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Supporting older patients in making healthcare decisions: The effectiveness of decision aids; A systematic review and meta-analysis

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ABSTRACT

Objective: To systematically review randomized controlled trials and clinical controlled trials evaluating the effectiveness of Decision Aids (DAs) compared to usual care or alternative interventions for older patients facing treatment, screening, or care decisions.

Methods: A systematic search of several databases was conducted. Eligible studies included patients ≥ 65 years or reported a mean of ≥ 70 years. Primary outcomes were attributes of the choice made and decision making process, user experience and ways in which DAs were tailored to older patients. Meta-analysis was conducted, if possible, or outcomes were synthesized descriptively.

Results: Overall, 15 studies were included. Using DAs were effective in increasing knowledge (SMD 0.90; 95% CI [0.48, 1.32]), decreasing decisional conflict (SMD −0.15; 95% CI [−0.29, −0.01]), improving patient-provider communication (RR 1.67; 95% CI [1.21, 2.29]), and preparing patients to make an individualized decision (MD 35.7%; 95% CI [26.8, 44.6]). Nine studies provided details on how the DA was tailored to older patients.

Conclusion: This review shows a number of favourable results for the effectiveness of DAs in decision making with older patients.

Practice implications: Current DAs can be used to support shared decision making with older patients when faced with treatment, screening or care decisions.

1. Introduction

Healthcare decisions are complex in the older adult population (i.e. adults aged 65 +) for several reasons. First, the body of evidence relating to treatment-specific outcome data is limited, because older patients are underrepresented in randomized controlled trials (RCTs) [1]. This is an even more pressing issue for the growing population of older patients with multiple chronic conditions, cognitive impairment or frailty [1], as these factors are associated with poorer health outcomes, higher rates of complications, and reduced life expectancy [2–5]. In addition, health-related goals and priorities are more heterogenous in the older adult population, compared to younger adults. Whereas younger adults most often prioritize extending life as the most important outcome, older patients more often prioritize maintaining function and independence, as well as reducing caregiver burden, as most important outcomes. In line with this, extending life is more often considered less important, while quality of life becomes more important [6–9].

When making a healthcare decision with an older adult, potential benefits and harms of the treatment options should be weighed, while taking the patients' context, individual goals and values into consideration [10]. To account for these important elements specific to decision making with older patients, a 'Dynamic model for shared decision making in frail older patients' was developed [11]. Shared decision making (SDM) is the process in which patient and healthcare provider (HCP) together decide on the best suitable care plan. To support this complex process, decision aids (DAs) can be used [12]. DAs are evidence-based tools designed to help patients make individualized and deliberative choices among options (including the status quo) [13]. In general, DAs support patients in three ways, by (1) providing information about options and associated benefits or harms, (2) supporting

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congruence between decisions and personal values, and (3) making their decision explicit for their HCP and relatives [13,14]. By doing so, using a DA can contribute to the process of shared decision making (SDM), as all three items are important elements of SDM [11,15].

Literature has shown that age-related cognitive changes may influence decision-making abilities and tendencies [16–18]. For example, older adults tend to make decisions faster, prefer fewer choice options and express greater difficulties in understanding information about available options [16,19–21]. Therefore, it is of specific interest to evaluate if DAs are effective in supporting older adults in decision-making as well. Van Weert and colleagues [22] published a systematic review in 2016, that summarized the available evidence on the effectiveness of using DAs in older patients. They demonstrated that DAs are effective in older patients in improving knowledge, increasing risk perception, decreasing decisional conflict, and enhancing participation in SDM. However, at the time of their review, only one DA was specifically developed for older patients, and the mean age of patients in most included studies was between 65 and 70 years, suggesting that the oldest-old (85 +) were not represented. Since then, projects such as the European Innovation Partnership on Active and Healthy Ageing in Europe [23], Holistic Continuity of Patient Care in Norway [24], and National Program Older patients care in the Netherlands [25] have created more awareness for the need for specific tools and interventions for older patients. This resulted in several newly developed DAs for older patients.

Considering the many innovative developments over the recent years concerning specific interventions for older patients, as well as a recent trend to include the oldest-old in the studies evaluating these interventions, we aim to investigate the effectiveness of DAs developed in recent years (2014–2022). We conducted a systematic review and meta-analysis of randomized controlled trials (RCTs) or clinical controlled trials (CCTs) evaluating the use of DAs as compared to usual care or alternative interventions for older adults facing treatment, screening or care decisions on attributes of the choice made and decision making process. We also evaluated user experience and in what manner the DA was specifically designed for older patients. Secondary outcomes are the choice made, adherence to chosen option, preference-based health outcomes and other health (service) outcomes reported. An overview of the studies published prior to February 2014 are published by van Weert et al. [22].

2. Methods

2.1. Search strategy

We conducted a search from February 2014 until January 2022 in the databases: MEDLINE (OvidSP), Embase (OvidSP), PsycINFO (OvidSP), Cochrane library central registry of studies (Whiley) and CINAHL (EBSCO HOST). Search terms were among others 'decision aid', 'older people', 'shared decision making', and 'informed choice'. We built upon the search strategy of van Weert et al. Appendix A demonstrates the details of the sources searched. Additionally, we checked the reference lists of included studies for any additional relevant reports.

Studies were eligible if they met the following Patient Intervention Comparison Outcome (PICO) framework [26]:

P: Older people (≥65 years) or surrogate decision makers for incapacitated older adults.

I: Decision aid.

C: Usual care or alternative interventions.

O1: Attributes of the choice made, attributes of the decision making process, user experience and design.

O2: choice made, adherence to chosen option, preference-based health outcomes and other health (service) outcomes reported.

2.1.1. Patients

We included studies that evaluated the use of a DA in older patients or DAs for surrogates (≥65 years) making a decision for an incapacitated significant other. Studies with a lower inclusion age than 65 years were also included if the mean sample age was ≥ 70 years or when the study reported an effectiveness analysis of the DA in a subsample of participant aged ≥ 70 years. The studied effects of a DA on other parties, such as HCPs, was beyond the scope of our paper.

2.1.2. Interventions

DAs were defined as 'interventions designed to help people make specific and deliberative choices among options (including the status quo) by making the decision explicit and by providing (at the minimum) information on the options and outcomes relevant to a person's health status' [27]. We included studies that evaluated DAs for decisions concerning treatment, screening, and care (e.g., advance care planning). DAs had to comply with the International Patient Decision Aids Standards (IDPAS)[14]. We excluded DA studies focusing on decisions about lifestyle changes, clinical trial entry, general education programs not geared to a specific decision, and DAs to promote a recommended option.

2.1.3. Comparisons

Eligible studies compared DAs to usual care, general information, clinical practice guideline, placebo intervention, or alternative interventions. We excluded studies that compared two different types of DAs.

2.1.4. Outcomes

We evaluated outcomes based on the IDPAS criteria for evaluating the effectiveness of using DAs [14,28]. Primary outcomes were (1) attributes of the choice made: knowledge, accurate risk perceptions and informed choice (2) attributes of the decision making process: helping the person to recognize that a decision needs to be made, decisional conflict, patient-provider communication, participation in decision making, and satisfaction and (3) user experience and design (not based on IDPAS criteria): how older patients experience using a DA, and in what manner the DA was specifically designed for older patients, if applicable.

Secondary outcomes were choice made, adherence to chosen option, preference-based health outcomes (e.g., anxiety, worry, caregiver burden, depression, self-efficacy, decision regret), and other health (service) outcomes reported.

2.1.5. Study designs

We included peer-reviewed studies using a RCT or CCT design. Both studies in primary and secondary care were eligible, and no limits existed on setting and study duration.

2.2. Study selection

Duplicate citations were removed using the web-based systematic review software Rayyan [29]. Selection of relevant records by screening title and abstract was performed by using the artificial intelligence (AI) tool ASReview [30]. This active-learning-based recommender system trains a classifier on the provided articles' abstracts and presents the user with the most relevant articles to review. This AI-aided and open-source tool allows for a more efficient screening process compared to a regular screening process, while minimizing errors [30]. For this purpose, a random sample of records (1% of total sample), the so-called training and calibration set, was assessed on relevance by screening titles and abstracts. These were independently screened by two clinical experts (SF, FvdB) and one methodological expert (LvM), and inconsistencies were discussed and resolved. This training set was used for ASReview to rank the remaining records on relevance. Based on initial calibration, one reviewer (LvM) screened titles and abstract, until our data-driven stop strategy was met: 50 consecutive exclusions (1% of total set)[31]. A random sample (1% of total set) from the exclusions

were checked to ensure no relevant records were missed. Full text selection and data extraction was done independently by two reviewers (LvM and FvdB or SF). In case of conflict, consensus was reached through discussion amongst the three reviewers. The included studies were checked by experts in the field for any missing reports.

2.3. Data-analysis

Meta-analysis was conducted for the outcomes for which this was possible. We pooled results across studies in cases where: (1) comparable outcome measures were used and (2) the effects were expected to be independent of the type of decision studied. Review Manager 5.4 software (RevMan 2014)[32] was used to estimate a weighted intervention effect with 95% confidence intervals. For continuous measures, standardized mean difference (SMD) was used to facilitate pooling of the different scales, except for the subscales for decisional conflict, where we used mean difference (MD). Guiding rules for interpreting SMDs are: 0.2 represents a small effect, 0.5 a moderate effect and 0.8 a large effect [33]. For dichotomous outcomes, relative risks (RR) were calculated. All data were analysed with a random-effects model because of the diverse nature of the studies that were combined and the anticipated variability in the populations and interventions of the included studies [22,27].

Data for which meta-analysis was not possible were synthesized descriptively. One author (LvM) summarized the reported effects on the various outcomes per study, comparing the effects per outcome, and drawing conclusions about the effectiveness. Findings were discussed between authors (LvM, EG, FvdB, SF) and consensus was reached.

2.3.1. Risk of Bias Assessment and GRADE assessment

Two reviewers (LvM, EG), appraised the risk of bias using the McMaster 'Risk of Bias in Randomized Controlled Trials' tool [34]. Both reviewers continued to perform a quality assessment of the evidence using Grading of Recommendations Assessment, Development and Evaluation (GRADE) criteria [35]. Inconsistencies in risk of bias or GRADE assessment were discussed between the reviewers until consensus was reached.

We follow the template developed by the GRADE working group to effectively communicate the summary of our findings: by narratively describing the effect of the intervention combined with the certainty of evidence for the effect [36].

Results are reported based on Preferred Reporting Items for Systematic reviews and Meta-Analysis (PRISMA) guidelines [37].

3. Results

3.1. Results of the search

The search yielded 4979 individual records. Using ASReview, a total of 601 (12.07%) records were screened. Of these, 468 records were excluded by the reviewer because they did not meet the PICO framework or our criteria for study design. The other excluded records (n = 4378) followed based on the ASReview algorithm. 133 reports were deemed relevant and included for full text review. This resulted in 15 included reports for data extraction and meta-analysis (Fig. 1). During full text review, most frequent reasons to exclude reports were that the study was not performed in older patients or that no subgroup analysis in older patients was performed. One study was excluded because it did not comply with IDPAS criteria. A table of excluded studies is enclosed as Appendix B.

In total, 15 studies investigated the effectiveness of using DAs in older patients. All DAs aimed to support patients themselves, and not their surrogates. Six DAs aimed to support patients in making a treatment decision [38–43], two studies focused on decisions to participate in cancer screening programs[44,45], five on decisions concerning cardiopulmonary resuscitation (CPR) and intubation [46–50], one on prevention of falls [51], and one on both diagnosis and treatment of gastrointestinal cancer [52]. Eight studies compared the DA with usual care [38,39,42,43,47–49], and eight compared the DA to an alternative intervention, such as educational pamphlets or verbal education[40,41,44–46,50–52]. Most studies included participants from the age of 65 or older [40,41,46,49–51], 70 or older [38,43,44], or 75 or older [45,47]. Three studies included participants with an age lower than 65 but reported a mean age of $\geq$ 70 years[39,42,48], and one study performed a subgroup analysis in older patients[52]. Four DAs were paper-based [38,44,45,51], and all others were digital or had a digital element integrated into the DA [39–43,46–50,52].

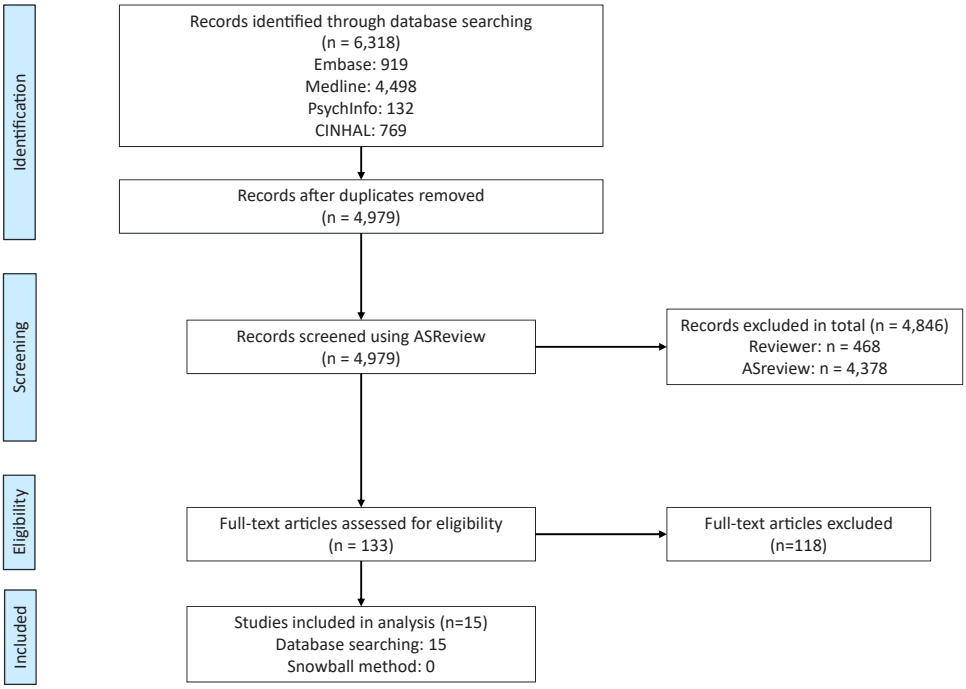

Fig. 1. PRISMA flowchart for study selection .

Most studies (9/15) reported in some way on the prevalence of patients with multiple chronic conditions in their study population using percentages, comorbidity scores or by reporting prescription drugs [38,40–43,48–51]. In these studies, patients with multiple chronic conditions make up a considerable part of the population with reported Charlson Comorbidity Index (CCI) scores varying from 4.5 to 7. Only a few studies (3/15) reported on the prevalence of frailty in their study population, using varying scales and indexes [43,48,52]. The prevalence of frail patients in these studies varied from low [43,52], to 35% of patients reporting moderate-severe frailty [48]. Three additional studies included patients with advanced illness and/or reduced life expectancy of one year, but did not report on the prevalence of frailty [39,46,47]. Four studies excluded patients with cognitive impairment or dementia [40,44–46], and only two studies reported on the prevalence of cognitive impairment in their study population [43,45]. In both studies the prevalence of cognitive impairment was very low, ranging from 1.5% to 3.1%. More study characteristics are described in Table 1.

