ARTICLE

Evaluation of telephone genetic counselling to facilitate germline *BRCA1/2* testing in women with high-grade serous ovarian cancer

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Abstract

Systemic healthcare issues and geographical challenges restrict women's access to *BRCA1/2* testing to inform the use of tailored treatments for high-grade serous ovarian cancer. Consequently, *BRCA1/2* testing in this population is low and improved testing pathways are urgently needed. This study aimed to determine the acceptability and feasibility of telephone genetic counselling (TGC) to facilitate treatment-focused *BRCA1/2* testing in Australia for women with high-grade serous ovarian cancer. Women who received TGC were invited to complete a survey examining their experiences of the service. A cost analysis was conducted to compare the service to standard, in-person genetic counselling. One hundred and seven women responded (48% response rate); 8 had a *BRCA1/2* variant affecting function. Geographical barriers prevented women from accessing genetic services in the past. All participants had a positive attitude towards testing, and regret following testing was minimal. While the impact of testing was greater for those with a positive test result, overall, genetic testing did not put the additional psychosocial burden on the participants. Participant's evaluations of the telephone interactions with the genetic counsellors were highly satisfactory. The service was also found to be cost-effective. This model of telephone genetic counselling was an acceptable and effective way to reduce barriers to *BRCA1/2* testing for women with ovarian cancer.

Introduction

Ovarian cancer remains a leading cause of death in women worldwide, however, opportunities to increase survival rates are rapidly emerging due to targeted therapies. In particular, poly (ADP-ribose) polymerase (PARP) inhibitors offer a survival advantage to women with relapsed high-grade serous ovarian cancer (HGSOC) who are known to have a *BRCA1/2* variant affecting its function [1].

The prevalence of germline *BRCA1/2* variants affecting function rises to over 17% among women who have HGSOC [2]. Prompt access to *BRCA1/2* testing is therefore not only essential to inform treatment decisions for women with HGSOC, but also to identify and offer risk management advice to at-risk relatives. Further, women have reacted positively to the offer of treatment-focused *BRCA1/2* testing, suggesting it does not add further psychosocial burden to the experience of a cancer diagnosis [3, 4]. Despite this, routine implementation of *BRCA1/2* testing has been inconsistent internationally, and referral rates in Australia for genetic counselling and testing amongst eligible ovarian cancer patients are low [2, 5, 6].

Previously, eligibility for *BRCA1/2* gene testing required the affected woman to have a family history of breast and/or ovarian cancer indicative of higher variant probability. These guidelines are now considered insufficient to capture an acceptable proportion of *BRCA1/2*-associated ovarian cancers [7, 8]. Current Australian guidelines recommend *BRCA1/2* genetic testing for all women diagnosed with HGSOC under the age of 70, and

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for all women, regardless of age, when there is a family history of ovarian cancer [9].

In reality, however, many women are still unable to access genetic testing. In Australia, geographical barriers are particularly pertinent, with approximately one-third of the population residing outside of metropolitan areas [10]. Even those living in major cities can face long wait times for appointments at overburdened familial cancer centres [10, 11]. These access barriers are particularly critical for women with HGSOE, where treatment is potentially available based on their genetic status and timeliness of access is fundamental due to the high risk of mortality from the malignant disease. As such, new models are required to increase access at key stages of the *BRCA1/2* testing pathway [7]. In addition, empirical research is urgently needed to elucidate patient preferences for, and acceptance of, new clinical service models and determine the extent to which they are feasible and cost-effective.

Telehealth models are frequently utilised to increase the reach of, and access to, clinical genetic services for individuals who experience barriers to attending in-person genetic counselling [12, 13]. Particularly, telephone genetic counselling (TGC) has long been recognised as a valid alternative to in-person consultations [13, 14]. To date, two clinical trials have investigated the impact of standard in-person genetic counselling (SIGC) versus TGC for *BRCA1/2* testing in cancer patients in the US [15, 16]. Both studies supported the efficacy of TGC with regard to minimising psychological distress, facilitating informed decision-making, and achieving positive counsellor-patient interactions [15, 16], even at 12-months follow up [17, 18]. The Schwartz et al. [15] trial also included an economic analysis, from which TGC was found to be lower cost than SIGC. However, both trials reported lower test uptake amongst women in the TGC group [15], particularly those of non-white ethnicity [19]. In a different investigation, Sie et al. [20] offered women a choice between receiving SIGC both pre- and post-test, or post-test only. While more women chose SIGC post-test only, and were satisfied with the service, those with higher distress levels were more likely to choose pre-test counselling in addition [20]. This suggests that TGC may not be appropriate for all women and underlying psychosocial characteristics should be considered. Ultimately, however, TGC for facilitating *BRCA1/2* testing is demonstrated to be a viable model.

