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Application of patient decision aids in treatment selection of cardiac surgery patients: a scoping review

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ABSTRACT

Background: The choice of treatment is an unavoidable challenge faced in the day to day medical decision making pertaining to patients with organic heart disease. As a professional discipline, cardiac surgery focuses on creating and using the most advanced evidence-based patient decision aids (PtDAs) to achieve high-quality decision-making.
Objectives: To describe the basic situation, influencing factors, and the outcome of indicators of PtDAs among cardiac surgery patients.
Methods: Seven electronic databases were systematically searched for relevant reviews on the application of PtDAs among cardiac surgery patients. The methodological framework proposed by Arskey and O'Malley was used to guide the scoping review. The extracted data was analyzed qualitatively and quantitatively.
Results: After dual, blinded screening of titles and abstracts, 12 articles were included in the review. 10 were quantitative studies, 1 was a mixed study, 1 was a qualitative study.
Conclusions: Compared with the burden of heart disease and the huge evidence base, the application of PtDAs in cardiac surgery is obviously insufficient. The published literature mainly provide information about the factors to be solved from the perspective of researchers, and also summarize obstacle factors. This is the basis for the application and construction of PtDAs in cardiac surgery patients.

Introduction

Heart disease (HD) includes coronary heart disease, heart failure, atrial fibrillation, valvular disease, sudden cardiac death, cardiomyopathy, aortic aneurysms and so on.[1] The WHO estimated that HD now represents 16% of total deaths from all causes.[2] In the United States, approximately 790, 000 men and women have a heart attack each year, and a person has a heart attack every 40 seconds.[3,4] With an aging population and changes in people's lifestyle, HD is estimated to remain the most important death cause for a while and leads to tremendous socio-economic burden.[5]

Medicine and surgery are the main treatment modalities for HD. The maturity of modern medicine and biotechnology has contributed to the development of cardiac surgery and also made it become one of the main treatment methods for some organic HD.[6] Heart surgery patients often face the risk of death, whether surgical procedures are most often planned or emergent.[7] Many patients and their families face great pressure in decision-making.[8] These pressures come from concerns about death or quality of life, as well as anxiety about medical costs and surgical plans.[6,9] Therefore, the decision-making process is complicated for patients requiring cardiac surgery. They need to fully understand the information regarding these diseases and make medically sound decisions with their doctors. Objective expression of disease conditions, proper communication of treatment benefits and risks is all related to reducing their decision-making conflicts and anxiety.[10] Understanding patients' values is conducive to establishing a good trusting relationship between doctors and patients. The important issue facing healthcare workers is how to help patients understand their diseases and how to guide surgical patients to express their values. It is well known that patients' health literacy plays an important role.[11] However, to date, studies have consistently shown that there is a low level of health literacy in the surgical

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population.[12] Lack of health literacy means they have a poor understanding of information, which makes it easier to ignore the expression of their wishes, especially in patients with emergency cardiac surgery. These are the problems that we encounter and need to handle in our clinical practice.

Patient decision aids (PtDAs) are tools to help patients understand the details of different options through manuals, web pages, etc when they face medical choices, and finally make the best decision-making.[13] It can not only protect patients' right to know and independent choice, but also alleviating patients' decision-making difficulties, improving decision-making satisfaction.[14] As a professional discipline, cardiology focuses on creating and using the most advanced evidence-based PtDAs to reduce decision-making conflict and promote shared decision-making.[15] The 2017 ACC/ AATS/ AHA/ ASE/ ASNC/ SCAI/ SCCT/ STS recommended that the treatment of coronary artery disease should be individualized based on patient's wishes.[16] The Heart Failure Society of America, American Association of Heart Failure Nurses endorsed the "critical" need to improve the informed consent process and increase shared decision making.[17] Although PtDAs are important in the treatment process for HD, the development and application of PtDAs for HD is still in the initial stage. PtDAs related to patients with HD have not been systematically reviewed, especially those patients who need heart surgery. Therefore, the scoping review aims to explore the use of PtDAs in patients undergoing cardiac surgery.

Methods

We followed the reporting framework of the scoping review presented by Arksey and O'Malley in 2005.[18] It has 5 steps: (1) identification of research questions and clarification of concepts; (2) development of literature search plan; (3) study selection; (4) charting the data; (5) collating, summarizing, and reporting the results. The scoping review applies to our study as it helps us to understand the current use of PtDAs in patients undergoing surgery for HD. It generally does not require strict quality evaluation of the literature, its evidence level is lower than the systematic evaluation in Cochrane and JBI guidelines. This study has been approved by the Bioethics Committee of Tongji Medical College of Huazhong University of Science and Technology.