3.2. Risk of bias and quality of evidence

Fig. 2 shows the risk of bias assessment of the included studies. A more detailed risk of bias assessment per outcome measure can be found in the Appendix (Appendix G). The criteria of most concern across the studies were lack of blinding of patients and personnel, and incomplete outcome data. The quality of evidence was most often downgraded due to risk of bias or imprecision (information size). A detailed GRADE assessment is enclosed in the Appendix (Appendix H).

3.3. Primary outcomes

A descriptive summary of findings and quality of evidence of the primary outcome measures 'attributes of the choice made' and 'attributes of the decision making process' can be found in Table 2. A detailed description of findings per study can be found in the Appendix (Appendix C and D). Table 3 provides the found results, effect measures and GRADE assessment. Results of the meta-analysis are shown in Appendix F. A descriptive summary of findings of the primary outcome measure 'user experience' can be found in Table 4, and 'design' in Table 5.

3.3.1. Attributes of the choice made

Of the attributes of the choice made, none of the studies reported on accurate risk perceptions, one study reported on informed choice, and nine studies assessed whether using DAs increased knowledge.

It is likely that the use of a DA increases the ability in older adults to make an informed choice. One study found that patients who used a DA were significantly more prepared to make an individualized decision (MD 35.7%; 95% CI 26.8–44.6) compared to an alternative intervention [44].

Studies showed that using a DA increases the knowledge of older patients. Seven studies were eligible to include in the meta-analysis (Appendix F). These studies compared the intervention group (IG) to the control group (CG) using a continuous knowledge measurement. Pooled results showed that older patients who used a DA had significant higher knowledge scores (SMD 0.90; 95% CI 0.48–1.32, Appendix F) [38–40,42,44–46], and quality of the evidence was high (Table 3). One study could not be included in the meta-analysis because it only reported median knowledge scores. It demonstrated that patients receiving a DA had significantly higher median knowledge scores ($p = 0.003$), compared to usual care [43]. Another study measured knowledge using a dichotomous outcome, and found no significant effect for patients using a DA compared to usual care [49].

3.3.2. Attributes of the decision making process

To assess the attributes of the decision making process, six studies measured the effects of using DAs on decisional conflict, five studies assessed patient-provider communication, two studies evaluated satisfaction with decision making, and one study reported on participation in decision making.

Studies showed that the use of a DA is likely to decrease decisional conflict in older patients. The meta-analysis demonstrated that using a DA significantly decreases decisional conflict (SMD −0.15; 95% CI −0.29 to −0.01, Appendix F) [38,41,42,45,47,48]. Two studies used the Decisional Conflict Scale (DCS), which consists of four subscales, i.e., 'feeling informed', 'values clarity', 'feeling supported', and 'uncertainty'. A total score measures the construct of overall decisional conflict [53]. Meta-analysis showed no significant difference between the IG and CG on the subscales 'feeling informed', 'feeling supported' and 'uncertainty' [38,41]. One additional study also reported on the subscale 'values clarity' and could be pooled with the other two studies. This demonstrated an effect in favour of the DA group (MD −3.83; 95%CI −6.91 to −0.75, Appendix F)[38,41,44].

Studies showed that use of DA increases the rates of conversation on the topic of interest between older adults and their provider. Meta-analysis showed that patients who received a DA were more likely to have patient-provider conversations about the topic addressed by the DA compared to those who received usual care or an alternative intervention (RR 1.67; 95% CI 1.21–2.29, Appendix F) [39,41,44–46].

Use of DA may result in little to no difference in satisfaction with decision making in older patients. Meta-analysis showed no significant effect on satisfaction with decision making while using a DA compared to usual care (SMD 0.03; 95% CI −0.17 to 0.23, Appendix F) [42,48].

One study reported on patients' participation in decision making, and the quality of SDM in particular, and the evidence is very uncertain concerning the effect of the use of a DA on SDM. They reported that patients receiving a DA reported a high quality of SDM, but this was not different from the group who received usual care[43].

3.3.3. User Experience and Design

Eight studies reported on the user experience of the DA. Because this was only studied in the intervention arm, a qualitative summary of the results is provided in Table 4 but no GRADE assessment was performed. Overall, positive feedback was given for the use of a DA in the decision making process. Two studies showed that patients found the DA highly acceptable [39,46]. Three studies found that patients were comfortable using the DA [39,40,46]. Five studies reported that most patients would recommend the DA to others[39,40,45–47]. Two studies reported on the helpfulness of the DA, and found that most of the patients found the DA helpful [40,41]. One study found that most patients reported to be very satisfied with using the DA [47]. Two studies reported that most patients found the DA understandable[41,50]. Concerning time spent using the DA, one study reported a mean time of seven minutes [41]. One study reported on use of the DA and concluded that patients receiving a DA used it significantly more compared to an information booklet[50].

Nine studies specified how the design of the DAs were targeted and/or tailored to older patients [40–45,47,50,52]. Table 5 provides a qualitative summary of these findings. Adjustments range from paper design with large fonts[44,45], to tailoring information according to age [42,44,45], comorbidities and functional status[41,45], to taking into account competing mortality [44,45].

3.4. Secondary outcomes

The behaviour and health outcomes that were reported in the included studies were categorized by choice made, adherence to chosen option, preference-based health outcomes, and other health (service) outcomes. Table 3 provides the found results and effect measures in combination with the GRADE assessment. A detailed description of findings per study as well as meta-analysis can be found in the Appendix (Appendix E and F).

Concerning the choice made, it is likely that older patients who use DAs to support decision making less often choose intubation[39,46], as well as full code (CPR and intubation) [49], and more often choose

Table 1
Characteristics of the included RCTs.

Study	Target population (inclusion and exclusion criteria[b])	Number of participants; participation rate (%)	Baseline characteristics of participants: age (years)[a] ; gender (female %); other[c]	Intervention*	Control	Outcome Measures
Brown (2019)	Inclusion: adults ≥ 70 years with advanced kidney disease Exclusion criteria: eligible for transplant	Total 41 IG 19; CG 22	Age: IG 77.2 (SD NR); CG: 78.6 (SD NR) Gender: IG 36.8; CG: 50.0 AKPS (mean): IG 83.7; CG 79.1 Any comorbid condition (%): IG 75.6; CG 85.4	OPTIONS intervention: the patient took home a workbook, audio recording and worksheet for reviewing. Consultation with a renal nurse occurred 1 and 3 months later if a decision had not been made.	Usual care	• Decisional conflict • Decisional regret • Knowledge • HRQoL
El-Jawahri (2015)	Inclusion: seriously ill hospitalized patients age ≥ 60 with an advanced illness and a prognosis of 1 year or less Exclusion: NR	Total 105 IG 75; CG 75	Age: IG 76 ± 13; CG 76 ± 9 Gender: IG 49; CG 52	Three-minute video describing CPR and intubation. Video included images of simulated CPR and intubation on a mannequin, and a patient receiving mechanical ventilation.	Usual care	• Stated preference for CPR and intubation • Knowledge • CPR and intubation orders in the medical record at discharge • CPR and intubation orders when readmitted to the hospital • Documented conversations with HCP
El-Jawahri (2016)	Inclusion: advanced heart failure patients aged ≥ 64 years, estimated likelihood of death > 50% within two years Exclusion: Short Portable Mental Status Questionnaire ≤ 6	Total 246 IG 123; CG 123	Age: IG 81 ± 8; CG 81 ± 9 Gender: IG 41; CG 38	Verbal description of the different goals of care (life-prolonging care, limited care, and comfort care) and of CPR/ intubation, in addition to a six-minute video depicting the three levels of care and CPR/intubation as well as an ACP checklist.	Alternative intervention: description for goals of care	• Proportion of patients preferring comfort care immediately after the intervention • CPR/intubation preferences • Knowledge
Eneanya (2021)	Inclusion: advanced chronic kidney disease patients aged ≥ 65 years Exclusion: history of dementia, legal blindness, or on a kidney transplantation waitlist	Total 105 IG 54; CG 51	Age (median (IQR)): IG 76 (70–81); CG 75 (70–81) Gender: IG 62; CG 36 CCI (median (IQR)): IG 7 (6–8); CG 7 (6–8)	Educational 11.5 min video, including images of older patients undergoing hemodialysis as well as peritoneal dialysis.*	Alternative intervention: verbal education read aloud to participant	• Knowledge • Preference for supportive kidney care • Satisfaction and acceptability of the DA
Greenberg (2020)	Inclusion: adults ≥ 65 years, discharged home from the emergency department with a mechanical fall risk Exclusion: NR	Total 200; IG 93; CG 91	Age (median (IQR)): IG 73.0 (68.0–79.0); CG 73.0 (69.0–78.0) Gender: IG 57.0; CG 60.4 Blood thinner prescription, all except aspirin (%): IG 35.5; CG 27.5 Blood pressure medication prescription (%): IG 74.2; CG 67.0	Paper based, personalized DA, with fall-prevention management options presented with advantages and disadvantages of each, and the ability to select interventions of highest value to the person.	Alternative intervention: Centers for Disease Control and Prevention (CDC) brochure on falls	• Goal-completion • Fall history
Heyland (2020)	Inclusion: Patients aged ≥ 75 years, with a complex care plan, a complicated, serious, life-threatening illness or a serious illness following a recent hospital stay, or if death within 12 months would not surprise the physician or if the physician thought it appropriate to start advance care planning. Exclusion: none	Total 123; IG 66; CG 57	Age: IG 73.5 ± 15.9; CG 74.4 ± 11.1 Gender: IG 50.0; CG 45.6	Plan Well Guide presentation, Dear Doctor letter and coach to communicate their values and preferences concerning Goals of Care Designation to the referring doctor via this letter.*	Usual care	• Completion of Goals of Care Designation forms 8–12 weeks after the intervention • Nature of medical order • Extent to which the order was consistent with the patient's expressed preferences • Decisional conflict • Satisfaction • Amount of time the physician spent with the patient finalizing goals of care.
Huang (2017)	Inclusion: patients ≥ 65 years with type 2 diabetes	Total 105 IG 75; CG 25	Age: IG 74.5 ± 6.4; CG 72.4 ± 5.6 Gender: IG 77; CG 80	Personalized web-based decision support tool that consisted of 1) interactive	Alternative intervention: Educational brochure	• Knowledge

(*continued on next page*)

Table 1 (*continued*)

Study	Target population (inclusion and exclusion criteria[b])	Number of participants; participation rate (%)	Baseline characteristics of participants: age (years)[a] ; gender (female %); other[c]	Intervention*	Control	Outcome Measures
	mellitus Exclusion: dementia		History of heart disease (%): IG 25; CG 28 History of lung disease (%): IG 8; CG 12 History of cancer (%): IG 25; CG 28	diabetes education module 2) simulation model for calculating life expectancy and risk of developing complications 3) treatment preference elicitation 4) geriatric condition screening 5) personalized patient printout *	regarding the HbA1c test	• Patient and physician communication about A1C goals, • Patient decisional conflict • Changes in identified goals • Feasibility of intervention
Knops (2014)	Inclusion: Adults ≥ 18 years, visiting the outpatient clinic for the first time with an asymptomatic abdominal aortic aneurysm ≥ 4.0 cm Exclusion: life expectancy of less than a year	Total 178 IG 91; CG 87	Age: IG 74 ± 8; CG 72 ± 9 Gender: IG 12; CG 14 Cerebrovascular comorbidity (%): IG 15; CG 13 Cardiac comorbidity (%): IG 32; CG 37 Hypertension (%): IG 64; CG 54 Diabetes Mellitus (%): IG 13; CG 17	Decision aid plus regular information from the surgeon. The decision aid consisted of a one-time viewing of an interactive CD-ROM elaborating on elective surgery versus watchful waiting.*	Usual care	• Decisional conflict one month later • Knowledge • Anxiety • Satisfaction with the conversation with the HCP • Physical QoL
Kobewka (2021)	Inclusion: in-patient adults ≥ 55 years, at the neurology or internal medicine department, who had a 1-year risk of death greater than 10%, and had an order in their medical record for CPR or no documented order Exclusion: NR	Total 200 IG 99; CG 100	Age: IG 76 ± 10; CG 78 ± 9 Gender: IG 44.4; 39.0 Self-assessed clinical frailty scale: mildly-moderately frail (%): IG 28.3; CG 29.0 severely-very severely frail (%): IG 7.1; CG 6.0 Elixhauser Comorbidity Score (mean (SD)): IG 11.5 (8.5); CG 11.6 (8.5)	Values clarification exercise and CPR video decision aid presenting the harms and benefits of CPR for people who have serious chronic disease. This was summarized in a Dear Doctor letter and patients were instructed to give it to their doctor.	Usual care	• Proportion of patients who had a no-CPR order at 14 days, death, or discharge (whichever came first) after enrolment • Preferences for CPR immediately after the intervention • Decisional conflict • Satisfaction with decision-making • Health care proxy's decision-making self-efficacy • Quality of documentation about goals for future medical care • Concordance between values and stated preference for CPR.
Lewis (2018)	Inclusion: patients ≥ 70 years who were not up to date with colorectal cancer screening, or were due for another colonoscopy based on standard surveillance recommendations for low-risk surveillance patients Exclusion: patients who were in surveillance for high-risk lesions, who had a previous history of colorectal cancer, inflammatory bowel disease or dementia	Total 424 IG 212; CG 212	Age: IG 76.6 ± 4.1; CG 77.1 ± 4.3 Gender: IG 61.3; CG 55.7	Paper based DA designed to facilitate individualized decision making; helping patients understand the potential risks, benefits, and uncertainties of CRC screening given advanced age, health state, preferences, and values and a value-clarification exercise.*	Alternative intervention: educational intervention with information about driving, suggestions to increase safe driving and a self-rating driving evaluation form	• Appropriate CRC screening behaviour 6 months after the index visit. • Appropriate screening intent immediately after the visit • Knowledge • Adequately clarified values • Patients' preferences for screening after reviewing the decision aid but before seeing the provider • (initiation of) conversation about CRC)
Merino (2017)	Inclusion: in-patient adults ≥ 65 years, admitted to the internal medicine ward Exclusion: none	Total 119 IG 59; CG 60	Age: IG 75.2 ± 7.7; CG 75.8 ± 8.6 Gender: IG 7.0; CG 0.0 Multiple morbidities (%): IG 24; CG 27	A 6-minute video describing code status choices. The video showed chest compressions, defibrillation, and intubation on a mannequin as well as palliative care specialists who discussed potential complications and	Usual care	• Participants' code status preferences. • Trust in medical providers • Resuscitation beliefs • Desire for life-prolonging interventions

(*continued on next page*)

