



## Review article

# Characteristics of music intervention to reduce anxiety in patients undergoing cardiac catheterization: scoping review



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## ABSTRACT

The characteristics of music interventions for reducing anxiety in patients undergoing cardiac catheterization were mapped. A scoping review was conducted according to the Joanna Briggs Institute methodology. Searches were performed in electronic portals and databases PubMed, CINAHL, PsycINFO, Cochrane, EMBASE, Scopus, LILACS, CAPES Thesis Portal (Brazil), DART-Europe E-theses Portal, Theses Canada Portal, Pro-Quest, and Google Scholar databases, gray literature, with no limitation on the year of publication. Eighteen articles were included in the search. The characteristics of the interventions were heterogeneous and not comprehensively described in the primary studies. The songs were predominantly of a single genre, instrumental, and selected by the interventionist, with a rhythm between 60 and 80 beats per minute. The interventions were delivered in a single session, mostly in the catheterization laboratory, before or during the procedure, by means of digital audio and earphones for over 20 min. The heterogeneity of interventions and incompleteness of information in the studies compromises the advancement of knowledge on the effects of music on health outcomes.

## 1. Introduction

Different strategies have been used to treat anxiety in patients undergoing cardiac catheterization; among them, music interventions have received attention from researchers [1, 2, 3]. The therapeutic use of music is recognized for its low cost [4], ease of application, and good acceptability [1, 2, 3, 4]. However, the results of studies on the effectiveness of these interventions are controversial [2, 3], which can be attributed to little attention being paid to the mechanisms of action of music for achieving the desired health outcomes [5, 6]. Although recent systematic reviews aimed at assessing the effectiveness of music interventions, to date, no studies have synthesized the literature based on the characteristics of music interventions and whether the interventions were effective or not. A lack of studies mapping the characteristics of effective music interventions prevents the selection of the most appropriate components of music interventions by clinicians and researchers, and compromises the synthesis of the available evidence, making it difficult to establish recommendations for use of this type of intervention in clinical practice [1, 2, 3].

## 1.1. Anxiety in patients undergoing cardiac catheterization

Cardiac catheterization is an invasive procedure widely used for the diagnosis or treatment of several cardiac conditions, among which coronary artery disease (CAD) [7]. Despite being invasive, cardiac catheterization has several benefits in comparison to other diagnostic and treatment methods, which has contributed to an increase in the number of procedures performed over time worldwide [7, 8, 9, 10]. Although cardiac catheterization is routinely performed in specialized hospitals and has a low incidence of adverse effects, it is still frequently unknown by the patient. Patients undergoing cardiac catheterization may face psychological and emotional repercussions such as anxiety, fear, concern, and insecurity due to the unknown [1, 2, 3].

Anxiety is a subjective phenomenon, characterized by an emotional reaction to stimuli perceived as a threat that, ultimately, has the purpose of preparing the individual to react to a dangerous situation [11]. Several factors can trigger anxiety, such as fear of the disease, hospitalization, and anesthesia, as well as the unfamiliar environment, previous experiences, and the procedure itself [12]. Anxiety has major impacts on

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cardiac function, including an increase in heart rate, blood pressure, and consumption of myocardial oxygen [12]. As a result, anxiety in patients undergoing cardiac catheterization has been related to negative health outcomes, such as decreased quality of life [13], increased mortality [14], progression of CAD [15], and exacerbation of cardiovascular symptoms [15]. The level of anxiety seems to increase significantly before the cardiac catheterization [16]. A recent study carried out in Ethiopia showed that the prevalence of anxiety before the procedure was 70.4% [95% CI (65.0–75.7%)] among patients undergoing cardiac catheterization [17].

Music-based interventions have been widely used to manage anxiety in these patients [1, 2, 3, 18]. Such interventions in patients undergoing cardiac catheterization can be administered by different healthcare professionals, including nurses [19]. Music is an intervention approved by the Nursing Interventions Classification (NIC), defined as “using music to help achieve a specific change in behavior, feeling, or physiology” [20].

This scoping review aimed to answer the following question: What are the characteristics of music interventions used to reduce anxiety in patients undergoing cardiac catheterization? The overall objective was to map the characteristics of music interventions used to reduce anxiety in patients undergoing cardiac catheterization, before, during, or after the procedure. Specifically, we sought to: 1) describe the goals and theory of music interventions; 2) describe the specific and nonspecific components of music interventions; 3) analyze the mode of delivery for intervention; 4) analyze the dose for intervention; and 5) synthesize the characteristics of music interventions according to their effect on anxiety intensity.

## 2. Method

A preliminary literature search was conducted in January of 2020, to identify literature reviews that possibly had already addressed the question of this review. The following databases were used: PROSPERO, MEDLINE, Cochrane Database of Systematic Reviews, and the Joanna Briggs Institute - JBI Database of Systematic Reviews and Implementations Reports. Three systematic reviews were found, but they were limited with regard to: the databases used, languages of the included studies, and/or omission of gray literature [1, 2, 3]. Another limitation of these reviews is that the characteristics of music intervention were summarized without identifying those related to effective/ineffective interventions. The present scoping review was more comprehensive, as it included articles published in languages not considered in existing reviews on the topic, as well as gray literature. Furthermore, the categorization of the characteristics of music interventions according to their efficacy/effectiveness represents an advance in terms of existing reviews.

### 2.1. Design

This scoping review was conducted according to the JBI methodology [21]. The recommendations of the *Preferred Reporting Items for Systematic Reviews and Meta-analyses for Scoping Reviews* (PRISMA-ScR) [22] were used in the preparation of this report. Ethics Committee approval was not required, as this was a review of available literature. The review protocol is registered at the *Center for Open Science Framework* (<https://osf.io/ym8pb/>) [23].

### 2.2. Search strategy

Music interventions were defined as those of a receptive nature, live or recorded, provided by a health care professional or music therapist, which relied on the auditory experience as the primary therapeutic component [5].

The characteristics of an intervention were considered to refer to specific and nonspecific components, as well as mode of delivery and dose [6]. Specific components are elements that can be related to the expected effect of the intervention; they are the active ingredients of the intervention [6]. Nonspecific components are elements that facilitate the

delivery of the intervention, but do not promote the expected effect of the intervention [6].

