Using patient decision aids to inform decisions about cancer susceptibility genetic testing and risk management: A narrative review of impact and experience

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Abstract

Objective

To evaluate how decision-support resources about taking up or interpreting genetic testing for hereditary cancer predispositions are experienced, and impact on cognitive or emotional outcomes.

Methods

A systematic review of quantitative, qualitative and mixed-methods studies involving adults with or without cancer who used an intervention to inform decisions about any cancer susceptibility genetic test or screening/risk-reducing options due to a known pathogenic gene variant. Interventions could be digital or paper-based and included information, education, risk presentation and decision-support resources. Study findings were summarised using narrative synthesis.

Results

Thirty-six publications describing 27 interventions were included. Interventions had a positive impact on experience and cognitive, emotional, and behavioural outcomes. None appeared to cause harm.

Conclusions

Decision-support resources should be used to complement the cancer genetic counselling patient pathway. These should be rigorously developed according to evidence-based frameworks and in collaboration with patients.

1. Introduction

People who have genetic testing and are found to carry a pathogenic gene variant that causes increased cancer risk ('carriers') are presented with choices about screening, prevention and early detection (SPED) [1, 2]. They are also encouraged to communicate with at-risk relatives so they can be offered predictive genetic testing to inform cancer risk management [3]. Genetic testing has traditionally been supported through genetic counselling: the 'process of helping people understand and adapt to the medical, psychological and familial implications of genetic contributions to disease' [4]. Increased importance of genomic test results to guide cancer treatment [5–7] [8, 9] and calls for population screening to identify carriers and offer targeted SPED to those at high risk [10–12] have created increased pressure on already stretched resources.

Internationally, there are not enough geneticists and genetic counsellors to provide timely pre- and post-test counselling for every person with cancer having testing. Oncologists and nurses have limited time in oncology clinics to elicit family history and fully inform patients making decisions about genetic testing and management, which are personal and can be difficult. Decision-making is multifaceted, dependent upon patient knowledge, expectations and self-efficacy as well as scientific uncertainty about cancer risk prediction and effectiveness of SPED recommendations. Even if knowledge can be increased through genetic counselling [13], people may not accept that risks apply to them [14, 15] or events will happen to them personally, for example due to framing [16] and anchoring-and-adjustment biases [17], which can be influenced by the way risks are communicated.

Shared decision-making

Shared decision-making between health care providers and patients is recommended [18], particularly where choices are personal and complex, as is typical with genetic testing. In the United Kingdom, the National Institute for Health and Care Excellence (NICE) provides evidence-based guidelines for clinical care. Regarding shared decision-making, NICE recommends that values, needs and information preferences be considered, and explanations of risks and benefits should be individualised as much as possible [19].

Decision support tools

Patient decision support tools (including decision aids) have been employed in many areas of medicine including cancer treatment [20] and screening [21]. They are useful when there is no clearly preferred option, or when feelings and choices may differ according to individual values. A Cochrane review of 105 studies including 31,043 patients using decision aids before/during clinic compared to usual care revealed increased knowledge and confidence about decisions aligned with personal values, without harmful effects [22]. However, clinicians must be mindful that the design and effectiveness of patient decision support tools are variable, with many decision aids not meeting the International Patient Decision Aids Standards (IPDAS) [23] or lacking a theoretical framework [24] to inform content delivery.

Decision aids for hereditary cancer susceptibility

Strategically using decision support tools to streamline the consent process for most people having genetic testing and then offering personalised post-test genetic counselling could be an efficient and scalable model for delivery [25] and preserve the limited genetic counselling resource to maximise patient benefit. Many web- or paper-based resources have been developed to deliver education about genetic testing options [26–31]. Digital tools have proved non-inferior to a Genetic Counsellor when measuring how the educational component of a genetic counselling session improves patient knowledge [32]. Patient decision
aids could supplement clinical counselling and promote shared decision-making about genetic testing for patients with cancer [33] and personalise post-test care of those identified to have a genetic cancer susceptibility [34, 35].

However, whilst web-based education may be highly acceptable [36], people will often seek online sources of information themselves [37], value individual choice, and may not view information if asked to do so at home rather than in clinic [38]. Purely educational tools will not replicate the tailoring of language and information and the facilitation of personalised values-based decision-making made possible through the therapeutic alliance formed during genetic counselling [39] and will not address all decisional needs. Therefore, there is a need to better understand the impact and experience of patient decision aids for genetic cancer susceptibility.

Study aims

A search of published literature and the International prospective register of systematic reviews (PROSPERO) did not identify any systematic review with broad inclusion criteria to examine decision support tools related to any genetic cancer predisposition. This systematic review aimed to evaluate patient interventions (any resources, including educational materials and decision aids) to support decision-making about genetic testing for any hereditary cancer susceptibility, or risk management for pathogenic variant carriers in terms of:

1. impact on outcomes, e.g. cognitive, emotional, or behavioural and
2. patient experience.

The extent to which existing decision-making interventions meet patients’ needs will be explored and recommendations for clinical practice and future research proposed.

2. Methods

The Centre for Reviews and Dissemination’s guidance for reviews in health care [40] and the Preferred Reporting Items for Systematic Reviews (PRISMA) 2009 statement [41] guided methods and reporting for this systematic review. Stakeholders were consulted from the planning phase and this included patient engagement in design and data synthesis. The protocol was published on PROSPERO: https://www.crd.york.ac.uk/prospero/display_record.php?RecordID=220460.

2.1 Literature searching

The following databases (and host platforms) were searched and re-run prior to final analysis (from database inception to 02/07/2021, English language only): MEDLINE (EBSCOhost), PsycINFO (EBSCOhost), Embase (OVID), CINAHL (EBSCOhost), Web of Science Core Collection, and the Cochrane Library (Cochrane Database of Systematic Reviews (CDSR); Cochrane Central Register of Controlled Trials (CENTRAL)). The search strategy combined key word and subject terms targeting three concepts: cancer genetics, decision-making, and written resources (Supplementary appendix 1).

