, including shoulder ROM [26], assessment of scar/s and for signs and symptoms of lymphoedema. The education session was

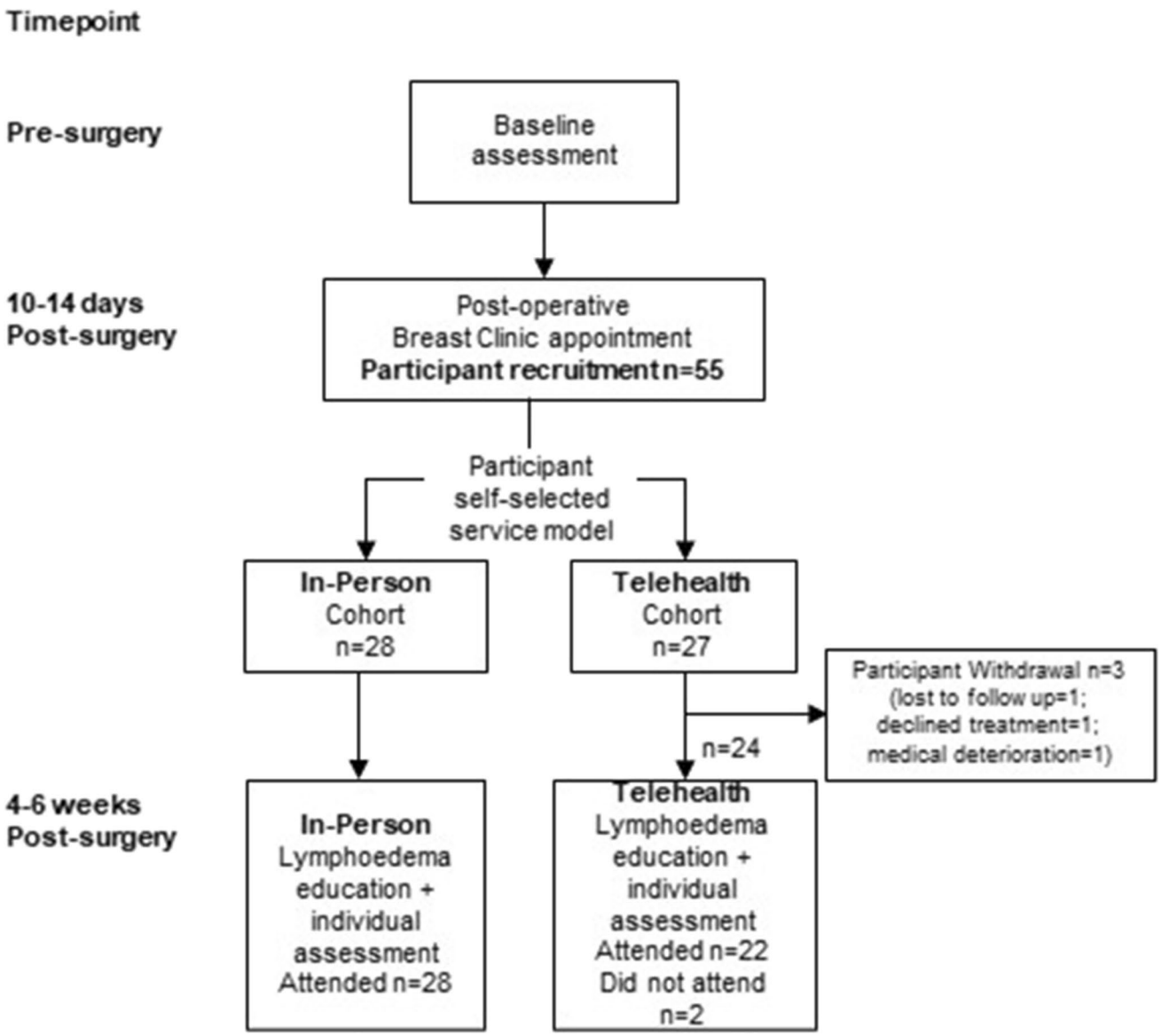

Fig. 1 Participant flow through physiotherapy care pathway for breast surgery

identical between cohorts, as was the individual assessment except for (i) bioimpedance spectroscopy (BIS) using the SOZO® device (ImpediMed Limited, Brisbane, Australia) to measure changes in extracellular fluid [10, 27] and to identify subclinical lymphoedema [28] and (ii) palpation, both of which could only be completed with the IP cohort.