Table 1 (*continued*)

Study	Target population (inclusion and exclusion criteria[b])	Number of participants; participation rate (%)	Baseline characteristics of participants: age (years)[a] ; gender (female %); other[c]	Intervention*	Control	Outcome Measures
				survival rates concerning in-hospital resuscitation.		
Nguyen (2019)	Inclusion: patients who were suspected of having colorectal, stomach, or esophageal malignancies or had received a preliminary cancer diagnosis Exclusion: NR	Total 232 IG 78; CG 163 (divided over three control groups; C1 54, C2 56, C3 53)	*Not specified per study arm* Overall: 63.50 ± 9.06 Subgroup 'older patients': 71.44 ± 4.23 Gender: overall 31.9; subgroup older patients 27.4 Frailty (higher score indicates higher frailty, range 1–15; mean (SD)): overall 2.46 (1.98); subgroup older patients 2.19 (1.86)	Mode-tailored website containing different pages with information about the fast-track clinic, how to prepare for consultations, and when to contact the clinic. Furthermore, the website contained information about the conditions (colorectal, stomach, or esophageal cancer), medical tests, treatment options, and practical information, such as a list of health care providers, frequently asked questions, and contact and location information.*	Alternative intervention: Three standardized, nontailored versions with text only (C1), text with visuals (C2), and text with videos (C3). As the images and videos were based on the textual content, they offered similar information. The information was offered in a standardized manner and could not be adapted by patients	• Extent to which patients felt the website was tailored to their situation • Website experience outcomes • Consultation experience outcomes • Recall of information • Knowledge after the consultation.
Schonberg (2020)	Inclusion: women aged 75–89 years who were scheduled for a routine visit or physical examination with their PCP who had a mammogram in the past 24 months Exclusion: mammogram within the past 6 months, dementia, less than seventh-grade education, breast cancer diagnosis	Total 546 IG 283; CG 263	Age: IG 79.7 ± 3.7; CG 79.8 ± 3.7 Gender: IG 100; CG 100 No cognitive impairment (%): IG 98.6; CG 97.3 Life expectancy ≥ 10 years; IG 63.3; CG 66.2	Paper-based DA including information on breast cancer risk factors, life expectancy, screening outcomes, and a values clarification exercise.*	Alternative intervention: home safety pamphlet	• Receipt of mammography screening. Knowledge Decisional conflict • Preferred decision-making role • Whether participants discussed mammography or HS with their PCP • Changes in screening intentions. • Anxiety and acceptability and safety of the DA.
Smith (2019)	Inclusion: adults ≥ 65 years, who lived in retirement villages or participated in community groups Exclusion: living in a long-term care facility	Total 153 IG 74; CG 79	Age: IG 76.4 ± 6.9; CG 76.2 ± 7.7 Gender: IG 63.5; CG 69.6 Comorbidities: Arthritis (%): IG 47.3; CG 51.9 heart problems (%): IG 25.7; CG 26.6 Diabetes (%): IG 13.5; IG 11.4 Cancer (%): IG 10.8; CG 6.5	Audio-visual and interactive web based/ DVD format plus booklet with visual information concerning complementary medicine (CM). The resource consisted of five modules, covering evidence, finding evidence, decision making in CM, working with CM practitioner, and monitoring CM decisions.*	Alternative intervention: Booklet with content focusing on: evidence-based CM modalities, guidance to sourcing reliable CM information, how to make decisions about evidence-based CM, why it is important to monitor and evaluate the use of CM, and details about how to discuss CM use with your health care provider. A second booklet provided written examples of the two case studies, and applying the information in practice	• Decision self-efficacy • Preparation for decision-making scale • Health literacy
Wyld (2021)	Inclusion: women aged ≥ 70 years with primary operable invasive breast cancer Exclusion: inoperable, locally recurrent or metastatic breast cancer or a history of previous invasive breast cancer within 5 years	Total 1339 IG 670; CG 669	Age: IG 78 ± 6; CG 77 ± 6 Gender: IG 100; CG 100 Barthel ADL index score (frailty) (mean (SD)): IG 96.0 (10.5); CG (97.1 (7.7) Moderate/severe ADL dependency (%): IG 12.5; CG 12.6 CCI (mean (SD)): IG 4.7 (1.6); CG 4.5 (1.5) Moderate-severe cognitive impairment (%): IG 3.1; CG 3.4	Two decision support interventions: 1) online tool, booklet, and brief decision aid to support the decision regarding surgery plus adjuvant endocrine therapy vs primary endocrine therapy, and 2) online tool, booklet, and brief decision aid to support the decision regarding adjuvant chemotherapy versus no chemotherapy.*	Usual care	• QoL • Patient knowledge • Shared decision-making • Decision regret, • Anxiety • Cognitive and emotional representations of cancer • Coping strategies • Overall and breast-cancer specific survival • Treatment choice

RCT: randomized controlled trial; IG: intervention group; CG: control group; HRQoL: health-related quality of life; CPR: cardiopulmonary resuscitation; HCP: healthcare provider; IQR: interquartile range; QoL: quality of life; NR: not reported; SD: standard deviation; AKPS: Australian Performance Score; CCI: Charlson Comorbidity Index; ADL: Activities of Daily Living; ACP: advance care planning
a Age is displayed in mean ± standard deviation unless stated otherwise; [b] exclusion criteria other than language requirement or ability to provide informed consent; [c] any information provided by the authors on comorbidities, cognitive- and functional status, frailty, life expectancy
*indicates that study describes how the DA was specifically tailored to the older adult population, details can be found in Table 5.

comfort care [46]. Furthermore, using DAs in older patients decreased medical orders for Intensive Care Unit (ICU) and CPR [47]. It is likely that use of a DA increases appropriate screening intentions [44,45] and fall prevention interventions[51]. The evidence relating to supportive kidney care[40], breast cancer treatment [43], aneurysm repair[42], and CPR alone [39,46,48] was very uncertain.

For adherence to chosen option, use of DAs was likely to increase older patients' screening attendance[45] and appropriate screening behaviour [44]. Use of DAs increased orders to withhold CPR and intubation at discharge and readmission [39]. Use of a DA may lead to no or little difference in agreement between the medical order and the patient's expressed preference concerning goals-of-care after 12 weeks [47]. The evidence was very uncertain concerning completed fall prevention interventions[51].

Concerning preference-based health outcomes, use of DAs likely decreases anxiety in older patients[42,43]. In addition, older patients using a DA to support decision making are more likely to prefer an active decision making role [45]. The evidence concerning self-efficacy [50], decision regret [38,43], and preparation for decision making [50] is uncertain. For all other health (service) outcomes measured, such as quality of life and survival, the evidence is uncertain as well.

4. Discussion and conclusion

4.1. Discussion

This review shows favourable results on the effectiveness of using DAs to support decision making with older patients. Using a DA improves knowledge, improves patient-provider communication, and is likely to reduce decisional conflict and increase the ability of older patients to make an informed choice. Older patients who use a DA more often prefer an active role in decision making and report less anxiety. Furthermore, DAs have an effect on choices concerning life sustaining treatments, demonstrating that older patients are less likely to choose ICU and CPR, and more likely to choose comfort care. Also, after using a DA, older patients often had more appropriate screening intentions and behaviour. Quality of the evidence of these findings range from moderate to high.

The findings on knowledge, decisional conflict, and informed choice are in line with the review of van Weert et al., who also studied the effectiveness of using DAs in older adults [22], indicating that the overall evidence concerning these attributes is robust. Van Weert et al. reported that using a DA increases risk perception, while none of the studies included in our review evaluated this. Van Weert et al. also found that use of a DA may enhance SDM. Our review includes one study that evaluated SDM as an outcome measure and found no effect. Contrarily to the findings published by van Weert et al., our review shows that use of DAs increases patient-provider communication while they found mixed results. New evidence in our review is that DAs may lead to older patients choosing more conservative options concerning life sustaining treatments (no CPR or intubation, preference for comfort care), and may reduce screening intentions.

The findings on knowledge, decisional conflict, patient-provider communication, and informed choice are in agreement with the Cochrane review on the effectiveness of using a DA in a general population [13]. Our findings on anxiety and screening intentions are not in line with the Cochrane review, where no effects on anxiety are reported and mixed results concerning screening intentions. The Cochrane review provides no evidence on choices concerning life sustaining treatments or comfort care.

This review shows that the design of tools and interventions specifically for older patients has increased over the past years. Compared to the review of van Weert et al. [22], where most studies (15/22) were conducted in patients with a mean age lower than 70 years and only one study stated that the DA was developed for older patients, our review is predominantly made up of studies that were specifically designed to assess the effects of a DA in older patients and most studies (10/15) were conducted in a population with a mean age of 75 years or higher. Nine studies describe in some or more detail how the DA was specifically targeted and/or tailored to older patients [40–45,47,50,52].

Despite these efforts, studies that evaluate how DAs can support the complex decision making process in older patients with multiple chronic conditions, frailty or cognitive impairment are still scarce. Patients with multiple chronic conditions make up a considerable part of the patients included in the studies of our review, but the developed DAs did not take into consideration the heightened complexity of decision making in the context of multimorbidity other than competing mortality.

Evidence concerning the use of DAs in older patients with cognitive impairment or dementia is limited. Four studies excluded patients with cognitive impairments or dementia [40,44–46], and studies that assessed the effectiveness of DAs for surrogates making a decision for an incapacitated significant other were not found. Only two studies reported the prevalence of cognitive impairment in the study population. The reported prevalence was lower than the prevalence of cognitive impairment in the general population [54]. The prevalence of patients with cognitive impairment in the remaining studies is unknown. Therefore, it remains uncertain whether our findings apply to older patients with cognitive impairments or dementia.

Similarly, only a few studies reported on the prevalence of frailty. While it is likely that the studies aimed at patients with advanced kidney disease[38,40], advanced heart failure [46], or poor prognosis [39,47], also include patients who are frail, this cannot be concluded with certainty. It is noteworthy that despite the increase of DAs developed for older patients specifically, details on these important patient characteristics are limited. Furthermore, participation rates varied from very low to reasonable (23–91%) which may limit the generalizability of our findings.

There are several strengths that can be identified for our review. To our knowledge, this is the first systematic review on DAs for older patients that also includes the oldest old (80 + years), that performs an assessment of the quality of evidence using GRADE, and that synthesizes the qualitative evidence regarding user experience and how DAs were tailored to the older adult population.

However, there also several limitations of this review. The first limitation is that the qualitative evidence on how to tailor DAs to older patients included in this review is thin. Details on how choices for tailoring were made and whether they were evidence-based is lacking. Performing a review of qualitative studies evaluating the effectiveness and appropriateness of different designs in different age groups could be an important step to gain insight into how DAs can be optimized to further facilitate the decision making process in older patients.

Another possible limitation is the use of an AI tool for title and abstract screening. This is a relatively novel way of increasing the reviewing process' efficiency. Simulation studies with ASReview demonstrated that the number of relevant abstracts found after reading 10% of the abstracts ranges from 70% to 100%[30]. In manual screening, the error rate is approximately 11% [55]. We reviewed 12% of all abstracts. To ensure we did not miss relevant papers the included

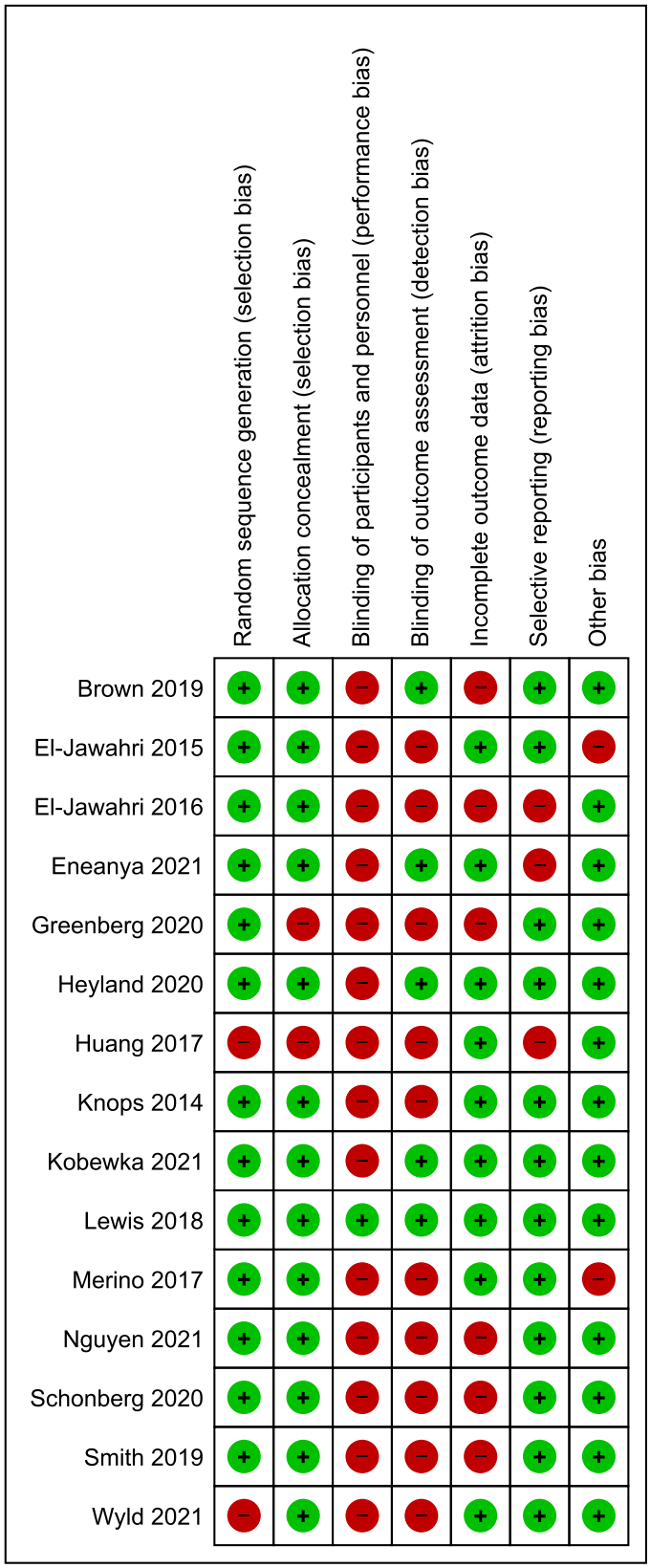

Fig. 2. Risk of Bias assessment of the included studies.

studies were checked by experts in the field, and a random set (1%) of excluded studies was screened manually. Therefore, the use of ASReview is likely to have no to minimal effects on our results.