In addition, other relevant studies were identified by examining bibliographies of included publications and using forward citation searching in Web of Science Core Collection. Grey literature was searched to identify unpublished resources (Supplementary appendix 2).

2.2 Study selection

Inclusion and exclusion criteria are detailed in Table 1. In brief, studies were included if they involved adults (with or without cancer) who used an intervention to assist decisions about genetic testing for any hereditary cancer predisposition or screening/risk-reducing options due to a pathogenic gene variant. Interventions could be delivered digitally or paper-based, and included one or more of the following: information, education, visual presentation of cancer risk and decision support. Quantitative, qualitative and mixed methods studies were included.

Table 1 Study inclusion and exclusion criteria
Population

1. People with a cancer diagnosis deciding about:
   a) genetic testing
   b) treatment or risk-reducing options based on genetic test results

2. People with a known pathogenic variant in a cancer predisposition gene deciding about risk-reduction options

3. People at increased risk deciding about genetic testing, including:
   a) people with a family history of cancer
   b) people with a personal history of cancer
   c) people with a known pathogenic variant in the family deciding about predictive testing
   d) people of Ashkenazi Jewish descent

Exclusion:

1. Under 18 years of age
2. Parents making decisions on behalf of their children
3. General population without any known raised cancer risk or with a family history using a tool or consultation to consider whether they are eligible for referral for genetic testing
4. People not at raised risk asked to consider hypothetical risk

Intervention

Written or pre-recorded patient-facing resources, including information, education, risk presentation, and decision support. Digital (e.g. web-based, email, smartphone, text messaging, non-live webinars) or paper-based.

Exclusion:

1. Genetic counselling sessions without giving patients a digital/written tool
2. Risk prediction models at population level to inform HCPs or guidelines
3. Tools to help HCPs identify patients for referral to genetic testing, e.g. family history questionnaire
4. Social media and patient fora
5. Resources to support people to cope with the process of genetic testing
6. Resources to facilitate communication with family members
7. Resources to facilitate reproductive decisions
8. Resources not available in English

Comparator

Control group if the study has one, but not necessary

Outcomes

Quantitative or qualitative evaluations of intervention acceptability and impact of decision aid, including cognitive outcomes (e.g. knowledge, intention to use genetic testing, perceived risk), emotional outcomes (e.g. satisfaction, decisional conflict, emotional burden, anxiety) and behaviour change following test results.

Studies describing intervention development process only included if impact or experience of patient captured in some way.

Exclusion:

1. Studies which examine factors influencing decision-making, but which are not focused on the impact of a written tool or resources on this process.
2. Studies which do not report any patient outcomes of interest to the review.

Study design

Any

All search results were exported to EndNote X9 software for de-duplication. Two reviewers (KK, KM) independently screened 20% of titles and abstracts (sampled in alphabetical order) as a pilot to test whether the inclusion/exclusion criteria were appropriate and to assess whether their application was accurately applied by both reviewers. Rayyan, a web application for collaboration on systematic reviews [42] was used. After each batch of 100 references in the 20% pilot, reviewers' decisions were unblinded and compared. There were 29 disagreements out of 500 and these were all resolved through discussion. Informed by the pilot, the eligibility criteria were adjusted following discussion with the wider research team (DE, CF, CG, LT). The remaining 80% of titles and abstracts were screened by the lead author (KK). Both reviewers completed full text screening. Where discrepancies arose, discussion took place (involving wider research team where necessary) until agreement was reached.

2.3 Data extraction and critical appraisal

Data from eligible publications were extracted into an Excel database with fields guided by the TIDieR (template for intervention description and replication) checklist [43]. Both reviewers performed independent data extraction for 10% of the included studies. Disagreements were resolved through discussion. Subsequently, the lead author extracted data from the remaining studies, checked by the second reviewer.

Critical appraisal was performed by two researchers (KK, KM). Depending upon the type of study, this was guided by NICE checklists for quantitative intervention studies and qualitative studies [44] or the mixed-methods appraisal tool [45].

2.4 Data synthesis
The review questions necessitated inclusion of a wide range of studies, mostly of quantitative but also mixed methods and qualitative design. Meta-analysis was not possible due to the heterogeneity of methodologies, populations and outcome measures. Narrative synthesis, often used for systematic reviews of healthcare interventions [46], was selected as the most appropriate method to synthesise findings without diluting the individual value contributed by different study designs [47, 48]. Tabulated data were examined to describe patterns and summarise estimates of intervention effect direction and size [49] [46]. Studies were grouped into clusters and subclusters based on type of patient intervention, study design, setting and reported outcomes (Figure 1) to facilitate post-hoc subgroup analysis [47]. Qualitative data were subjected to thematic analysis to interpret primary themes and concepts, and representative patient narratives were chosen to be presented in their original form to illustrate these themes [48].

3. Results

Sixty-four publications regarding 46 patient interventions were found to be eligible from the searches (more than one publication was included regarding some of the interventions). Figure 2 shows the flow of study selection using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram [41]. Most studies were from United States (n=26), followed by Australia (n=12) and Netherlands (n=12). A pragmatic decision was taken to focus data synthesis on studies published from 2011 onwards, and the protocol was amended accordingly. Older studies were less relevant to our research question and based on outdated guidelines. As shown in Figure 3, 36 publications were retained, describing 27 interventions divided into two clusters and four subclusters as illustrated in Figure 1.