Reports of experimental and quasi-experimental studies that used music interventions for anxiety reduction in adult patients before, during, or after cardiac catheterization in the hospital setting were included in this review, regardless of whether they presented evidence of efficacy/effectiveness. Studies in Portuguese, English, and Spanish were included, in addition to gray literature, with no limits as to publication date. Articles that were excluded were those not available in their entirety online, not obtained after contacting the authors, that used interventions with music associated with other treatments, and in which valid and reliable instruments for assessing anxiety were not used.

An initial search was conducted in the CINAHL and MEDLINE databases using the terms Anxiety; Cardiac Catheterization; Coronary Angiography, Music, Music Therapy, with the aim to identify keywords in the titles, abstracts, and indexed terms of the retrieved citations. Then, a systematic literature search was performed in the following databases and portals: PubMed, CINAHL, PsycINFO, Cochrane, EMBASE, Scopus, and LILACS. The search for unpublished studies was performed in CAPES Thesis Portal (Brazil), DART-Europe E-theses Portal, Theses Canada Portal, Pro-Quest, and Google Scholar databases. Specific search strategies were created for each database or portal with the help of a professional librarian, using all the keywords and index terms identified in the first step.

### 2.3. Study selection

All retrieved records were uploaded to EndNote version X9/2019, and duplicates were removed. Study selection occurred in two steps. The first was to select potential research reports of interest by reading titles and abstracts, and the second was a complete reading of the reports selected in the previous step. When the texts were not available online, manuscripts were requested from the authors, if contact information was available.

Three reviewers selected the citations, by reading titles and abstracts. All reviewers had taken the Joanna Briggs Institute's Comprehensive Systematic Review Training [24]. Two of the reviewers selected the citations independently. At the end of this process, their selection was compared and inconsistencies were resolved by consensus. The third reviewer performed an analysis of all citations to ensure that the inclusion and exclusion criteria were uniformly applied.

No analysis of the methodological quality of the studies included in the review was performed.

### 2.4. Data extraction

The eligible studies were read in entirety by the same three reviewers. Data were extracted by two of the reviewers, independently, using a standardized instrument developed in Microsoft Excel® specifically for this purpose. The data from the extraction sheet were grouped into: 1) characterization of the studies, and 2) characterization of the music interventions.

The variables characterizing the studies were: author, year of publication, country where the study was conducted, manuscript language, objective, study design, sample characteristics (size, sex, age), perioperative period in which the intervention was implemented and in which anxiety was assessed, instrument used to measure anxiety, and level of anxiety at the different time points of assessment.

The characteristics of the intervention extracted from the studies were: objectives of the interventions; theory of the interventions; specific components, i.e., genre (e.g., classical, rock, jazz), style (instrumental and/or vocal), volume, rhythm, harmony, and timbre; selection of the music by the patient or interventionist; non-specific components, i.e., environmental factors (brightness, noise, number of people during the intervention); the dose, i.e., sessions, duration, and purity (any other components besides those mentioned that could facilitate the intervention's delivery that could affect the anxiety level); mode of

delivery, i.e., place and time of delivery of the intervention, delivery method (earphones, loudspeakers, or other devices); delivery format (live, cassette tape, CD, MP3 player, or other format); effect of the intervention on anxiety level.

### 2.5. Data analysis

The extracted data were described by means of frequencies and synthesized in a narrative format according to the characteristics of the articles, study methods, and the music interventions. The reasons for exclusion of the studies analyzed in their entirety were recorded.

## 3. Results

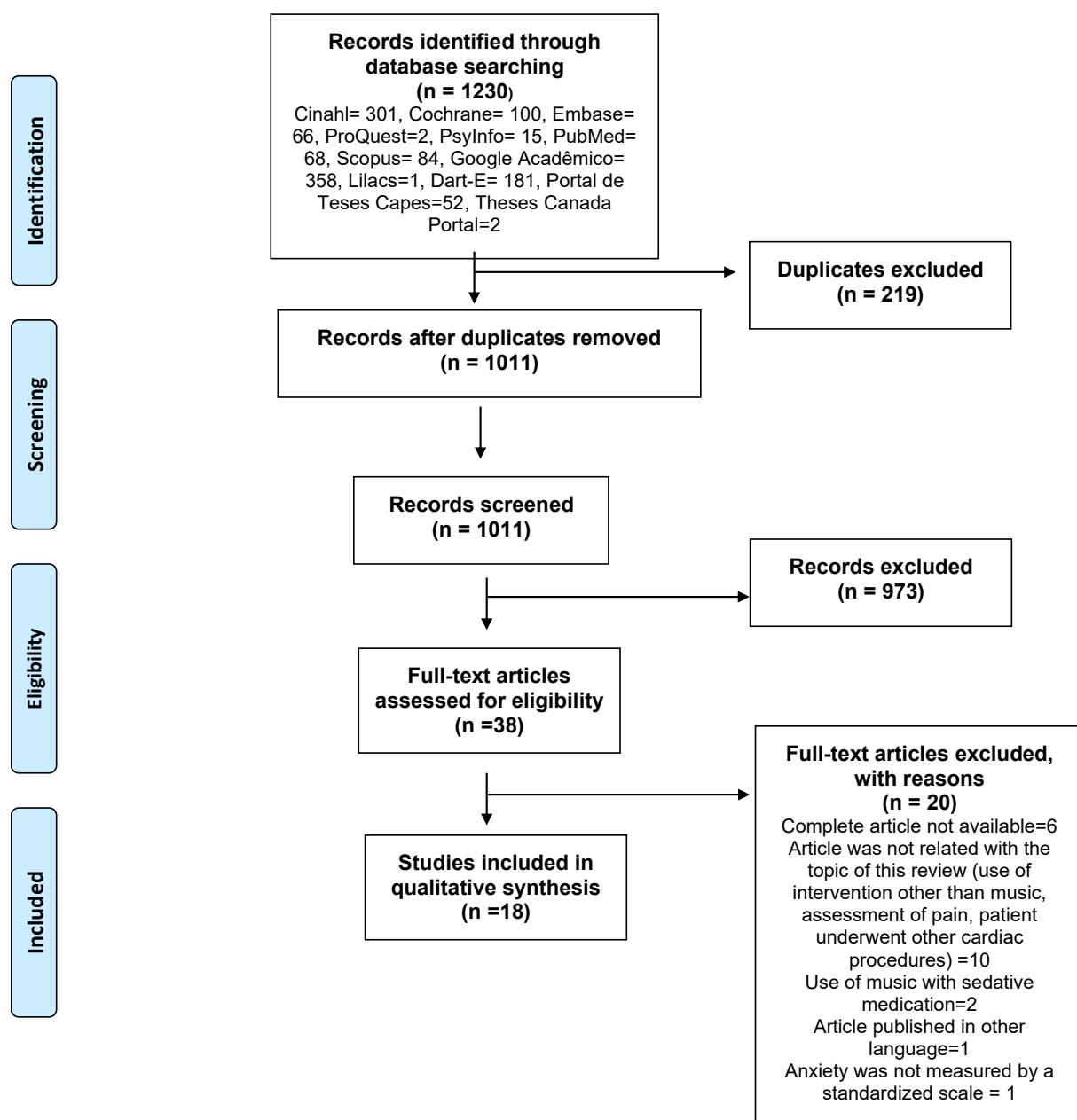
The search was conducted in January of 2020, and 1230 articles were obtained. After duplicates were removed ( $n = 218$ ), and articles were selected by reading titles and abstracts, 38 articles remained to be read in