Moreover, we were not able to analyse the underlying evidence used in the development of the DAs, and whether this evidence is appropriate for older patients, for older patients living with multiple chronic conditions and/or cognitive impairment, and for frail older patients. However, it is well known that the heterogeneity of the older adult population is poorly represented in clinical studies and endpoints studied may not reflect the specific needs of older patients[56]. While some studies indicate that the DA tailors the provided information according to age, comorbidities, and functional status [41,44,45], the underlying evidence remains elusive. Taking into account the vast heterogeneity of older patients concerning cognitive and functional status, comorbidities, frailty, as well as personal goals, values and preferences, the authors of this paper deem the patient-clinician encounter imperative to the process of tailoring evidence and information to the individual.

Therefore, for older patients, it is even more crucial to integrate the use of DAs effectively in the patient-clinician encounter, as DAs should be seen as tools to support SDM rather than replacing the encounter altogether. Recognizing that the SDM process is more complex in older patients with multimorbidity, frailty and cognitive impairment[11,57,58], it can be argued that the manner in which DAs are designed to support SDM currently, by including a value clarification step and presenting different options alongside their benefits and harms, does not suffice for older patients. The authors of this paper recommend that future decision aids developed for older patients should aim to go beyond what is currently common practice and explore how the elements of SDM unique to older patients, such as goal elicitation in the context of multiple chronic conditions or including personal health outcomes such as functional independence instead of single disease-specific outcomes, can be supported.

Table 2
Descriptive summary of findings of attributes of the choice made and decision making process.

	Outcome	Results	Quality of evidence
Attributes of the choice made	Knowledge	Use of a DA increases the knowledge of older adults	High
	Accurate risk perceptions	No evidence was found regarding the effect of a DA on accurate risk perceptions in older adults	NO GRADE
	Informed choice	Use of a DA is likely to increase the ability in older adults to make an informed choice	Moderate
Attributes of the decision making process	Decisional conflict	Use of DA is likely to decrease decisional conflict in older adults	Moderate
	Patient provider communication	Use of DA increases the rates of conversation on the topic of interest between older adults and their provider	High
	Satisfaction with decision making	Use of DA may result in little to no difference in satisfaction with decision making in older adults	Low
	Participation in decision making: quality of SDM	The evidence is very uncertain concerning the effect of DA on shared decision making involving older adults and their provider	Very low

DA: decision aid; SDM: shared decision making

4.2. Conclusion

To conclude, the results of this review show that using DAs can be

Table 3
Summary of the results per outcome measure and quality of the evidence.

Outcome	Result (s)	Number of studies	Quality of Evidence[b]
Attributes of the choice made			
Knowledge[a]	More knowledge in IG: SMD 0.90; 95% CI 0.48–1.32 Two studies, both in favor of DA, not included in pooling.	9	High
Informed choice	Greater ability to make an individualized decision in IG: MD 35.7%; 95% CI 26.8–44.6	1	Moderate
Attributes of the decision-making process			
Decisional conflict	Less decisional conflict in IG:	6	Moderate
Total[a]		2	Very low
Subscale informed[a]	SMD − 0.15; 95% CI	3	Moderate
Subscale values clarity[a]	− 0.29 to − 0.01	2	Very low
Subscale feeling supported[a]	MD − 9.18; 95% CI − 21.83–3.46	2	Very low
Subscale uncertainty[a]	MD − 3.83; 95%CI − 6.91–0.75 MD − 2.10; 95% CI − 18.51–14.31 MD 7.68; 95% CI − 20.06–35.42		
Patient provider communication[a]	Higher rates of conversation about the topic of interest between patient and provider in IG: RR 1.67; 95% CI 1.21–2.29	5	High
Satisfaction with decision-making[a]	No difference between IG and CG: SMD 0.03; 95% CI − 0.17–0.23	2	Low
Participation in decision-making: shared decision making	No difference in the quality of shared decision making between IG and CG (high in both groups): Median difference: 0	1	Very low
Choice made			
Preference for no CPR[a]	IG more likely to choose no CPR: RR 1.57; 95% CI 1.00–2.46	3	Low
Preference for no intubation[a]	IG more likely to choose no intubation: RR 1.61; 95% CI 1.36–1.91	2	Moderate
Code status preference	IG less likely to choose a full code: Full code: 34 p.p. difference	1	Moderate
Order for ICU and CPR	Written medical orders for ICU and CPR are lower in the IG: RD − 26%; 95%CI − 41 to − 8	1	High
Goals-of-care preferences	IG more likely to choose comfort care: 21 p.p. difference; 95%CI not reported	1	Moderate
Preference for supportive kidney care	IG more likely to choose supportive kidney care: 8 p.p. difference; 95%CI not reported	1	Low
Appropriate screening intentions	More patients had appropriate screening intentions in the IG: 13.1%; 95%CI 4.5–22.9 IG rate their screening intentions lower: RR 1.41; 95%CI 1.01–1.98	2	Moderate
Fall prevention interventions	More patients in the IG chose at least one intervention to complete: 65.1 p.p. difference; 95%CI not provided	1	Moderate
Aneurysm repair	No difference in amount of patients who chose elective aneurysm repair between IG and CG: 2 p.p. difference; 95%CI not provided	1	Low
Breast cancer treatment	More patients chose primary endocrine therapy in patients with an estrogen receptor-positive tumor in the IG: difference 5.5; 95% CI 1.1–10.0 Fewer patients chose adjuvant chemotherapy in the IG: difference − 4.5; 95%CI − 8.0–0 No difference between IG and CG in chemotherapy in care of cancers with a high recurrence risk: difference − 5.0; 95%CI − 12.2–2.3	1	Low
Adherence to chosen option			
Screening attendance	Fewer patients underwent screening in the IG: RD − 9.1%; 95%CI − 1.2 to − 16.9% RR 0.84; 95%CI 0.75–0.95	1	Moderate
Appropriate screening behaviour based on health status	More appropriate screening behavior in the IG: 9.7p.p.; 95%CI 1.6–20.9	1	Moderate
Orders to withhold CPR	Withhold CPR at hospital discharge: 38 p.p. difference; 95%CI not provided. Withhold CPR at readmission: 36 p.p. difference; 95%CI not provided.	1	High
Orders to withhold intubation at discharge and at readmission	Withhold intubation at hospital discharge: 45 p.p. difference; 95%CI not provided. Withhold intubation at readmission: 44 p.p. difference; 95%CI not provided.	1	High
Agreement Goals-of-care decisions and patient preference	No difference between IG and CG in agreement between medical order and patient's expressed preference after 12 weeks: RD 10%; 95%CI − 9–28.	1	Low
Completing fall prevention interventions	No difference between IG and CG in completed interventions: Median completed interventions: 1	1	Very Low
Preference-based health outcomes			
Anxiety[a]	Patients report less anxiety in the IG: SDM − 0.35; 95%CI − 0.45 to − 0.26	2	Moderate
Self-efficacy	No difference in decision self-efficacy between IG and CG at the end of the intervention: MD 3.8; 95%CI − 2.1–9.7 No difference in decision self-efficacy between IG and CG after two months: MD 4.4; 95%CI − 1.15–9.95	1	Low

(*continued on next page*)

Table 3 (*continued*)

Outcome	Result (s)	Number of studies	Quality of Evidence[b]
Decision regret	No difference between IG and CG in decision regret six weeks after the intervention: MD 6.7; 95%CI not provided No difference between IG and CG in decision regret six months after the intervention: MD 0.5; 95%CI not provided Results from Brown et al. not interpretable	2	Very low
Preparation for decision-making	No difference between groups in the preparation for decision making scale at the end of intervention: MD 6.3; 95%CI − 2.8–15.4 No difference between groups after two-months follow-up: MD 0.2; 95%CI − 9.1–9.5	1	Low
Preference for an active decision making role	IG preferred a more active decision making role compared to CG: RR 0.65; 95%CI 0.45–0.95	1	Moderate
Other health (service) outcomes			
Health related quality of life	Not interpretable.	1	No GRADE
Physical quality of life[a]	No difference between IG and CG after one month: MD 1; 95%CI not provided No difference between IG and CG at four and ten months: MD 0; 95%CI not provided The results from the study of Brown (2019) were uninterpretable.	2	Low
Quality of life	No difference between IG and CG after six weeks: MD − 0.23; 95%CI − 2.96–2.50 No difference between IG and CG after six months: MD − 0.20; 95%CI − 2.69–2.29	1	Low
Post-operative mortality	No events in both groups	1	No GRADE
Mortality	No events in both groups	1	No GRADE
Survival	No difference in overall survival between groups: HR 1.07; 95%CI 0.80–1.43 No difference in cause-specific survival between groups: HR 0.88; 95%CI 0.54–1.44	1	Very low
Adverse events	No events in both group	1	No GRADE
Falls	No difference in falls between groups during the study time: 4.2 p.p. difference in favor of IG; not significant; 95% CI not provided Fewer falls after 12 months in the IG: 12.4 p.p. difference; 95%CI not provided	1	Low
Post-operative major morbidity	No difference between groups in post-operative major morbidity: 6 p.p. difference in favor of IG; not significant; 95%CI not provided	1	Very Low
	No difference in aneurysm rupture during watchful waiting: 8 p.p. difference in favor of IG; not significant; 95%CI not provided		
Perception of cancer	No difference between groups in the perception of cancer six weeks after the intervention: MD 0.3; 95%CI not provided No difference between groups in the perception of cancer six months after the intervention: MD 8.9; 95%CI not provided	1	Very low
Trust in medical team	Fewer patients agreed with 'my doctors and healthcare team want what is best for me' in the IG: 17 p.p. difference; 95%CI not provided	1	Low
Aggressiveness of end-of-life care	No difference between groups in amount of patients that agree with 'I would like to live as long as possible, even if I never leave the hospital': 0 p.p. difference, 95%CI not provided	1	Very low

SDM: standardized mean difference; 95%CI: 95% confidence interval; CG: control group; IG: intervention group; MD: mean difference; p.p.: percent point; RR: risk ratio; RD: risk difference; OR: odds ratio; HR: hazard ratio

[a] Pooled outcome

[b] assessed using the Grading of Recommendations Assessment Development and Evaluation (GRADE) method

effective to support SDM with older patients by increasing knowledge and improving patient-provider communication. DAs are likely to reduce decisional conflict, reduce anxiety, and help older patients make an informed choice. Older patients who use a DA are less likely to opt for life sustaining treatment such as ICU and CPR, and more likely to choose comfort care. Moreover, use of DA may lead to more appropriate screening intentions and behaviour. Whether DAs contribute to decision-making satisfaction remains uncertain. Whether a DA is a suitable tool for older patients with frailty and cognitive impairments remains uncertain.

4.3. Practice implications

DAs can be used to support SDM with older patients when faced with treatment, screening or care decisions. Considering the complexity of SDM with older patients with multiple chronic conditions, frailty and/or cognitive impairment, the patient-clinician encounter remains imperative to tailoring the decision making process to the individual patient. The current body of DAs developed for older patients does not yet support all the elements of SDM unique to the older adult population. Further research could help elucidate how this can be achieved. Further qualitative research could help elucidate how the design and format of DAs can be effectively tailored to older patients. It is important that future studies including older adults report on the prevalence of multiple chronic conditions, cognitive impairment and frailty in their study populations in order to draw conclusions for these important groups.

Table 4
Summary of findings of user experience of the DA.

First author (year)	User Experience of the DA
El-Jawahri (2015)	• Patients found the DA highly acceptable. • 79% of patients were very comfortable using the DA. • 60% of patients would definitely recommend the DA to other patients. • 33% of patients would probably recommend the DA to other patients.
El-Jawahri (2016)	• Patients found the DA highly acceptable. • 79% of patients were very comfortable using the DA.
Eneanya (2021)	• 96% of patients was very comfortable using the DA. • 96% of patients would definitely recommend the DA to other patients. • 96% of patients felt the DA was helpful.
Heyland (2020)	• 86% of patients would definitely or probably recommend the DA to other patients. • 72% of patients were very satisfied with the DA.
Huang (2017)	• 84% of patients felt the DA was helpful. • 91% reported that the DA was easy to use and understand. • The mean time spent using the DA was seven minutes.
Nguyen (2019)	• The mode-tailored website resulted in higher knowledge in older patients than the text-only website, the text with images website, and the text with video website.[a b] • The mode-tailored website resulted in better information recall in older patients than the text-only website, the text with images website, and the text with video website.[a b] • Older patients reported significantly more anxiety in the mode-tailored website compared with the text-only website.[a]
Schonberg (2020)	• 94.9% of patients would recommend the DA to other patients.
Smith (2019)	• More than 80% of patients rated the content of the DA as excellent or good. • After two months, patients reported more use of the DA.[a]

IG: intervention group; CG: control group; DA: decision aid
a Outcome is compared with control; standard font indicates significant results ($p < .05$ unless otherwise stated) in favor of the IG; italic font indicates no significant results.
b Significance level not provided.

Table 5
Summary of findings on design: how the DA was specifically targeted and/or tailored to older patients.

First author (year)	Design choices
Eneanyu (2021)	• Videos depict older patients in different settings (hospital or at home; dialysis or conservative therapy)
Heyland (2020)	• Appendix of the study describes elaborately the development of the DA, and how qualitative data has helped the authors choose language to discuss goals of care with older adults
Huang (2017)	• Includes education on 'geriatric diabetes principles' for physicians • Touch screen design so it is easier to use for patients who have trouble with a computer mouse • DA includes geriatric condition screening, and takes into account comorbidities and functional status
Knops (2014)	• the DA provided insight into the balance of benefit and harm of surgical and conservative approaches, taking into account age, co-morbidity and size of the aneurysm.
Lewis (2018)	• Paper design, large font and simple graphics • Seventh-grade reading level • Six different versions targeted to different age groups and genders • Takes into account 'competing mortality' • Explains why individualized decision making is important for older adults
Nguyen (2019)	• Mode-Tailored website: based on individual preference to process online health information the DA is offered in text, video or visuals. Mode could be switched at any time.
Schonberg (2020)	• Paper design, large font and white spaces • Sixth-grade reading level • Life expectancy, breast cancer risk factors are tailored to age and health status • Takes into account 'competing mortality'. For example, it calculates a life expectancy score and informs users with a shorter life expectancy that having a mammogram is unlikely to help them live longer
Smith (2019)	• Multi-media intervention to overcome low health literacy skills
Wyld (2021)	• Elaborate description of development of the DA using focus groups and semi structured interviews with older adults with breast cancer. These focus groups and interviews informed the topics, and were the foundation of format and style choices. • Plain English

DA: decision aid

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CRediT authorship contribution statement

van den Bos Frederiek: Writing – review & editing, Validation, Supervision, Methodology, Investigation, Data curation, Conceptualization. **van Weert Julia C.M.:** Writing – review & editing, Methodology. **Festen Suzanne:** Writing – review & editing, Validation, Methodology, Investigation, Data curation, Conceptualization. **van Munster Barbara C.:** Writing – review & editing, Supervision, Methodology. **Rake Ester A.:** Writing – review & editing. **van Mun Liza A. M.:** Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **de Groot Janke F.:** Writing – review & editing, Supervision, Conceptualization. **Gans Emma A:** Writing – review & editing, Writing – original draft, Visualization, Validation, Project administration, Methodology, Investigation, Formal analysis,

Conceptualization.

