Guideline for Writing a Scoping Review

Introduction

A scoping review is a form of evidence and knowledge synthesis that applies systematic and transparent methods to provide insight into the breadth, volume, and key characteristics of the available literature on a given research topic. It can clarify how concepts are used, identify gaps in existing knowledge, and inform decisions about whether a full systematic review is warranted or which questions require further primary research.

A scoping review is particularly suitable when:

- The question is conceptually broad and exploratory (e.g., “What is known about …?”).
- Multiple study designs and methodologies are expected.
- The objective is to explore the extent, range, and nature of research activity rather than to estimate an effect size.
- Key concepts, definitions, or frameworks in the field require clarification.

This guideline is based on methodological and reporting guidance from KU Leuven Libraries, the JBI Manual for Evidence Synthesis, the PRISMA-ScR statement, and academic library resources on scoping reviews, complemented by recent methodological work of the OMFS-IMPATH research group on the conduct of scoping reviews such as:

- Artificial intelligence serving pre-surgical digital implant planning: a scoping review (online link)
- Artificial intelligence for orthodontic diagnosis and treatment planning: a scoping review (online link)

Methodological framework

Step 1. Defining the research question

The first step should be to formulate the research question. The question is typically broad and exploratory and should be explicitly stated in the article.

For scoping reviews, the primary framework is PCC (Population–Concept–Context):

- **Population (P):** individuals, groups, or specimens of interest (e.g., patients with oral cancer, mandibular fractures, cystic lesions).
- **Concept (C)** : the main topic, intervention, exposure, or phenomenon (e.g., imaging modalities, surgical techniques, diagnostic criteria, AI-based tools).

- **Context (C)** : the setting or environment (e.g., tertiary oral and maxillofacial surgery centres, dental clinics, pathology laboratories).

When the scoping review has a strong intervention focus, elements of PICO (Population–Intervention–Comparison–Outcome) can be used to further structure the question:

- **Population (P)** : target group (e.g., adults with impacted mandibular third molars).
- **Intervention (I)** : intervention or technique (e.g., cone-beam CT for preoperative assessment).
- **Comparison (C)** : comparator, if applicable (e.g., panoramic radiography, conventional CT, or no imaging).
- **Outcome (O)** : outcomes of interest (e.g., diagnostic accuracy, detection of anatomical variations, surgical complications).

From the frameworks above, the research question then can be formulated:

PCC

> "What is known about the use of cone-beam computed tomography (Concept) for diagnosing temporomandibular joint disorders (Population) in tertiary oral and maxillofacial surgery settings (Context)?"

PICO

> "Which imaging protocols and diagnostic outcomes (Outcome) have been reported for cone-beam computed tomography (Intervention), compared with panoramic radiography or conventional CT (Comparison), in the preoperative assessment of impacted mandibular third molars in adults (Population)?"

In addition to the main research question, specific review objectives are formulated to clarify what the scoping review will do with the identified literature (e.g., to map existing imaging protocols, describe reported diagnostic outcomes, and identify gaps in study populations, settings, or outcome measures).

Step 2. Defining the eligibility criteria

Eligibility criteria are usually structured around the research framework (PCC/PICO), the types of evidence sources, and the publication characteristics.

Types of evidence sources indicate which study designs and document types are eligible, for example:

- Primary peer-reviewed research articles.
- Guidance and consensus documents.
- Policy and organisational documents.
- Grey literature, such as theses and dissertations, conference abstracts or proceedings, and technical or research reports.

Purely opinion papers, narrative commentaries, editorials, and letters are generally excluded, unless explicitly justified by the review aim.

Publication characteristics that can be used as inclusion and exclusion criteria include:

- Language (e.g., inclusion of articles published in English and other languages accessible to the review team).
- Publication period
- Publication type

Step 3. Developing the review protocol

The protocol serves as a predefined plan for the conduct of the scoping review and promotes transparency, consistency, and reproducibility.