The IP cohort attended the intervention at the quaternary hospital facility, while the TH cohort attended the intervention from their home, using their own Internet-enabled computer device/s, via the clinically validated videoconferencing platform eHAB® (NeoRehab; Brisbane, Australia). Clinicians providing the TH intervention were trained in the use and functionality of eHAB® prior to study commencement. All TH participants completed a test connection using their chosen device with an independent staff member prior to the intervention.

Outcome measures

Participant demographics and clinical characteristics were recorded upon entry to the study. Participants also completed the following clinical measures prior to their appointments:

- QuickDASH (disabilities of the arm, shoulder and hand) questionnaire [29] is an 11-item validated questionnaire that assesses upper limb function, its impact on daily/social activities and severity of upper limb symptoms. Each item is scored on a 5-point Likert scale (from 1 = no

difficulty, impact or symptoms to 5 = inability/extreme impact or symptoms) to calculate a total score from 0 (no disability) to 100 (great disability) [30]. Within current clinical practice, the QuickDASH was administered both pre-operatively and post-operatively prior to the intervention.

- Breast cancer and lymphoedema symptom experience index (BCLE-SEI) [31, 32] is a self-report instrument with two sub-sections measuring the presence of symptoms related to BC, BCRL and associated distress. Only the symptom occurrence section was collected for this study. This 26-item questionnaire scores the presence of BCRL symptoms and movement restriction in the at-risk arm using a 5-point Likert scale (0 = not present to 4 = very severe symptoms). The presence of hand/arm swelling in isolation or the presence of ≥ 9 symptoms is considered to discriminate BC survivors with lymphoedema from those at risk of lymphoedema. The total score of these reported symptoms is summed to determine the severity of symptom occurrence [31, 32].

Primary outcome

Attendance for both the group education and individual assessment was recorded via the hospital's electronic scheduling system.

Secondary outcomes

Participant satisfaction

Following completion of the intervention, all participants were invited to complete a study-specific experience survey concerning waiting times, costs, access to their healthcare provider and overall satisfaction. Additional items included for the TH cohort were TH perceptions and quality of the videoconferencing connection. All items were scored on a 5-point Likert scale (1 = completely disagree to 5 = completely agree).

Participant costs

Participant-related costs associated with attending the appointment were recorded via a study-specific self-reported cost diary.

Technical disruptions and clinician satisfaction

Technical issues that occurred during the TH education and individual sessions were recorded by the treating clinician at the completion of each TH appointment. Clinician satisfaction with the group education session and individual assessment session was completed for each participant appointment using a 5-point scale (1 = completely dissatisfied; 5 = completely satisfied).

Data analysis

Data was analysed using SPSS software V25 (IBM SPSS Inc., Chicago, IL, USA) and presented descriptively. Clinical characteristics and attendance rates between cohorts were compared using either independent samples *t*-tests (continuous variables) or Chi-square or Fisher's exact tests (categorical variables). Individual items of the participant experience survey were compared between cohorts using Mann–Whitney U tests. Alpha was set at $p < 0.05$.

For the costing analysis, all costs are reported as 2019 AUD$ values. The cost for working participants +/− carers was based on their reported hourly wage rate, while the cost for non-working participants +/− carers was based on opportunity cost and valued using the Australian hourly minimum wage rate of $19.49 per hour [33]. These costs were calculated based on the duration of time reportedly taken off work or taken to attend the appointment for those not working. Due to the variation in duration of IP appointments (60–420 min) reported by the participants, the maximum time for combined education and assessment was truncated to 150 min (90 min for the appointment and 60 min waiting) for those participants who did not take time-off from paid work. Travel-related costs for the IP cohort were calculated based on their nominated mode of transport. Travel by private car was calculated using the return distance (km) from the participant's residential suburb and multiplied by $0.68/km as per Australian Tax Office guidelines [34]. Parking costs were included as the value nominated by the participant. Return costs incurred for other modes of transport (e.g. bus/train), as well as other relevant out-of-pocket expenses (e.g. meals), were included as the value nominated by the participant. Participant costs for each study cohort are presented descriptively using mean (sd) and median (Q1 and Q3 quartiles).