To address known limitations within current pathways for *BRCA1/2* testing in ovarian cancer patients, a novel model of TGC was developed at an Australian familial cancer centre (see Box 1). A three-stage study was developed to evaluate the TGC service from the perspective of both participating women and their referring oncologists. A cost analysis was also performed to

determine the incremental cost difference for TGC compared to SIGC. This paper presents the findings relating to participating women's experiences, and the cost analysis. A framework proposed by Maxwell [21] was used to aid the interpretation of the results. The framework was designed to assess the quality of health service across six domains: equity, access, acceptability, efficiency, effectiveness, and appropriateness. The aim of this study was to assess the TGC service in terms of access, acceptability, effectiveness and equity.

Method

Participants

Women with HGSOE aged 18 years and over, who had received TGC between January 2016 and May 2017, were invited to participate in the survey. Women were excluded if they had a history of a psychiatric or cognitive disorder that may affect their ability to provide informed consent, or if they were not fluent in English. Women with HGSOE referred for SIGC between January 2008 and December 2013 were eligible for inclusion for the comparator arm of the cost analysis.

Survey design

The survey was designed to examine the TGC service from a patient's perspective. Survey domains included: socio-demographics; prior access to genetic services; acceptability of the TGC model, including the preferred provider of genetic testing; and effectiveness of the genetic counselling provided via telephone. The survey comprised of validated measures, purposefully designed questions and open-text boxes. Table 1 outlines the survey measures. The survey was available either as a paper-based version or online, hosted using REDCap at The University of Melbourne, Australia [22].

Data collection

Between July 2017 and January 2018, eligible women received a 'survey package' via post, containing a letter of invitation to participate (including an 'opt-out' card), a participant information sheet and consent form, a paper-based copy of the survey, and a reply-paid envelope. The letter also included the option to complete the survey online. Paper-based survey responses were entered into REDCap. After three weeks, non-responders were followed-up over the telephone. If needed, a research assistant assisted participants to complete the survey verbally over the phone. The clinical database populated by the genetic counsellors

Box 1 A novel model of TGC implemented at an Australian Familial Cancer Centre

TGC – Telephone genetic counselling
 VUS – Variant of unknown significance

involved in the TGC service was accessed to obtain data regarding call durations and the family history risk assessment, and to confirm participants' test results.

Data analysis

Raw data were cleaned in Microsoft Excel and analysed using Stata IC 14. Open-text responses were transcribed before being recoded into categorical variables. Dummy variables were created for several demographic variables (e.g., educational level was dichotomised to tertiary/non-tertiary). In accordance with the genetic counsellor's practice, participants with a variant of unknown significance (VUS) were considered to have received a negative test result (i.e., variant affecting function not detected). Violations to normality and homogeneity of variance informed the use of non-parametric inferential statistical tests. Mann–Whitney *U*-tests were used to look for relationships between outcome measures and predictors, with $p < 0.05$ considered statistically significant.

Cost analysis

A cost analysis of TGC compared to SIGC was conducted from the perspective of the healthcare system, using a bottom-up micro-costing approach. Costs were included if they were incurred up to 12-months from the date of referral to the genetics service. Resource use was calculated using the time taken for each task (in minutes) recorded in the clinical database for all genetic service activities for patients in the SIGC and TGC pathways. Procedures and events were excluded from the costing if they were common for both pathways, including: file preparation, data entry, blood collection supplies and phlebotomy, genetic testing and laboratory costs. Included costs were: (1) pre-test counselling telephone interview (intake, SIGC only), (2) pre-test genetic counselling, (3) appointment letters (SIGC only), (4) shipping of blood collection kits (TGC only), (5) post-test genetic counselling, and (6) time for additional contacts and tasks performed as recorded in the clinical database. Salary costs were based on public health sector Victorian