Identification of research questions and clarification of concepts

This study aimed to clarify the application of PtDAs in patients undergoing HD surgery. We identified 3 questions: (1) what PtDAs were available for patients undergoing cardiac surgery? (2) what factors may affect their use? (3) how to evaluate the effects of PtDAs? The core concept involved in this study was Patient Decision Aids: Patient decision aids (PtDAs) were defined by the International Patient Decision Aids Standards (IPDAS) as "*tools designed to help people participate in decision making about health care options*", providing "*information on the options*" and helping patients "*clarify and communicate the personal value they associate with different features of the options*".[13]

Development of literature search plan

The document search plan was formulated by a research librarian and 5 research group members. The initial search was conducted in PubMed and Web of Science databases. Then, we analyzed the text words and index words in the retrieved paper title and abstract, which are the key terms to be used in the next step. All identified keywords and index words were used to search on PubMed, EMBASE, CINAHL, Web of Science, Cochrane Library, CNKI, and Wan Fang database. All databases were searched from their inception to January 2022. Grey literature was searched using Google Scholar, professional society's websites, as well as clinical trials registries (Clinical Trial.gov, World Health Organization International Clinical Trials Registry Platform). The final search strategy is shown in Appendix A.

Study selection

Inclusion criteria: (1) The research object was the personnel involved in decision-making; (2) PtDAs used for disease treatment modality selection; (3) PtDAs provided information about the decision at hand and helped to choose between at least two options; (4) Articles were published in English or Chinese; (5) Quantitative research, qualitative research, and mixed research. Exclusion criteria: (1) Only the PtDAs development process was recorded; (2) Articles on medicinal decisions alone were excluded; (3) Studies were systematic or narrative reviews. We removed the duplicated literature using the Zotero software, then reviewed the title, abstract and content of the article in strict accordance with the inclusion and exclusion criteria. A full−text screen was then performed to determine acceptability into the final review. In instances of disagreement, a third reviewer adjudicated. Fig. 1 illustrates the search process.

Charting the data

Data extraction was a process that clearly displays the basic characteristics and other information of articles. Both reviewers independently charted the data from eligible studies using a standardized data charting form. Discrepancies in data extracted were negotiated until consensus was reached. A third reviewer reviewed all extracted data. The following study characteristics were extracted from studies:authors, years of publication and country of origin, aims/objectives of the study, sample and sample characteristics, etc.

Collating, summarizing, and reporting the results

We discussed the data extraction results of all articles, which were undertaken by the entire research team in an iterative process until agreement was reached on the impact of the thematic findings and scoping review. Two data analysis methods were used in this study: (1) Descriptive analysis: It mainly includes the research scope, distribution, and numerical analysis of the results extracted from the literature. In this study, we mostly use constants and percentages for description; (2) Qualitative thematic analysis: It is mainly used to present the current situation or theme of the included literature. We incorporated the literature into NVivo software for management. After getting familiar with the content of the article, we analyzed and encoded the content of the article word by word according to our research problems. For the text with given coding, we checked and considered whether it needs to be changed. Then we compared the similarities and differences between codes, integrated them, and constructed descriptive topics. Finally, based on several rounds of repeated analysis, everyone needed to agree on the theme.

Results

What PtDAs were available for patients undergoing cardiac surgery?

We retrieved a total of 1309 pieces of literature and finally included 12 of them. The basic characteristics of the included literature are shown in Tables 1 and 2. There were quantitative studies (83.33%), mixed studies (8.33%), and qualitative studies (8.33%). These studies were conducted in the United States (58.33%), Canada (25%), the Netherlands (8.33%), and China (8.33%). Sample size varied from 13 to 581. In addition, these studies were related to coronary artery disease (33.33%), heart failure (16.67%), valvular heart disease (16.67%), arrhythmia (16.67%), ischemic heart disease (8.33%) and autologous pre-donation in cardiac surgery (8.33%). The most

