BMJ Open

Genetics Adviser: a protocol for a mixed-methods randomised controlled trial evaluating a digital platform for genetics service delivery

Salma Shickh,[1,2] Daena Hirjikaka,[2] Marc Clausen,[2] Rita Kodida,[2] Chloe Mighton,[1,2] Emma Reble,[2] Jordan Sam,[2] Seema Panchal,[3,4] Melyssa Aronson,[4,5,6] Tracy Graham,[4,7] Susan Randall Armel,[4,8] Emily Glogowski,[9] Christine Elser,[3,10,11] Andrea Eisen,[7] June C Carroll,[12,13] Cheryl Shuman,[4] Emily Seto,[1,14] Nancy N Baxter,[1,2,15,16] Adena Scheer,[1,2,16] Serena Shastri-Estrada,[17] Geoff Feldman,[18] Kevin E Thorpe,[19,20] Kasmintan A Schrader,[21,22] Jordan Lerner-Ellis ,[23,24,25] Raymond H Kim ,[6,10,11] Hanna Faghfoury,[26] Yvonne Bombard [1,2]

To cite: Shickh S, Hirjikaka D, Clausen M, *et al*. Genetics Adviser: a protocol for a mixed-methods randomised controlled trial evaluating a digital platform for genetics service delivery. *BMJ Open* 2022;**12**:e060899. doi:10.1136/bmjopen-2022-060899

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2022-060899).

Received 07 January 2022
Accepted 24 March 2022

Check for updates

© Author(s) (or their employer(s)) 2022. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

For numbered affiliations see end of article.

Correspondence to
Dr Yvonne Bombard;
yvonne.bombard@utoronto.ca

ABSTRACT

Introduction The high demand for genetic tests and limited supply of genetics professionals has created a need for alternative service delivery models. Digital tools are increasingly being used to support multiple points in the genetic testing journey; however, none are transferable across multiple clinical specialties and settings nor do they encompass the entire trajectory of the journey. We aim to evaluate the effectiveness of the Genetics Adviser, an interactive, patient-facing, online digital health tool that delivers pre-test counselling, provides support during the waiting period for results, and returns results with post-test counselling, encompassing the entire patient genetic testing journey.

Methods and analysis We will compare the Genetics Adviser paired with a brief genetic counselling session to genetic counselling alone in a randomised controlled trial. One hundred and forty patients who previously received uninformative genetic test results for their personal and family history of cancer will be recruited from familial cancer clinics in Toronto and offered all clinically significant results from genomic sequencing. Participants randomised into the intervention arm will use the Genetics Adviser to learn about genomic sequencing, receive pre-test counselling, support during the waiting period and results, supplemented with brief counselling from a genetic counsellor. Participants in the control arm will receive standard pre-test and post-test counselling for genomic sequencing from a genetic counsellor. Our primary outcome is decisional conflict following pre-test counselling from the Genetics Adviser+genetic counsellor or counsellor alone. Secondary outcomes include: knowledge, satisfaction with decision-making, anxiety, quality of life, psychological impact of results, empowerment, acceptability and economic impact for patients and the health system. A subset of patients will be interviewed to assess user experience.

Ethics and dissemination This study has been approved by Clinical Trials Ontario Streamlined Research Ethics Review System (REB#20–035). Results will be shared through stakeholder workshops, national and international conferences and peer-reviewed journals.

Trial registration number NCT04725565.

Strengths and limitations of this study

- This randomised control trial (RCT) will provide high-quality evidence on the outcomes and costs of receiving pre-test counselling, return of results, and post-test counselling from the Genetics Adviser.
- Our study will include qualitative interviews with participants, enabling an in-depth understanding of patients' experiences using the Genetics Adviser.
- All participants in this study have undergone prior genetic counselling and genetic testing for cancer gene panels and will be English speaking, and therefore, our results may not be transferable to patients presenting for an initial genetics consultation.
- However, this trial reflects a non-hypothetical study of patients being offered all clinically significant findings from genomic sequencing and the actual return of those results through the Genetics Adviser.
- We will evaluate the clinical effectiveness and costs of the Genetics Adviser for delivering care throughout the full patient genetic testing journey including the pre-test counselling, support while waiting for results, return of results and post-test counselling.

INTRODUCTION

Genomic testing is rapidly disseminating across medical disciplines.[1] As the use of genomic testing becomes embedded into routine practice, there is a need to develop innovative strategies to harness the full potential for prevention and treatment made

BMJ Open: first published as 10.1136/bmjopen-2022-060899 on 29 April 2022. Downloaded from http://bmjopen.bmj.com/ on September 29, 2023 by guest. Protected by copyright.

possible by these emerging tests. Genomic medicine has reached a critical juncture; as a direct consequence of the high demand for testing and limited supply of professionals (genetic counsellors, geneticists), alternative delivery models are emerging.[2–4] Novel mainstreaming approaches that allow for genomic tests to be ordered by non-genetics specialists (eg, oncologists and cardiologists) and digital tools that are being used to supplement components of the genetic counselling journey are being widely implemented, with both models aiming to improve access and wait times for testing and counselling.[1 5 6 7]

A diverse range of innovative digital tools have been developed across specialties, including primary care, prenatal screening, hereditary cancer care and paediatrics.[5 8 9] Various tools have been developed to support multiple points in the genetic testing journey, including education, clinical assessment, family history-taking, post-test counselling and follow-up, using various modalities such as conversational chatbots, e-books, educational videos and electronic decision aids.[5 7 8 10] Overall, digital genomic tools have been well received by patients, with high levels of usability, acceptability and satisfaction reported.[9 11] Digital genomic tools have also been shown to improve patient-reported outcomes, including increasing knowledge, reducing decisional conflict, initiating active decision-making and facilitating patient-centred care.[5 12] From the clinician and healthcare system perspective, digital tools have improved provider capacity and efficiency.[7 13] Despite the increasing use of digital tools in genomic medicine, none have applicability across multiple clinical specialties or settings, nor do any of them encompass the entire trajectory of the genetic testing journey.[6] This is a critical gap given the rise of large-scale initiatives to bring genomics into routine healthcare, such as the Genome UK initiative.[14]