Table 1 Survey measures

Measure	Purpose	Scoring	Interpretation
Multidimensional Measure of Informed Consent [26]	Measures informed decision-making	Scores from three subscales, knowledge, attitudes and uptake, combined. Uptake was 100% for this sample as all women received <i>BRCA1/2</i> testing.	Informed choice = good knowledge + positive attitude + uptake of test <i>OR</i> good knowledge + negative attitude + no test. Remaining combinations = uninformed.
Knowledge	Assesses knowledge of hereditary breast and ovarian cancer syndromes. ^a	Seven multiple choice questions with each correct answer scoring 1 point. Number of correct scores summed (range 0–7).	Cut off for good knowledge was ≥ 5 points. Poor knowledge was considered < 5 .
Attitude	Measures attitude towards a topic. Participants responded to the statement: “ <i>For me, having genetic testing to determine my BRCA1/2 mutation status was...</i> ”	4 statements dichotomised as positive or negative (e.g. beneficial/harmful). Participants responded to each using a 7 point Likert scale. Scores summed (range 4–28) and average calculated.	Lower scores indicated most positive attitudes. Positive attitude was considered a score of ≤ 16 .
Decision Regret Scale [27]	Measures regret regarding a decision. Participants responded to the statement: “ <i>Please think about the decision you made about whether or not to have BRCA1/2 testing.</i> ”	5 items with response options on 5 point Likert scales (<i>strongly agree</i> = 1; <i>strongly disagree</i> = 5). Items 2 and 5 reverse coded. Raw scores were converted to a score out of 100 by subtracting 1 and multiplying by 25. A final score was obtained by summing and averaging the 5 converted scores.	Higher scores indicating greater regret (where 0 = no regret at all).
Impact of Events Scale [28]	Measures cancer-specific psychological distress.	Participants asked to rate the frequency of intrusive (8 items) and avoidant (7 items) thoughts using a 4 point Likert scale (<i>not at all</i> = 1; <i>often</i> = 4). Subscales summed for total stress score (range 0–60).	Higher scores indicating more distress; 0–8 = subclinical, range, 9–25 = mild range, 26–43 = moderate range, 44 + = severe range
Multidimensional Impact of Cancer Risk Assessment [24]	Measures the psychological impact of receiving genetic test results.	Participants asked to indicate frequency of 6 negative and 4 positive internal events ^b using 4 point response options (<i>not at all</i> = 1; <i>often</i> = 4). Total score and subscale scores obtained.	Higher scores suggest greater distress (range 0–24) and greater positive experiences (range 0–16).
Measure adapted from Elliott et al. [29]	Assesses satisfaction with the competency, directiveness and respectfulness of the genetic counsellor.	12-item measure when participants responded either; disagree, neutral, agree and not applicable. Items 3, 7, 9 and 12 were reverse worded. Percentages calculated.	Skewed distribution of percentages towards ‘agree’ or ‘disagree’ indicate stronger feelings towards an item,
Genetic Counselling Satisfaction Scale [30]	Measures satisfaction with the genetic counsellor interaction. ^c	6 items relating to satisfaction with the genetic counsellor. Participants asked response using 5 point Likert scales (<i>strongly disagree</i> = 1; <i>strongly agree</i> = 5). Score for each item summed to a total score (range 0–30).	High scores indicated greater satisfaction.

^aAdapted from Wang [31] Ten of the original 17 questions were removed due to lack of relevance (e.g., questions regarding risk management strategies and those only referring to breast cancer) with the remaining 7 questions modified, where necessary, to suit an Australian context

^bA third subscale, uncertainty, was removed from this measure as it related primarily to risk management strategies and concerns not relevant to end-of-life patients

^cAdditional questions adapted from an existing genetic services evaluation study used to indirectly assess satisfaction by eliciting participants’ perspectives about specific components of the TGC experience (e.g., participants were asked if they felt that they had sufficient time to make a decision regarding genetic testing) [32]

Award rates plus on-costs of 14.5%. Postage services and equipment were based on market prices. No discounting was applied due to the short timeframe. Costs are reported in 2017 Australian Dollars (AUD\$), and inflated where necessary using the World Bank Consumer Price Index [23].