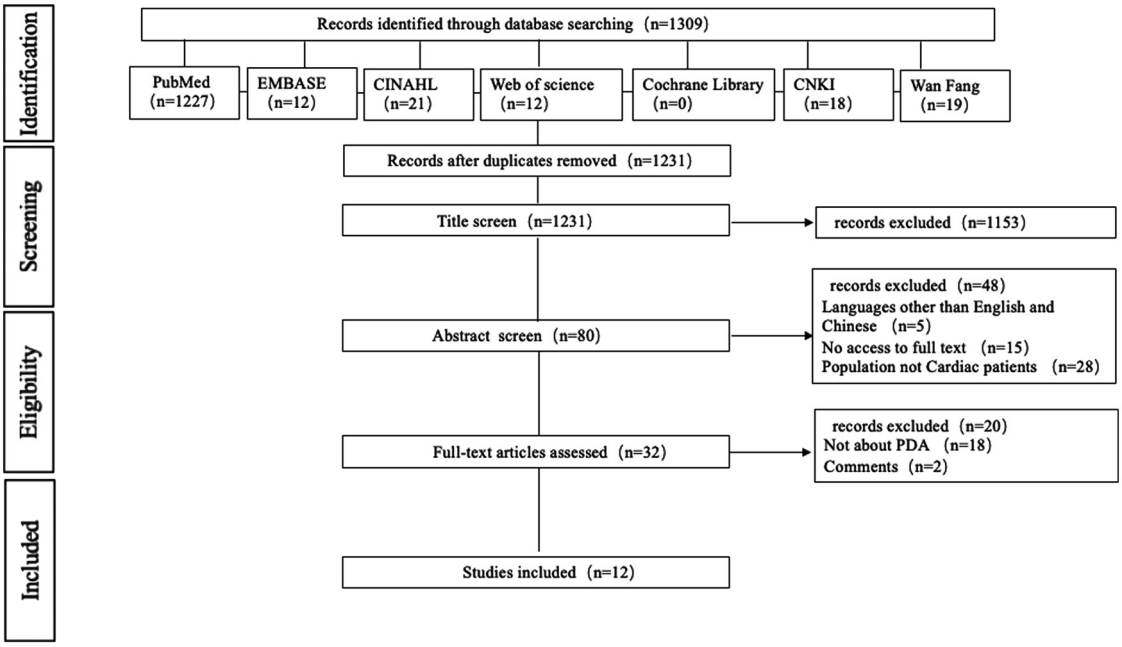

Fig. 1. Search strategy outcomes and numbers of papers assessed.

Table 1
Overview of included Quantitative studies

#	Authors, (year), Country	Key issues	Sample (IG/CG) and settings	Intervention	Data collection	Results
1	Kostick et al, (2018), USA[19]	Advanced Heart Failure (Left Ventricular Assist Device (LVAD))	N=98 (47/51) Hospital, Medical, Center, Clinic and Health Care	Patients received the PtDAs (booklets and videos) after formal evaluation for LVAD eligibility but before standard education (SE) and implantation. All patients received 1 week and 1 month follow-up.	A questionnaire survey was conducted on patients' knowledge, quality of the decision process, outcome of decision choices, and acceptability of decision aids.	Improved knowledge at 1-week follow-up (68% *vs* 59%, $P = 0.02$) no significant difference at 1-month follow-up (64% *vs* 61%, $P = 0.29$), Increased life satisfaction (28 *vs* 23 out of 30; $P = 0.006$), Improved quality of life ($P = 0.02$; $P = 0.03$), High acceptance of decision aids (83%-94%), No significant improvement in the quality of decision making.
2	Chhatriwalla et al, (2020), USA[20]	Coronary Artery Disease (stent selection in PCI)	N=581 (332/136/113), Medical Center and Heart Institute	The PtDAs were administered in the catheterization laboratory "preparatory" area prior to the patient's procedure, some of these patients have been coached by a decision coach. Their intervention was carried out under the principle of motivational interview.	Patients were interviewed and questionnaires were administered on their knowledge, choice of treatment options, perception of decision making, quality of the decision process, and physical condition.	Under the guidance of the decision-making coach, patients have a higher level of knowledge (4.3 ± 1.5 *vs* 2.3 ± 1.4, $P < 0.001$), are more willing to express their values (68.9% *vs* 35.6%, $P < 0.001$), and improve their autonomy to participate in medical decision-making ($P < 0.001$).
3	Coylewright et al, (2016), USA[21]	PCI choice decision aid for Stable Coronary Artery Disease	N=124(65/59), outpatient clinic	The PtDA (paper-based decision aid) delivered upstream from diagnostic coronary angiography. All patients were followed up for 3 months.	A questionnaire survey was conducted on patients' knowledge, decision-making conflict and participation.	Improved knowledge (60.3% *vs* 39.6%, $P = 0.034$), but did not improve patients' decision-making conflict ($P > 0.05$) and decision-making participation. (21.3% *vs* 16.0%; mean difference 5.2%; 95% *CI*, −0.5 to 10.9; $P = 0.071$)
4	Doll et al, (2019), USA[22]	Coronary Artery Disease (medical therapy, coronary artery bypass graft surgery,	N=203(103/100) Hospital and outpatient clinic	Patients used a web-based decision aid to explore their treatment options after diagnostic coronary	The patients' knowledge, value preference, symptom burden and quality of the decision process were	Improved knowledge and control preferences ($P < 0.01$), but had no impact on decision-making quality and treatment choice.