full. From these, 20 were excluded. The reasons for exclusion are described in Figure 1. Eighteen articles were included in the review, two of which were gray literature.

### 3.1. Characteristics of the studies

The studies were published between the years 2002 and 2019, in English ( $n = 17$ ; 94.4%) and Portuguese ( $n = 1$ ; 5.6%), and were conducted by authors from the following countries: United States ( $n = 5$ ; 27.7%), Iran ( $n = 4$ ; 22.2%), Germany ( $n = 2$ ; 11.1%), Turkey ( $n = 2$ ; 11.1%), Brazil ( $n = 1$ ; 5.5%), Indonesia ( $n = 1$ ; 5.5%), Sweden ( $n = 1$ ; 5.5%), Canada ( $n = 1$ ; 5.5%), and China ( $n = 1$ ; 11.1%).

Fourteen of the included studies (77.8%) were clinical trials, and four (22.2%) were quasi-experimental studies. The sample size of the studies ranged from 32 to 261 participants. The 18 included studies represented a total of 2159 participants, with a mean age of 60 years, of which 57.1% ( $n = 1234$ ) were male.



**Figure 1.** Study selection flowchart. Fonte: Moher D, Liberati A, Tetzlaff J, Altman DG, Group P. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med. 2009;6(7):e1000097 [22].

The State-Trait Anxiety Inventory (STAI) was the most commonly used instrument to assess anxiety, either alone ( $n = 10$ ; 55.5%) or associated with other instruments ( $n = 4$ ; 22.2%). In seven studies (38.8%), music intervention was administered only before the cardiac catheterization. In one study (5.5%), it was administered only after the procedure, in seven studies (38.8%) during, two studies (11.1%) before and after and in one study (5.5%) before, during and after the cardiac catheterization. Eleven (61.1%) studies showed evidence that music intervention promoted reduction of anxiety in patients undergoing cardiac catheterization, compared to usual care and other interventions. Table 1 shows the synthesis of the characteristics of the studies included in the review.

### 3.2. Objectives and intervention theory

In addition to analyzing the effect of the intervention on anxiety, some studies evaluated the effect of the music intervention on vital parameters, such as blood pressure, heart rate, and respiratory rate ( $n = 14$ ; 77.7%) [25, 26, 27, 28, 29, 31, 32, 33, 36, 37, 38, 39, 41, 42]; pain ( $n = 2$ ; 11.1%) [35, 41]; oxygen saturation ( $n = 2$ , 11.1%) [31, 36]; anxiolytic and analgesic consumption ( $n = 2$ ; 11.1%) [35, 41]; heart rate variability and skin temperature ( $n = 1$ ; 5.5%) [29]; endothelial function ( $n = 1$ ; 5.5%) [37]; vasovagal reaction ( $n = 1$ ; 5.5%) [41]; stress and depression ( $n = 1$ ; 5.5%) [34]; relaxation and comfort ( $n = 1$ ; 5.5%) [35]; and, uncertainly and mood ( $n = 1$ ; 5.5%) [38]. The intervention theory was not described in any of the studies.

### 3.3. Other characteristics of music intervention according to the effect on anxiety intensity

Eleven (61.1%) studies [25, 26, 27, 28, 29, 31, 32, 33, 34, 36, 42] showed that music intervention significantly reduced the level of anxiety in patients undergoing cardiac catheterization. The synthesis of the characteristics of the interventions with music used in these studies is described in Table 2. The remaining studies ( $n = 7$ ; 38.8%) did not demonstrate the anxiety-reducing effect [30, 37, 38, 39, 41], or the study design did not provide this type of analysis (Table 3), because the authors used different instruments to assess anxiety before and after catheterization [35] or did not provide the anxiety measures before catheterization [40].

### 3.4. Specific components

The characteristics of music interventions considered as specific components were: genre and style of music; volume, timbre and harmony; and, selection of music by the patient or interventionist (Tables 2 and 3).

### 3.5. Nonspecific components

The characteristics of the music interventions considered as nonspecific components were environmental factors (brightness, noise, number of people during the intervention delivery) (Tables 2 and 3). Factors related to the control of the environment have been reported by only a few studies [29, 32, 33, 34, 36, 42].

Delivery of other nonspecific components was found in five (27.8%) studies [29, 33, 34, 36, 40]. In studies conducted by Rejeh et al. (2016) [36], and Moradipناه et al. (2009) [34], patients were in a private room, in a comfortable position, and instructed to avoid reading, talking on the phone, listening to the radio, or watching television. In the study by Chang et al. (2011), the room temperature was set at 21–23 °C, and a thin blanket was placed over the abdomen and lower limbs of the patients [29]. Patients were also instructed not to consume tobacco, coffee, tea, or any caffeinated beverage 1 h prior to study participation, and to turn off their cell phones at the time they were positioned on the bed [29].

Another nonspecific component mentioned was offering the patient the possibility to use the bathroom before the music intervention began [33].