Results

A total of 55 participants were recruited into the study with 28 selecting IP care (control cohort) and 27 selecting to receive the intervention via TH (experimental cohort) (Fig. 1). Following recruitment, three participants in the TH cohort were unable to commit to attending an appointment (lost to follow up = 1; declined treatment = 1; medical deterioration = 1), leaving 24 participants in the TH group who were available to attend an appointment.

Overall, there were no significant differences between the cohorts with regard to demographic and clinical characteristics (Table 1).

Table 1 Participant characteristics

Characteristic	Telehealth Cohort ($n = 27$)	In-Person Cohort ($n = 28$)	Sig. (p)
Age, years (SD)	53.2 (11.7)	57.6 (10.5)	0.143
Sex (female), *n* (%)	27 (100)	26 (92.9)	0.157
Return travel distance to RBWH (km), mean (SD)	61.8 (78.7)	37.9 (27.2)	0.135
Type of BC surgery, *n* (%)			
Wide local excision	11 (40.7)	7 (25.0)	0.118
Mastectomy	10 (37.0)	15 (53.6)	
Both	3 (11.1)	0 (0)	
Other	3 (11.1)	6 (21.4)	
Side of BC surgery, *n* (%)			
Unilateral	20 (74.1)	22 (78.6)	0.695
Bilateral	7 (25.9)	6 (21.4)	
Axillary surgery, *n* (%)			
ALND Level 1	6 (22.2)	8 (28.6)	0.281
ALND Level 2	6 (22.2)	2 (7.1)	
ALND Level 3	15 (55.6)	18 (64.3)	
Side of axillary surgery, *n* (%)			
Unilateral	27 (100)	26 (92.9)	0.157
Bilateral	0 (0)	2 (7.1)	
Time since BC surgery (days), mean (SD)	39.1 (10.7)[^]	40.8 (15.3)	0.676
Commenced adjuvant treatment[#] (yes), *n* (%)	16 (59.3)	18 (64.3)	0.701
Clinical Measures:			
QuickDASH score, mean (SD)			
Pre-operative	9.25 (10.83)	15.6 (19.87)	0.204
Post-operative	33.3 (17.86)	30.12 (24.73)	0.616
BCLE-SEI:			
Number of symptoms, mean (SD)	10.83 (4.6)	10.92 (5.55)	0.951
Total symptom score, mean (SD)	19.79 (12)	21.42 (16.2)	0.690
≥9 symptoms +/- arm/hand swelling, *n* (%)	18 (75)	17 (65.4)	0.459

ALND, axillary lymph node dissection; *BC*, breast cancer; *BCLE-SEI*, Breast Cancer and Lymphoedema Symptom Experience Index; *RBWH*, Royal Brisbane and Women's Hospital; *SD*, standard deviation

[^]Calculated only for those participants that attended appointment ($n = 22$)

[#]May be inclusive of chemotherapy, endocrine or radiation treatment

Attendance

All participants who nominated the IP intervention attended their appointment (100%), while 22/24 (92%) participants attended the TH intervention ($p = 0.208$).

Participant satisfaction

Overall participant experience was positive, and no significant differences were demonstrated between cohorts (Table 2). The TH cohort reported high levels of satisfaction (median across all domains ≥ 4 [IQR 4–5]) with regard to both technical (i.e. audio/visual quality, ease of use) and clinical (i.e. privacy, rapport, ability to follow instructions) aspects of the TH consult.

Technical disruptions and clinician satisfaction

No TH appointments experienced a major technical failure that resulted in the appointment being unable to be completed. Although minor technical issues (e.g. the need to refresh or exit and recall) were reported in 42.9% of appointments, TH training conducted prior to study commencement enabled clinicians to effectively manage these issues online, allowing all TH appointments to be successfully completed. Clinicians reported high satisfaction in delivering both the education session (median = 4 [IQR 4–5]) and individual assessment (median = 4 [IQR 3–4]) via TH.

Table 2 Participant satisfaction for delivery of combined education and individual review

Item	Telehealth cohort ($n=21$)* Median (IQR)	In-person cohort ($n=28$) Median (IQR)	Sig. (p)
- I am satisfied with the length of time I waited to start my treatment	5 (4–5)	5 (4–5)	0.374
- I am satisfied with the costs involved with accessing my treatment	5 (4.5–5)	5 (4–5)	0.451
- I am satisfied with my ability to access recommended healthcare professionals	5 (4–5)	5 (4.25–5)	0.522
- Overall, I am satisfied with my treatment experience	5 (4–5)	5 (5–5)	0.355

*Only 21 participant satisfaction surveys were returned for telehealth cohort

Participant costs

The median participant-related cost per appointment was $39.68 (IQR $28.52–$68.64) for the TH cohort and $154.26 (IQR $81.89–$251.48) for the IP cohort, demonstrating a median difference of $114.58 in favour of the TH cohort. Table 3 provides a breakdown of participant-related costs.