Results

Between January 2016 and May 2017, 284 women received TGC (Fig. 1). A *BRCA1/2* variant affecting function was identified in 26 women (9.2%), and a VUS was found in 12 (4.2%). All women with a *BRCA1/2* variant affecting function were referred to their local familial cancer centre by the TGC genetic counsellor (Table 2).

One hundred and seven women completed the survey (response rate 48%). Kruskal–Wallis one-way analysis of variance tests were performed to compare the responders, non-responders and those who opted out of the study. No differences were found between the groups regarding time spent on the telephone with the genetic counsellor ($\chi^2(2) = 1.08$, $p = 0.58$), months since receiving *BRCA1/2* results ($\chi^2(2) = 2.03$, $p = 0.36$) or years since ovarian cancer diagnosis ($\chi^2(2) = 2.35$, $p = 0.31$). There was, however, a difference in the median age of the women ($\chi^2(2) = 10.75$, $p = 0.004$). A Dunn's test with Bonferroni correction indicated that those who opted out were significantly older (median = 74) than responders (median = 68), $p = 0.002$ and non-responders (median = 69.5), $p = 0.007$.

Chi-square analysis also indicated that the three groups did not differ based on metropolitan or regional location

Fig. 1 Flowchart of women participating in the study. No variant detected = Neg, *BRCA1/2* variant affecting function = Pos, Variant of uncertain significance = VUS. ¹Telephone disconnected, email undeliverable and/or survey package returned to sender. ² $n = 9$ had a child participate in TGC on their behalf and $n = 4$ required an interpreter. ³Upon follow up via telephone, $n = 11$ expressed an interest in the

study but had yet to respond, including $n = 2$ positive women who explained they were too busy at the time. ⁴ $n = 3$ stated that they could not remember their result, but were confirmed to have a negative result in the database. ⁵ $n = 10$ were inpatients at the time of follow up (including $n = 1$ pos), $n = 8$ believed they had not received telephone genetic counselling

Table 2 Clinical pathway for women receiving TGC ($n = 284$) found to have a functional change in the *BRCA1/2* gene or a variant of unknown significance

	<i>BRCA1/2</i> ($n = 26$) n (%)	VUS ($n = 12$) n (%)
State/Territory		
Victoria	4 (15.4)	3 (25.0)
New South Wales	2 (7.7)	1 (8.3)
Queensland	13 (50.0)	5 (41.6)
Western Australia	6 (23.1)	2 (16.6)
South Australia	1 (3.8)	–
ARIA class		
Metropolitan	15 (57.7)	8 (66.6)
Regional	10 (38.5)	4 (33.3)
Missing	1 (3.8)	–
Setting of referral to TGC		
Public	16 (61.5)	3 (25.0)
Private	10 (38.5)	9 (75.0)
Onward referral to genetics service		
Victoria	5 (19.2)	2 (16.6)
New South Wales	1 (3.8)	–
Queensland	13 (50.0)	–
Western Australia	6 (23.1)	–
South Australia	1 (3.8)	–

($\chi^2(2) = 1.59$, $p = 0.10$), socio-economic status ($\chi^2(8) = 7.23$, $p = 0.45$), state/territory of residence ($\chi^2(12) = 11.90$, $p = 0.45$), referral from public or private setting ($\chi^2(2) = 2.47$, $p = 0.11$) or genetic test result ($\chi^2(2) = 1.06$, $p = 0.90$). Socio-demographics and basic indicators of service delivery, therefore, did not influence willingness to participate; notably genetic test result.

Participant characteristics

Table 3 presents socio-demographics for the 107 responders. The majority (89%) of participants reported that they did not have a *BRCA1/2* variant affecting function. Similarly, the genetic counsellors assessed most women (80.4%) as being at low familial risk of cancer. Four participants (3.7%) received a VUS result.

Meantime since cancer diagnosis and *BRCA1/2* testing was 4.7 years and 6 months, respectively. All but one woman indicated that they had communicated their genetic test result to family, with 42% informing some or all family members, and 34% informed those most likely to be impacted. The women reported a moderate level of psychological distress level (indicated by a score of 26–43 on the Impact of Events Scale) associated with their ovarian cancer diagnosis (mean [M] = 26.2, standard deviation [SD] = 18.14).