Declaration of Competing Interest

None.

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Appendix A. Search Strategy

Embase.com.

No.	Query	Results
#41	#39 AND #40	919
#40	'aged'/exp OR 'geriatrics'/exp OR 'elderly care'/exp OR elder* :de,ab,ti OR eldest:de,ab,ti OR frail* :de,ab,ti OR geriatri* :de,ab,ti OR ((old NEXT/1 age*):de,ab,ti) OR ((oldest NEXT/1 old*):de,ab,ti) OR senior* :de,ab,ti OR senium:de,ab,ti OR ((very NEXT/1 old*):de,ab,ti) OR septuagenarian* :de,ab,ti OR octagenarian* :de,ab,ti OR octogenarian* :de,ab,ti OR nonagenarian* :de,ab,ti OR centarian* :de,ab,ti OR centenarian* :de,ab,ti OR supercentenarian* :de,ab,ti OR 'older people':de,ab,ti OR ((older NEXT/1 subject*):de,ab,ti) OR ((older NEXT/1 patient*):de,ab,ti) OR ((older NEXT/1 age*):de,ab,ti) OR ((older NEXT/1 adult*):de,ab,ti) OR 'older man':de,ab,ti OR 'older men':de,ab,ti OR 'older male* ':de,ab,ti OR 'older woman':de,ab,ti OR 'older women':de,ab,ti OR 'older female* ':de,ab,ti OR ((older NEXT/1 population*):de,ab,ti) OR ((older NEXT/1 person*):de,ab,ti)	3792841
#39	#38 AND [01–01–2014]/sd	5358
#38	#22 AND #37	8505
#37	#23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 OR #32 OR #33 OR #34 OR #35 OR #36	885281
#36	(double NEAR/1 blind$):ti,ab,kw	210224
#35	random$:ti,ab,kw	377362
#34	placebo:ti,ab,kw	336221
#33	'crossover procedure'/mj	1287
#32	'single blind procedure'/mj	100
#31	'double blind procedure'/mj	3515
#30	'randomization'/mj	1947
#29	'multicenter study'/mj	4662
#28	'prospective study'/mj	33729
#27	'major clinical study'/mj	10
#26	'clinical trial'/mj	17368
#25	'clinical study'/mj	50781
#24	'randomized controlled trial'/mj	11219
#23	'controlled study'/mj	7038
#22	#13 OR #21	233668
#21	#14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20	52441
#20	'informed choice':ti,ab,kw	2147
#19	'decision aid$':ti,ab,kw	5193
#18	'shared decision making':ti,ab,kw	15522
#17	((personal OR interpersonal OR individual) NEAR/1 (decision$ OR choice OR preference$ OR participat$)):ti,ab,kw	7970
#16	(parent$ NEAR/1 (decision$ OR choice OR preferenc$ OR participat$)):ti,ab,kw	534
#15	((women OR men) NEAR/1 (decision$ OR choice OR preference OR participation)):ti,ab,kw	616
#14	((patient$ OR consumer$) NEAR/1 (decision$ OR choice OR preference OR participation)):ti,ab,kw	25278
#13	#5 AND #12	202745
#12	#6 OR #7 OR #8 OR #9 OR #10 OR #11	4214423
#11	consumer:ti,ab,kw	57693
#10	patient:ti,ab,kw	3826451
#9	'informed consent':ti,ab,kw	88999
#8	'health education'/exp/mj	122471
#7	'patient attitude'/exp/mj	106549
#6	'health behavior'/exp/mj	150868
#5	#1 OR #2 OR #3 OR #4	634758
#4	'educational technology'/mj	1193
#3	decision$:ti,ab,kw	603460
#2	'decision theory'/mj	548
#1	'decision making'/mj	66249

Medline (Ovid).

#	Searches	Results
1	choice behavior/	34242
2	decision making/	101411
3	exp decision support techniques/	81126
4	Educational Technology/	1613
5	decision$.tw.	435278
6	(choic$ or preference$).tw.	513052
7	communication package.tw.	22
8	or/1–7	1009100

(*continued on next page*)

(*continued*)

#	Searches	Results
9	exp health education/	256282
10	Health Knowledge, Attitudes, Practice/	122124
11	informed consent.tw,hw.	67278
12	patient.tw,hw.	2993484
13	consumer.tw,hw.	84349
14	or/9–13	3313464
15	8 and 14	266563
16	((patient$ or consumer$) adj1 (decision$ or choice or preference or participation)).tw.	18075
17	((women or men) adj1 (decision$ or choice or preference or participation)).tw.	461
18	(parent$ adj1 (decision$ or choice or preferenc$ or participat$)).tw.	4530
19	((personal or interpersonal or individual) adj (decision$ or choice or preference$ or participat$)).tw.	6265
20	shared decision making.tw.	10275
21	decision aid$.tw.	3665
22	informed choice.tw.	1648
23	or/16–22	41655
24	15 or 23	282372
25	clinical trial.pt.	533441
26	randomized controlled trial.pt.	556745
27	random$.tw.	1286301
28	(double adj blind$).tw.	161242
29	double-blind method/	169621
30	or/25–29	1739922
31	24 and 30	34053
32	limit 31 to ed= 20140101–20220201	14685
33	exp "Aged"/ or exp "Aged, 80 and over"/ or exp "Frail Elderly"/ or exp "Geriatrics"/ or exp "Geriatric Psychiatry"/ or exp "Geriatric Nursing"/ or exp "Geriatric Dentistry"/ or exp "Dental Care for Aged"/ or exp "Health Services for the Aged"/ or (elder* or eldest or frail* or geriatri* or old age* or oldest old* or senior* or senium or very old* or septuagenarian* or octagenarian* or octogenarian* or nonagenarian* or centarian* or centenarian* or supercentenarian* or older people or older subject* or older patient* or older age* or older adult* or older man or older men or older male* or older woman or older women or older female* or older population* or older person*).ti,ab,kf.	3599389
34	32 and 33	4498

PsychInfo (Ovid).

#	Searches	Results
1	decision$.tw.	232719
2	(choic$ or preference$).tw.	245981
3	exp decision making/	132017
4	computer assisted instruction/	17349
5	or/1–4	483508
6	exp health education/	19875
7	exp health personnel attitudes/	25439
8	informed consent.tw,sh.	10144
9	patient.tw,hw.	273862
10	consumer.tw,hw.	65291
11	exp health behavior/	38692
12	or/6–11	414213
13	5 and 12	59985
14	((patient$ or consumer$) adj1 (decision$ or choice or preference or participation)).tw.	8129
15	((women or men) adj1 (decision$ or choice or preference or participation)).tw.	328
16	(parent$ adj1 (decision$ or choice or preferenc$ or participat$)).tw.	4940
17	((personal or interpersonal or individual) adj (decision$ or choice or preference$ or participat$)).tw.	6336
18	shared decision making.tw.	3274
19	decision aid$.tw.	1551
20	informed choice.tw.	569
21	or/14–20	23848
22	13 or 21	74382
23	random$.tw.	221956
24	(double adj blind$).tw.	25066
25	placebo$.tw,hw.	42761
26	or/23–25	247917
27	22 and 26	5481
28	limit 27 to up= 20140101–20220201	2630
29	exp "aged (attitudes toward)"/ or exp geriatrics/ or exp Elder Care/ or exp Geriatric Patients/ or (elder* or eldest or frail* or geriatri* or old age* or oldest old* or senior* or senium or very old* or septuagenarian* or octagenarian* or octogenarian* or nonagenarian* or centarian* or centenarian* or supercentenarian* or older people or older subject* or older patient* or older age* or older adult* or older man or older men or older male* or older woman or older women or older female* or older population* or older person*).ti,ab.	194821
30	28 and 29	132

CINHAL via Ebsco.

#	Query	Results
S10	S8 AND S9	769
S9	MH "Aged+ " OR MH "Aged, 80 and Over" OR MH "Frail Elderly" OR MH "Geriatrics" OR MH "Geriatric Psychiatry" OR MH "Gerontologic Nursing+ " OR MH "Gerontologic Care" OR MH "Health Services for the Aged" OR TI (elder* OR eldest OR frail* OR geriatri* OR "old age*" OR "oldest old*" OR senior* OR senium OR "very old*" OR septuagenarian* OR octagenarian* OR octogenarian* OR nonagenarian* OR centarian* OR centenarian* OR supercentenarian* OR "older people" OR "older subject*" OR "older patient*" OR "older age*" OR "older adult*" OR "older man" OR "older men" OR "older male" OR "older woman" OR "older women" OR "older female" OR "older population*" OR "older person*") OR AB (elder* OR eldest OR frail* OR geriatri* OR "old age*" OR "oldest old*" OR senior* OR senium OR "very old*" OR septuagenarian* OR octagenarian* OR octogenarian* OR nonagenarian* OR centarian* OR centenarian* OR supercentenarian* OR "older people" OR "older subject*" OR "older patient*" OR "older age*" OR "older adult*" OR "older man" OR "older men" OR "older male" OR "older woman" OR "older women" OR "older female" OR "older population*" OR "older person*")	451,487
S8	S5 AND S6 (vanaf 2014)	2767
S7	S5 AND S6	4894
S6	(MH "Clinical Trials+") OR PT clinical trial OR TI (clinic* N1 trial*) OR AB (clinic* N1 trial*) OR TI random* OR AB random* OR (MH "Random Assignment") OR TI placebo* OR AB placebo* OR (MH "Quantitative Studies") OR (TI ((singl* or doubl* or trebl* or tripl*) N1 (blind* or mask*))) OR (AB ((singl* or doubl* or trebl* or tripl*) N1 (blind* or mask*)))	657,592
S5	S3 AND S4	26,989
S4	(TI ((patient* or consumer*) N1 (decision* or choice or preference or participation))) OR (AB ((patient* or consumer*) N1 (decision* or choice or preference or participation))) OR (TI ((women or men) N1 (decision* or choice or preference or participation))) OR (AB ((women or men) N1 (decision* or choice or preference or participation))) OR (TI (parent$ N1 (decision* or choice or preferenc* or participat*))) OR (AB (parent$ N1 (decision* or choice or preferenc* or participat*))) OR (TI ((personal or interpersonal or individual) N1 (decision* or choice or preference* or participat*))) OR (AB ((personal or interpersonal or individual) N1 (decision* or choice or preference* or participat*))) OR TI "shared decision making" OR AB "shared decision making" OR ((TI (decision aid* or informed choice))) OR ((AB (decision aid* or informed choice)))	43,429
S3	(S1 AND S2)	170,581
S2	(MH "Health Behavior+") OR (MH "Consumer Participation") OR (MH "Health Education+") OR (MH "Health Knowledge") OR (MH "Professional Knowledge+") OR (MH "Consent+") OR TI informed consent OR AB informed consent OR TI patient OR AB patient OR TI consumer OR AB consumer	2202,443
S1	(MH "Decision Making+") OR (MH "Information Seeking Behavior") OR (MH "Help Seeking Behavior") OR (ti(choic* or preference*)) OR (AB(choic* or preference*)) OR TI decision* OR AB decision* OR (MH "Educational Technology")	370,643

Appendix B. Excluded studies based on full-text review

Author (first year)	Exclusion reason
Allen (2018)	Wrong population
Allen (2020)	Wrong population
Baena-Canada (2015)	Wrong population
Banegas (2013)	Wrong population
Barton (2016)	Wrong population
Berger-Hoger (2017)	Wrong population
Berry (2013)	Wrong population
Berry (2018)	Wrong population
Bishop (2019)	Wrong population
Bolan (2018)	Wrong population
Bourmaud (2016)	Wrong population
Bowen (2017)	Wrong population
Brazell (2015)	Wrong population
Brito (2015)	Wrong population
Buhse (2015)	Wrong population
Buhse (2018)	Wrong population
Causarano (2015)	Wrong population
Chabrera (2015)	Wrong population
Chambers (2013)	Wrong population
Chen (2015)	Wrong population
Chen (2019)	Wrong intervention
Coylewright (2016)	Wrong population
Cuypers (2018)	Wrong outcome
Cuypers (2019)	Wrong population and wrong outcomes
Cuypers (2019)	Wrong population
Davis (2014)	Wrong population
Denizard-Thompson (2020)	Wrong population
Durand (2021)	Wrong population and no DA
Einterz (2014)	Wrong population
Fraenkel (2015)	Wrong population
Frencher (2016)	Wrong population
Fung (2021)	Wrong population
Gabel (2020)	Wrong population
Gebel (2020)	Wrong population
Gorawara-Bhat (2017)	Wrong method (qualitative study)
Green (2020)	Wrong population
Haas (2019)	Wrong population
Hacking (2013)	Wrong intervention
Hacking (2014)	Wrong population and wrong method
Halley (2015)	Wrong population
Hanson (2017)	Wrong intervention
Hawley (2016)	Wrong population
Hawley (2018)	Wrong population

(*continued on next page*)

(*continued*)

Author (first year)	Exclusion reason
Hoefel (2020)	Wrong publication type (review); reference checking performed
Hoffman (2017)	Wrong population
Humphries (2021)	Wrong intervention
Humphries (2021)	Wrong target population
Ibrahim (2017)	Wrong population
Ivlev (2017)	Wrong publication type (review); reference checking performed
Ivlev (2018)	Wrong publication type (review); reference checking performed
Jain (2015)	Wrong publication type (review); reference checking performed
Jayakumar (2021)	Wrong population
Jonker (2020)	Wrong population, wrong outcomes, and wrong intervention
Kim (2021)	Wrong population
Kistler (2017)	Wrong outcomes
Korteland (2017)	Wrong population
Kostick (2018)	Wrong population
Krassuki (2019)	Wrong publication type (review); reference checking performed
Krishnamurti (2019)	Wrong population
Kunneman (2020)	Wrong population
Landrey (2013)	Wrong population
LeBlanc (2015)	Wrong population
Lewis (2015)	Wrong population
Manne (2016)	Wrong population
Martin (2017)	Wrong population
Matlock (2014)	Wrong population
McBride (2016)	Wrong population and wrong intervention
Meisel (2017)	Wrong population
Mertz (2020)	Wrong population
Miller (2018)	Wrong population
Mohamed (2020)	Wrong population
Moin (2019)	Wrong population
Moin (2021)	Wrong population
Montoya (2021)	Wrong population
Moulton (2018)	Wrong population
Moyo (2018)	Wrong publication type (review); reference checking performed
Osaka (2017)	Wrong population
Parkinson (2018)	Wrong population
Pathak (2019)	Wrong population
Perestelo-Perez (2017)	Wrong population
Petzel (2018)	Wrong population
Pillay (2020)	Wrong population
Probst (2020)	Wrong population
Resnicow (2014)	Wrong population
Ruparel (2019)	Wrong population
Ruzek (2016)	Wrong population
Salkeld (2016)	Wrong population
Schaffer (2018)	Wrong population
Semjonow (2019)	Wrong publication type
Sferra (2021)	Wrong population
Shaffer (2014)	Wrong population
Sheridan (2013)	Wrong publication type (baseline results)
Sheridan (2014)	Wrong population
Sherman (2016)	Wrong population
Shrik (2017)	Wrong population
Smallwood (2017)	Wrong population
Song (2017)	Wrong population
Stacey (2014)	Wrong population
Stacey (2016)	Wrong population
Starosta (2015)	Wrong population
Stegman (2020)	Wrong intervention
Stein (2013)	Wrong population
Subramanian (2019)	Wrong population
Tappen (2020)	Not able to access full text
Tiedje (2021)	Wrong population
Tran (2015)	Wrong population
Trenaman (2017)	Wrong population and wrong outcomes
Trenaman (2020)	Wrong population and wrong outcomes
Van Tol-Geerdink (2016)	Wrong population
Van Weert (2016)	Wrong publication type (review); reference checking performed
Wang (2021)	Wrong population
Watts (2014)	Wrong population
Watts (2015)	Wrong population
Wilkens (2019)	Wrong population
Wilson (2019)	Wrong outcomes
Yu (2020)	Wrong outcomes
Yun (2019)	Wrong population

Appendix C. Summary of findings of the outcome attributes of the choice made; results in intervention group (IG) compared with control group (CG).[a]

First author (year)	Knowledge	Informed Choice
Brown (2019)	More knowledge about risk and benefits of dialysis.[b]	
El-Jawahri (2015)	More knowledge about CPR. More knowledge about intubation.[b]	
El-Jawahri (2016)	More knowledge about CPR. More knowledge about intubation.[b]	
Eneanya (2021)	*No difference in knowledge about supportive kidney care.*[b]	
Knops (2014)	More knowledge about asymptomatic abdominal aortic aneurysm and the treatment options.[b]	
Lewis (2018)	More knowledge about colorectal cancer screening.[b]	Greater ability to make an individualized decision.
Merino (2017)	*No difference in knowledge about resuscitation and intubation.*	
Schonberg (2020)	More knowledge about benefits and harms of screening.[b]	
Wyld (2021)	More knowledge about breast cancer screening.	