3.1 Critical appraisal of studies

Most (n=17) studies contained strong certainty of evidence/low risk of bias, 13 contained medium certainty of evidence/moderate risk of bias and three contained weak certainty of evidence/high risk of bias (Supplementary appendix 3). Study design varied, from publications describing development of interventions with some preliminary patient evaluation in a hypothetical decision-making setting [35, 50–57] to larger randomised controlled trials in target populations [58–63]. Follow-up was often short (less than two months), with only a few studies recording outcomes as long as 12 months after intervention [60, 62, 64–66]. Qualitative study designs resulted in some rich findings [67–71] but some lacked rigorous analysis methods leading to more shallow data [52, 67]. Overall, external validity was limited by lack of diverse patient groups, with most samples consisting of White, well-educated participants.

3.2 Target population

Cluster 1 interventions supported decisions about genetic testing for people diagnosed with breast (72, [71], [73], [67], [74], [64], [68], [38]), ovarian [75], breast/ovarian [76] and colorectal cancer (77, [78]) as well as people (mostly) unaffected by cancer with a family history (60, [79], [80], [61],[55, 56]) or of Ashkenazi Jewish heritage ([58], [69]) (see Table 1). All Cluster 2 interventions targeted BRCA1 or BRCA2 pathogenic variant carriers to support decisions about risk management. These were designed for carriers unaffected by cancer ([62], [52]), carriers with personal history of breast cancer ([70], separate versions tailored to breast cancer history [35] or not specified [54, 66], [53], [59]).

3.2.1 Setting for delivery of patient intervention

Cluster 1 interventions were designed to replace face-to-face genetic counselling prior to testing ([76], [74], [64], [38], [75], [55, 69]) or to supplement genetic counselling ([60], [79], [80], [77], [71], [73], [58], [61], [67], [51, 56]), which may have been delivered in the mainstream setting by oncology professionals ([72], [78], [59]). Cluster 2 interventions were exclusively to supplement standard of care genetic counselling for people known to have high cancer risk due to a pathogenic gene variant.

3.3 Characteristics of interventions

3.3.1 Conceptual/theoretical framework

In most publications, a conceptual/theoretical framework to inform design was not stated. However, six decision aids were based on underlying theory [61] [50], [81], [60] [78] [66, 73], [71] [56] (see Table 2). These included theories related to information tailoring [50, 60, 81], such as the elaboration likelihood model of communication persuasion which examines how presenting personalised messages can encourage more thoughtful decision-making [82] [83]. The health belief model [84] suggests behaviour change is maximised if interventions address threat severity and personal benefits and the transtheoretical model of health behaviour change [85] describes stages of change that people move through before taking action. These two behaviour change theories informed content presentation in a psychoeducational intervention and measurement of intention to pursue genetic counselling and testing [73]. Another theory informed information presentation [71, 73]: the fuzzy-trace model postulates decision-making is influenced by a quick, intuitive ‘getting the gist’ which is personal and values-based, and can be more important than memory of information learned verbatim [83].
### Table 2
Characteristics and main findings of studies (see Excel file)

<table>
<thead>
<tr>
<th>Population</th>
<th>1. People with a cancer diagnosis deciding about:</th>
</tr>
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<tr>
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</tbody>
</table>

Whilst not all decision aids were informed by theory, some [70], [71], [66], [52], [35], [56], [62] followed recommended guidelines such as the Ottawa Decision-Support Framework (ODSF) [86] which includes a values-based exercise to improve decision quality and process. Similarly, the multiattribute value and utility models [87, 88] guided inclusion of pros and cons of cancer risk management choices that patients rated according to personal importance [66], and the informed choice model [89, 90] was used to theorise that increased knowledge would improve decision-making quality and genetic testing uptake [56].

### 3.3.2 Format and content of interventions

The intervention delivery mode varied widely. For Cluster 1 studies aimed at supporting decisions about genetic testing and replacing the need for in-person counselling before testing, a brief information letter was used [76], [74], [64], or letter and digital options including a website [56], video [38] or chatbot [55]. Educational presentations to supplement genetic counselling ranged in length from seven-minute video [75], 12-minute DVD [73] or animated slides [80], 15-minute DVD delivered to small groups [58], 20-minute voice-recorded presentation [61] and CD-ROM about microsatellite instability testing in colorectal cancers that took on average 24 minutes to view [78].
Paper-based resources were either brief (one-page) and focused on treatment-related implications of genetic testing for people with breast cancer [67] or longer (15-page) including a worksheet to record personal weighing up of options [35, 54, 62]. Others made resources available online with printable content [71, 52]. Visual aids were created to improve cancer risk communication in genetic counselling using pictures, diagrams and tables [51] or by comparing an interactive spinner-game format to random dot icon arrays [79]. Digital decision support tools were mostly interactive [70, 77, 71, 66, 59, 69] and some also included computer-tailoring for personal characteristics to present more relevant information [60, 72, 53, 56].

3.4 Impact of interventions

A summary of the main findings is presented in Table 2, with narrative synthesis below.

3.4.1 Knowledge/understanding/expectations

Improvement in cancer genetics knowledge or realistic genetic counselling expectations was statistically significant for many interventions [60, 72, 78, 58, 61, 51] but not all [77]. However, measurement was often by self-report, using unvalidated questionnaires and/or with lack of pre- and post-counselling measures or control group. In one study, participants stated viewing an educational video increased knowledge, however qualitative data gathered via semi-structured interview suggested gaps in knowledge remained, for example many thought genetic counselling was the same as genetic testing [68].