We aimed to address these gaps by transforming our original Genomics ADvISER decision aid[9 13 15] into a comprehensive patient-centred digital platform (Genetics Adviser) to guide patients through the genetic testing trajectory from pre-test counselling, through the waiting period and to the results disclosure (figure 1). In brief, the Genetics Adviser begins with a pre-test learning module where they learn about genetics and testing using a combination of video, text and graphic imagery, responsive to different learning styles. Next, users explore frequently asked questions (FAQs), risks and benefits of testing, engage in a values clarification and a risk tolerance exercise (with tailored feedback). The last stage of the pre-test module allows users to review all types of clinically significant findings available from genomic sequencing (adaptable to the clinic/settings' specific results offerings), make their selections and review important considerations. They are then able to download a summary of their session. Prior to receiving their results, participants can also log back into the Genetics Adviser for a check-in. This involves a review of the genomic findings they selected, things to consider, questions assessing how prepared they are for the results and helpful resources to access during the crucial waiting period. The final module includes the return of results, which presents an overview of the results and an action plan, with a shareable summary report intended to be shared with the patient's healthcare provider.

Hypotheses and aims

We aim to evaluate the effectiveness of the Genetics Adviser at three critical junctures along the patient genetic testing journey: (1) pre-test counselling, (2) waiting period and (3) return of results.

Our primary aim is to evaluate the effectiveness of the Genetics Adviser paired with brief genetic counselling

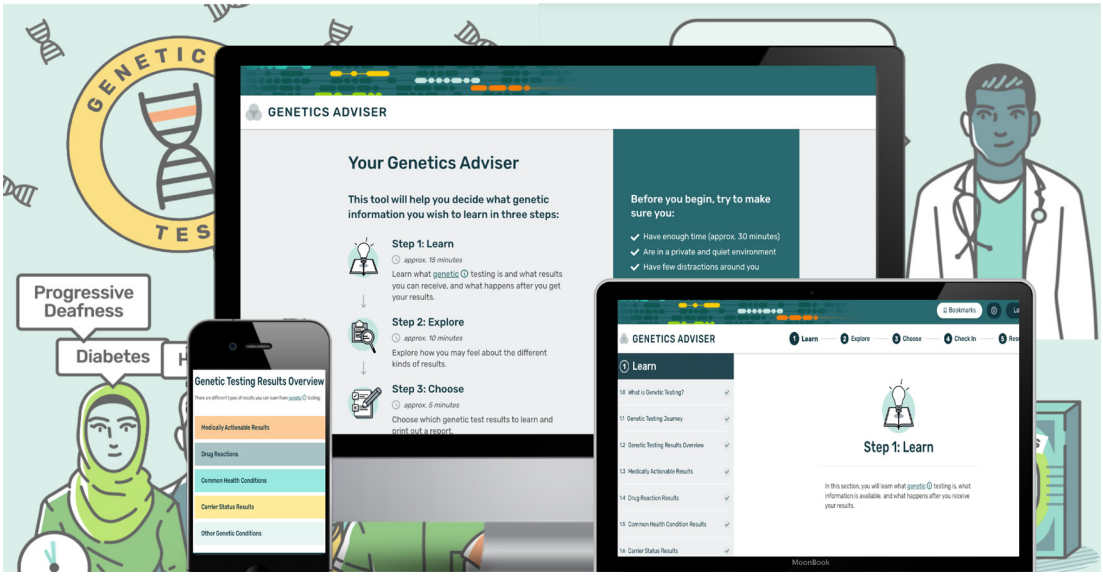

Figure 1 The Genetics Adviser, delivering pre-test counselling, waiting period support and result disclosure via all mobile applications such as smartphones and tablets or computer/desktop applications.

BMJ Open: first published as 10.1136/bmjopen-2022-060899 on 29 April 2022. Downloaded from http://bmjopen.bmj.com/ on September 29, 2023 by guest. Protected by copyright.

Table 1 Study measures across time points

Time point	Baseline*	+0 weeks†	+2 weeks‡	+2 months§	+4–6 months¶
Demographics and medical history	●				
State Trait Anxiety Inventory (6-item)[35]	●	●	●	●	●
Knowledge Scale[33]	●	●	●	●	●
Genetic Self Efficacy Scale[38 39]	●	●	●	●	●
Genomics Outcome Scale[40]					●
Decisional Conflict Scale[29]		●	●	●	●
Participant Satisfaction with Genetics Education[41]		●		●	●
Web-based Participants' Quantitative Feedback Regarding the Interactive Computer Module†† [41]		●		●	●
Satisfaction with Decision-Making Scale[34]		●	●		
The Feelings About genomiC Testing Results (FACToR) Questionnaire[37]					●
SF-12: Quality of Life**[36]	●				●
Economic Impact**					●
BRIEFS[42]	●				
eHEALS[43]	●				
Health Care System Distrust Scale[44]	●				
Control Preferences Scale[45]	●				

*T0.
†T1I/C/T2I.
‡T2C/T3I.
§T3C/T41.
¶T4C/T5I/T6I.
**Only for T4C and T6I.
††Only for T1I, T4I and T5I.
BRIEFS, Brief Health Literacy Screening Tool; e-HEALS, e-Health Literacy Scale; SF-12, 12-item Short Form Survey.