Table 3 Participant socio-demographics

Age		
Mean (95% CI)	66.9 (65.3–68.5)	
Range	45–89	
Median	67	
	n	%
State/Territory		
Victoria	12	11.2
New South Wales	10	9.3
ACT	1	0.9
Queensland	64	59.8
Western Australia	15	14.0
South Australia	5	4.7
ARIA class		
Major cities	52	48.6
Inner regional	33	30.8
Outer regional	17	15.9
Remote	3	2.8
U nmatched ^a	2	1.9
Socio-economic rank ^b		
1 st quartile	18	16.8
2 nd quartile	15	14.0
3 rd quartile	21	19.6
4 th quartile	30	28.0
5 th quartile	21	19.6
Missing data	2	0.2
Relationship status		
Not partnered	40	37.4
Partnered	64	59.8
Missing data	3	2.8
Education level		
Non tertiary	50	46.7
Tertiary	54	50.5
Missing data	3	2.8
Have children		
Yes	93	86.9
Have children including daughter(s)		
Yes	73	78.5

^aPostcode reserved for non-standard use (e.g., PO Boxes, government departments and large companies)

^bThe Socio-Economic Indexes for Areas (SEIFA) was developed to capture areas of socio-economic advantage and disadvantage across Australia. Specially, the Index of Relative Advantage and Disadvantage was used to categorise the women based on the postcode they provided. The 1st quartile represents the lowest scoring 25% of areas and the 5th quartile represents the highest scoring 25% of areas

Decision-making about *BRCA1/2* testing

‘Clinical management’ and ‘increased risk for family members’ were the two major factors influencing the

decision to have *BRCA1/2* testing. Family members contributed to the decision-making process for 29% of the sample.

All women demonstrated a positive attitude towards genetic testing ($M = 4.6$, $SD = 1.6$). With the cut-off for 'good knowledge' set at five or more correct answers out of seven, 40.2% of the participants scored below this range. Given that uptake of testing was 100%, the factor influencing informed choice for testing was knowledge. Based on this, 45.5% of the women made an informed choice to have genetic testing, as described by the multidimensional measure of informed consent (MMIC) [22].

Decisional regret was low ($M = 4.25$), and 72% of the women had no regret regarding their decision to undergo treatment-focused *BRCA1/2* genetic testing.

Impact of receiving *BRCA1/2* results

Using the multidimensional impact of risk assessment (MICRA) score, the overall psychological impact of receiving *BRCA1/2* results was low ($M = 7.9$, $SD = 7.5$ for a negative test result; $M = 16.8$, $SD = 9.7$ for a positive test result; $M = 12.0$, $SD = .63$ for a VUS result). A Mann–Whitney *U*-test indicated the impact of receiving genetic test results was greater for those with a *BRCA1/2* variant affecting function (median = 13.5, interquartile range [IQR] = 17.5) compared to those with a negative or VUS result (median = 6, IQR = 10), $z = 2.64$, $p = 0.008$. The result also caused more distress for those with a *BRCA1/2* variant affecting function (median = 6, IQR = 17) compared to those without (median = 0, IQR = 1), $z = 2.942$, $p = 0.003$ for MICRA distress sub-scale. Participant 003 wrote, "[It] Would have been different if it [the test] was positive, but [I] haven't thought about it lately." However, another from the same participant comment indicated that receiving a negative result did cause some mixed emotions, "As my test result was negative I was upset as it ruled out some treatment for my recurrent ovarian cancer. I was also relieved about my result for my family members' sake."

Acceptability of the TGC service

The sample reported little prior access to genetic services, with one reason being geographical barriers (49.5% resided outside of major cities). One woman wrote that travelling to a genetics appointment was, "Too far to travel and too expensive." Another explained she was, "not physically or emotionally well enough" to attend her scheduled appointment. Most of the women (97.2%) were satisfied with the timing of the telephone call, and 99 (94.3%) were satisfied with the information provided. When asked if they would have preferred face-to-face counselling, 49% responded 'No' and 33.6% had no preference. One woman

wrote, "Telephone counselling was efficient and felt like a face-to-face appointment. I liked it!"