(*continued*)

Table 1 (*Continued*)

#	Authors, (year), Country	Key issues	Sample (IG/CG) and settings	Intervention	Data collection	Results
		percutaneous coronary intervention)		angiography and all were followed up for 3 months.	investigated by questionnaire.	
5	Anaya et al, (2019), USA[23]	Valve Choices in Surgical Aortic Valve Replacement	N=23(10/13) Hospital	Cardiac surgeons consider whether patients need decision aids. All patients were followed up for 12 weeks.	The knowledge, treatment preference and decision conflict of patients were investigated	Improved knowledge (100% *vs* 25%, $P = 0.02$), reduced decision-making conflict ($P = 0.04$), and did not change treatment options.
6	Laupacis et al, (2006), Canada[24]	autologous predonation in cardiac surgery	N=120(60/60), Heart Institute	Patients received the PtDAs (a 25-min audiotape and accompanying 19-page booklet) before the patients saw the surgeons when they had not yet made a decision.	The knowledge, choice, quality of the decision process were investigated by questionnaire.	Improved knowledge ($t = 5.171$, $P = 0.001$), Improved risk perception ($t = 4.989$, $P = 0.001$), Improved satisfaction with decision making ($P < 0.05$), play a more independent role ($P = 0.001$ versus $P = 0.454$), Reduced decisional conflict ($t = 2.072$, $P = 0.041$, effect size = 0.41)
7	Morgan et al, (2000), Canada[25]	Ischemic Heart Disease (medical therapy, bypass surgery and angioplasty)	N=187(90/97), Hospital	Decision aids (Interactive Videodisc) were used to assist patients at least 4 weeks before surgery, all patients were followed up for 6 months	A questionnaire survey was conducted on knowledge, quality of the decision process and health status.	Improved knowledge (75% *vs* 62%, $P < 0.001$), Increased patient decision-making autonomy, no difference in decision satisfaction and health status.
8	Carroll et al, (2017), Canada[26]	Arrhythmia (implantable cardioverter defibrillator)	N=82(41/41), Care center	Patients used decision-making aids(booklets) to understand relevant knowledge before consulting with experts, all patients were followed up for 3 months.	A questionnaire survey was conducted on knowledge, decisional conflict and preparation.	Improved knowledge (47.5% *vs* 23.09%), reduced decision-making conflict (95% confidence interval (*CI*)] was − 22. 1[− 30.23, − 13.97).
9	Korteland et al, (2017), Netherlands[27]	Heart valve disease (Prosthetic Heart Valve Selection)	Hospital N=138(67/71)	Identify patients undergoing surgery to use decision aids before preoperative consultation, all patients were followed up for 3 months.	A questionnaire was used to investigate the patients' decision-making quality, knowledge, preferred role, anxiety and depression, quality of life.	Improved knowledge (85% *vs* 68%, P =0.004), Improved mental health (54 *vs* 50, $P = 0.032$), other results were not statistically significant.
10	Shi Runze (2018), China[28]	Implantable Cardioverter Defibrillator	N=54(27/27), Hospital	Patients used decision-making aids to understand information at admission, preoperative conversation and after operation.	A questionnaire was used to investigate the patients' decision-making conflict, knowledge and ICD acceptance.	Improved knowledge ($U = 32.000$, $P < 0.005$), Reduced decision-making conflict (18. 98 ± 8.19 *vs* 23.59 ± 7.63, $P < 0.05$), ICD acceptance was not statistically significant
11	Matlock et al, (2020), USA[29] (Quantitative component)	Advanced Heart Failure (Left Ventricular Assist Device (LVAD)	N=248(113/135), Medical Center	Decision aids (Interactive Videodisc) were used to assist patients before formal LVAD education, all patients were followed up for 1 and 6 months.	The patients' knowledge, quality of the decision process, control preference, illness acceptance, depression and quality of life were investigated by questionnaire.	Improved knowledge (P =0.03), more obvious preferences ($P < 0.001$), other results were not statistically significant.

IG: Intervention Group
CG: Control Group

common setting of the studies was hospital (58.33%). Most studies were single center studies (58.33%) and had followed-up (83.33%), and the maximum time was 6 months. The use of PtDAs mainly included whether surgery was needed and uncertain surgical plans. The forms of PtDAs included paper-based (66.67%), website (16.67%), video (16.67%), CD (8.33%), magnetic tape (8.33%). In terms of PtDAs implementers, the most common implementers were cardiologists (100%) and nurses (41.67%).

What factors may affect their use?

A total of 11 studies (91.67%) described the factors affecting the use of PtDAs. We read and coded these contents. These factors were classified into three categories: the quality problem of the PtDAs, medical environment, and patients. (Table 3)

Eleven studies (100%) described the quality problems of PtDAs. Six studies (54.55%) related to the auxiliary content of PtDAs, and five

Table 2
Overview of included Qualitative research

#	Authors, (year),Country	Study aim/s	Sample/participants	Data collection method and analysis results	Results; key themes
1	Coylewrigh et al, (2016), USA[30]	Describe cardiovascular clinicians' perceptions following use of a decision aid for Left Ventricular Assist Device.	cardiologists and physician extenders (n=13)	semi-structured qualitative interview, theory-driven interview guide, using a researcher-developed codebook	(1) Gaps exist in clinician knowledge around SDM; (2) Clinicians are often uncomfortable with modifying baseline practice; (3) Clinicians express interest in using DAs after initial exposure within a research setting
2	Matlock et al, (2020), USA[29] (Qualitative component)	Describe cardiovascular clinicians' perceptions following use of a decision aid for stable coronary artery disease (CAD) "PCI Choice".	A total of 69 interviews were conducted with 48 clinicians at 3 time points.	RE-AIM framework, qualitative Content Analysis methodology, using a researcher-developed codebook	(1) clinician-level interactions with the DA; (2) team-level experiences with implementation, and (3) system-level observations.