versus genetic counselling alone in the pre-test time point, where individuals receive information about all types of clinically significant findings from genomic sequencing. Based on prior literature,[5] we hypothesise that use of the Genetics Adviser will reduce patients' decisional conflict (primary outcome) and anxiety and improve patient knowledge and satisfaction with decisions compared with genetic counselling alone following their selection of clinically significant findings from genomic sequencing (GS). The primary time points of comparison will be after a pre-test counselling session with a genetic counsellor for the control versus after using the Genetics Adviser and speaking with a genetic counsellor for the intervention group (table 1 and figure 2). Our exploratory aims are

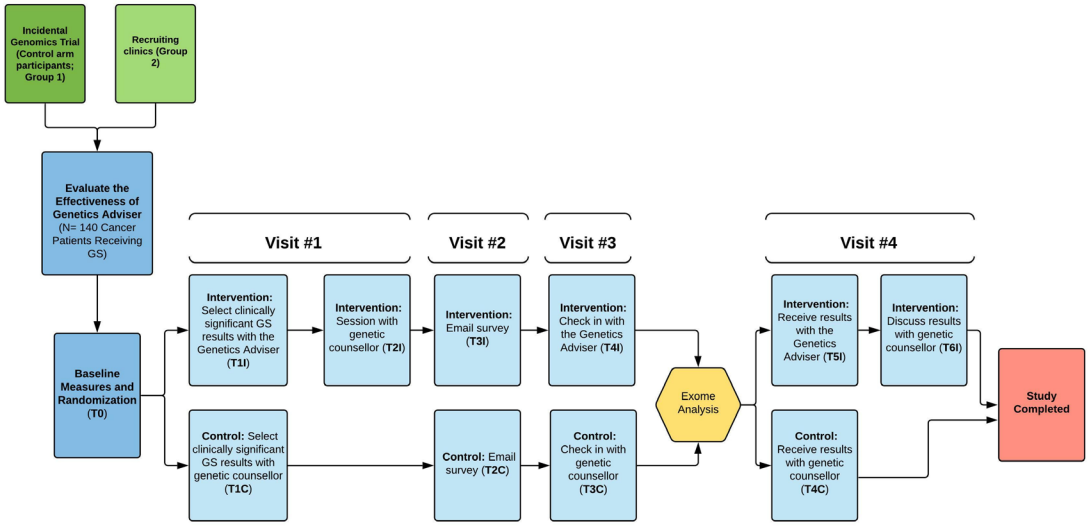

Figure 2 Overview of the Genetics Adviser trial.

BMJ Open: first published as 10.1136/bmjopen-2022-060899 on 29 April 2022. Downloaded from http://bmjopen.bmj.com/ on September 29, 2023 by guest. Protected by copyright.

to evaluate effectiveness of the platform in supporting patients while they wait for results and to explore the impact of returning results via the Genetics Adviser compared with receiving results from a genetic counsellor on decisional conflict, knowledge, satisfaction and anxiety.

METHODS

Study setting

The main study site is St. Michael's Hospital, Unity Health Toronto in Toronto, Ontario, Canada. As the trial is recruiting during the COVID-19 pandemic, all recruitment and procedures are being conducted virtually, via Zoom Healthcare or phone. Recruitment began in May 2021 and will end in October 2022.

Study design

This is a mixed-methods (explanatory-sequential design),[16 17] non-blinded randomised controlled superiority trial. We will evaluate whether use of the Genetics Adviser paired with genetic counselling reduces decisional conflict compared with genetic counselling alone, in addition to its impact on knowledge, satisfaction with decision-making, anxiety, quality of life, empowerment, acceptability and costs and efficiency. As part of the trial, participants will be randomised to either use the Genetics Adviser or undergo traditional genetic counselling to select and receive clinically significant findings from genomic sequencing (exome sequencing). A subset of participants will participate in a follow-up qualitative interview to assess user experience of the Genetics Adviser. This protocol follows the 2013 SPIRIT guidance on clinical trials (online supplemental file 1).[18 19]

Population

We will recruit participants from the control arm of the parent study (group #1) *The Health Outcomes, Utility and Costs of Returning Incidental Genomics Findings* (NCT#03597165; 'Incidental Genomics' trial described elsewhere).[20] Control arm participants from the parent trial included adult patients with cancer who underwent genomic sequencing and only received results for their primary indication (cancer). To supplement this sample, we will also recruit patients from cancer genetics clinics at Mount Sinai Hospital (MSH), Princess Margaret Cancer Centre (PMCC) and Sunnybrook Health Sciences Centre (SHSC) located in Toronto, Ontario, Canada (group #2).

Sample size

The study will require 64 patients/arm (128 total) to detect the minimal clinically important difference of 0.3 using the Decisional Conflict Scale (DCS), assuming a standard deviation of 0.6, an alpha of 0.05 (two sided) and power of 0.8.[21 22] Given attrition rates in previous trials, we anticipate having to possibly oversample using group 2 participants, up to a total sample size of 140 participants.

Eligibility criteria

Inclusion

- Previous participants in the control arm of the Incidental Genomics Trial[20] who have given permission to be recontacted for future related research AND patients with:
  - Personal and family history of cancer or polyposis suggestive of a hereditary cancer syndrome.
  - Previous uninformative genetic test results (negative or variant of uncertain significance (VUS), ie, a variant for which the risk association with disease is unknown).
  - ≥18 years of age.

Exclusion (group #2)

- Received a positive or clinically significant (actionable) genetic result in a cancer gene (eg, *BRCA1* pathogenic variant) consistent with the family history such that genomic sequencing would not be clinically useful to provide a molecular diagnosis.
- Received previous genomic sequencing.
- Patient or partner is pregnant or planning to become pregnant. This exclusion criterion was intended to avoid any stress related to potential receipt of carrier results. If a participant or their partner were to become pregnant over the study period, they would not be excluded.
- Patient has recurrent or metastatic cancer (stage 4). This exclusion criterion was intended to avoid burdening patients amidst ongoing health challenges or if they are in active cancer treatment.[23]
- If they or relatives participated in previous studies related to the Genomics Adviser including: the usability of the original Genomics Adviser[9]; the RCT of the Genomics Adviser[13 15]; or the intervention arm of the Incidental Genomics Trial, in which they would have used the Genomics Adviser to select their preferred clinically significant findings.[20]
- Do not speak or read English.