IG = intervention group; CG = control group; CPR = cardiopulmonary resuscitation

[a] Unless otherwise stated are the described results effects in the intervention group (IG) as compared to the control group (CG). Standard font indicates significant result ($p < .05$ unless otherwise stated) in favor of the IG; italic font indicates no significant results.

[b] Included in meta-analysis.

Appendix D. Summary of findings of the outcome attributes of the decision-making process; results in intervention group (IG) compared with control group (CG).[a]

First author (year)	Decisional conflict	Patient-provider communication	Satisfaction with decision making	Participation in decision making
Brown (2019)	*No difference in decisional conflict (total)*[b] Per item: *No difference in being informed*[b] *No difference in value clarification*[b] *No difference in support*[b] More uncertainty[b]	n.m	n.m	
El-Jawahri (2015)	n.m	More documented conversations with HCP about preference for CPR and intubation.[b]	n.m	
El-Jawahri (2016)	n.m	More likely to report goals-of-care conversations with HCP.[b]	n.m	
Heyland (2020)	Less decisional conflict (total).[b] *No difference in patient decision conflict rated by physicians.*	n.m	n.m	
Huang (2017)	*No difference in decisional conflict (total)*[b] Per item: Better informed[b] *No difference in value clarification*[b] *No difference in support*[b] *No difference in uncertainty*[b]	*No difference in conversation rates.*[b]	n.m	
Knops (2014)	*No difference in decisional conflict (total).*[b]	n.m	*No difference in satisfaction with decision-making.*[b]	
Kobewka (2021)	*No difference in decisional conflict (total).*[b] Less conflict about understanding the treatment options. Less conflict about value clarification.	n.m	*No difference in satisfaction with decision-making.*[b]	
Lewis (2018)	Clearer values about colorectal screening.[c]	More conversations with HCP about colorectal cancer screening.[b]		
Schonberg (2020)	*No difference in decisional conflict (total).*[b]	More documented conversations with HCP about breast cancer screening.[b]		
Wyld (2021)	n.m	n.m		*No difference in quality of SDM*

n.m. = not measured; IG = intervention group; CG = control group; CPR = cardiopulmonary resuscitation; HCP = health care provider; SDM = shared decision making

[a] Unless otherwise stated are the described results effects in the intervention group (IG) as compared to the control group (CG). Standard font indicates significant result ($p < 0.05$ unless otherwise stated) in favour of the IG; italic font indicates no significant results. [b] Included in meta-analysis.[c] Only measured the decisional conflict subscale values clarity.

Appendix E. Summary of findings of the outcome behavior and health outcomes; results in intervention group (IG) compared with control group (CG).[a]

First author (year)	Choice made	Adherence to chosen option	Preference-based health outcomes	Other health (service) outcomes
Brown (2019)	n.m.	n.m.	*No difference in decision regret after four weeks.* *No difference in decision regret after twelve weeks.*	*No difference in physical QoL after one month.* *No difference in mental QoL after one month.* *No difference in mental QoL after twelve weeks, compared with four weeks.* No intervention-related adverse events were observed.[c]
El-Jawahri (2015)	More likely to not want CPR.[b] More likely to not want intubation.[b]	More likely to withhold CPR by hospital discharge. More likely to withhold CPR at readmission. More likely to withhold intubation by hospital discharge. More likely to withhold intubation at readmission. Fewer patients were intubated when stated they did not want intubation at baseline.	n.m.	n.m.
El-Jawahri (2016)	More likely to not want CPR.[b] More likely to not want intubation.[b] More preferred comfort care.	n.m.	n.m.	n.m.
Eneanya (2021)	*No difference in preference for supportive kidney care.*	n.m.	n.m.	n.m.
Greenberg (2020)	More patients chose at least one fall prevention intervention to complete	*No difference in completed fall prevention interventions.*	n.m.	*No difference in falls during the study.* Fewer falls after twelve months.
Heyland (2020)	*No difference in completion of Goals of Care Designation forms.* Less written medical orders for ICU and CPR.	*No difference in agreement between medical order in the goals-of-care decisions form and expressed preference.*	n.m.	n.m.
Knops (2014)	*No difference in choice of elective aneurysm repair.*	n.m.	*No difference in anxiety.*[b]	*No difference in physical QoL scores after one month.* *No difference in post-operative mortality.* *No difference in post-operative major morbidity.* *No difference in aneurysm rupture during watchful waiting.*
Kobewka (2021)	*No difference in preference for CPR.*[b] *No difference in preference for CPR after 14 days.*	*No difference in CPR orders after 14 days follow-up.*	n.m.	n.m.
Lewis (2018)	More appropriate colorectal cancer screening intentions.	Higher appropriate screening behaviour after 6 months follow-up.	n.m.	n.m.
Merino (2017)	Less likely to choose full code.	n.m.	n.m.	Fewer patients agreed with 'my doctors and healthcare team want what is best for me'[c] *No difference between in amount of patients that agree with 'I would like to live as long as possible, even if I never leave the hospital'*
Schonberg (2020)	Screening intentions were more often rated lower.	Fewer patients underwent screening after 18 months follow-up.	More patients preferred an active decision-making role.[c]	*No difference in breast cancer mortality.* More patients died of other causes.[c] Fewer patients received a breast cancer diagnosis.[c]
Smith (2019)	n.m.	n.m.	*No difference in self-efficacy.* *No difference in self-efficacy after two months.* *No difference in preparation for decision-making.* *No difference in preparation for decision-making after two months.*	
Wyld (2021)	More patients with ER-positive tumour underwent primary endocrine therapy. Less patients underwent adjuvant chemotherapy. *No difference in chemotherapy in high recurrence risk cancers.*	n.m.	*No difference in anxiety after six weeks.*[b] *No difference in anxiety after six months.* *No difference in decision regret after six weeks.* *No difference in decision regret after six months.*	*No difference in QoL after six weeks.* *No difference in QoL after six months.* *No difference in overall survival rates.* *No difference in cause-specific survival rates.* *No difference in perception of cancer after six weeks.* *No difference in perception of cancer after six months.*

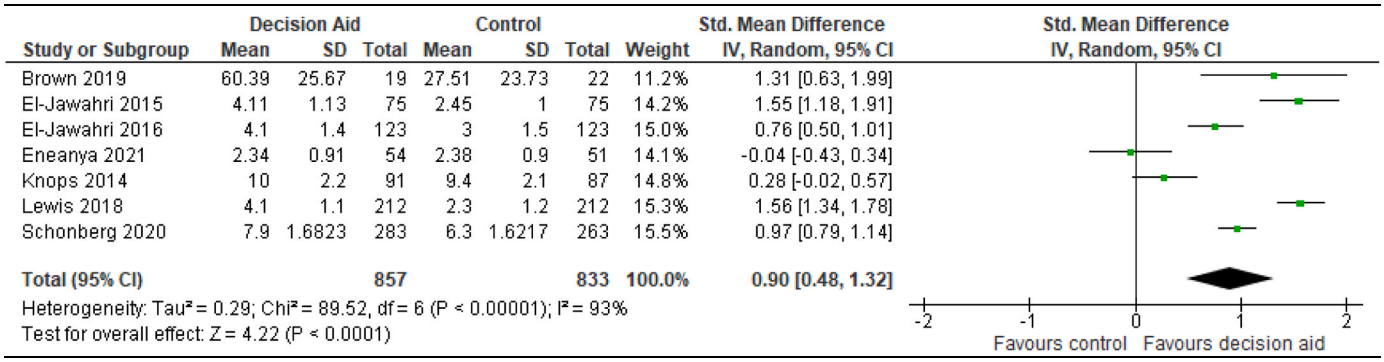
n.m. = not measured; IG = intervention group; CG = control group; ICU = Intensive Care Unit; CPR = cardiopulmonary resuscitation; QoL = quality of life; ER = estrogen receptor; DA = decision aid

[a] Unless otherwise stated are the described results effects in the intervention group (IG) as compared to the control group (CG). Standard font indicates significant result ($p < .05$ unless otherwise stated) in favor of the IG; italic font indicates no significant results.

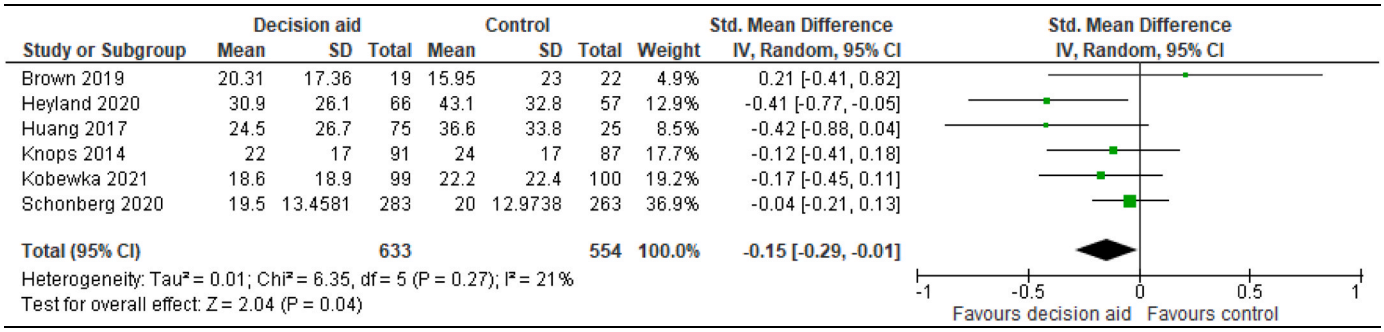
[b] Included in meta-analysis.

[c] Significance level not provided.

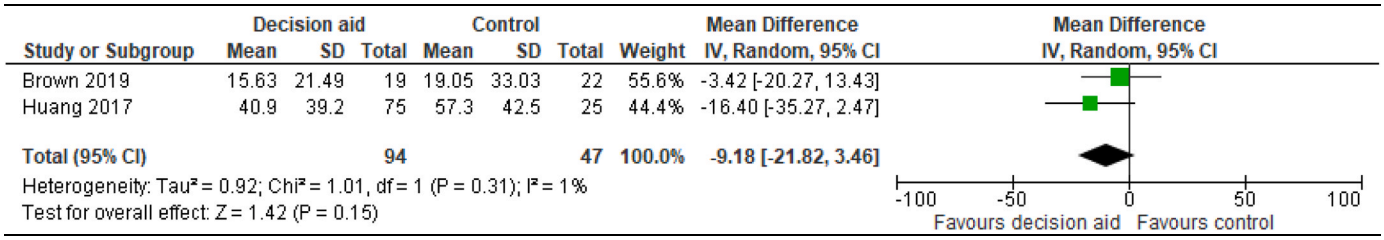
Appendix F. Results of the meta-analysis



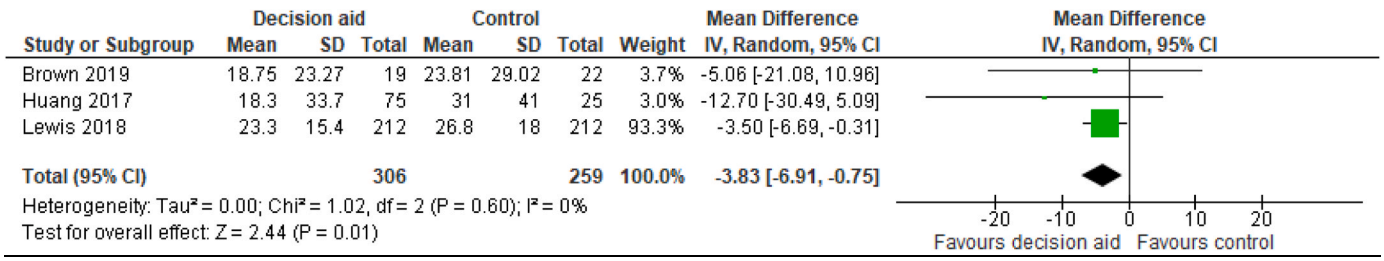
1. Forest plot depicting standardized mean difference for knowledge.



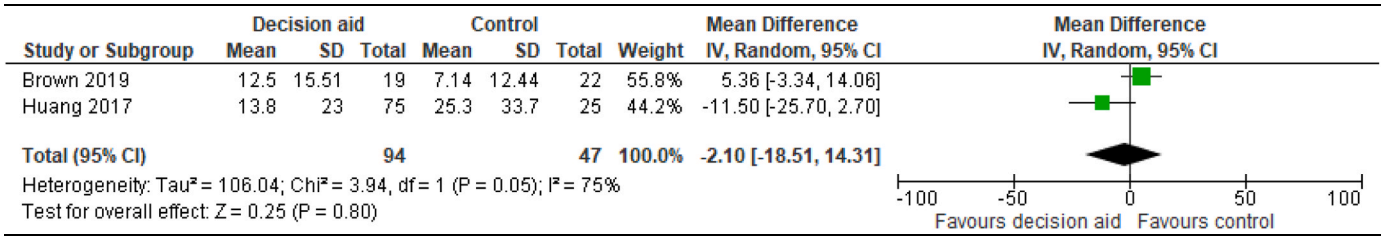
2. Forest plot depicting standardized mean difference for decisional conflict.