Table 3
Factors affecting the application of PtDAs in cardiac surgery

Primary Theme	Secondary Themes	
		No. of studies (n (%))
quality problem[19-27,29,30] (11/11, 100%)	**Content**[19,20,22,25,27,30]	(6/11, 54.55%)
	objectivity[22,27,30]	
	readability[27]	
	timeliness[19,20,25,30]	
	Form[20,24,27,29,30]	(5/11, 45.45%)
	individualization[20,24,27,29,30]	
	complex design[29]	
	Implementation process[19-24,26,27,29]	(9/11, 81.82%)
	lack of standardized application process[19-24,26,29]	
	impact of failure cases[26,27]	
medical environment[19-27,29,30] (11/11, 100%)	**Medical staff**[20-27,29,30]	(10/11, 90.91%)
	knowledge[21,24,25,29]	
	skill[21,24,25,27,29]	
	time[22,23,26,30]	
	working pressure[21,26]	
	prejudice[20,21,29,30]	
	doctor's treatment preference[23]	
	unclear division of labor among users[21,24,30]	
	Hospital[19-22,24-26,30]	(8/11, 72.73%)
	imperfect system[20,22,25,26]	
	managers do not pay attention[20,24]	
	human resources[19-22,25,30]	
	insufficient financial support[20,26]	
patients[19,20,22,24-27,29,30] (9/11, 81. 82%)	**Demographic characteristics**[19,22,25-27,29,30]	(7/11, 63.64%)
	age[27,29]	
	education[19,22,25,29]	
	preference[19,27]	
	personal schedule[27]	
	economics[30]	
	disease situation[19,20,24]	
	Psychology[22,26]	(2/11, 18.18%)
	anxious[22]	
	distrust [22]	
	Social relations[19,22]	(2/11, 18.18%)
	paternalistic decision making[19,22]	
	family influence[22]	

studies (45.45%) related to the form of PtDAs. Nine studies (81.82%) involved the problems existing in the implementation process at this stage. The most common problem was lack of standardized application process.

Eleven studies (100%) related to the influencing factors of medical environment. In addition to low user participation enthusiasm (90.91%), they also related to the impact of hospitals on the use of PtDAs (72.73%). The most common influencing factor was the lack of human resources (such as the lack of decision-making coach, etc), the second was the lack of skills (such as communication skills).

Nine studies (81.82%) related to the patient's impact on PtDAs. Seven studies (63.64%) paid attention to the demographic characteristics of patients. Only two studies (18.18%) related to the psychological factors and mentioned the impact of social relations.

How to evaluate the effects of PtDAs?

ODSF and International PtDA Standards were used to guide the development process of PtDAs.[31] Even for researchers who do not develop their PtDAs using the ODSF, they often evaluate it using the

ODSF-based Scale to determine patients' decision-making process.[32] We used this framework to summarize the results section of the included literature. Eleven studies (91.67%) involved quantitative studies with twenty-eight quantitative outcome measures. According to the "DECISIONAL OUTCOMES" section of ODSF, we divided them into three main themes: quality of the decision-making, quality of the decision-making process, impact. We manually classified the specific content and coded into 8 secondary themes (Table 4). The most commonly used outcome indicators are knowledge (39.29%), decision conflict (32.14%), decision-making role preference (25%).

Eleven studies (100%) explored the impact of PtDAs on decision quality including the evaluation of patients' disease knowledge (100%) and personal preference (81.82%). Although the content of knowledge scale was different, all studies showed that the application of PtDAs can improve the level of knowledge. In terms of patient preferences, the most commonly used was the Control Preferences Scale, which was used to evaluate the expected and actual roles of patients in the decision-making process.

Eleven studies (100%) explored the impact of PtDAs on the quality of decision-making process, including decision preparation, decision support and decision satisfaction. Decision conflict was the most commonly used outcome indicators in decision quality evaluation (81.82%), and the second was decision satisfaction (27.27%) and decision regret (27.27%).

Nine studies (81.82%) explored the impact of decision support on patients, including health, feasibility and others. Three studies (27.27%) have explored whether PtDAs have an impact on treatment choice, and the result of 2 of them was "Yes".[20,24]

Discussion

This scoping review demonstrates the application status of PtDAs in cardiac surgery patients, influence factors and outcome indicators. Despite numerous scope reviews on PtDAs, this is the first scoping review on the treatment options of cardiac surgery patients.