Recruitment

We will use different strategies to recruit participants in two groups. Group #1 includes control participants from the Incidental Genomics Trial who have had genomic sequencing but were only offered primary (cancer) findings in that trial. For this trial, these participants will have their sequence data reanalysed and be offered all clinically significant results (ie, secondary and incidental findings). The research coordinator will contact these participants via telephone or email to invite them into the next study. Individuals who are interested in the study will be sent a copy of the study information sheet and consent form via email or mail (based on their preference). If the individual is interested in participating in the study, the research coordinator will schedule a time to obtain verbal consent and if they are interested, enrol them in the study.

BMJ Open: first published as 10.1136/bmjopen-2022-060899 on 29 April 2022. Downloaded from http://bmjopen.bmj.com/ on September 29, 2023 by guest. Protected by copyright.

Group #2: we will recruit additional patients from genetics clinics at MSH, PMCC and SHSC who have already had panel testing for a cancer diagnosis and are eligible for genomic sequencing, similar to previous trials.[13 20] The procedure for recruitment will be the same at all participating clinics. Eligible patients will be informed about the study by a genetic counsellor during a clinic visit or over the phone when their uninformative genetic test results (VUS or negative) are returned. During a clinic visit, interested patients will be provided a copy of the study invite package. If interested, they will be asked to fill out the contact form that will be given to the study coordinator who will follow up with the patient. If results are disclosed over the phone or other virtual method, the genetic counsellor will fill out the study contact form for interested patients. For both methods, the study coordinator will contact interested patients via the phone and explain the study further. Patients will have the option of also contacting the study coordinator directly and will be given the study coordinator's phone and email contact information by the counsellor. If the patient is not interested in participating, the recruiting genetic counsellor will ask the patient to state a reason for refusal, which will be documented on the contact sheet.

Procedure for qualitative recruitment

A subset of participants will be invited to participate in qualitative interviews. Participants will be able to refuse to take part in the qualitative component and still participate in the RCT. We will interview up to 40 participants in total in the intervention arm of the study, likely sufficient to reach thematic saturation, that is, when further analysis does not reveal novel themes or findings. [24 25] We will first purposively sample participants by sociodemographic characteristics (eg, gender, age and ethnicity) and then theoretically sample based on emerging findings.[26 27 28]

Data collection

After being consented by the study coordinator, all participants will complete a baseline questionnaire (T0) and then be randomised into the intervention arm or control arm. The baseline questionnaires will assess genome sequencing knowledge, anxiety, digital and health literacy, empowerment (ability to use results to inform health decisions), quality of life, attitudes towards healthcare and autonomy in decision-making (table 1). The research team already has demographic and medical history information collected from group #1 participants' medical charts with their consent from the previous Incidental Genomics Study.

Group #2 participants will complete demographic information and cancer history questionnaires and will have medical history information collected from their medical charts, with their consent. The study genetic counsellor will access medical chart information for these participants from the recruiting clinics, which will be used to confirm cancer and genetic testing history.

Randomisation

Participants will be consecutively randomised and allocated from an existing list of eligible subjects using computer-generated randomisation through REDCap in a 1:1 ratio, stratified by clinic, with random permuted blocks of varying sizes.

Study arms

All participants in the intervention and control arms will be offered the opportunity to receive all clinically significant findings from research genomic sequencing. Participants who were not part of the Incidental Genomics parent trial will receive primary cancer results regardless of the study arm, consistent with what was offered to all participants in the parent trial who received all types of clinically significant findings (primary, secondary and incidental findings).

Intervention

Following consent, baseline measures (T0) and randomisation, participants in the intervention arm will use the Genetics Adviser to learn about genomic sequencing and make their selections regarding the types of clinically significant findings they want to receive, and then complete another set of measures (T1I). Participants will then have a brief genetic counselling session with a genetic counsellor, followed by another round of study measures administered by the counsellor (T2I). All of these measures (T0, T1I and T2I) are completed during the first visit (figure 2). Following the first visit, participants will be emailed a link to complete self-administered measures at 2 weeks (T3I). Two months after the baseline meeting, participants will use the *Check-in module* of the Genetics Adviser, and then self-administer another set of measures (T4I).

Four to 6 months after the baseline appointment, participants will be notified via email that their genomic sequencing results are ready to view through the Genetics Adviser. The email will be sent by the study genetic counsellor who will provide instructions on how to access the Genetics Adviser and their results, along with a link to complete self-administered measures after viewing the results on their own (T5I). The study genetic counsellor will also schedule a meeting with the participant after they have viewed their results. The results meeting with the genetic counsellor will include an in-depth explanation of the results and action plan as well as the administration of the last set of measures (T61).

Control

After participants have been consented and randomised into the control arm, they will complete study measures alongside the research coordinator (T0). Then, the genetic counsellor will provide pre-test genetic counselling about genomic sequencing. The participant will then choose which types of clinically significant findings they would like to receive, before completing additional study measures with the counsellor (T1C) (table 1 and

BMJ Open: first published as 10.1136/bmjopen-2022-060899 on 29 April 2022. Downloaded from http://bmjopen.bmj.com/ on September 29, 2023 by guest. Protected by copyright.

figure 2). Following the first visit (figure 2), participants will be emailed a link to complete self-administered measures at 2 weeks (T2C). Two months after the first visit, participants will complete a 2-month check-in with the genetic counsellor, completing study measures afterwards (T3C). Four to 6 months after the first visit, participants will be notified that genomic sequencing results are ready to be reviewed with the genetic counsellor (figure 2). The counsellor will contact the participant to book a time to review the results and complete another set of measures (T4C).