### 3.6. Delivery mode

Delivery mode consisted of location and time of delivering the intervention, method of delivery (headphones, speakers, or other devices), format of delivery (live, cassette tape, CD, MP3 player, or other format) (Tables 1 and 2).

### 3.7. Intervention dose

The dose of the intervention included the assessment of purity, the length, and the number of sessions used (Tables 1 and 2).

Regarding the purity of the intervention, two studies (11.1%) [26, 28] reported that no additional information was offered to the patients; in seven studies (38.8%) [29, 31, 35, 38, 39, 41, 42], the authors described that patients in the intervention group received usual care in association with the intervention.

In eight [25, 26, 29, 32, 33, 34, 36, 42] of the ten studies in which anxiety was reduced, the delivery of other elements that could also contribute to the anxiety reduction response was identified (Table 2). Among the remaining studies, two reported that all patients received preoperative medications as part of usual care [41, 42]. Weeks and Nilsson (2011) reported that an intervention guide guaranteed standardized delivery of the intervention and uniformity of data collection [40].

## 4. Discussion

This scoping review mapped the literature regarding the characteristics of music interventions delivered before, during, and after cardiac catheterization to reduce patient anxiety. Because anxiety is a subjective phenomenon, measured means of patient report, several measurement instruments with adequate psychometric evidence of validity are available for use [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43]. The most widely used instrument in the studies included in this review was the STAI, which is consistent with the literature [1, 25, 26, 27, 28, 29, 31, 32, 33, 35, 36, 37, 38, 41].

The results of this review suggested that the interest of researchers in studying interventions with music to reduce anxiety in patients undergoing cardiac catheterization is recent. However, the effects of music for treatment of physical and emotional disorders have been known since ancient times [44]. Two American nurses at the beginning of the 20th century used music to alleviate the physical and emotional pain of soldiers wounded in the two World Wars [45].

The scientific production on this subject is concentrated in selected countries. The majority of the studies was conducted by American [27, 33, 37, 38, 40] and Iranian [31, 34, 36, 42] researchers, with relatively small samples and from a single center, which compromises the generalizability of results to other countries, and makes it difficult to analyze cultural influences on the anxiety reduction response to music. In this review, only one of the studies was conducted in Brazil [39].

### 4.1. Intervention goals and theory

Our results show that music intervention is heterogeneous in terms of secondary aims, specific and nonspecific components, doses, and modes of delivery, which can compromise the synthesis and interpretation of study results in systematic reviews and meta-analyses.

None of the studies included in this review described the intervention theory. In another systematic review, the authors found that 49% of the studies did not provide information on the theoretical or rational model that guided the selection of music [46]. Guidelines that provide direction for preparation of reports of music interventions recommend that the theory of intervention or rationale for the use of music be reported by the

**Table 1.** Summary of study characteristics included in the scoping review.

Code, authors, year of publication, and country	Objective	Design	Sample & comparison groups	Instruments	Music intervention	
					When performed	Effectiveness
1 Akarsu, et al., 2019 [25], Turkey	To determine the effects of interventions with nature sounds and headphones only on anxiety of patient after percutaneous coronary intervention	RCT	n = 114 (62.9 years; 75.43% male) Nature sounds group vs. Headphones group vs. Control group	STAI and VAS	After CC	Anxiety intensity in the control group was higher immediately and 30 min after the intervention than in the music and earplug groups.
2 Argstatter, et al., 2006 [26], Germany	To evaluate whether the preventive ( <i>coaching</i> ) or adjuvant use of music therapy reduces subjective and objective anxiety, as well as reducing the use of sedative medications	RCT	n = 83 (66.5 years, 57.8% male sex) Music group vs. Coaching group vs. Control group	STAI and HADS	During CC	The music intervention was associated with a greater decline in anxiety intensity compared to the control group.
3 Buffum, et al., 2006 [27], USA	To evaluate whether music reduces anxiety in patients before angiography.	RCT	n = 170 (66.8 years, 97.64% male sex) Music group vs. Control group	STAI	Before CC	After the music intervention, the anxiety level was significantly lower in the Music group.
4 Çetinkaya, et al., 2018 [28], Turkey	To evaluate the effect of music offered during coronary angiography on anxiety levels and hemodynamic parameters	RCT	n = 171 participants (66.8 years, 57.30% male sex) Music group vs. Control group	STAI	During CC	After the intervention there was significant reduction in intragroup anxiety for both groups.
5 Chang, et al., 2011 [29], China	To evaluate the effect of music on psychophysiological indices in patients awaiting catheterization	RCT	n = 54 (61.9 years, 59.25% male sex) Music group vs. Control group	STAI	Before CC	There was a reduction in the intensity of anxiety in both groups. However, the reduction was significantly greater in the Music group than in the Control group.
6 Darmadi, et al., 2019 [30], Indonesia	To determine the effectiveness of Murottal therapy and classical music in reducing anxiety in patients before catheterization	QE	n = 32 (44.8 years, sex distribution not reported) Murottal therapy group vs. Classical music group	NRS	Before CC	Mild anxiety was predominant after the intervention in both groups. The reduction in anxiety score was greater in the Murottal therapy group.
7 Forooghy, et al., 2015 [31], Iran	To investigate the effect of music therapy on anxiety and hemodynamic parameters during percutaneous angioplasty	RCT	n = 64 (58.4 years, 64.06% male sex) Music group vs. Control group	STAI	During CC	The level of anxiety was significantly lower after the intervention in the Music group, but not in the Control group.
8 Goertz, et al., 2011 [32], Germany	To evaluate the anxiolytic effects of different musical styles in patients undergoing catheterization, and to assess whether there is a difference if the music is selected by the patient or randomly assigned	RCT	n = 197 (65 years, 68.02% male sex) 2 groups: music selection by patient vs. therapist 4 subgroups: Classical music, Relaxing modern music, Jazz, No music	STAI	During CC	All the subgroups that received music intervention showed significantly reduced anxiety intensity compared to the subgroups that did not receive music intervention, both in the group that selected the music according to their preference and in the group in which the music was selected by the interventionist.
9 Hamel, 2001 [33], USA	To determine the effects of music therapy on anxiety, heart rate, and blood pressure in patients awaiting scheduled cardiac catheterization	QE	n = 101 (mean age not reported, 62.37% male sex) Music group vs. Control group	STAI	Before CC	The Music group showed lower baseline levels of anxiety and more marked reduction in anxiety intensity after the music intervention compared to the Control group.
10 Moradipناه, et al., 2009 [34], Iran	To evaluate the effect of music on stress, anxiety and depression before and after angiography	RCT	n = 74 (50.6 years, 50% male sex) Music group vs. Control group	DASS	Before and After CC	The reduction in anxiety intensity was significantly greater in the Music group than in the Control group before catheterization.
11 Nilsson, et al., 2009 [35], Sweden	To evaluate the effect of music on anxiety, angina, pain, relaxation, and comfort in patients during the angiographic procedure, and to evaluate differences in relation to sex	RCT	n = 238 (65.5 years, 50% male sex) Music group vs. Control group	NRS and STAI	During CC	After the intervention, no statistically significant difference was identified in anxiety scores between the groups.
12 Rejeh, et al., 2016 [36], Iran	To investigate the impact of nature sounds on anxiety and physiological parameters in patients undergoing coronary angiography	QE	n = 130 (61.7 years, 49.23% male sex) Nature sounds group vs. Control group	STAI	Before CC	The anxiety level in the Music group was significantly lower than in the Control group immediately before (after the intervention with music), during, immediately after, and 20 min after the catheterization.
13 Ripley, et al., 2014 [37], USA	To determine the impact of music intervention on endothelial function, hemodynamics, and anxiety before, during, and after cardiac catheterization	RCT	n = 70 (62 years, number of male participants not reported) Music group vs. Control group	STAI	Before and after CC	No difference in anxiety level was identified in the comparison between groups