The time taken for consent over the phone was approximately 16 min for all participants. Duration for returning results, however, was result-dependent; an average of 22.5 min for a positive *BRCA1/2* result, 9.7 min for a negative result and 11.25 min for a VUS result. On average, the genetic counsellors spent significantly more time on the phone with women who had a *BRCA1/2* variant affecting function compared to women without (38.8 versus 25.7 mins; $z = 2.7$, $p = 0.02$).

Participants were asked to rank their preferred provider of genetic testing, with first preference assigned 3 scores, second reference 2 scores and third preference 1 score. Oncologists were the participants' most preferred health professional to offer *BRCA1/2* testing (first preference for 50% of the sample). While oncologists were also the preferred health professional to deliver the test results according to cumulative preferences, a greater number of participants (37%) selected genetic counsellors as their first preference (Fig. 2).

Ninety-four (94.3%) agreed that their genetic counsellor had explained things in a clear and understandable way, and 96.3% felt they had been treated with respect at all times. A small number felt that their genetic counsellor had not been supportive of their decision and had frequently interrupted them during the TGC appointment (3.7% and 4.7%, respectively). Despite this, women were highly satisfied with their genetic counselling, as indicated by high scores of the Genetic Counselling Satisfaction Scale overall ($M = 19.7$). One woman wrote, "I felt very reassured by The Counsellor [sic] in my decision to receive genetic testing... Thank you for this wonderful service..." A Mann–Whitney *U* rank-sum test indicated that genetic counsellor satisfaction was significantly higher among women who received a positive *BRCA1/2* result compared to women who did not (median = 30 versus median = 27; $z = 2.251$, $p = 0.02$).

Two issues with the TGC service were identified in the open text comments at the end of the survey. Participant 014 explained that her blood sample had been lost, which went unnoticed for several weeks: "Should the pathology service be better informed? Or when possible, [could] the patient give their blood sample at Peter Mac centre? ...Should there be closer monitoring of the blood collection time and safe arrival of the blood sample at the testing centre? [sic]". Participant 027 wrote, "Getting the blood test done was difficult as they wouldn't do it at local collection centre." These comments indicate that barriers to completing *BRCA1/2* testing still exist in some circumstances.

Cost of the TGC service

Costing information was extracted for 50 SIGC patients (10 with a *BRCA1/2* variant affecting function) and 72 TGC

Fig. 2 Preferred health professional to facilitate *BRCA1/2* testing. * Genetic counsellor ** General practitioner. ^a8 women had no preference, 6 women were unsure how to answer this question and 3 missing responses. ^b14 women had no preference, 3 women were unsure how to answer this question and 3 missing responses

Table 4 Per patient cost analysis for standard care pathway versus TGC

Event ^a	Unit cost (AUD\$) ^b	Standard in-person genetic counselling		Telephone genetic counselling		Incremental cost
		Time per patient (h)	Cost per patient	Time per patient (h)	Cost per patient	Difference
Intake phone call	45.81	0.25	11.45	–	–	–11.45
Pre-test counselling	45.81	0.92	42.15	0.25	11.45	–30.70
Appointment letters						
Preparation	35.32	0.25	8.83	–	–	–8.83
Postage	3.00	–	6.00	–	–	–6.00
Blood collection						
Express post	14.50	–	–	–	14.50	+14.50
Shipping box	12.80	–	–	–	12.80	+12.80
Preparation	35.32	–	–	0.15	5.30	+5.30
Courier	31.90	–	–	–	31.90	+31.90
Post-test counselling	45.81	0.67	30.69	0.25	11.45	–19.24
Additional clinical contact	45.81	0.18	8.25	0.09	4.12	–4.13
Total		2.27	107.37	0.74	91.52	–15.85

^aCosts for appointment letters and blood kit preparation are based on the hourly salary for an administrative assistant. Genetic counselling and additional clinical contact is based on the hourly ward for a genetic counsellor

^bAll unit costs are in 2017 Australian Dollars (AUD\$)

patients (24 with a *BRCA1/2* variant affecting function; Table 4). The median time spent on genetic counselling for the TGC group was lower than for women in the SIGC group. The majority of costs for TGC arose from shipping and delivery for blood samples. The median per patient cost for TGC was AUD \$91.52 compared to AUD\$107.37 for SIGC. The total cost to identify a single individual with a variant affecting function was AUD\$999.68 for TGC and AUD\$1172.87 for SIGC.