For the counselling components of the study, two study genetic counsellors will be trained on scripts to ensure consistency in the content and delivery of the counselling material.

Data management

The participants' choices for which findings they would like to receive from GS will be recorded in REDCap. The server is administered by the Applied Health Research Centre at SMH. Each team member will have their own individual login and password. The REDCap data collection form includes notes taken by the genetic counsellor from the discussion with the participant (participant study number, and cancer and genetic testing history for new participants) as well as the participants' category selections, notes about questions the participants asked during the counselling session and the start and end time of the session. All data will be kept on secure servers at SMH.

If participants miss any sessions, we will follow up with them to ensure they complete their measures on time. Participants can choose to leave the study at any time. Results of any analysis, including sequencing data and any other information recorded before withdrawal will still be used by the researchers for the study purposes, but no new information will be collected.

Outcomes

The primary outcome is decisional conflict, assessed via the validated DCS, [29 30] and consistent with the Ottawa Decision Support Framework.[31] The DCS is a reliable and sensitive measure of decisional conflict with a total of 16 items scored from 1 to 5. [32] Total scores range from 0 (no decisional conflict) to 100 (extremely high decisional conflict), with scores lower than 25 associated with implementing decisions and scores over 37.5 associated with decision delay.[32] The primary time point will be T2I versus T1C (adviser+genetic counsellor vs genetic counsellor only during the pre-test time point), but we will also assess decisional conflict following return of results by the adviser+genetic counsellor versus the counsellor alone (T6I vs T4C) as a secondary analysis to allow us to evaluate the impact of the Genetics Adviser across the entire genetic testing journey.

Secondary outcomes (table 1) include *knowledge*, measured using an established questionnaire[33]; *satisfaction with decision-making* measured using the Satisfaction with Decision scale[34]; *anxiety* measured using the state subscale of the State-Trait Anxiety Inventory,[35] a commonly used psychological assessment tool to measure state anxiety in adult populations including those with chronic conditions; *quality of life* measured by the 12-item Short Form Survey[36]; *return of results impact* measured via the validated Feelings About genomiC Testing Results (FACToR) scale[37]; *empowerment* measured via the Genetic Self- Efficacy Scale[38 39] and the six-item Genomics Outcome Scale, derived from the Genetic Counselling Outcome Scale[40] and modified for GS; *acceptability* measured via the Participant Satisfaction with Genetics Education questionnaire[41] and Web-Based Participants' Quantitative Feedback Regarding the Interactive Computer Module[41]; *health literacy* measured by the BRIEF and Health Literacy Screening tool[42]; *digital health literacy* measured by the eHealth Literacy Scale[43]; *attitudes towards healthcare* measured by the Health Care System Distrust Scale[44]; and *autonomy in decision-making* measured by the Control Preferences Scale.[45]

With regards to economic impact, we will compare short-term costs to participants and the health system between the two study arms. Health system resource use and costs will consist of genetic counsellor time and costs. We will account for genetic counsellor time by the counsellor self-reporting the length of all sessions and time spent on case preparation (writing letters, uploading documents to the Genetics Adviser, etc). We will then calculate the costs of genetic counsellor time by multiplying the average time counsellors spent for patients in each arm by the national average hourly wage for counsellors. Time and costs will be compared between the two arms. Costs to patients will include time off work and lost wages associated with using the tool or having genetic counselling, which will be captured using internally developed questions. Patient time and costs will be compared between arms.

Qualitative study of user experience with the Genetics Adviser

The study coordinator will interview 40 intervention participants who indicated an interest in participating in the interviews. The coordinator will confirm their interest and will schedule the telephone interview if they elect to proceed. Using an interview guide, the coordinator will explore their experience receiving pre-test education, support during the waiting time and return of results via the Genetics Adviser, their decision-making process and their views on benefits and concerns (online supplemental file 2). The interview guide was developed based on a literature review and expert input and will be modified based on findings from the data analysis. These interviews will take approximately 1 hour, be audio-recorded and transcribed verbatim. The interviewer will also take field notes immediately after each interview.

Data analysis

Quantitative

Primary and secondary outcomes

The analysis of outcomes will follow the intention-to-treat approach. Mean scores for the primary outcome, mean

BMJ Open: first published as 10.1136/bmjopen-2022-060899 on 29 April 2022. Downloaded from http://bmjopen.bmj.com/ on September 29, 2023 by guest. Protected by copyright.

DCS, will be compared using a t-test (assuming normal distribution). The secondary outcomes, satisfaction with decision-making, quality of life, impact of results, empowerment, autonomy in decision-making, knowledge of GS findings and counselling session lengths will be compared using a t-test or analysis of covariance (ANCOVA). Anxiety, literacy, knowledge of sequencing benefits and sequencing limitations scores will be assessed by summing the number of correct responses to the questions and compared adjusting for baseline scores using ANCOVA. The primary time points of comparison will be T1C for the control versus T2I for the intervention group (figure 2).

Exploratory outcomes

As part of an exploratory analysis, we will compare the impact of the delivery of results between the adviser and the counsellor on participants' decisional conflict, knowledge, satisfaction and anxiety scores. This comparison will be conducted using a t-test or ANCOVA test (depending on the presence of baseline measures) and consist of three analyses: (1) T1I versus T1C, which compares the Genetics Adviser alone vs genetic counselling at the pre-test time point, (2) T5I versus T4C, which compares the Genetics Adviser alone versus genetic counselling at the return of results time point and (3) T6I versus T4C, which compares the Adviser paired with the counsellor to the counsellor alone after return of results.