The accuracy of cancer risk perception significantly improved by adding personalised visual aids to genetic counselling [79], with effects sustained up to six-months. However, recorded presentations before a shortened session had mixed results when compared to traditional counselling in randomised trials. An educational video followed by a shortened genetic counselling session was non-inferior to traditional counselling for increased knowledge, satisfaction and risk perception for community-recruited participants offered Ashkenazi Jewish founder BRCA1 and BRCA2 pathogenic variant testing [58]. People with a relative who died of ovarian cancer were offered 52-gene panel testing using a digital presentation viewed at home followed by a short telephone consultation with a genetic counsellor, which was non-inferior to traditional counselling for knowledge, satisfaction and psychological factors but not for ovarian cancer risk perception [61].

Notably, study participants were primarily well-educated with high baseline knowledge, which contributed to a ceiling effect for improvement potential. There was more variability in age, educational status and knowledge in studies including all people with a cancer diagnosis, compared to mostly unaffected cohorts who had presented for genetic counselling.

3.4.2 Distress/anxiety/cancer worry

Mental well-being outcomes such as distress, anxiety, cancer worry and depression tended to be below clinically relevant thresholds at baseline and follow-up, indicating no significant evidence of psychological harm from cluster 1 interventions [58, 60, 61, 73, 76, 91] [74]. For people newly diagnosed with cancer, levels were transiently increased and comparable to levels generally reported at this expectedly challenging stage of life and genetic testing using decision support tools did not increase symptoms [76], [73, 74] [38, 65]. However, several studies excluded patients with psychological conditions [38, 65, 67, 92–94], so it is not known how interventions might have influenced mental well-being in these groups.

Some cluster 2 interventions for carriers showed time-dependent results, with cancer-related distress higher in the decision aid group compared to usual care at one month, but lower from one- to six-months, possibly indicative of a deliberative decision-making process [66] or declining over time but similar in decision aid and usual care groups [62]. Distress was also shown to vary by topic, with lower levels regarding chemoprevention compared to risk-reducing breast and ovarian surgery decisions [62].

3.4.3 Genetic testing uptake

Written information instead of pre-test counselling led to genetic testing uptake in 405/1015 (45.4%) [91] and 542/818 (66.2%) [92] patients with breast and 83/1015 (68.0%) with ovarian cancer [91], although there was no comparator group and older people were less likely to take part in the studies. An educational video followed by brief counselling in community-recruited participants led to high genetic testing uptake, with 92% of video vs. 96% of the traditional counselling group electing testing, and video delivered a significant time saving (19.4 vs 45.8 minutes, p<0.001) [61]. In a similar study, 89% across DVD and traditional counselling groups had genetic testing, with the DVD method saving 20.5 minutes of counselling time [58]. However, there was lower uptake of genetic testing amongst patients with ovarian cancer shown a video in oncology clinic instead of referral for genetic counselling (162/295, 55%) [75]. Despite interventions increasing knowledge and interest in genetic testing, patients particularly valued their doctor's advice and did not always follow through on scheduling a genetic counselling appointment [72, 73]. Some interventions were used to manage expectations about being offered genetic testing [55, 63], a successful approach for people at lower risk who do not meet eligibility criteria for testing in current guidelines. These participants were educated about the low likelihood of having a pathogenic variant and the reasons why testing was not indicated.

3.4.4 Decisional conflict

Decisional conflict describes level of uncertainty about which choice to make. The decisional conflict scale measures factors that contribute to decisional conflict, such as level of support received whilst making a decision, information provided to support decision making and the contribution of personal values in decision making [95]. Results from this review suggest people with lower health literacy, knowledge or support and higher decisional conflict or distress may need additional decision support and genetic counselling [80, 72, 64].

An educational resource to shorten pre-test genetic counselling was non-inferior to standard care with respect to decisional conflict in people with a family history of ovarian cancer (video, [61]) and people diagnosed with breast cancer before age 50 years (pamphlet, [74]). Baseline levels of decisional conflict were moderate in people referred for genetic risk assessment, and showed significant decrease at two-months after using an interactive, web-based decision aid about breast reconstruction after risk-reducing mastectomies, compared to standard of care counselling [59]. One study in 239 high risk patients with
colo colorectal cancer [78] showed that a decision aid impacted decisional conflict by increasing knowledge and preparedness to make a decision. Decisional conflict was also influenced by knowledge-independent factors such as attitudes about testing and learning about hereditary cancer risk which, along with other barriers, are often not addressed in decision aids.

**BRCA1** and **BRCA2** pathogenic variant carriers with no history of cancer had low baseline decisional conflict about breast risk management options in intervention and control groups, which declined with time up to 12-months and was not significantly influenced by a paper-based decision aid used at home after post-test genetic counselling [62].

### 3.5 Evaluation of interventions

#### 3.5.1 Satisfaction and acceptability

Satisfaction and acceptance of interventions was high across clinical settings and participant groups; however, usage was often untracked, and many studies did not compare to standard care in a randomised controlled trial. Where optional usage was monitored or self-reported, this revealed 64/100 (64%) used an interactive CD-ROM [66], 94/140 (67%) used a website [77], and 53/60 (88%) viewed a video [73]. A much lower percentage (487/4254, 11.4%) of people presenting for colonoscopy screening engaged with a chatbot to answer questions about their family history to determine eligibility for genetic testing [55]. Most (95/161, 59%) people with breast cancer chose to use streamlined pre-test information instead of genetic counselling; when presented with letter and video options, most only read the letter and none contacted the doctor with questions [38]. There was no regret at 12-months about choosing streamlined genetic testing, which identified a pathogenic **BRCA** variant in 8/95 (8%) of participants [65]. Similarly, 96% of people with breast cancer were satisfied at 12-months with a short letter instead of pre-testing and only 11/818 (2%) contacted the genetic counsellor for support [64]. Only 20/1015 (1.9%) of people with breast or ovarian cancer who received written pre-test information in oncology contacted the genetic counsellor [91].