Discussion

The findings from this study indicate that a model of TGC is an effective method of facilitating *BRCA1/2* testing for

women with HGSOc and costs less than SIGC. This research supports two randomised control trials demonstrating that TGC is a non-inferior alternative to SIGC regardless of test result [15, 16]. Together, these trials and the findings from this research provide evidence to suggest that TGC is an acceptable model that can bridge barriers to accessing prompt genetic testing

Access

The detection of *BRCA1/2* variants affecting function identified through TGC was 9%, which is almost within the bounds of previous population-based analyses (14.1%, 95% CI 11.9%–16.3%) [2]. Within this 9%, 17 TGC participants were

estimated to be of low familial risk of cancer prior to testing, and according to previous guidelines, would not have been eligible for Medicare-funded genetic testing. This highlights the importance of new pathways to access *BRCA1/2* testing for all women diagnosed with a HGSOc. A major benefit of telehealth models is increased equity of access [12, 13]. Over half of the sample resided in non-metropolitan areas, and geographical barriers were noted as preventing access to genetic services in the past. Given that TGC can be provided to a patient in their home, the service eliminates the need to travel. As such, more Australian women have the opportunity to access *BRCA1/2* testing. However, systemic barriers still exist as reported by participants, which prevented prompt blood collection and DNA analysis.

Acceptability

Meiser et al. [4] described a mixed emotional response to receiving *BRCA1/2* results after treatment-focused genetic testing. For example, those with a *BRCA1/2* variant affecting function reported feelings of both sadness and relief at their positive result, as it opened up treatment options [4]. Conversely, one participant in this sample, who received a negative result, reported relief for their family, but sadness that PARP inhibitors were no longer an option for them.

The participants in this study had a positive attitude towards genetic testing, and overall, the psychosocial burden of undergoing treatment-focused genetic testing was minimal. While distress regarding their ovarian cancer diagnosis was moderate, the impact of receiving *BRCA1/2* test results was low. This is consistent with prior research indicating that genetic testing does not cause distress over and above the impact of receiving a cancer diagnosis [3]. In contrast to this, and similar to prior research by Cella et al. [24], receiving results did have a slightly greater impact on, and caused more distress in, those found to have a *BRCA1/2* variant affecting function.

Genetic counselling satisfaction

Most of the participants indicated that their preferred health professional to offer *BRCA1/2* testing was their oncologist. This is unsurprising given the trusted and close bond that often develops between doctor and patient when they experience a longitudinal relationship. Despite this preference, satisfaction with the genetic counsellors was high; slightly more so for those with a *BRCA1/2* variant affecting function. This could be related to the longer call times associated with returning a positive *BRCA1/2* result, which could allow more time to develop rapport. Furthermore, more than one-third of the participants chose genetic counsellors as their first preference to return results, possibly indicating that many participants were aware of the

skills and expertise possessed by genetic counsellors in communicating genetic information.

Effectiveness

In one study of patient perceptions of TGC, self-reported satisfaction did not differ between TGC and SIGC [25]. However, although the TGC group did find the process more convenient, the group perceived lower levels of support and emotional recognition from their genetic counsellor [25]. While the participants reported high satisfaction with their genetic counsellor interactions in the current study, some women did not perceive their conversations to be ‘counselling’, and a further eight declined to participate in the survey for the same reason. Therefore, individual understandings of the purposes of genetic counselling, as well as different participant characteristics (such as the level of anxiety) [19, 20], may also mediate the effectiveness of a TGC service.

Format

The telephone format did not deter the women from using the service. Further, the women appreciated the opportunity to receive genetic counselling without needing to leave their home when they were feeling too unwell to travel. This illustrates how this service increased accessibility to genetic services ensuring a population who were less able to travel were not denied the opportunity to have genetic testing.

Given that genetic services are already overburdened, it is important to understand where in the TGC pathway that genetic counsellors invest the most time. In the development of the TGC service, approximately 15 min was allocated to the pre-test consent conversation and 10 min to returning the results. These timeframes were achieved for those with a negative test result; however, the average call time for returning a positive *BRCA1/2* result was over 20 min. Clearly, the bulk of the time is spent returning positive results, and implementing this finding into the triaging process may better optimise the genetic counsellor’s time.