(continued on next page)



Table 1 (continued)

Code, authors, year of publication, and country	Objective	Design	Sample & comparison groups	Instruments	Music intervention	
					When performed	Effectiveness
14 Taylor-Piliae, et al., 2002 [38], China	To evaluate the effect of nursing interventions using music therapy or sensory information on anxiety, uncertainty, and mood immediately before cardiac catheterization	QE	n = 45 (58.2 years, 80% male sex) Music group vs. Sensory information group vs. Control group	STAI	Before CC	There was no statistically significant difference in anxiety score when comparing the three groups or over time.
15 Watanabe, 2011 [39], Brazil	To evaluate the effect of music on anxiety, provided before, during, and after cardiac catheterization	RCT	n = 261 (59 years, 60.15% male sex) Music group vs. Control group	BAI and VAS	During CC	There was no difference in anxiety intensity when comparing the Music and Control groups.
16 Weeks, et al., 2011 [40], USA	To evaluate the effect of the music offered by pillow, music offered by speaker, and ambient sounds on patients' experience of anxiety and well-being during coronary angiography	RCT	n = 98 (67.4 years, 47.95% male sex) Pillow group vs. Loudspeaker group vs. Control group	NRS	During CC	There was no difference in anxiety between the groups receiving music by pillow or by speaker. The control group had higher levels of anxiety than the pillow and the speaker groups.
17 Bally, et al., 2003 [41], Canada	To determine the effect of patient-controlled music on psychological stress to coronary angiography	RCT	n = 113 (58.5 years, 56.63% male sex) Music group vs. Control group	STAI	Before, during and after CC	Anxiety intensity was similar when comparing the two groups before and after catheterization. No difference was found between the groups regarding the difference in the intensity (after-before) of anxiety.
18 Poorolajal, et al., 2017 [42], Iran	To evaluate the effect of relaxation technique on anxiety and hemodynamic response in patients undergoing surgical procedures	RCT	n = 144 (51 years, 29.16% male sex) Relaxation technique group vs. Control group	HADS	Before CC	After intervention, the anxiety score was significantly lower in the Music group compared to the Control group.

RCT: Randomized Clinical Trial, QE: Quasi-Experimental, STAI: State-Trait Anxiety Inventory, NRS: Numerical rating Scale, HADS: Hospital Anxiety and Depression Scale, VAS: Visual Analog Scale, BAI: Beck Anxiety Inventory, DASS: Depression, Anxiety and Stress Scales, CC: Cardiac Catheterization, USA: United States of America.

authors [47]. Intervention theory refers to the description of the mechanisms of the intervention that lead to expected outcomes, mediated by the immediate objectives [6]. Therefore, intervention theory contributes to establishing the objectives of the intervention and to explaining how the components of the intervention lead to the expected effect [6].

#### 4.2. Specific components

Genre and selection of music by the patient according to preference, or previously determined by the interventionist, were the most consistently described characteristics of the interventions. In the studies that used nature sounds [25, 36], MusiCure® [35, 37, 40] Benson's relaxation technique [42], and classical music [30, 31, 34, 39], the music was selected by the researchers. In four studies that used assorted styles [27, 29, 38, 41], the patient could select the music according to his or her preference, from a limited range of possibilities. In the ALMUT study [32], the researchers compared the effect of music selection by the patient or the researcher on the patients' anxiety level, without identifying significant differences between the groups.

Music genre is an important component of music interventions, particularly because past experiences may influence the individual's response to the music intervention. In fact, the literature points out that emotions that occur in response to music are learned [48]; so positive or unpleasant emotions can be evoked during listening. This might be an important consideration when analyzing the effectiveness of music interventions. If the intervention does not lead to the desired outcome, researchers need to consider that the lack of response to the music intervention might be due to negative emotions associated with the genre or type of music delivered.

Despite the fact that emotions in response to music are learned, a systematic review compared the effects of music therapy on psychological and physiological outcomes in cancer patients [49]. The data showed that although patient preference in music selection had no impact on anxiety level, when preference was accounted for, a larger, statistically significant effect size was obtained, as opposed to pre-selection by the

interventionist, which resulted in a smaller effect size, without statistical significance [49].

The other intervention-specific components were not consistently described in the studies. However, tempo (speed), rhythm, timbre, dynamics (volume), harmony, melody, and lyrics are essential characteristics of music intervention, as their interaction stimulates neurophysiological responses that have a powerful influence on mood and emotional experience, producing states of arousal and relaxation [50]. Thus, such characteristics can be used to regulate vital signs, neural activity, and emotional response [50]. In particular, rhythm influences the rhythmicity of internal organs, which is evidenced by the synchronization of physical movements, heart and respiratory rate, and neural activity [50].