Discussion

Lymphoedema surveillance models are essential for early detection and subsequent management of BCRL. However, many people find attending these appointments IP prohibitive. While attendance for both models was high, a slightly lower attendance rate was observed for TH compared to IP lymphoedema education and assessment sessions for post-operative individuals with risk for BCRL. Overall, the TH model demonstrated high levels of participant and clinician satisfaction, minimal technical disruptions and considerable cost savings for the participant, thus supporting its feasibility as a viable model of care.

Although the TH intervention reported slightly lower attendance, it is unclear that this was directly related to the mode of service delivery particularly as participants self-selected their preferred service. These findings are in contrast to recent studies exploring the influence of delivery mode on attendance at public specialist outpatient services, however, may be a reflection of this study's small sample size [35, 36]. Regardless, this highlights that while TH is known to be more convenient, accessible and incurs reduced financial costs compared to IP care [37, 38], there are other factors that can influence attendance, including forgetting to attend appointments or confusion with appointment details [36]. Hence, it could be posited that the two participants who did not attend their TH appointment may have done so regardless of the mode of delivery. Appointment attendance, along with the associated time and effort coordinating, travelling to and waiting for care, has been reported by individuals undergoing BC treatment as contributing to the burden of treatment [19]. The convenience that TH provides in accessing care is particularly relevant in this population where competing appointments, along with treatment side effects, may challenge IP attendance. Even more so, the challenge of needing to travel long distances in Australia for care, along with the onset of the current COVID-19 pandemic, has highlighted the imperative for vulnerable populations to have the option to receive care remotely. Overall, there was high participant satisfaction with the TH mode of delivery, with no significant differences in reported satisfaction between the TH and IP cohorts. Clinician satisfaction with delivery of the group education and individual participant assessments via TH was also high. These findings are consistent with previously reported studies utilising TH models with other clinical populations [22, 38, 39]. Minimal technical disruptions were also experienced, in line with other TH studies [22, 38, 39], demonstrating the capability of TH to successfully deliver both group and individual sessions.

Substantial cost savings were reported by the TH cohort across all domains (travel-related costs, participant/

Table 3 Participant costs for attendance at combined group education and individual review (AUD$)

	Telehealth cohort ($n=22$)		In-person cohort ($n=28$)	
	Mean (sd)	Median (Q1–Q3)	Mean (sd)	Median (Q1–Q3)
Travel-related costs	–	–	$43.05 (±$30.88)	$41.83 ($20.00–$64.58)
Participant work/ opportunity costs	$33.29 (±$18.56)	$29.76 ($23.56–$39.68)	$80.46 (±$38.91)	$49.60 ($39.68–$55.90)
Carer work/opportunity costs	$18.52 (±$34.21)	$0 ($0–$29.76)	$78.46 (±$120.25)	$29.76 ($0–$75.40)
Other out-of-pocket expenses	$10.79 (±$27.17)	$0	$14.96 (±$27.21)	$2.50 ($0–$18.75)
TOTAL	$62.60 (±$61.81)	$39.68 ($28.52-$68.64)	$216.94 (±$152.71)	$154.26 ($81.89-$251.48)

carer work and opportunity costs and other out-of-pocket expenses). By reducing the time spent away from work and other commitments, TH can be seen to mitigate the known appointment burden and financial impact (both direct and indirect costs) associated with BC treatments and other chronic conditions [40]. This is particularly pertinent as almost two-thirds of all participants in this study had commenced adjuvant treatment, requiring attendance at regular IP appointments. A recent systematic review by Kruse et al. [41] identified cost as a primary barrier to the organisational adoption of TH. However, the simplification of web-based TH platforms, accessible on any computer device, has mitigated infrastructure costs, and institutional TH platforms are now available in many public health facilities across Australia. As such, within the context of a quaternary hospital facility where this study was conducted, the health service costs associated with delivering care either via TH or IP (e.g. staff labour, physical infrastructure, depreciable costs) were considered negligible and hence should not be considered a barrier to adopting TH.