### 3.5.2 Experience and emotional outcomes

Two qualitative studies explored the experience of people with breast cancer using interventions to decide about genetic counselling/testing. In a telephone structured interview study to evaluate acceptability and emotional impact of a one-page pamphlet about treatment-focused genetic testing, 7/17 people thought the pamphlet sufficient for decision making, whilst 10/17 believed more information was needed, e.g. discussion with health care professional (HCP) or searching online. Four out of 17 were worried by reading the pamphlet: three were reminded of breast cancer diagnosis and one worried about relatives. Think-aloud interviews reviewing a web-based decision aid revealed people with breast cancer preferred less text, to get the ‘gist’, with optional, more detailed information, and wanted a ‘friendlier’ feel to patient pictures [71]. This is in contrast to study findings about another web-based decision aid tailored for personal characteristics [50], in which people with breast cancer spent more time looking at information and selected to receive extensive detail, however when looking at the information 12/85 (14.4%) then found it upsetting.

The JeneScreen web-based programme for Ashkenazi Jewish founder pathogenic variant testing was evaluated in a pre- and post-test interview study of 11 people without cancer [69]. Similar to findings from another study involving people with breast cancer [71], participants wanted less pre-test information upfront and suggested a staged approach: “…But you may not get that result, so you wouldn’t need to go into as much detail about that topic...only if you need the information”. Ten out of 11 were satisfied with online consent to testing and suggested it was more convenient: “Online, everybody prefers online”, “If it required me going somewhere to meet someone, then it probably would have taken me longer to get around to doing it”. However, a participant aged 71 years referred to her age as the reason she would prefer in-person support: “Well, I am over 70, I prefer to do things where I am speaking to someone”.

A psychoeducational intervention (PEI) containing information about hereditary breast cancer testing was explored by focus groups (paper version, [57]) and semi-structured interviews (video format, [68]). The paper PEI was visually attractive and culturally acceptable: “I like the cover; you have a variety of ethnic groups and ages” and appreciated as a take-home resource: “you’re only going to remember a little piece of what [your health care professional says]...but hand me books...I can flip through it and then...write down notes to ask the next time I see somebody”; “I would see it, I can hold it, I can turn the pages...it prompts me to start thinking” [57]. Participants with breast cancer had emotional reactions to patient narratives in the video PEI: “It just makes you realize [sic] that other people feel or felt like that….touching to watch the stories because I can relate, I kind of teared up” [68].

Focus groups with 15 **BRCA** carriers with breast cancer guided development and evaluation of a web-based decision aid [70]. Key decision-making motivating factors were identified, such as feeling obliged e.g. “do the right thing” to save life by having risk-reducing ovarian surgery, or HCPs being strong influencers on decisions, e.g. “my surgeon was gung-ho”, describing consultations about risk-reducing mastectomies. Inclusion of a values-based exercise was appreciated: “When it is in black and white in front of me and I am able to block out everybody else, what they want, what they think I should do and I can look at it and say what is the best thing step by step for me and then get a print out – that is huge”. Timing for presentation of decision aids was debated, suggesting need for personalisation, with one person summing up: “The patient will probably let you know if they are ready for it or not”. Patients preferred to use decision aids in clinical settings: “more geared up...more serious about it if it was in an office than at home”, while clinicians (also included in focus groups) were keen for at-home use but cautioned that support was needed: “…are they really going to know how to self-interpret with what they’ve just done?”

### 4. Discussion And Conclusion

#### 4.1 Discussion

This systematic literature review identified a heterogenous range of interventions to support decision-making about genetic testing for cancer susceptibility, or cancer risk management for pathogenic variant carriers. Regarding the aims of this review, i) no negative impact on cognitive, emotional or behavioural outcomes was found, although some studies found a lack of positive effect on some outcomes and ii) all studies evaluating experience reported positive feedback. This is in accordance with systematic review findings of Ottawa Decision Support Framework (ODSF)-based decision support in 24 randomised
controlled trials which showed decision aids used across a variety of medical specialities resulted in higher quality decisions and less HCP resource, compared to usual care [96]. Some of the interventions included in this review used a framework such as ODSF/IPDAS, but many did not which could have impacted effectiveness. The ODSF was recently updated following a review of use across 18 countries and >50,000 patients [97] to include decisional outcomes such as proportion of patients undecided, feeling uninformed, unsupported or unsure of values. There has been limited evaluation of these outcomes in decision support for cancer susceptibility, and their inclusion should be given consideration in future research.

Streamlined, cost-effective pathways and patient resources are needed for HCPs to deliver genomic testing ‘routinely to all people with cancer’, a commitment of the NHS Genomic Medicine Service [98] to inform surgical/treatment options, future cancer risks and risk to relatives. Patient-friendly genetic test reports that are well understood are a point of care strategy to improve communication about result implications and next steps [99]. Written or digital educational materials can be non-inferior to genetic counselling in the pre-test setting to deliver the educational component of counselling and increase knowledge [32, 58, 61]. However, content needs careful development and regular updates in collaboration with patients, with attention to tailoring for personal characteristics, cultural acceptability, visual presentation of cancer risks and values-based exercises to improve decision quality. Setting, mode of delivery and accessibility should be given due consideration and evaluation. People may not use an intervention if asked to view a video/website/chatbot, or look at something at home, and they will rarely contact an HCP with questions. It is not known whether these people did not need support or did not realise what support and benefit genetic counselling could provide for them. More research is needed to determine the best strategy to triage for barriers, higher decisional conflict and lack of support to make decisions about genetic testing. Those with more decision support needs should be referred to genetic counselling along with being offered tailored paper- and/or web-based patient resources.