Qualitative

Thematic analysis,[46] employing constant comparison[27] will be used to analyse the transcripts. We will begin by open coding the data, which involves labelling the data with descriptive codes. Two team members will code transcripts independently and meet to discuss codes until consensus is reached. The next step involves constant comparison, in which codes will be compared across interviews to determine common and divergent themes and relationships among them and to characterise the entire dataset. Consistent with constant comparison, data will be analysed concurrent with data collection to explore preliminary themes and revise the interview guide accordingly. As part of the analysis process, the two coders will meet with the other team members for analysis meetings that will incorporate peer debriefings and analysis of field notes. Interviews will consider participants' sociodemographic factors that may influence their informational and decisional needs and the user experience of the Genetics Adviser. Validation methods will include triangulation and member-checking.[47 48]

Patient and public involvement

We have an established advisory board consisting of patients with GS experience, genetic counsellors, geneticists, oncologists, decision-makers and shared decision-making experts. The advisory board was consulted to identify end-user needs, goals and key genetic counselling attributes to inform product development and subsequently provide feedback on digital wireframes and videos and on usability and acceptability testing. The patient advisory board will also be involved in the conduct and reporting of the study.

Changes since trial registration

The following secondary outcomes have been added since the trial registration: Genetic Self-Efficacy Scale[38 39] (added as a pre-test/post-test empowerment scale); Genomics Outcome Scale[40] (added to capture a positive oriented measure for patient impact); Participant Satisfaction with Genetics Education[41] (added as an alternative satisfaction scale); Web-Based Participants' Quantitative Feedback Regarding the Interactive Computer Module[41] (added to measure participants' reactions to the tool); FACToR Questionnaire[37] (added as a post-test measure of distress); the 4-Item Brief Health Literacy Screening Tool[42] and the e-Health Literacy Scale[43] (added as baseline measures); Health Care System Distrust Scale[44] and Control Preferences Scale[45] (added for a substudy); and quality of life and costs were added to allow for planned economic evaluations. The Preparation for Decision-Making Scale was removed because it was felt to be redundant with the Satisfaction with Decision-Making and the Decisional Conflict scales.

Furthermore, the estimated date for the collection of the primary outcome measure has changed from February 2022 to October 2022 because of changes to the recruitment timeline of the Incidental Genomics trial, to which recruitment of this study is tied. Lastly, the analysis of qualitative data will use thematic analysis, changed from grounded theory, based on recommendations from the funder reviewers.

ETHICS AND DISSEMINATION

Ethical approval

This study has been approved by Clinical Trials Ontario Streamlined Research Ethics Review System (REB#20–035).

Ethics

Informed consent will take place over the phone or Zoom Healthcare and will be audio-recorded using an external recorder. All participants will receive a copy of the consent form for their own records (online supplemental file 3).

The study coordinator will review the consent form in detail and answer any questions regarding the study. For group #2 participants, the consent will ask for permission for access to medical records at recruiting clinics and for all participants, permission to be recontacted for future studies. All information collected during this study, including personal information, will be kept confidential. All data gathered will be kept in a secured location at St. Michael's Hospital. In the case that protocol amendments are required, revisions will be submitted to the Streamlined Research Ethics Review System. All changes will be communicated to the study team and ethics board.

BMJ Open: first published as 10.1136/bmjopen-2022-060899 on 29 April 2022. Downloaded from http://bmjopen.bmj.com/ on September 29, 2023 by guest. Protected by copyright.

If there are any changes that directly affect patients or require consent, all enrolled patients will be informed of the changes.

There will be data and sample transfer agreements between SMH and each of the recruiting sites. The study will not have a data monitoring committee given that we do not anticipate severe adverse effects and was not required for our study by the Research Ethics Board (REB). To assure compliance with ethical and study protocols, the St. Michael's Hospital REB regularly conducts audits of research studies.

Dissemination

This trial evaluates the effectiveness of a novel, interactive patient-centred platform that will support patients through their genetic testing journey—the Genetics Adviser. We will present data from this trial through local, national and international conferences and publications in peer-reviewed journals. Authorship eligibility will be based on The International Committee of Medical Journal Editors. Furthermore, we will organise a stakeholder workshop with genetic counsellors, geneticists, oncologists, family physicians, laboratory professionals, industry and patients to optimise the use of this platform in clinical practice and across different specialties. The final trial dataset will be accessed by the principal investigator, immediate study team and biostatistician.

Author affiliations
[1]Institute of Health Policy, Management and Evaluation, University of Toronto, Toronto, Ontario, Canada
[2]Li Ka Shing Knowledge Institute, St Michael's Hospital, Unity Health Toronto, Toronto, Ontario, Canada
[3]Marvelle Koffler Breast Centre, Mount Sinai Hospital, Sinai Health System, Toronto, Ontario, Canada
[4]Department of Molecular Genetics, University of Toronto, Toronto, Ontario, Canada
[5]Zane Cohen Centre, Mount Sinai Hospital, Sinai Health System, Toronto, Ontario, Canada
[6]The Hospital for Sick Children, Toronto, Ontario, Canada
[7]Sunnybrook Health Sciences Centre, Toronto, Ontario, Canada
[8]Princess Margaret Cancer Centre, Toronto, Ontario, Canada
[9]GeneDx Inc, Gaithersburg, Maryland, USA
[10]University Health Network, Toronto, Ontario, Canada
[11]Faculty of Medicine, University of Toronto, Toronto, Ontario, Canada
[12]Ray D Wolfe Department of Family Medicine, Mount Sinai Hospital, Sinai Health System, Toronto, Ontario, Canada
[13]Department of Family and Community Medicine, University of Toronto, Toronto, Ontario, Canada
[14]Centre for Global eHealth Innovation, Techna Institute, University Health Network, Toronto, Ontario, Canada
[15]Melbourne School of Population and Global Health, The University of Melbourne, Melbourne, Victoria, Australia
[16]Department of Surgery, University of Toronto, Toronto, Ontario, Canada
[17]Workplace Safety and Insurance Board, Toronto, Ontario, Canada
[18]Ontario Disability Coalition, Toronto, Ontario, Canada
[19]Applied Health Research Centre (AHRC), Li Ka Shing Knowledge Institute of St Michael's Hospital, Toronto, Ontario, Canada
[20]Dalla Lana School of Public Health, University of Toronto, Toronto, Ontario, Canada
[21]BC Cancer, Vancouver, British Columbia, Canada
[22]Department of Medical Genetics, The University of British Columbia, Vancouver, British Columbia, Canada
[23]Pathology and Laboratory Medicine, Mount Sinai Hospital, Sinai Health System, Toronto, Ontario, Canada
[24]Department of Laboratory Medicine and Pathobiology, University of Toronto, Toronto, Ontario, Canada
[25]Lunenfeld Tanenbaum Research Institute, Sinai Health System, Toronto, Ontario, Canada
[26]Fred A Litwin and Family Centre in Genetic Medicine, University Health Network, Toronto, Ontario, Canada