The purpose of the physiotherapy intervention at 4–6 weeks post-operatively is two-fold—to provide timely lymphoedema education and to monitor the recovery of post-operative shoulder ROM and for early signs of BCRL. Timely and accessible education for BC survivors regarding BCRL, risk factors and risk mitigation is critical for their awareness of the condition [3]. TH provided a viable medium for the delivery of the interactive education session [42]. Reliability of shoulder ROM assessment via TH has also been established [26], while scar visualisation and other potential musculoskeletal sequelae of BC surgery, including cording, could be observed via videoconferencing. It should be noted, however, that BIS assessment and clinician palpation were only performed in the IP cohort. Svensson and colleagues [43] recently demonstrated that self-assessment of changes in tissue texture in the at-risk arm and symptom self-reporting were closely associated with measurable BCRL by BIS and showed strong agreement with therapist assessment for BCRL, hence being a reliable indicator for further diagnostic assessment by a lymphoedema-trained health professional [43]. Other methods of self-assessment, screening and monitoring for BCRL have also been shown to reliably identify the need for further assessment by a health professional [12, 23, 28, 44, 45]. Self-monitoring via measurement of arm circumference can reliably be achieved by women with risk for BCRL [12, 44] or by caregivers supported by health professionals via TH [23]. Two studies of in-home monitoring for individuals at high risk for BCRL utilised a BIS device in the home [28, 45], which was found to be feasible and to enhance self-management strategies, but is not currently accessible for every at-risk individual due to cost. Our study instead utilised participant self-reporting via the BCLE-SEI symptom occurrence sub-scale [31, 32]. Of interest, a high proportion of participants (75% TH, 65.4% IP) met the diagnostic cut-off for possible BCRL [31, 32] according to the BCLE-SEI at this early post-operative time point. The association between this score and the gold standard of BIS is unknown, as we were unable to determine this with our IP cohort due to an incomplete BIS dataset.

In line with current clinical practice, individualised management plans were developed for all participants to optimise post-operative recovery of shoulder ROM and function. Any participant identified with, or suspected of having, BCRL was offered IP lymphoedema assessment. If BCRL was diagnosed, appropriate management was instigated. All other participants were offered subsequent IP lymphoedema surveillance at regular time points from 3 to 24 months post-operatively, consistent with current recommended guidelines [11, 28].

There are limitations to this study. The study was conducted in a single quaternary public hospital facility, and, therefore, results may not be generalisable to other contexts. Participants who did not attend their appointments were not specifically followed up (beyond standard hospital procedure) to determine whether the mode of delivery influenced this decision. While not a primary outcome of interest, a potential clinical limitation of this study was the ability to detect the development of BCRL for the TH cohort in the absence of reliable objective assessments including BIS. At the time of conducting this study, we utilised the BCLE-SEI in lieu of other established measures of symptom reporting. There has been more recent evidence to suggest other self-assessment tools would be more clinically appropriate [43, 46]. Further research is needed to understand the feasibility of using TH as part of a lymphoedema surveillance pathway. This includes hybrid models of care incorporating reliable methods of self-assessment, remote and IP attendance, to support at-risk individuals to access prospective surveillance to facilitate the early identification and timely management of BCRL.

Conclusion

Telehealth provided accessible lymphoedema education and assessment at a single post-operative time point for individuals with BC, with minimal technical disruption and was associated with favourable participant and clinician satisfaction and cost savings. The recent development and validation of other methods of self-assessment, screening and monitoring for BCRL support the increased uptake of TH and other remote models of care for this cohort, with potential applicability to other

populations where risk for cancer-related lymphoedema exists.

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Authors' contributions LN and HRH conceptualised the study and led the study design with support from MC, JP and CB. LN led the data acquisition with support from MC, JP and TC.

LN and MC planned the data analysis with support from TC.

MC led the interpretation of the results with input from LN and TC.

LN and MC drafted the manuscript, with support from all co-authors. All authors provided feedback and approved the final version of the manuscript.

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Data availability The participants of this study did not give written consent for their data to be shared publicly, so due to the sensitive nature of the research supporting data is not available.

Declarations

Competing interests The authors declare no competing interests.

Ethical approval Ethical approval was granted for the conduct of this study by the Royal Brisbane and Women's Hospital Human Research and Ethics Committee (Ref No: HREC/18/QRBW/249).

Conflict of interest The authors declared competing interests.

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