Quantifying genetic cancer risk (known as ‘penetrance’) depends on the gene variant as well as the age, medical and family history of the individual [100–103]. Understanding of risk conferred by variants in cancer susceptibility genes has progressed at pace due to advances in genomic sequencing technology and large consortium studies [104–106]. Despite these advances, uncertainty remains about the likelihood that a carrier will develop cancer, which type of cancer and at what age. This is often experienced as trading one type of uncertainty for another, first finding out the genetic test result and then diverting thoughts and energy to thinking (or worrying) about what happens next. In patient-centred healthcare, uncertainty is multidimensional, including ethical [107], as well as scientific, system-based and personal factors linked to values, understanding and context for the individual [108, 109]. Communication about uncertainty in a transparent, accessible way that engenders trust is a challenge for creators of a decision aid, but if done successfully could improve understanding and emotional response [110–112] and make patients feel part of a team with their HCP [113].

Designing studies in clinical settings to examine the extent to which decision-making interventions meet needs is challenged by the need to personalise for patient characteristics and secure endorsement by health care teams working with limited resources. Emerging research suggests that using digital technology such as smartphone applications could be acceptable and accessible for populations with lower literacy to consent for genomic testing [114], however continued bioethics exploration is needed to optimise inclusivity and meet patient needs. One size does not fit all, but harnessing digital technology to personalise decision support resources can empower more people to take an active role in their care plan and improve health outcomes, consistent with the goals of the NHS Long Term Plan [115] and Universal Personalised Care Action Plan [116].

Future work

This review will inform development and clinical implementation of a prototype decision aid to supplement genetic counselling for hereditary cancer syndromes. Most decision aids have focussed on pre-genetic test decisions rather than cancer risk management after results. This highlights a need for more resources for pathogenic variant carriers, particularly for genes other than BRCA1 and BRCA2. The decision aid we develop will be tailored based on personal characteristics to present risk estimates and relevant options for cancer risk management for carriers. This will be multi-modal to allow wider dissemination, using an interactive website with the option to print personalised paper-based versions. Our research group will appraise components of decision aids identified in this review and undertake co-design with patient collaborators. Stakeholders from clinical genetics, oncology, charities, ethics, academic and health care bodies will be engaged. The Person-Based Approach [117] will be used to develop and iteratively optimise content and delivery of the decision aid.

Limitations

Non-peer reviewed, published resources may not have been identified. The decision to exclude pre-2011 publications resulted in loss of some relevant (but dated) evidence. Since genetics and technology are evolving so rapidly, it was decided that the review would be more relevant if it was focussed on more recent publications. The findings of this systematic review may be subject to uncertainty due to methodological limitations of the included studies, including: lack of comparison to usual care using randomised controlled trials; use of unvalidated outcome measures; potential bias due to missing data (included untracked usage of resources in intervention groups) and short-term follow-up. Samples often lacked pathogenic variant carriers (where included, these were exclusively BRCA1 and BRCA2). Studies were commonly conducted in a single centre or only one country and therefore may not be generalisable to other populations. Lack of patient empowerment in research co-design was a common limitation, and recruitment was largely restricted to well-educated groups that were not ethnically diverse.

4.2 Conclusions

More longitudinal research is needed regarding whether people complete actions in line with the decisions they make about cancer susceptibility genetic testing and cancer risk management using decision aids. Longer term studies are important to understand whether people retain knowledge and accurate risk perception and maintain low levels of distress and decisional conflict over time. Evaluation should drive an iterative process of development and refinement of patient decision aids and determine the most effective mode of delivery in oncology and genetics services to improve health outcomes. Sustainable funding to update and securely host decision aids is essential to ensure patients are provided with personalised cancer risk estimates and options based on current evidence and clinical guidelines.
There is clear potential for patient decision aids and other resources to improve shared decision-making about hereditary cancer predisposition without causing harm. These should be designed in collaboration with patients and stakeholders, including empowerment of seldom heard-from communities less likely to take part or historically excluded in formal research. Psychological behavioural theory and a proven framework e.g. the ODSF [86] should underpin design, and quality standards should be met, e.g. IPDAS [23].

4.3 Practice implications

HCPs in oncology should be provided with education and patient-facing resources such as decision aids for genetic testing for cancer susceptibility and risk management options. Decision aids should be endorsed by professional bodies trusted by the communities being served and hosted securely online. Clinical implementation will involve evaluating the decision aid in complex care pathways, with the resource limitations present in the health care setting. Paper resources can be widely disseminated by HCPs who can additionally signpost patients to the opportunity to delve into more extensive information and decision support via an interactive, web-based platform. To increase shared decision-making leading to higher quality decisions and outcomes for people with hereditary cancer susceptibility, further research is needed to understand what works for whom, how, why and in what setting [118], [119].