Acknowledgements We would like to thank Pivot Design Group for their assistance with the design and development of the Genetics Adviser.

Contributors YB leads the study, conceived and designed the protocol. NNB, JCC, ES, AS, KET, KAS, RHK and HF codesigned the study. MC codesigned the study and wrote the protocol. EG, SP, JCC, ES, SS-E, GF and CS assisted in designing the Genetics Adviser. SS, DH, MC, RK, CM, ER, JS, SP, MA, TG, SRA, CE, AE, JL-E and HF assisted in data collection. SS, DH and MC assisted with drafting the manuscript. All authors read and approved the final version of the manuscript.

Funding This research was supported by a Project Grant and a Foundation Grant from the Canadian Institutes of Health Research (CIHR-165963 and 143 310 respectively) and funding from St. Michael's Hospital (N/A) and the University of Toronto McLaughlin Centre (MC-2018–04).

Disclaimer The funders have no role in study design, data collection and analysis, decision to publish or preparation of manuscripts.

Competing interests None declared.

Patient and public involvement Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

Patient consent for publication Not applicable.

Provenance and peer review Not commissioned; peer reviewed for ethical and funding approval prior to submission.

Supplemental material This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: http://creativecommons.org/licenses/by-nc/4.0/.

ORCID iDs
Jordan Lerner-Ellis http://orcid.org/0000-0003-3685-5679
Raymond H Kim http://orcid.org/0000-0002-2147-8674
Yvonne Bombard http://orcid.org/0000-0002-9516-4539

REFERENCES

1 Bunnik EM, Dondorp WJ, Bredenoord AL, *et al*. Mainstreaming informed consent for genomic sequencing: a call for action. *Eur J Cancer* 2021;148:405–10.
2 Sturm A. Improving Access to Genetic Counselors under H.R. 3235, the "Access to Genetic Counselor Services Act" of 2019. American Society of Human Genetics. Available: https://www.ashg.org/publications-news/ashg-news/nsgc-hr-3235/
3 Villegas C, Haga SB. Access to Genetic Counselors in the southern United States. *J Pers Med* 2019;9. doi:10.3390/jpm9030033. [Epub ahead of print: 01 07 2019].
4 Ormond KE, Laurino MY, Barlow-Stewart K, *et al*. Genetic counseling globally: where are we now? *Am J Med Genet C Semin Med Genet* 2018;178:98–107.
5 Birch PH. Interactive e-counselling for genetics pre-test decisions: where are we now? *Clin Genet* 2015;87:209–17.
6 Bombard Y, Hayeems RZ. How digital tools can advance quality and equity in genomic medicine. *Nat Rev Genet* 2020;21:505–6.

BMJ Open: first published as 10.1136/bmjopen-2022-060899 on 29 April 2022. Downloaded from http://bmjopen.bmj.com/ on September 29, 2023 by guest. Protected by copyright.