Application status

Patient participation in medical decision-making has been recognized as an important part of high-quality health care services.[33] The development and application of PtDAs are effective ways to achieve win-win between doctors and patients.[34] In this study, we included twelve articles on the treatment options of cardiac surgery patients, more than half of the studies (58.33%) have been conducted in the United States and have received financial support. These studies involved heart failure, coronary artery disease and heart valve disease. In addition, ten studies (83.33%) were published after 2015, and eleven studies (91.67%) were conducted in developed countries, with obvious temporal and spatial distribution characteristics.

Cardiac surgery is a suitable field for studying medical decision-making. Doctors often discuss the results of surgery according to the patient's age and complications in the dialogue of informed

Table 4
Outcome indicators of PtDAs in cardiac surgery patients

Primary Theme	Secondary Themes	No. of studies (n (%))
Quality of the decision-making [19-29] 11(11/11, 100%)	**Knowledge**[19-29]	11(100%)
	disease knowledge[19-29]	
	risk perception[24]	
	Personal preference[19-25,27,29]	9(81.82%)
	consistency between expectation and reality[19,20]	
	role preference[19-22,24,27,29]	
	treatment preference[20,22,23,25]	
	consistency between patients and doctors[25]	
	whether there is a pre-established medical treatment[19]	
	degree of participation[21]	
	attitude towards decision-making[22]	
Quality of the decision-making process [19-29] 11(11/11, 100%)	**Decision preparation**[19,21-24,26-29]	9(81.82%)
	decision conflict[19,21-24,26-29]	
	degree of decision preparation[19,26]	
	Decision satisfaction [19,21,24,25,27,29]	6(54.55%)
	degree of decision satisfaction[19,24,25]	
	decision regret [19,27,29]	
	shared decision evaluation[19,21]	
	Decision support [19,20,29]	3(27.27%)
	autonomous support perception[20]	
	pressure perception[29]	
	perception of nursing quality [19]	
Impact [19,20,22, 24-29] 9(9/11, 81. 82%)	**Health**[19,20,22,25,27,29]	6(54.55%)
	symptom burden [22]	
	general health [25]	
	depression and anxiety[27,29]	
	quality of life[27,29]	
	life satisfaction[19]	
	treatment options [19,20,24]	
	Feasibility [19,26,28,29]	4(36.36%)
	PtDAs acceptance [19,26]	
	equipment acceptance [28]	
	disease acceptance[29]	
	scheme completion rate and quality[26]	
	Others[26]	1(9.09%)
	referral rate [26]	

consent.[15] The content of PtDAs for cardiac surgery patients involves not only the treatment methods such as open surgery and minimally invasive surgery, but also the selection of some surgical equipment. However, their decision-making is more than that, intraoperative risk and postoperative rehabilitation are related to the quality of life attracting their attention.[35] As mentioned in table 1, only one study involves the decision-making assistance implementation of special treatment during cardiac surgery, the application of PtDAs in cardiac surgery patients still has a lot of room for development.

Our review showed that the PtDAs used in the included studies were developed by their team. They included doctors, nurses, statisticians, research assistants, and others who were also involved in the application of PtDAs. The role of PtDAs was to supplement and then conduct high-quality conversations, and who leaded the conversation matters. Doctors had specialized medical knowledge and communication skills, eleven studies highlighted their dominant role in the decision-making process. Interestingly, one study included the role of a decision coach.[20] Due to the effectiveness of a decision coach still being uneven, it is unclear that how much it contributes to the results when combined with PtDAs and compared with routine care.[13]

In addition, we found that these PtDAs had the following characteristics. First of all, all tools needed to make decision-makers clear about the medical decisions they need to make. Second, they needed to provide evidence-based information. Finally, patients should be assisted in understanding the relevance of different decisions to personal values. Lack of localized PtDAs limited their scope of use. To ensure that the contents of PtDAs meet the actual decision-making needs, it is necessary to develop them in multiple languages according to national practice.

Influence factors

The development of cardiac surgery was inseparable from the innovation of doctors, leading to the slight difference between the content of PtDAs and doctors' technology. It was difficult to ensure that the content involved in the latest medical achievements. “Easy-to-understand language” was listed as one of the most important quality indicators by PtDAs.[36] It was important to use images to express patients’ subjective feelings, reduce or avoid using words like “high risk” alone and prevent patients from being confused due to vague expression.[37] In terms of the form, the network PtDAs had the advantages of high interaction with patients and no location restrictions compared with paper materials.[38] However, some elderly patients in cardiac surgery had difficulties in using computers and the network in general, and this resulted into poor or no use of the resources provided on those platforms.

Although PtDAs were usually used in elective surgery decision-making, they still lack a standardized process. 1-week time period after eligibility was a crucial decision-making period for patients,[19] especially those in critical or near-critical condition. The time between diagnosis and surgery is uncertain because we cannot accurately determine the trajectory of HD. Intervening too early often leads to patients forgetting the information, while intervening too late leads to patients being unfamiliar with that information. In addition, the application of PtDAs in cardiac surgery is likely to be repeated. Taking coronary heart disease as an example, preoperative patients are faced with the choice of surgical scheme, and the use of postoperative anticoagulants and antithrombotic drugs, doctors need to repeatedly communicate these choices, depending on each patient’s personal situation.