Online resource 1 MEDLINE search strategy
<table>
<thead>
<tr>
<th>MEDLINE Search</th>
<th>Concept 1</th>
<th>Concept 2</th>
<th>Concept 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Key concepts</strong></td>
<td>People with cancer, at risk of cancer, or family members considering genetic testing</td>
<td>Decision making</td>
<td>Written Intervention terms</td>
</tr>
<tr>
<td><strong>Free text terms / natural language terms</strong></td>
<td>(familial or genetic* or gene* or heredit* or inherit* or predispos* or susceptib* or &quot;TGF*&quot; or &quot;treatment focused genetic test&quot;)</td>
<td>Decision W1 (process* OR support* OR aid* OR tool* or making or -aid) (146,517)</td>
<td>(digital n3 (tool* or solution? or platform? or technolog* or dashboard? or portal) (6007)</td>
</tr>
<tr>
<td></td>
<td>N2 (cancer* or neoplasm* or tumor* or malignant* or carcinoma* or sarcoma* or adenocarcinoma*) (53,765)</td>
<td>&quot;Choice behavior&quot; (1,594)</td>
<td>(&quot;database tool?&quot; or &quot;interactive tool?&quot; or &quot;software tool?&quot; or &quot;internet tool&quot; or &quot;internet intervention&quot; or &quot;electronic tool?&quot; or &quot;electronic device?&quot; or &quot;computer* assisted intervention?&quot;) (6009)</td>
</tr>
<tr>
<td></td>
<td>(&quot;hereditary cancer&quot; or &quot;cancer predisposition&quot;) (4,521)</td>
<td>&quot;Patient preference&quot; (3,933)</td>
<td>(digitiz* or digitis* or digitali*) (26,400)</td>
</tr>
<tr>
<td></td>
<td>Li Fraumeni or Li-Fraumeni or TP53 or BRCA1 or &quot;BRCA 1&quot; or BRCA2 or &quot;BRCA 2&quot; or PALB2 or &quot;Breast Cancer 1&quot; or &quot;Breast Cancer 2&quot; or Lynch or HNPCC or MLH1 or MSH2 or MSH6 or PMS2 or &quot;Familial Adenomatous Polyposis&quot; or FAP or APC (68,394)</td>
<td>Decid* (88,647)</td>
<td>&quot;patient portal?&quot; (637)</td>
</tr>
<tr>
<td></td>
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<td>(&quot;risk commun*&quot; or &quot;risk assess*&quot; or &quot;risk informat*&quot; or &quot;risk appraisal*&quot; or &quot;risk perception*&quot; or &quot;risk perception method&quot;) (7,208)</td>
<td>(&quot;e-technology&quot; or &quot;electronic technology&quot; or &quot;e-clinical&quot;) (354)</td>
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<td>&quot;web portal?&quot; (725)</td>
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<td>(ipad or PDA or &quot;personal digital assistant&quot; or &quot;mobile phone&quot; or &quot;smartphone&quot; or smartphone? or mobile app? or mobile technolog* or mobile health? or mobile media? or &quot;health app&quot; or &quot;m health&quot; or palmtop? or laptop? or &quot;hand held device?&quot; or &quot;text message*&quot; or SMS or IVR or &quot;interactive voice recognition&quot; or &quot;voice activation&quot; or &quot;web deliver&quot;) (46,856)</td>
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<td></td>
<td></td>
<td></td>
<td>(interactive and website?) (1039)</td>
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<td></td>
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<td></td>
<td>(&quot;web based&quot; or &quot;web tool?&quot; or &quot;web delivery&quot; or &quot;web delivered&quot; or podcast?) (31,718)</td>
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<td>(&quot;e-mail&quot; or email or &quot;electronic mail&quot;) (14184)</td>
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<td>Handout? (1025)</td>
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<td>Brochure? (2,247)</td>
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<td>Intervention? (861,034)</td>
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<td>Pamphlet? (1,818)</td>
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<td>Program* (854,368)</td>
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<td>Material? (695,933)</td>
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<td>Resource? (326,225)</td>
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<td>Algorithm? (246,436)</td>
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<td>Navigation? (23,118)</td>
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<td>Aid? (163,159)</td>
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<td>Framework (273,266)</td>
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<td>Paper? (831,297)</td>
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<table>
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<tr>
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<th>Concept 2</th>
<th>Concept 3</th>
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<td>(MeSH terms, Emtree terms)</td>
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<td>EXP Decision Making+ (200,616)</td>
<td>Patient Navigation/ (571)</td>
</tr>
<tr>
<td>Consider: explode major headings, subheadings</td>
<td>BRCA1 Protein/ (3,754)</td>
<td>EXP Decision Support Techniques (76,873)</td>
<td>Patient Portals (303)</td>
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<td>Genes, BRCA2/ (2,175)</td>
<td>Risk reduction behaviour (5,023)</td>
<td>Patient Education Handout (415)</td>
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<td>MM Mobile Applications/ (4568)</td>
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<td>Hereditary Breast and Ovarian Cancer Syndrome/ (220)</td>
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<td>MM Communications Media/ (1140)</td>
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<td>Lynch syndrome II (21)</td>
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<td>MM smartphone/ (3020)</td>
</tr>
<tr>
<td></td>
<td>EXP Genetic Testing/ and EXP neoplasms (9561)</td>
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<td>EXP computer systems/ (177,776)</td>
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<td>Neoplastic syndromes, hereditary/ (2,090)</td>
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<td>EXP internet/ (79,132)</td>
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<tr>
<td></td>
<td>EXP genetic predisposition to disease/ and EXP neoplasms (36785)</td>
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<td>MM Pamphlets/ (1782)</td>
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<td></td>
<td>EXP Disease susceptibility/ and MM neoplasms(40674)</td>
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<td>= TOTAL (3,850,529)</td>
</tr>
<tr>
<td></td>
<td><strong>= TOTAL:</strong></td>
<td><strong>(470,577)</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(142,259 once neoplasms combined with each of the general disease susceptibility thesaurus terms to limit the results to cancer-related).</td>
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**Online Resource 2** List of conference proceedings and grey literature searches
<table>
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<tr>
<td>2 Annual conference Clinical Genetics of Cancer (identified by database searches) 2017 <a href="https://www.ncbi.nlm.nih.gov/pmc/articles/PMC841194/">PMC841194</a></td>
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<tr>
<td>3 Annual conference of hereditary cancers 2016 <a href="https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5731602/">PMC5731602</a></td>
<td>17</td>
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<tr>
<td>5 1st International symposium on Hereditary Breast and Ovarian Cancer: 2005 Not found</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 2nd International symposium on Hereditary Breast and Ovarian Cancer: 2007 Not found</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 3rd International symposium on Hereditary Breast and Ovarian Cancer: 2010 <a href="https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2768503/">PMC2768503</a></td>
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<td>8 4th International symposium on Hereditary Breast and Ovarian Cancer: 2012 <a href="https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3320236/">PMC3320236</a></td>
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<tr>
<td>9 5th International symposium on Hereditary Breast and Ovarian Cancer: 2014 <a href="https://europepmc.org/article/PMC3997469">PMC3997469</a></td>
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<td>10 6th International symposium on Hereditary Breast and Ovarian Cancer 2016 <a href="https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4900850/">PMC4900850</a></td>
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<tr>
<td>11 7th International symposium on Hereditary Breast and Ovarian Cancer 2018 <a href="https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6023566/">PMC6023566</a></td>
<td>163</td>
<td>2</td>
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<tr>
<td>12 NHS Evidence hereditary cancer decision aid Not found <a href="https://www.evidence.nhs.uk/">Evidence.nhs.uk</a> [accessed 03/07/2020]</td>
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<tr>
<td>13 TRIP (Turning Research Into Practice) <a href="https://www.tripdatabase.com/">Tripdatabase.com</a> [accessed 03/07/2020] (title:(hereditary or familial or predisposition or susceptibility) and cancer)(title:Decision (process* OR support* OR aid* OR tool* or making or aid)(title:(handout* or brochure* or booklet* or leaflet* or paper or intervention* or web* or digital* or online or internet or pamphlet* or program* or material* or resource* or algorithm* or tool or navigation* or technology* or aid*))</td>
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<tr>
<td>14 Google Scholar <a href="https://scholar.google.com/">Scholar.google.com</a> [accessed 27/11/2020] All words: gene*, decision* At least one of: cancer, BRCA* Location: anywhere in article</td>
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| All words: heredit*, cancer  
Exact phrase: genetic testing  
At least one of: intervention or aid or decision  
Location: anywhere in article | | |
| 16 Google Scholar [accessed 27/11/2020] | First 200 of 78100 | 0 |
| All words: cancer, decision*  
Exact phrase: genetic testing  
Location: anywhere in article | | |