These essential characteristics of music are therefore profoundly related to neurobiological responses and provide a mechanism by which modifications in bodily responses to interventions with music can be explained [51].

#### 4.3. Nonspecific components

None of the studies considered the control of ambient light. The control of light during music intervention could facilitate the delivery of the intervention by eliminating a stimulant factor. On the other hand, light exerts a series of biological effects that include, among others, mood regulation and cognitive functions [52].

The control of external noise in some of the studies included in this review had the primary objective of providing a quiet environment without distractions [29, 32]. Besides causing distraction, the ambient noise may also be anxiety provoking and, therefore, interfere with the music intervention outcomes [51]. The literature suggests that the healthcare team itself and monitoring equipment are important sources of ambient noise [50]. The adequate control of these sources of noise while delivering music interventions should be recommended.

Controlling the number of people with access to the patient during the delivery of intervention was intended to avoid interruptions. The

**Table 2.** Summary of characteristics of music interventions that reduced anxiety in patients undergoing cardiac catheterization.

Study	Specific components					Non-specific components			Dose			Delivery mode			
	Genre	Style	Volume	Rhythm, timbre, harmony	Music selection	Light	Noise	Access to the patient	Sessions	Duration	Purity	Place	Perioperative moment	Method	Format
1 [25]	NS	**	PP	NM	P	NM	NM	NM	1	30 min	Patients were instructed to close their eyes and follow the flow of the music	ICU	After	Earphone	MP3 player
2 [26]	Clas.	Inst.	Pred.	NM	I	NM	NM	NM	1	Duration of the procedure	Music therapist offered relaxing information and was available during the procedure to assure the patient's peace of mind	CL	During	Earphone	NM
3 [27]	Var	Inst.	NM	NM	P	NM	NM	NM	1	15 min	NM	WR	Before	LS	CD player
4 [28]	Sufi*	Inst.	NM	60-80 rhythm/minute	I	NM	NM	NM	1	15–20 min	NM	CL	During	Earphone	Mp3
5 [29]	Var	NM	PP	60-80 beats/minute, slow speed, soft melody	P	NM	Relatively quiet environment	Controlled	1	30 min	Patients were instructed not to consume stimulant drinks or cigarettes 30 min before the procedure and to keep mobile phones turned off. A blanket was positioned over the abdomen and legs of the patients.	CL	Before	Earphone	Smartphone
7 [31]	Clas	Inst	NM	NM	I	NM	NM	NM	1	20–40 min	NM	CL	During	Earphone	MP3 player
8 [32]	Var	Inst	Pred	60-80 beats/minute, low dynamic contrast variation	P & I	NM	Minimized	NM	1	Duration of the procedure	Patients were oriented to steps of the catheterization, were comforted by the nurse, and the noise from the procedure room was reduced as much as possible	CL	During	LS	CD player
9 [33]	Trance–Zendance	Inst	PP	NM	I	NM	NM	NM	1	20 min	Patients were instructed to be comfortable and to use the restroom before the procedure if necessary	Telemetry Unit	Before	Earphone	CD player
10 [34]	Var	NM	NM	60-80 bpm	I	NM	NM	NM	2	20 min each	Patients were instructed to sit comfortably and avoid distractions	NM	Before and after	Earphone	CD player and cassette
12 [36]	NS	**	Pred [25-50d]	NM	I	NM	Minimized	NM	1	20 min	Patients were instructed to sit comfortably and avoid distractions	Private room	Before	Earphone	CD player
18 [42]	NM	NM	NM	NM	I	NM	NM	NM	1	20 min	Patients were instructed to be comfortable, keep their eyes closed, relax their muscles, and maintain controlled breathing	NM	Before	Earphone	Audio file

\*Sufi music has both vocal and instrumental components and was performed using a Turkish classical instrument called “Ney” (a reed flute); \*\* Not applicable; NS: Nature sounds; PP: patient preference; NM: not mentioned; P: patient; I: interventional; ICU: intensive care unit; Pred: predefined; CL: Catheterization laboratory; Var: varied; Inst: Instrumental; WR: waiting room; LS: Loudspeaker; Clas: classical.

**Table 3.** Summary of characteristics of music interventions that did not reduce anxiety in patients undergoing cardiac catheterization.

Study	Specific components				Non-specific components				Dose			Delivery mode			
	Genre	Style	Volume	Rhythm, timbre, harmony	Music selection	Light	Noise	Access to the patient	Sessions	Duration	Purity	Place	Perioperative moment	Method	Format
6 [30]	Clas	Inst	Pred (60 dB)	NM	I	NM	NM	NM	1	30 min	NM	CL	Before	Earphone	Smartphone
11 [35]	MusiCure <sup>®</sup>	**	Pred (60 dB)	NM	I	NM	NM	NM	1	NM	NM	CL	During	LS	Maysound <sup>®</sup>
13 [37]	MusiCure <sup>®</sup>	**	NM	NM	I	NM	NM	NM	1	NM	NM	NM	Before and during	Audio Pillow	NM
14 [38]	New Age	Inst	NM	NM	P	NM	NM	NM	1	15–20 min	NM	NM	Before	Earphone	Cassette
15 [39]	Clas	NM	Pred (25 of the device used)	NM	I	NM	NM	NM	1	NM	NM	CL	During	LS	Mp3
16 [40]	MusiCure <sup>®</sup>	**	Pred (60 dB)	NM	I	NM	NM	NM	1	NM	Interventionist's Manual	CL	During	LS and Audio Pillow	Mp3
17 [41]	Var	NM	NM	NM	P	NM	NM	NM	3	NM	NM	CL	Before, During, and After	Earphone	Cassette

Legend: NM: not mentioned; P: patient; I: interventionist; CL: Catheterization laboratory; Var: varied; Inst: Instrumental; LS: Loudspeaker; \*A special kind of 'universal' and 'genre-less' soundscapes that appeal to everyone regardless of music taste, listening habits and music preferences; \*\* Not applicable; Clas: classical.

interruption of music during the intervention may negatively affect achievement of the expected benefits. During the delivery of music interventions, even the presence of family members should be carefully evaluated, as there is no consensus in the literature as to the effect of the presence of family members or significant o on symptom management [53, 54].