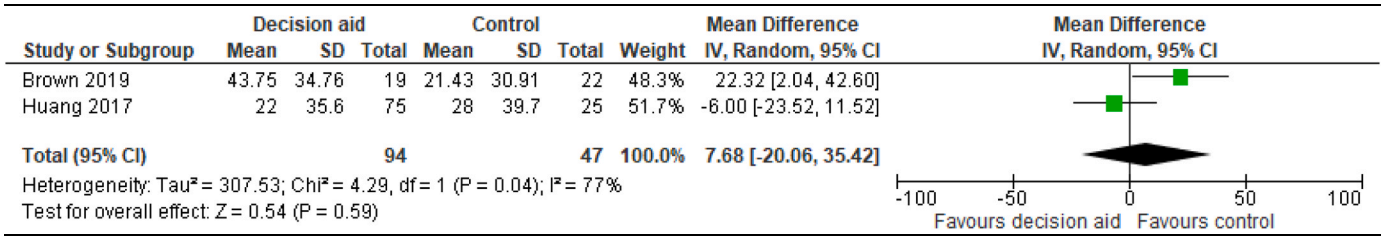
3. Forest plot depicting standardized mean difference for the subscale informed for decisional conflict.



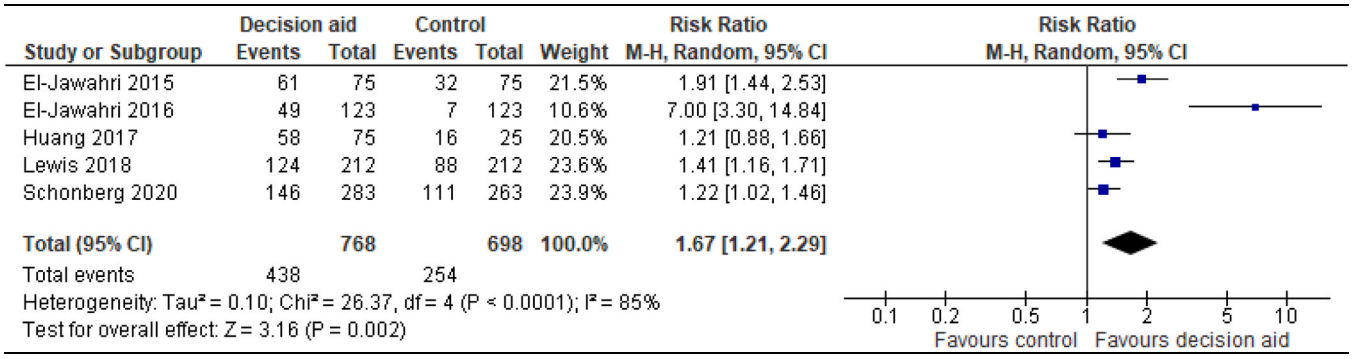
4. Forest plot depicting standardized mean difference for the subscale values clarity for decisional conflict.



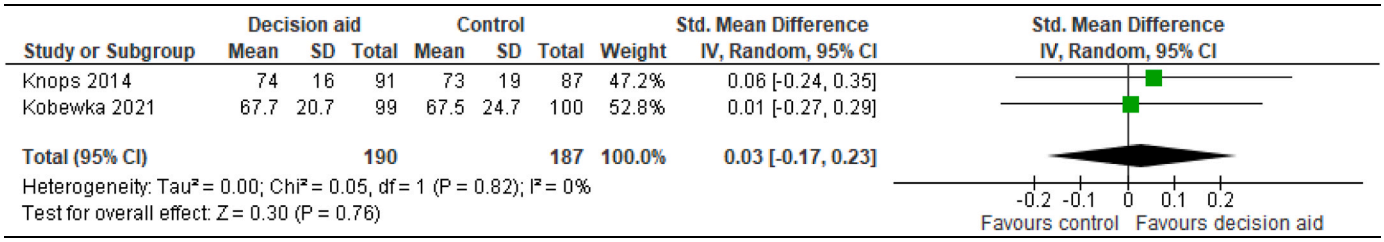
5. Forest plot depicting standardized mean difference for the subscale feeling supported for decisional conflict.



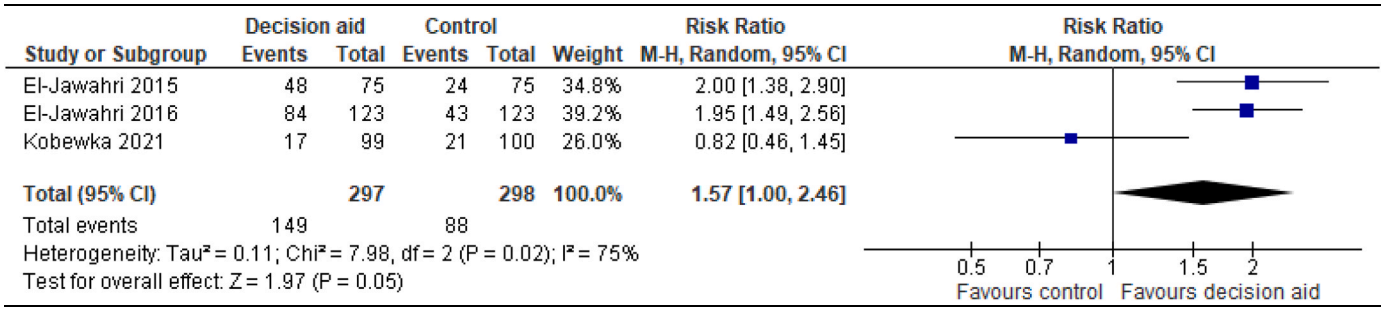
6. Forest plot depicting standardized mean difference for the subscale uncertainty for decisional conflict.



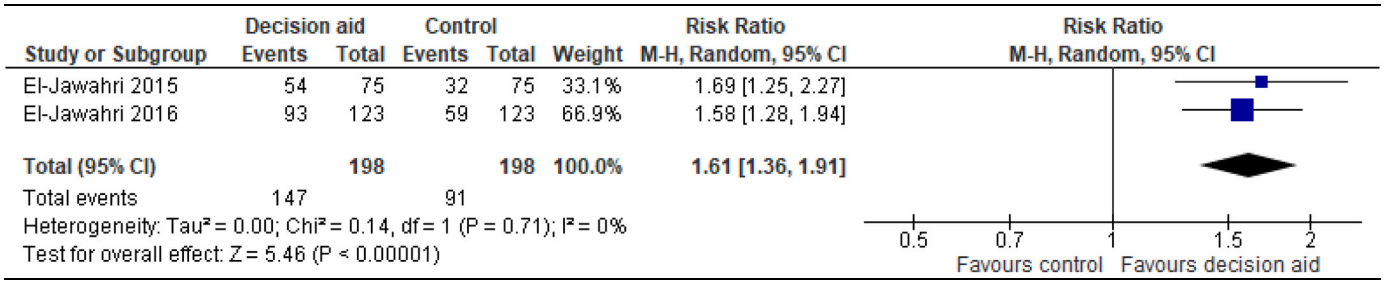
7. Forest plot depicting risk ratio for patient-provider conversations on the topic of the DA.



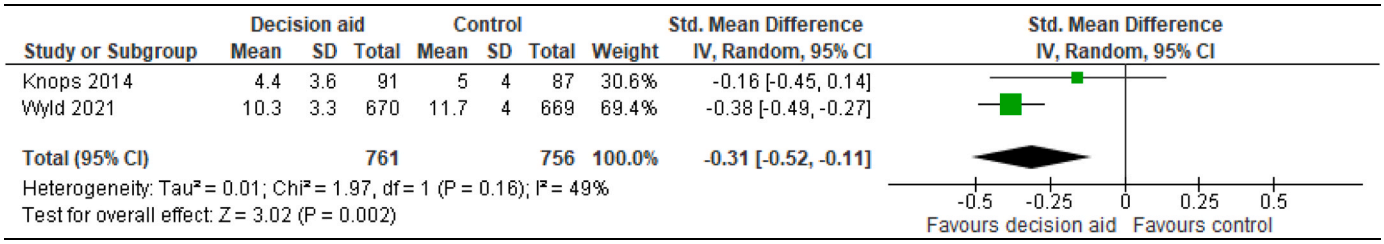
8. Forest plot depicting standardized mean difference for satisfaction with decision making.



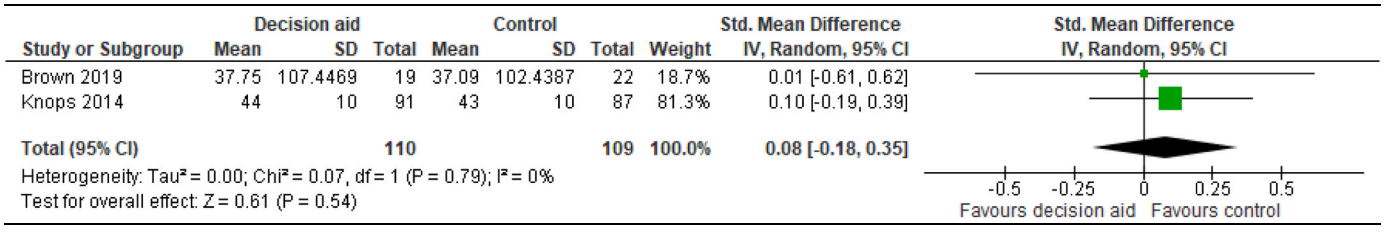
9. Forest plot depicting risk ratio for preference against CPR.



10. Forest plot depicting risk ratio for preference against intubation.



11. Forest plot depicting standardized mean difference for anxiety.



12. Forest plot depicting standardized mean difference for physical quality of life.

Appendix G. Risk of bias tables per study and outcome

Study	1 Was the allocation sequence adequately generated?	2 Was the allocation adequately concealed?	3a Were patients blinded?	3b Were healthcare providers blinded?	3c Were data collectors blinded?	3d Were outcome assessors blinded?	3d Were data analysts blinded?	3e Was knowledge of the allocated interventions adequately prevented?	4 Was loss to follow-up (missing outcome data) infrequent?	5 Are reports of the study free of selective outcome reporting?	6 Was the study apparently free of other problems that could put it at a risk of bias?	7 Overall risk of bias
Brown 2019	Definitely yes *Computer random number generator was used.*	Probably yes *No information about concealment of allocation.*	Definitely no *Patients were not blinded.*	Definitely no *HCPs were not blinded.*	Definitely yes *Data collectors were blinded.*	Definitely yes *Outcome assessors were blinded.*	Definitely yes *Data analysts were blinded.*	Probably yes	Definitely no *12% loss to follow-up in total (most in the intervention arm). Intention to treat analysis was performed.*	Probably yes *Data analyses was different in the protocol than performed in the study, however, this was justified in the study.*	Probably yes *Study appears to be free of other sources of bias.*	Low risk: knowledge, decisional conflict, adverse events Some concerns: decision regret, health related quality of life, physical quality of life
El-Jawahri 2015	Definitely yes *Computer random generation used.*	Definitely yes *Individual assignments were concealed in numbered envelops.*	Definitely no *Patients were not blinded.*	Definitely no *HCPs were not blinded.*	Definitely yes *Research assistants who collected additional variables from the medical records were blinded.*	Definitely no *Research assistant who obtained CPR and intubation preferences was not blinded.*	Probably no *Not reported whether data analysts were blinded.*	Probably no	Definitely yes *No loss to follow-up*	Definitely yes *Outcomes reported in the protocol are similar with the article.*	Probably yes *Study appears to be free of other sources of bias.*	Low risk: knowledge, patient-provider communication, recommend DA to others Some concerns: preference for CPR, preference for intubation)
El-Jawahri 2016	Definitely yes *Computer random number generator used.*	Definitely yes *Assignments were concealed in numbered envelopes.*	Definitely no *Patients were not blinded.*	Definitely no *HCP were not blinded.*	Definitely no *Data collectors were not blinded.*	Probably no *Not reported whether outcome assessors were blinded.*	Probably no *Not reported whether data analysts were blinded.*	Probably no	Definitely no *54% loss to follow-up (most in intervention arm) and reasons are not reported. The amount of patients loss to follow-up does not differ very much from the amount of events. This could result in bias.*	Probably no *More outcomes and longer follow-up are mentioned in the protocol than in measured in the study, without justification.*	Probably yes *Study appears to be free of other sources of bias.*	High: all
Eneanya 2021	Definitely yes *Computer random number generator was used.*	Definitely yes *Assignments were concealed in envelopes.*	Definitely no *Patients were not blinded.*	Probably no *NR if HCPs were blinded. They did not have an active role in patient consultation.*	Probably no *Not reported whether data collectors were blinded.*	Definitely yes *Outcome assessors were blinded.*	Probably no *Not reported whether data analysts were blinded.*	Probably no	Definitely yes *5% no outcome data. No attrition bias.*	Probably no *Protocol states 12 weeks follow-up, but this is not reported in the article.*	Probably no *Knowledge scale is not validated.*	Some concerns: preference for supportive kidney care, user experience High: knowledge
Greenberg 2020	Definitely yes *Computer random number generator was used.*	Probably no *Use of study identification number (open random allocation schedule).*	Definitely no *Patients were not blinded.*	Definitely no *Healthcare providers were not blinded.*	Definitely no *Data collectors were not blinded.*	Definitely no *Outcome assessors were not blinded.*	Definitely no *Data analysts were not blinded.*	Definitely no	Probably no *8% loss to follow-up and incomplete outcome data. No attrition bias.*	Definitely yes *Outcome in the protocol are similar with outcome in the article.*	Probably yes *Study appears to be free of other sources of bias.*	High: all