Two qualitative studies showed that most cardiac surgeons had a positive attitude towards PtDAs. Adequate discussion time can promote patients' participation in medical decision-making, but the workload of cardiac surgery and the driving of doctors' interests may lead to doctors' less time in using PtDAs. Most studies emphasized the impact of communication skills on the use of PtDAs, because effective communication can enhance the trust relationship between doctors and patients. Some communication models have been developed and used:Communication-centered Epistemic Model of Shared Decision Making (CEM-SDM),[39] and Model of collaborative decision making.[40] Our review also highlights the impact of the organizational level. Timely updating PtDAs requires not only time and human resources, but also the coordination and support of medical and health systems and policies, such as formulating reasonable update strategies, ensuring adequate funding sources and the continuity of medical decision-making, etc.

The use of PtDAs is inseparable from the participation of patients. Patients with high education level are more willing to participate in medical decision-making.[41] Heart surgery is a source of emotional distress for the patient.[42] Individuals in different emotional states have different clinical decisions. Mentality and emotion can have a negative impact on personal information processing ability.[43] Two studies (16.67%) investigated the effects of social relationships on decision-making. The first is the paternalistic decision-making dominated by doctors that is applicable in some clinical situations. For example, when a heart disease patient in need of rescue is admitted to the emergency department, we may first let the doctor dominate rescue process, and discuss the next medical decision after the condition is relieved. The second is the influence of family members. Some heart disease patients undergoing elective surgery have a long time understanding the treatment information. In this process, they will inevitably receive suggestions from their families. We encourage family members to supervise the decision-making process, but too much participation may weaken the effect of PtDAs. We cannot guarantee that the final decision-making result is truly in line with the patient's values.

Treatment outcome

In the process of medical decision-making, patients need knowledge to make informed decisions about their health. Eleven studies (91.67%) involving quantitative outcome measurement used knowledge as an outcome indicator. Interestingly, these studies have confirmed the important role of PtDAs in improving the knowledge level of cardiac surgery patients. However, the core of high-quality decision-making is to choose whether it is in line with the patient's values and preferences. Knowledge alone is not enough to ensure high-quality decisions, especially in surgery. The risk of cardiac surgery is high and the treatment effect varies across different patients, showing that the improvement of decision-making quality must not rely solely on the evaluation of surgical effect. Combining the objectivity of medicine with the values of patients and making decisions that are most in line with the interests of patients is a high-quality decision.

The scoping review also summarizes the outcome indicators related to the quality of the decision-making process. We should recognize that PtDAs are auxiliary tools, but they are not necessarily implemented in the decision-making process, let alone the implementation of shared decision-making. Ideally, if PtDAs were widely accepted and became part of medical decision-making, the first thing needed to prove is that they can help provide decision support to patients. Our scope review found that most studies did not have an important impact on the quality of decision-making process in cardiac surgery patients. Not surprisingly, it is still a serious problem to integrate reliable decision support standards and SDM framework into the development of PtDAs. Although the use of ODSF-based Scales contributed much to understanding the quality of decision-making, we need to rationally comprehend the results of the scales filled in by patients themselves. A key point in the decision-making process of cardiac surgery patients cannot be ignored is time, especially for those patients who are in a critical situation or are extremely hesitant about the treatment plan. Time should become an

evaluation index of decision-making efficiency. We can use some scales to measure it, such as time stress scale.

Finally, the review noted the impact of PtDAs on clinical practice in cardiac surgery patients, including health-related outcomes, the feasibility of decision aids, etc. In patients with HD, multimorbidity is the norm, and layered on top of this are the closely related but separate phenomena of disability and frailty. The improvement of the quality of life of cardiac surgery patients depends more on surgical technology, previous health status, and postoperative care. Therefore, PtDAs have little impact on patients' health. It is worth noting that the choice of measurement time is important. Taking the quality of life as an example, the increase of quality of life after cardiac surgery is the most significant one month later.[44] Psychological states such as anxiety and depression will not improve until one year after heart surgery.[45] Most of the studies we included are followed up for 1 month and 3 months. Future studies focusing on finding the potential long-term efficacy of PtDAs should be continued. In addition, the feasibility of PtDAs should take its cost-effectiveness as an important outcome indicator.[46]

Limitations

Considering that some of PtDAs displayed in the form of websites are inaccessible to us and the theoretical frameworks are slightly different, we were not able to code and summarize the core elements of the PtDAs involved in the research. Moreover, we did not strictly evaluate and integrate the quality of these studies, causing us to use the word "most" or probability in the outcome indicators, instead of accurately expressing the results. Another limitation was that we only searched 7 databases, a few relevant publications might be missed.