One of the factors controlled for by Chang et al. (2011) [29], was room temperature. In hospital settings, room temperature is usually controlled by team members who must consider the preservation of medical equipment, comfort of staff, and thermal comfort of patients, which is an important aspect related to well-being [55].

#### 4.4. Delivery mode and dose

Music interventions were delivered predominantly in the catheterization laboratory [26, 27, 28, 30, 35, 39, 40], either before [30, 33, 34, 38, 41, 42] or during [26, 28, 29, 32, 35, 39, 40] the catheterization, in a single session. The ease of access to the patient at this location, and the timing, may justify these choices.

Researchers noted that anxiety level appears to increase significantly before cardiac catheterization, with a prevalence of approximately 35% the day before the procedure [16]. In a prospective cohort study that investigated anxiety levels in patients undergoing cardiac catheterization, the anxiety score was found to be higher pre-procedure ( $51.5 \pm 28.0$ ) compared to post-procedure ( $42.7 \pm 26.5$   $p < 0.001$ ) [56].

One aspect that deserves attention is that the intervention with music should not postpone the catheterization. In addition to negative consequences related to delay of the procedure, especially in acute and severe cases [57], waiting for the procedure is, in itself, reported to be anxiogenic [58].

Individual earphones were the most commonly used method for delivering the intervention [25, 28, 29, 30, 31, 33, 36, 38, 42] which may be associated with practicality, ease of use, and lower cost associated with disinfection of the device, as it can be discarded after use. Other modes of delivery included individual devices (pillows) and loudspeakers. Pillows may be associated with increased cost, as they are more expensive than disposable headphones, and require special care to avoid cross-contamination between patients. Loudspeakers, although an interesting solution in terms of environmental sustainability, may be inconvenient for the staff, who will also be exposed to the music. All of these devices can interfere with communication between patient and staff during the procedure. However, researchers have often instituted measures to ensure effective communication, regardless of the patient's age [26, 32, 35, 39, 40, 41].

Regarding the format, most studies used compact disk (CD), Mp3, and smartphone recordings, which allow for music to be delivered in a digital format. Digital sound ensures that the intensity of the waves is accurately reproduced, eliminating frequency instabilities inherent in other types of recording [59].

Single sessions before or during catheterization were the most commonly used dosing and delivery timing in the studies, with a predominance of 20 [33,34,36] and 30-minute sessions [25, 29, 30]. Single sessions can facilitate the delivery of the intervention, as compared with multiple sessions. Accurate description of the dose of the intervention is important if its effects on outcomes are going to be analyzed properly. In the study by Buffum et al. (2006), patients in the intervention group were given the option to continue listening to music during catheterization, indicating an increase in the intervention dose for some patients [27].

The purity of the intervention is determined by the dose of specific components other than music and nonspecific components that facilitate the delivery of the intervention [6]. In regard to other specific components that were delivered, it is not possible to state how much they influenced the outcomes, as the studies did not have a control group in which such elements were implemented in the absence of the music. Although it is not expected that the nonspecific components that



facilitated the delivery of the intervention influenced the level of anxiety, it cannot be stated with certainty that they did not influence observed outcomes. As an example, the interventionist's manual that is intended to ensure the fidelity of the intervention may have ensured the delivery of the intervention as planned, and may have contributed to the observed outcomes [40].

This comprehensive review of the literature revealed the heterogeneity of characteristics employed in music interventions, and the weakness of research reports that do not present, in general, a detailed description of essential elements related to the production of the effects of music on people's health. Also, the findings of this review present the parsimony necessary for interpreting the results of other literature syntheses that analyzed the effect of music intervention on anxiety in patients undergoing cardiac catheterization.

However, some limitations of this review should be addressed. This scoping review [21], did not include the methodological quality of studies, therefore it is not guaranteed that the description of the interventions and the reports themselves were guided by widely recognized guidelines [60, 61]. Another aspect is that the studies included for review involved only patients undergoing cardiac catheterization, which limits the generalizability of our findings to other patient groups.

## 5. Conclusion

This review showed that studies with music intervention used to reduce anxiety in patients undergoing cardiac catheterization are quite heterogeneous. The description of the interventions is generally incomplete, focusing on describing the genre and how the music is selected, either based on the patient's preference or selected by the researchers. Little emphasis was given to the description of the non-specific components (lighting, noise, number of people around the patient, and room temperature), so their effect on the delivery of the intervention could not be analyzed. Furthermore, other elements were delivered, which affects the purity of the intervention, and may have contributed to the anxiety-reducing effect observed in the studies. Therefore, it is not possible to conclude that music was the only component responsible for anxiety reduction.