**Online Resource 3 Critical appraisal**

For quantitative studies, the National Institute for Health and Care Excellence (NICE) quantitative intervention studies checklist was used [44]. Aspects of study design and reporting were appraised. Each study was then awarded an overall study quality grading for internal validity and external validity (see legend). For qualitative studies, the NICE quality appraisal checklist for qualitative studies was used [44]. Aspects of study design and reporting were appraised. Each study was then subject to an overall assessment grading of how well the study was conducted, as far as could be ascertained from the paper (see legend). For mixed-methods studies, the mixed methods appraisal tool (MMAT) was used [45]. Responses to appraisal of study criteria in the table are presented as yes, no, or N/A (not applicable or not able to ascertain from the paper).
<table>
<thead>
<tr>
<th>Authors (year), country, time of recruitment</th>
<th>Quantitative rating 5.1 internal validity</th>
<th>Quantitative rating 5.2 external validity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albada et al. (2011), Netherlands, 02/2008-04/2010</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Albada et al. (2012)</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>Albada et al. (2015)</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>Arrick et al. (2019), USA, dates not specified</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cragun et al. (2020), USA, 11/2018-03/2020</td>
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<td>Gornick et al. (2018), USA, 02/2014-05/2016</td>
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<td>Hoberg-Vetti et al. (2016), Norway, 09/2012-04/2015</td>
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<td>Heald et al. (2020), USA</td>
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<td>Kasting et al. (2019), USA, 03/2015-09/2015</td>
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<td>+</td>
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<td>Manchanda et al. (2016), UK, 02/2009-07/2010</td>
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<td>++</td>
</tr>
<tr>
<td>McCuaig et al. (2019), Canada, 05/2015-03/2018</td>
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<td>++</td>
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<td>Quantitative rating 5.1 internal validity</td>
<td>Quantitative rating 5.2 external validity</td>
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<td>Metcalfe et al. (2017), Canada, 09/2008-06/2011</td>
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<td>Tea et al. (2018), Austria, 02/2015-02/2016</td>
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<tr>
<td>Kautz-Freimuth</td>
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<tr>
<td>Meiser et al. (2012), Australia, dates not specified</td>
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</table>
Authors (year), country, time of recruitment | Quantitative rating S.1 internal validity | Quantitative rating S.2 external validity

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Legend:
++ All or most of the checklist criteria have been fulfilled, where they have not been fulfilled the conclusions are very unlikely to alter.
+ Some of the checklist criteria have been fulfilled, where they have not been fulfilled, or not adequately described, the conclusions are unlikely to alter.
− Few or no checklist criteria have been fulfilled and the conclusions are likely or very likely to alter.

Declarations

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Statements and declarations: the authors have no relevant financial or non-financial interests to disclose.

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**Figures**

![Diagram](image)

**Figure 1**

Studies included in the systematic review were grouped into clusters describing the type of patient intervention and subclusters relating to the study design and reported outcomes.
Figure 2

Flowchart showing the flow of study selection for the systematic review

- Records identified through database searching (n = 4210)
- Additional records identified through other sources (n = 2)
- Records after duplicates removed (n = 2749)
- Records screened by inspection of title and abstract (n = 2567)
- Records excluded (n = 2514)
- Full-text articles assessed for eligibility (n = 53)
- Reasons full-text articles excluded (n = 8):
  - General population without any known raised risk (n = 2)
  - Intervention did not support genetic testing decision or risk reduction (n = 2)
  - Intervention depended on real-time interaction (n = 2)
  - General population and intervention did not support genetic testing decision or risk reduction (n = 3)
  - Study did not evaluate outcomes of interest (n = 1)

Articles included in review (n = 64*)

*These 64 articles described 46 interventions. Research findings about some of the interventions were reported in more than one article.
Figure 3

Studies included in data synthesis, grouped into clusters and subclusters