Conclusions

The essence of timely application of decision PtDAs to help family members of cardiac surgery patients participate in decision making is obvious, either within a wider set of advance care planning measures or as part of clinical routine. However, PtDAs are quite a small part considering the tremendous burden of HD and the huge evidence base. This scoping review highlighted the current status and outcome indicators of the use of decision aids in cardiac surgery patients, and points out the factors that may affect the implementation of clinical practice. We found that the current application of PtDAs in cardiac surgery is mostly focused on elective surgery. With the rapid developments in medical technology, more research is needed to explore how technologically advanced decision aids could help facilitate the decision quality in cardiac surgery, without excluding critical patients or otherwise disadvantaged groups. Furthermore, the design of SDM scales and tools are also specifically validated for cardiac surgery SDM that should be encouraged. And finally, given the importance of information exchange, more knowledge is needed to integrate the key roles of different health care providers into the medical decision-making process of cardiac surgery.

Credit Author Statement

ZYR, ZD, PYQ, and ZZ contributed to the concept and design of the study, which was led by ZYR. ZD, LJ, and ZLS developed the search strategy, ZD and ZZB performed the literature search. ZD, LJ, ZJ and WQS performed the study selection, extraction, and analysis of data. ZD and CZL drafted the first version of the manuscript, and all authors critically revised the manuscript for important intellectual content and gave final approval of the version to be published.

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Conflict of Interest statement

none

Appendix A. Search strategy

PubMed

Search: ((("Decision Support Techniques"[Mesh] OR "Decision Support Techniques" [tiab] OR "Decision model"[tiab] OR "decision aid*"[tiab])) AND (("Heart Diseases"[Mesh] OR "Valvular disease*"[tiab] OR "Congenital heart disease*"[tiab] OR "Coronary Artery Disease"[tiab] OR "Aortic disease"[tiab] OR "Sudden Cardiac Arrest"[tiab] OR "Heart Failure"[tiab] OR "Cardiac arrhythmia"[tiab] OR "Cardiomyopathy"[tiab]))) AND ("Surgical Procedures, Operative"[Mesh] OR "Surgical Procedures, Operative*"[tiab])

EMBASE

('decision support techniques':ab,ti OR 'decision model':ab,ti OR 'decision aid':ab,ti) AND ('heart disease':ab,ti OR 'tricuspid valve disease':ab,ti OR 'congenital heart disease':ab,ti OR 'coronary artery disease':ab,ti OR 'aortic disease':ab,ti OR 'sudden cardiac death':ab,ti OR 'heart failure':ab,ti OR 'cardiac arrhythmia':ab,ti OR cardiomyopathy:ab,ti) AND surgery:ab,ti

CINAHL

(TI "Decision Support Techniques *") OR (TI "Decision model *") OR (TI "decision aid *") OR
(AB " Decision Support Techniques *") OR (AB " Decision model *") OR (AB " decision aid *")
AND
(TI " Heart Diseases *") OR (TI " Valvular disease *") OR
(TI " Congenital heart disease *") OR (TI " Coronary Artery Disease *") OR
(TI " Aortic disease *") OR (TI " Sudden Cardiac Arrest *") OR
(TI " Heart Failure *") OR (TI " Cardiac arrhythmia ") OR (TI " Cardiomyopathy ") OR
(AB " Heart Diseases *") OR (AB " Valvular disease *") OR
(AB " Congenital heart disease *") OR (AB " Coronary Artery Disease *") OR
(AB " Aortic disease *") OR (AB " Sudden Cardiac Arrest *") OR
(AB " Heart Failure *") OR (AB " Cardiac arrhythmia ") OR (AB " Cardiomyopathy ")
AND
(AB " Surgery*") OR (TI " Surgery*")

Web of science

TS = (Decision Support Techniques * OR Decision model * OR decision aid*) AND TS = (Heart Diseases * OR Valvular disease * OR Congenital heart disease * OR Coronary Artery Disease * OR " Aortic disease *" OR " Sudden Cardiac Arrest *"OR " Heart Failure *" OR " Cardiac arrhythmia *" OR " Cardiomyopathy*" AND TS = ("Surgical Procedures, *" OR "best practice*")

Cochrane Library

((Decision Support Techniques * OR Decision model * OR decision aid *) AND Heart Diseases * OR Valvular disease * OR Congenital heart disease * OR Coronary Artery Disease * OR Aortic disease * OR Sudden Cardiac Arrest * OR Heart Failure * OR Cardiac arrhythmia OR Cardiomyopathy * AND surgical):ti,ab,kw OR (MeSH descriptor: [Thoracic Surgery as Topic] Explode all trees)

CNKI

(SU%= 'shared decision making'+ decision aids') AND (SU%='Heart Disease '+'Coronary heart disease ' + 'Valve Diseases '+ 'ICD').

Wan Fang

Title or keywords:(decision aids or shared decision making) and Title or keywords:(Heart Disease or Coronary heart disease or Valve Diseases or ICD).

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