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Heyland 2020	Definitely yes *Randomization* via *sequentially numbered, opaque sealed envelopes prepared by an uninvolved biostatician.*	Definitely yes *Opaque sealed envelopes used.*	Definitely no *Patients were not blinded.*	Definitely no *HCPs were not blinded.*	Definitely yes *Data collectors were blinded.*	Definitely yes *Concealed randomized blinded assessment of patient outcomes.*	Definitely yes *Concealed randomized blinded assessment of patient outcomes.*	Probably no *Patients and HCP were not blinded, but outcome assessors were.*	Definitely yes *3% loss to follow-up in total.*	Definitely yes *Outcomes mentioned in the protocol are also mentioned in the article.*	Probably yes *Study appears to be free of other sources of bias*	Low: all
Huang (2017)	Probably no *Randomisation was performed at physician level.*	Probably no *Physician determined randomization.*	Probably no *Patients were not blinded to the intervention, but were blinded to the study hypotheses and were unaware of allocation.*	Definitely no *HCPs were not blinded.*	Probably no *Procedure for research assistant was different per study arm.*	Probably no *Procedure for research assistant was different per study arm.*	Probably no *Procedure for research assistant was different per study arm.*	Probably no	Definitely yes. *5% loss to follow-up in the intervention arm, 0% in the control.*	Probably no *Follow-up in the protocol is 32 months, however, follow up is not mentioned in the article.*	Probably no *Decisional conflict scale is validate in breast cancer screening, prostate cancer screening, and influenza immunization, but not in diabetes.*	High: all
Knops (2014)	Definitely yes *Minimisation procedure with randomization* via *computer random number generator.*	Probably yes *No information about concealment of allocation.*	Definitely no *Patients were not blinded.*	Probably yes HCPs were blinded, but patients were not prohibited to share their allocation with their HCP.	Definitely no *Data collectors were not blinded.*	Definitely no *Outcome assessors were not blinded.*	Definitely no *Data analysts were not blinded.*	Probably no	Probably yes *7% loss to follow-up. Most loss in the intervention arm. For outcomes 'choice for aneurysm repair', 'postoperative mortality', and* 'postoperative major morbidity'*, this is a large part of the evens.*	Definitely yes *Outcomes mentioned in the protocol are also mentioned in the article.*	Probably yes *Study appears to be free of other sources of bias and scale is validated (not for knowledge).*	Low: decisional conflict, satisfaction with decision making, anxiety, physical quality of life Some concerns: choice for aneurysm repair, knowledge, postoperative mortality, postoperative major morbidity
Kobewka (2021)	Definitely yes *Computer random number generator was used.*	Definitely yes *Patients were randomized using a randomly permuted blocks.*	Definitely no *Patients were not blinded.*	Definitely no *HCPs were not blinded.*	Probably yes *Outcome assessors were blinded.*	Definitely yes *Outcome assessors were blinded.*	Definitely yes *Analysis was done by a statistician who was blinded to allocation.*	Probably no	Definitely yes *0.5% loss to follow-up.*	Definitely yes *Outcomes in the study protocol were also mentioned in the article.*	Probably yes *Study appears to be free of other sources of bias, and scale to measure decisional conflict was validated, although in other diseases.*	Some concerns: all
Lewis (2018)	Definitely yes *Computer random number generator used.*	Definitely yes *Allocation was concealed through use of opaque, sealed envelopes.*	Probably yes *Control group received an educational intervention. Patients did not know if they were the intervention or the control group.*	Probably no *Care givers could have been aware of allocation.*	Definitely yes *Researchers and research assistants (RAs) were unaware of the assignment.*	Definitely yes *Researchers and research assistants (RAs) were unaware of the assignment.*	Definitely yes *Researchers and research assistants (RAs) were unaware of the assignment.*	Probably yes	Definitely yes *3% loss to follow-up in total.*	Definitely yes *Outcomes in the protocol are also mentioned in the article.*	Probably yes *Knowledge measurement is not validated.*	Low: all

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Merino (2017)	Definitely yes *Randomisation* via *random number generator.*	Probably yes *No information about concealment of allocation.*	Definitely no *Patients were not blind to the intervention.*	Not applicable *HCPs were not involved in the study before assessing the outcomes.*	Probably no *Study coordinator was not blinded.*	Probably no *Study coordinator was not blinded.*	Probably no *Study coordinator was not blinded.*	Probably no	Definitely yes *No loss to follow-up.*	Probably yes *Protocol is not available.*	Probably no *Questionnaires are not validated.*	Low: choice for full code Some concerns: knowledge, trust in medical team, aggressiveness of end-of-life care
Nguyen (2019)	Definitely yes *Patients were randomly assigned using randomization software.*	Probably yes *No information about concealment of allocation.*	Probably no *Patients were not blind to the intervention, but were unaware that there were other website versions than the one they received.*	Probably no *Not described whether HCPs were blinded.*	Probably no *Not described whether data collectors were blinded.*	Probably no *Not described whether outcome assessors were blinded.*	Probably no *Not described whether data analysts were blinded.*	Probably no	Probably no *7% loss to follow-up, reasons are not specified. No attrition bias.*	Definitely yes *Outcomes mentioned in the protocol are also described in the article.*	Probably yes *Study appears to be free of other sources of bias and knowledge questionnaire is standardized.*	Some concerns: all
Schonberg (2020)	Definitely yes *Statistician performed randomization.*	Definitely yes *Sealed envelopes used.*	Definitely no *Patients were not blind to the intervention*	Definitely no *HCP were not blind to the intervention*	Definitely no *RAs were not blinded to patient randomization assignment.*	Definitely no *RAs were not blinded to patient randomization assignment.*	Definitely no *RAs were not blinded to patient randomization assignment.*	Definitely no	Probably no *9% loss to follow-up in total. No attrition bias.*	Probably yes *Protocol is not available.*	Probably yes *Study appears to be free of other sources of bias and questionnaires are adapted or validated.*	Some concerns: all
Smith (2019)	Definitely yes Computer generated by online randomisation service.	Probably yes *Sealed opaque envelopes used.*	Definitely no *Patients were not blinded.*	Probably no *Not described whether HCPs were blinded.*	Probably no *Not described whether data collectors were blinded.*	Probably no *Not described whether outcome assessors were blinded.*	Definitely yes *Study analyst was blinded.*	Probably no	Probably no *14% loss to follow-up. No attrition bias.*	Definitely yes *Outcomes described in the protocol are also mentioned in the article.*	Probably yes *Study appears to be free of other sources of bias and scale is validated.*	Some concerns: all
Wyld (2021)	Probably no *Centres were subjected to 1;1 block randomization, stratified by current therapy. This is a predictable sequence.*	Probably yes *No information about concealment of allocation.*	Definitely no *Patients were not blind to the intervention.*	Definitely no *HCPs were not blind to the interventionn.*	Probably no *Not described whether data collectors were blinded.*	Probably no *Not described whether outcome assessors were blinded.*	Probably no *Not described whether data analysts were blinded.*	Definitely no	Probably no *Exact amount of loss to follow-up is unclear and reasons not reported.*	Definitely yes *Outcomes mentioned in the protocol are also mentioned in the article.*	Probably no *Not all scales are validated.*	High: all

Appendix H. GRADE assessment per outcome

Every outcome was assessed based on risk of bias, inconsistency (heterogeneity), indirectness, imprecision and other considerations per GRADE methodology. The tables below show the number of studies included, the reason for downgrading the level of evidence if applicable, and the overall GRADE. A detailed report of the GRADE assessment for the included RCTs in this study can be requested by contacting the first author.

Outcome 1: Attributes of the choice made.

Number of studies	Motivation for downgrading the level of evidence	GRADE overall
Knowledge		
9: *Brown (2019); El-Jawahri (2015); El-Jawahri (2016); Eneanya (2021); Knops (2014); Lewis (2018); Schonberg (2020); Wyld (2021); Merino (2017)*	Level of evidence was not downgraded after assessment	High
Informed Choice		
1: *Lewis (2018)*	The optimal information size was not reached, and the level of evidence was downgraded by 1 level	Moderate

Outcome 2: Attributes of the decision-making process.

Number of studies	Motivation for downgrading the level of evidence	GRADE overall
Decisional conflict		
6: *Brown (2019); Heyland (2020); Huang (2017); Knops (2014); Kobewka (2021); Schonberg (2020)*	The optimal information size was not reached, and the level of evidence was downgraded by 1 level	Moderate
Decisional conflict; subscale informed		
2: *Brown (2019); Huang (2017)*	The level of evidence was downgraded by 3 levels because of high risk of bias, the optimal information size was not reached and because the 95% CI includes the null effect.	Very Low
Decisional conflict; subscale values clarity		
3: *Brown (2019); Huang (2017); Lewis (2018)*	The optimal information size was not reached, and the level of evidence was downgraded by 1 level	Moderate
Decisional conflict; subscale feeling supported		
2: *Brown (2019); Huang (2017)*	The level of evidence was downgraded by 3 levels because of risk of bias, inconsistency (heterogeneity) and imprecision of the results (optimal information size is not reached, 95%CI includes the null effect.	Very Low
Decisional conflict; subscale uncertainty		
2: *Brown (2019); Huang (2017)*	The level of evidence was downgraded by 3 levels because of risk of bias, inconsistency (heterogeneity) and imprecision of the results (optimal information size is not reached, 95%CI includes the null effect.	Very Low
Patient provider communication		
5: *El-Jawahri (2015); El-Jawahri (2016); Huang (2017); Lewis (2018); Schonberg (2020)*	Level of evidence was not downgraded after assessment	High
Satisfaction with decision-making		
2: *Knops (2014); Kobewka (2021)*	The level of evidence was downgraded by 2 levels because of risk of bias and imprecision of the results (optimal information size is not reached, 95%CI includes the null effect.	Low
Shared decision-making		
1: *Wyld (2021)*	The level of evidence was downgraded by 2 levels because of risk of bias and imprecision of the results (optimal information size is not reached, 95%CI includes the null effect.	Very Low

Outcome 3: Health and behaviour outcomes.

Number of studies	Motivation for downgrading the level of evidence	GRADE overall
Preference for no CPR		
3: *El-Jawahri (2015); El-Jawahri (2016); Kobewka (2021)*	The level of evidence was downgraded by 1 level because of inconsistency (heterogeneity) and by 1 level because of imprecision (95%CI includes the null effect).	Low
Preference for no intubation		
2: *El-Jawahri (2015); El-Jawahri (2016)*	The level of evidence was downgraded by 1 level because of risk of bias.	Moderate
Appropriate screening intentions		
2: *Lewis (2018); Schonberg (2020)*	The level of evidence was downgraded by 1 level because of indirectness of the evidence.	Moderate
Preference for full code		
1: *Merino (2017)*	The optimal information size was not reached, and the level of evidence was downgraded by 1 level.	Moderate
Order for ICU and CPR		
1: *Heyland (2020)*	Level of evidence was not downgraded after assessment.	High
Goals-of-care preferences		
1: *El-Jawahri (2016)*	The level of evidence was downgraded by 1 level because of risk of bias.	Moderate
Preference for supportive kidney care		
1: *Eneanya (2021)*	The level of evidence was downgraded by 2 levels because of imprecision of the results (optimal information size is not reached, 95%CI includes the null effect).	Low
Fall prevention interventions		
1: *Greenberg (2020)*	The level of evidence was downgraded by 1 level because of risk of bias.	Moderate GRADE
Aneurysm repair		

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Number of studies	Motivation for downgrading the level of evidence	GRADE overall
1: *Knops (2014)*	The level of evidence was downgraded by 3 levels because of risk of bias and imprecision of the results (optimal information size is not reached, 95%CI includes the null effect).	Low GRADE
Breast cancer treatment		
1: W*yld (2021)*	The level of evidence was downgraded by 3 levels because of risk of bias and imprecision of the results (optimal information size is not reached, 95%CI includes the null effect.	Low GRADE

Outcome 4: Adherence to chosen option.

Number of studies	Motivation for downgrading the level of evidence	GRADE overall
Screening attendance		
1: *Schonberg (2020)*	The optimal information size was not reached, and the level of evidence was downgraded by 1 level.	Moderate GRADE
Appropriate screening behavior		
1: *Lewis (2018)*	The optimal information size was not reached, and the level of evidence was downgraded by 1 level.	Moderate GRADE
Completing fall prevention interventions		
1: *Greenberg (2020)*	The level of evidence was downgraded by 3 levels because of risk of bias and imprecision of the results (optimal information size is not reached, 95%CI includes the null effect).	Very low GRADE
Goals-of-care decisions		
1: *Heyland (2020)*	The level of evidence was downgraded by 2 levels because of imprecision of the results (optimal information size is not reached, 95%CI includes the null effect).	Low GRADE
Orders to withhold CPR		
1: *El-Jawahri (2015)*	Level of evidence was not downgraded after assessment.	High GRADE
Orders to withhold Intubation		
1: *El-Jawahri (2015)*	Level of evidence was not downgraded after assessment.	High GRADE

Outcome 5: Preference-based health outcomes.

Number of studies	Motivation for downgrading the level of evidence	GRADE overall
Anxiety		
2: *Knops (2014); Wyld (2021)*	The level of evidence was downgraded by 1 level because of risk of bias.	Moderate
Self-efficacy		
1: *Smith (2019)*	The level of evidence was downgraded by 2 levels because of imprecision of the results (optimal information size is not reached, 95%CI includes the null effect).	Low
Decision regret		
2: *Brown (2019); Wyld (2021)*	The level of evidence was downgraded by 3 levels because of risk of bias, imprecision of the results and other concerns (results from one study were not well described and not interpretable).	Very Low
Preparation for decision making		
1: *Smith (2019)*	The level of evidence was downgraded by 2 levels because of imprecision of the results (optimal information size is not reached, 95%CI includes the null effect).	Low
Preferred role in decision making		
1:*Schonberg (2020)*	The optimal information size was not reached, and the level of evidence was downgraded by 1 level.	Moderate

Outcome 6: Other health service outcomes.

Number of studies	Motivation for downgrading the level of evidence	GRADE overall
Health related quality of life		
1: *Brown (2019)*	No evidence	No GRADE
Physical QoL		
2: *Brown (2019); Knops (2014)*	The level of evidence was downgraded by 2 levels because of imprecision of the results (optimal information size is not reached, 95%CI includes the null effect).	Low
Quality of life		
1: *Wyld (2021)*	The level of evidence was downgraded by 2 levels because of risk of bias and imprecision (95%CI includes the null effect).	Low
Post-operative mortality		
1: *Knops (2014)*	No events took place	No GRADE
Mortality		
1: *Schonberg (2020)*	No events took place	No GRADE
Survival		

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Number of studies	Motivation for downgrading the level of evidence	GRADE overall
1: *Wyld (2021)*	The level of evidence was downgraded by 3 levels because of risk of bias and imprecision of the results (optimal information size is not reached, 95%CI includes the null effect).	Very Low
Adverse events		
1: *Brown (2019)*	No events took place	No GRADE
Falls		
1: *Greenberg (2020)*	The level of evidence was downgraded by 2 levels because of risk of bias and imprecision (optimal information size is not reached).	Low
Post-operative major morbidity		
1: *Knops (2014)*	The level of evidence was downgraded by 3 levels because of risk of bias and imprecision of the results (optimal information size is not reached, 95%CI includes the null effect).	Very Low
Perception of cancer		
1: *Wyld (2021)*	The level of evidence was downgraded by 3 levels because of risk of bias and imprecision of the results (optimal information size is not reached, 95%CI includes the null effect).	Very low
Trust in medical team		
1: *Merino (2017)*	The level of evidence was downgraded by 2 levels because of imprecision (optimal information size was not reached) and other concerns (scale to measure trust is not validated).	Low
Aggressiveness of end-of-life care		
1: *Merino (2017)*	The level of evidence was downgraded by 3 levels because of imprecision (optimal information size was not reached and 95%CI includes the null effect) and other concerns (scale used is not validated).	Very Low

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