At minimum, the protocol should include:

- Title, background, and rationale
- Aim and research question(s)
- Eligibility criteria
- Information sources and search strategy
- Study selection methods
- Data charting plan
- Analysis and presentation

Any important deviations from the protocol during the review should be documented and reported in the final manuscript. Where feasible, the protocol can be registered or archived on publicly accessible platform, such as:

- Open Science Framework (OSF) – a general open repository that accepts protocols for scoping reviews and other study types (https://osf.io).
- International Prospective Register of Systematic Reviews, (PROSPERO) – for scoping reviews with a clear health-related focus (https://www.crd.york.ac.uk/prospero/).

Step 4. Identifying information sources and developing the search strategy

Information sources are selected according to the topic, discipline, and scope of the scoping review. For work in health science, these typically include:

- Bibliographic databases (MEDLINE (via PubMed or Ovid), Embase, Web of Science, Scopus).
- Clinical trial and study registries (ClinicalTrials.gov, EU Clinical Trials Register, ISRCTN).
- Specialised or complementary sources (Cochrane Library).

- Grey literature (Theses and dissertations, conference abstracts or proceedings, technical or research reports from research groups, regulatory bodies, or international organisations).

A good search strategy is essential for identifying relevant literature. The search strategy is based on the concepts defined in the research question (PCC/PICO) and should:

- Combine controlled vocabulary terms (e.g., MeSH, Emtree) and free-text keywords.
- Use Boolean operators (AND, OR, NOT), truncation (*), and phrase searching where appropriate.
- Include synonyms and related terms for key concepts (e.g., “cone-beam computed tomography”, “CBCT”, “3D dental imaging”)

__Workflow for developing and translating the search__

In this guideline, the construction and translation of search strategies follow the approach taught in the “Workflow search strategy (for a systematic review)” presentation (Doctoral School Biomedical Sciences, KU Leuven, 2Bergen Leercentrum Désiré Collen, 2023; internal material).

- Search strategy in PubMed (MEDLINE)
  1. Identify appropriate MeSH terms for each main concept.
  2. Combine MeSH terms with free-text terms in title/abstract [tiab]
  3. Explore the MeSH tree structure to identify broader or narrower terms, and repeat the process for each concept (https://www.ncbi.nlm.nih.gov/mesh)

  * For the concept third molar, the MeSH term is “Molar, Third”. Relevant free-text synonyms in title/abstract may include “third molar”, “third molars”, “wisdom tooth”, and “wisdom teeth”. These can be combined as:

  ("Molar, Third"[Mesh] OR "third molar"[tiab] OR "wisdom tooth"[tiab] OR "wisdom teeth"[tiab])*

- Search strategy in Embase
  1. Identify the corresponding Emtree terms for each concept (https://www.embase.com/emtree).
  2. Combine Emtree terms with free-text terms using Embase field codes (e.g., :ti,ab,kw).
  3. Emtree subject headings can be exploded using /exp. Exploding a term means that Embase retrieves records indexed with that Emtree term and all narrower, more specific terms beneath it in the hierarchy. This is useful when a broad capture of the concept is desired.
  4. Adapt the syntax while preserving the underlying logic of the PubMed search.

  * For the concept third molar, the emtree term is *'third molar'*, together with the synonyms in title/abstract, it can be built as:

  ('third molar'/exp OR 'molar, third':ti,ab,kw OR 'third molar':ti,ab,kw OR 'wisdom tooth*':ti,ab,kw)*

- Search strategy in Web of Science (WoS) Core Collection
  1. WoS has no index terms such as MeSh (PubMed) or Emtree (Embase)
  2. Use the field tags of TS=("term1" OR "term1_2" OR "term1_3")

  * For the concept third molar, the search strategy can be built as:

  TS=("Molar, Third" OR "third molar" OR "wisdom tooth" OR "wisdom teeth")*

- Search strategy in Cochrane Library
  1. Collect all [MeSH]-terms within one concept and rewrite them with [mh "term"]
  2. Collect all [tiab]-terms within one concept and rewrite them with ("term 1" OR "term 2" OR …):ti,ab,kw

  * For the concept third molar, the search strategy can be built as:

  #1: [mh "Molar, Third"]
  #2: ("third molar" OR "wisdom tooth" OR "wisdom teeth"):ti,ab,kw*
  #3: #1 OR #2
  - #1 captures the MeSH descriptor.
  - #2 captures free-text synonyms in title, abstract, and keyword fields.
  - #3 combines both

<u>Example of concepts and search terms</u>

To illustrate the identification of concepts and search terms, an example from general medicine is often used:

Example research question:

"What is the efficacy of ciprofloxacin in the treatment of otitis media?"