7 McCuaig JM, Tone AA, Maganti M, *et al*. Modified panel-based genetic counseling for ovarian cancer susceptibility: a randomized non-inferiority study. *Gynecol Oncol* 2019;153:108–15.
8 Birch P, Adam S, Bansback N, *et al*. Decide: a decision support tool to facilitate parents' choices regarding genome-wide sequencing. *J Genet Couns* 2016;25:1298–308.
9 Bombard Y, Clausen M, Mighton C, *et al*. The Genomics ADvISER: development and usability testing of a decision aid for the selection of incidental sequencing results. *Eur J Hum Genet* 2018;26:984–95.
10 Adam S, Birch PH, Coe RR, *et al*. Assessing an interactive online tool to support parents' genomic testing decisions. *J Genet Couns* 2018. doi:10.1007/s10897-018-0281-1
11 Grimmett C, Brooks C, Recio-Saucedo A, *et al*. Development of breast cancer choices: a decision support tool for young women with breast cancer deciding whether to have genetic testing for BRCA1/2 mutations. *Support Care Cancer* 2019;27:297–309.
12 Shickh S, Rafferty SA, Clausen M, *et al*. The role of digital tools in the delivery of genomic medicine: enhancing patient-centered care. *Genet Med* 2021;23:1086–94.
13 Bombard Y, Clausen M, Shickh S, *et al*. Effectiveness of the Genomics ADvISER decision aid for the selection of secondary findings from genomic sequencing: a randomized clinical trial. *Genet Med* 2020;22:727–35.
14 Managing incidental and pertinent findings from WGS in the 100,000 Genomes Project, PHG Foundation (2013), ISBN 978-1-907198-12-0
15 Shickh S, Clausen M, Mighton C, *et al*. Evaluation of a decision aid for incidental genomic results, the Genomics ADvISER: protocol for a mixed methods randomised controlled trial. *BMJ Open* 2018;8:e021876.
16 Schoonenboom J, Johnson RB. How to Construct a Mixed Methods Research Design. *Kolner Z Soz Sozpsychol* 2017;69:107–31.
17 Tashakkori A, Teddlie C. *Handbook of mixed methods in social & behavioral research*. SAGE Publications, 2003: xv, 768 p.
18 Chan A-W, Tetzlaff JM, Gøtzsche PC, *et al*. Spirit 2013 explanation and elaboration: guidance for protocols of clinical trials. *BMJ* 2013;346:e7586.
19 Chan A-W, Tetzlaff JM, Altman DG, *et al*. Spirit 2013 statement: defining standard protocol items for clinical trials. *Ann Intern Med* 2013;158:200–7.
20 Shickh S, Clausen M, Mighton C, *et al*. Health outcomes, utility and costs of returning incidental results from genomic sequencing in a Canadian cancer population: protocol for a mixed-methods randomised controlled trial. *BMJ Open* 2019;9:e031092.
21 Wakefield CE, Meiser B, Homewood J, *et al*. Randomized trial of a decision aid for individuals considering genetic testing for hereditary nonpolyposis colorectal cancer risk. *Cancer* 2008;113:956–65.
22 Laupacis A, O'Connor AM, Drake ER, *et al*. A decision aid for autologous pre-donation in cardiac surgery-a randomized trial. *Patient Educ Couns* 2006;61:458–66.
23 Miller FA, Hayeems RZ, Bytautas JP, *et al*. Testing personalized medicine: patient and physician expectations of next-generation genomic sequencing in late-stage cancer care. *Eur J Hum Genet* 2014;22:391–5.
24 Sandelowski M. Sample size in qualitative research. *Res Nurs Health* 1995;18:179–83.
25 Morse JM. Designing funded qualitative research. In: Denzin NKL, ed. *Handbook of qualitative research*. Thousand Oaks, CA.: Sage, 1994.
26 Miles M, Huberman AH. *Qualitative data analysis; an expanded sourcebook*. Newbury Park, CA: Sage, 1994.
27 Strauss A, Corbin J. *Basics of qualitative research: techniques and procedures for developing grounded theory*. Second ed. Sage Publications, 1998.
28 Coyne IT. Sampling in qualitative research. purposeful and theoretical sampling; merging or clear boundaries? *J Adv Nurs* 1997;26:623–30.
29 O'Connor AM. Validation of a decisional conflict scale. *Med Decis Making* 1995;15:25–30.
30 O'Connor AM, Tugwell P, Wells GA, *et al*. A decision aid for women considering hormone therapy after menopause: decision support framework and evaluation. *Patient Educ Couns* 1998;33:267–79.
31 O'Connor A. Ottawa decision support framework (ODSF). Available: https://decisionaid.ohri.ca/odsf.html [Accessed January 2 2022].
32 Connor AM. User Manual- decisional conflict scale, 2010. Available: https://decisionaid.ohri.ca/docs/develop/User_Manuals/UM_decisional_conflict.pdf [Accessed January 2 2022].
33 Kaphingst KA, Facio FM, Cheng M-R, *et al*. Effects of informed consent for individual genome sequencing on relevant knowledge. *Clin Genet* 2012;82:408–15.
34 Holmes-Rovner M, Kroll J, Schmitt N, *et al*. Patient satisfaction with health care decisions: the satisfaction with decision scale. *Med Decis Making* 1996;16:58–64.
35 Julian LJ. Measures of anxiety: State-Trait anxiety inventory (STAI), Beck anxiety inventory (BAI), and hospital anxiety and depression Scale-Anxiety (HADS-A). *Arthritis Care Res* 2011;63:S467–72.
36 Ware J, Kosinski M, Keller SD. A 12-Item short-form health survey: construction of scales and preliminary tests of reliability and validity. *Med Care* 1996;34:220–33.
37 Li M, Bennette CS, Amendola LM, *et al*. The feelings about genomiC testing results (factor) questionnaire: development and preliminary validation. *J Genet Couns* 2019;28:477–90.
38 Carere DA, Kraft P, Kaphingst KA, *et al*. Consumers report lower confidence in their genetics knowledge following direct-to-consumer personal genomic testing. *Genet Med* 2016;18:65–72.
39 Kaphingst KA, McBride CM, Wade C, *et al*. Consumers' use of web-based information and their decisions about multiplex genetic susceptibility testing. *J Med Internet Res* 2010;12:e41.
40 Grant PE, Pampaka M, Payne K, *et al*. Developing a short-form of the genetic counselling outcome scale: the genomics outcome scale. *Eur J Med Genet* 2019;62:324–34.
41 Fan CW, Castonguay L, Rummell S, *et al*. Online module for carrier screening in Ashkenazi Jewish individuals compared with in-person genetics education: a randomized controlled trial. *J Genet Couns* 2018;27:426–38.
42 Haun J, Luther S, Dodd V, *et al*. Measurement variation across health literacy assessments: implications for assessment selection in research and practice. *J Health Commun* 2012;17 Suppl 3:141–59.
43 Norman CD, Skinner HA. eHEALS: the eHealth literacy scale. *J Med Internet Res* 2006;8:e27.
44 Shea JA, Micco E, Dean LT, *et al*. Development of a revised health care system distrust scale. *J Gen Intern Med* 2008;23:727–32.
45 Degner LF, Sloan JA, Venkatesh P. The control preferences scale. *Can J Nurs Res* 1997;29:21–43.
46 Braun V, Clarke V. Using thematic analysis in psychology. *Qual Res Psychol* 2006;3:77–101.
47 Morse JM. Approaches to qualitative-quantitative methodological triangulation. *Nurs Res* 1991;40:120–123.
48 Sandelowski M. Rigor or rigor mortis: the problem of rigor in qualitative research revisited. *ANS Adv Nurs Sci* 1993;16:1–8.

BMJ Open: first published as 10.1136/bmjopen-2022-060899 on 29 April 2022. Downloaded from http://bmjopen.bmj.com/ on September 29, 2023 by guest. Protected by copyright.