Decision-making

None of the participants made a decision to have *BRCA1/2* testing that was inconsistent with their attitudes towards testing. The participants’ reasons for pursuing genetic testing mirrored those of other studies: gaining access to improved treatment options and information for family members [4]. Despite the positive attitude towards testing, not all participants made an ‘informed choice’ to have *BRCA1/2* testing (as per the MMIC). For a choice to be ‘informed’ it has to be made with adequate knowledge and a decision consistent with attitudes; the limiting factor in this case being knowledge. It could be argued, however, that

given that the vast majority of the women did not have a *BRCA1/2* variant affecting function, knowledge retention of hereditary breast and ovarian cancer syndromes would not be particularly relevant to those who received an uninformative result. Further, this ‘uninformed’ choice did not impact scores on the Decisional Regret Scale; no participants demonstrated any decisional regret regarding their decision to undergo *BRCA1/2* genetic testing.

Equity

TGC led to a cost-saving of AUD\$15.85 per woman tested, and AUD\$173.19 per *BRCA1/2* variant affecting function identified compared to SIGC. The difference was primarily due to the reduced counselling time compared to SIGC. As well as being an acceptable model, the cost-effectiveness of the service provides further rationale for its continued implementation. Thus, more women in the future will have access to efficient *BRCA1/2* testing, improving equity. The cost analysis excluded consideration of patient travel time and expense in attending a genetics service, which would likely be substantial for the >50% of women who resided outside a metropolitan area. Thus, the TGC model could also be more cost-effective for these women; however, this was unable to be determined due to lack of available data.

Limitations

Given the response rate of 48%, the opinions of many women who received TGC within the study timeframe were not captured. Similarly, the results are not representative of all women with HGSOC. It is also possible that the results were affected by response bias, whereby only those women with either highly positive, or negative, experiences completed the survey. Further, at recruitment, the mean time since receiving TGC was 6 months. Recall bias may have therefore affected participants’ memory of the TGC service and how they responded: three women failed to remember their negative *BRCA1/2* status.

The survey was also distributed to women at various stages of cancer treatment and disease progression. Of the 48 (21.5%) women who opted out of this study, ten women were too unwell or hospitalised at the time of recruitment, and three explained that personal circumstances prevented them from participating. A further 24 women who received TGC between January 2016 and May 2017 were already deceased and while they were not included in the response rate, this amount of mortality provides insight into the impact of advanced ovarian cancer on the population who received TGC. These factors that may be caused by health implications of the women’s ovarian cancer diagnosis or disease progression likely contributed to the low response rate.

Only eight respondents had a *BRCA1/2* variant affecting function, and four had a VUS. Given the population

frequency of *BRCA1/2* variants affecting function, it was not expected that the distribution of test results would be equal. While these findings are therefore primarily drawn from women who received a negative result, they do represent the majority of women receiving TGC. Ultimately, however, the ability to generalise findings to those receiving a positive result or a VUS is limited.

Similarly, while the results indicate that TGC is an acceptable way to facilitate *BRCA1/2* testing, it cannot be concluded that the method is more acceptable than SIGC. While results of two randomised control trials indicate that TGC is non-inferior to SIGC regardless of the test result, a randomised control trial comparing *BRCA1/2* positive, *BRCA1/2* negative and VUS participants’ experiences of TGC versus SIGC would mitigate the limitations inherent to this single-arm descriptive study.

Conclusion

This study showed that TGC is a low-cost, acceptable and effective approach to bridging access gaps and improving equity to *BRCA1/2* testing for women with ovarian cancer. Further, the offer of genetic testing in this context does not cause distress. These findings support previous research suggesting that TGC for *BRCA1/2* testing is a viable alternative to face-to-face genetic counselling, providing a strong evidence base for its continuation. Ultimately, by reducing barriers to *BRCA1/2* testing, not only will more women with HGSOC have more efficient access to targeted therapies, but also at-risk relatives can be identified earlier, potentially reducing ovarian cancer mortality in the future.

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Compliance with ethical standards

Conflict of interest Bettina Meiser has a remunerated consultant role with the company Astrazeneca with respect to an unrelated project. The remaining authors declare that they have no conflict of interest.

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