## Appendix A. Search strategies used in databases

DATABASE	DATE	STRATEGY
PubMed	28-01-2020	(((((Anxiety[MeSH Terms]) OR Anxiety[Text Word]))) AND (((((((Music[MeSH Terms]) OR Music[Text Word]) OR Music Therapy[MeSH Terms]) OR Music Therapy[Text Word]) OR Complementary Therapies[MeSH Terms]) OR Complementary Therap* [Text Word]) OR Alternative Therap* [Text Word]) OR relaxation therapy[MeSH Terms]) OR relaxation therap* [Text Word] OR alternative medicine[Text Word] OR relaxation training[Text Word])) AND (((((((Cardiac Catheterization[MeSH Terms]) OR Cardiac Catheterization* [Text Word]) OR coronary angiography[MeSH Terms]) OR coronary angiograph* [Text Word] OR angioplasty[MeSH Terms]) OR angioplast* [Text Word]) OR Coronary Balloon Angioplasties[MeSH Terms]) OR balloon[Text Word] OR heart catheterization* [Text Word]))) OR (((Percutaneous Coronary Intervention[MeSH Terms]) OR Percutaneous Coronary Intervention* [Text Word])) Sort by: PublicationDate Filters: English; Portuguese; Spanish = 66
CINAHL	03-02-2020	((MH "Anxiety") OR TI Anxiety OR AB Anxiety) AND (((MH "Music") OR (MH "Music Therapy") OR (MH "Music Therapy (Iowa NIC)") OR (music OR "music therapy" OR "music intervention") OR "Relaxation Therapy" OR "Alternative Therapies" OR "Complementary Therapies" OR "Alternative Medicine" OR "Relaxation Training") AND (MH "Heart Catheterization") OR TI "Heart Catheterization" OR AB "Heart Catheterization" OR TI "cardiac catheterization" OR AB "cardiac catheterization" OR "Angioplasty" OR "Balloon" OR "Coronary Balloon Angioplasties" OR "Coronary Angiography" OR "Percutaneous Coronary Intervention") = 319 With language filter = 301
Scopus	28-01-2020	((TITLE-ABS-KEY (anxiety)) AND ((TITLE-ABS-KEY (music) OR TITLE-ABS-KEY (music AND therapy) OR TITLE-ABS-KEY (complementary AND therapy) OR TITLE-ABS-KEY (alternative AND therapy) OR TITLE-ABS-KEY (relaxation AND therapy) OR TITLE-ABS-KEY (alternative AND medicine) OR TITLE-ABS-KEY (relaxation AND training))) AND ((TITLE-ABS-KEY (cardiac AND catheterization) OR TITLE-ABS-KEY (coronary AND angiography) OR TITLE-ABS-KEY (heart AND catheterization) OR TITLE-ABS-KEY (percutaneous AND coronary AND intervention) OR TITLE-ABS-KEY (angioplasty) OR TITLE-ABS-KEY (coronary AND balloon AND angioplasties) OR TITLE-ABS-KEY (balloon))) = 88 With language filter = 84
Embase	28-01-2020	('anxiety'/exp OR 'anxiety') AND ('music'/exp OR 'music' OR 'music therapy'/exp OR 'music therapy' OR 'alternative medicine'/exp OR 'alternative medicine' OR 'relaxation training'/exp OR 'relaxation training') AND ('heart catheterization'/exp OR 'heart catheterization' OR 'angiography'/exp OR 'angiography' OR 'percutaneous transluminal angioplasty'/exp OR 'percutaneous transluminal angioplasty' OR 'transluminal coronary angioplasty'/exp OR 'transluminal coronary angioplasty') = 66 With language filter = 66

(continued on next column)

Researchers must describe the specific and nonspecific elements of music interventions and, when including elements that affect the purity of the intervention, analyze the effect of these elements on the outcome of interest. Similarly, the characteristics of the interventions with which the music intervention or the characteristics of usual care are compared should be described in sufficient detail.

## Declarations

### Author contribution statement

All authors listed have significantly contributed to the development and the writing of this article.

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### Data availability statement

Data included in article/supp. material/referenced in article.

### Declaration of interest's statement

The authors declare no conflict of interest.

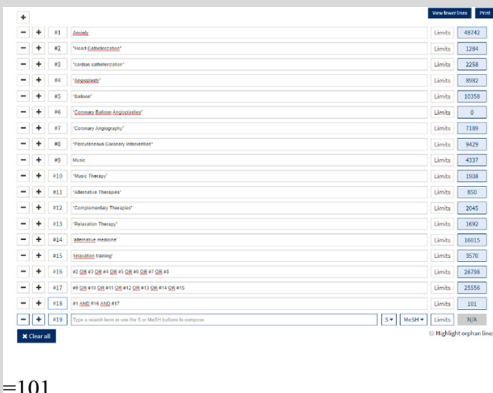
### Additional information

No additional information is available for this paper.

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(continued)

DATABASE	DATE	STRATEGY
PsycINFO	28-01-2020	anxiety AND (music OR music therapy OR Complementary Therap* OR Alternative Therap* OR relaxation therap* OR alternative medicine OR relaxation training) AND (Cardiac Catheterization* OR coronary angiograph* OR angioplast* OR balloon OR heart catheterization* OR Percutaneous Coronary Intervention*) = 16 With language filter = 14
Google Scholar databases	01-02-2020	Anxiety AND ("coronary angiography" OR "cardiac catheterization") AND (music OR "music therapy") AND (filetype:PDF OR filetype:html) = 358
Cochrane	25-01-2020	 =101
LILACS	28-01-2020	(ansiedade OR Anxiety) AND (Music OR Música OR Music Therapy OR Musicoterapia OR Complementary Therapies OR Terapias Complementares OR Terapia Complementar OR Relaxation Therapy OR Relaxamento OR Terapias de Relaxamento) AND (Cardiac Catheterization OR Cateterismo Cardíaco OR Coronary Angiography OR Angiografia Coronária OR Angioplasty, Balloon, Coronary OR Angioplastia Coronária com Balão OR Angioplasty OR Angioplastias OR Angioplasty, Balloon OR Angioplastia com Balão OR Percutaneous Coronary Intervention OR Intervenção Coronária Percutânea OR Intervenção Coronariana Percutânea) [Palavras] = 1
DART-Europe E-theses Portal	28-01-2020	Anxiety AND (Music OR Music Therapy OR Complementary Therapies OR Relaxation Therapy OR Alternative Therapies OR Alternative Medicine OR Relaxation Training) AND (Cardiac Catheterization OR Coronary Angiography OR Angioplasty OR Balloon OR Percutaneous Coronary Intervention) = 244 With language filter = 181
CAPEs Thesis Portal (Brazil)	28-01-2020	(ansiedade OR anxiety) AND (música OR music OR music therapy OR musicoterapia) = 52
Theses Canada Portal	28-01-2020	anxiety AND (music OR music therapy) = 2
Pro-Quest	28-01-2020	ab(Anxiety) AND ti(Anxiety) AND ab(music OR music therapy OR Complementary Therapy OR Alternative Therapy OR relaxation therapy OR alternative medicine OR relaxation training) AND ti(music OR music therapy OR Complementary Therapy OR Alternative Therapy OR relaxation therapy OR alternative medicine OR relaxation training) AND ab("Cardiac Catheterization" OR "coronary angiography" OR angioplasty OR balloon OR "heart catheterization" OR "Percutaneous Coronary Intervention") AND ti("Cardiac Catheterization" OR "coronary angiography" OR angioplasty OR balloon OR "heart catheterization" OR "Percutaneous Coronary Intervention") = 1

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