This can be structured as a PICO:

- P: patients with otitis media
- I: ciprofloxacin
- C: no treatment or placebo
- O: efficacy

From this PICO, two main concepts are identified: "otitis media" and "ciprofloxacin". For each concept, relevant MeSH/Emtree terms and free-text synonyms are collected and later combined in the search strategy.

PubMed	
Concept 1: "Otitis Media"[Mesh] OR "otitis media"[tiab] OR "middle ear inflam*"[tiab] OR "middle ear infection*"[tiab]	**Concept 2:** "ciprofloxacin"[Mesh] OR ciprofloxacin*[tiab] OR cipro[tiab] OR ciprinol[tiab]
Embase	
Concept 1: 'otitis media'/exp OR 'otitis media*':ti,ab,kw OR 'false latent otitis':ti,ab,kw OR 'middle ear infection*':ti,ab,kw OR 'tympanitis':ti,ab,kw	**Concept 2:** 'ciprofloxacin'/exp OR 'ciprofloxacin*':ti,ab,kw OR 'acire':ti,ab,kw OR 'bacquinor':ti,ab,kw OR 'bactiflox':ti,ab,kw OR 'baflox':ti,ab,kw OR 'baycip':ti,ab,kw OR 'bernoflox':ti,ab,kw OR 'c-flox':ti,ab,kw OR 'c-floxacin':ti,ab,kw OR 'cetraflox':ti,ab,kw OR 'cetraxal':ti,ab,kw OR 'ciclodin*':ti,ab,kw OR 'cidroxal':ti,ab,kw OR 'ciflo':ti,ab,kw OR 'ciflox*':ti,ab,kw OR 'cifran':ti,ab,kw OR 'cilab':ti,ab,kw OR 'ciloquin*':ti,ab,kw OR 'cilox*':ti,ab,kw OR …
Web of Science Core Collection	
Concept 1: TS=("otitis media" OR "middle ear inflam*" OR "middle ear infection*" OR "false latent otitis" OR "tympanitis")	**Concept 2:** TS=(ciprofloxacin* OR "cipro" OR "ciprinol" OR "acire" OR "alcon cilox" OR "bacquinor" OR "bactiflox" OR "baflox" OR "baycip" OR "bernoflox" OR "c-flox*" OR "cetraflux" OR "cetraxal" OR "ciclodin*" OR "cidroxal" OR "ciflo" OR "ciflox*" OR "cifran" OR "cilab" OR "ciloquin*" OR "cilox*" OR …)
Cochrane Library	
Concept 1: • #1: [mh "Otitis Media"] • #2 ("otitis media" OR (middle NEXT ear NEXT inflamm*) OR (middle NEXT ear NEXT infection*) OR "false latent otitis" OR tympanitis):ti,ab,kw • #3: #1 OR #2	**Concept 2**: • #4: [mh "Ciprofloxacin"] • #5: (cirpofloxain OR cipro OR ciprinol OR acire OR "Alcon cilox" OR bacquinor OR bactiflox OR baflox OR baycip OR bernoflox OR "c-flox*" OR cetraflux OR cetraxal OR ciclodin* OR cidroxal OR ciflo OR ciflo* OR cifran OR cilab OR ciloquin* OR cilox* OR …):ti,ab,kw • #6: #4 OR #5 • #7: #3 AND #6

Both concepts should be combined with "AND" in the advanced search.

Step 5. Study selection (screening)

The fifth step is the selection of evidence sources based on the predefined eligibility criteria. This process is typically organised in two stages and should be documented in a transparent manner.

Management of search results

Search results from all databases, registries, and other sources are exported and combined in a reference management tool or screening platform. Duplicate records are identified and removed before screening (e.g., using EndNote, Zotero, Rayyan, Covidence, or equivalent tools).

Title and abstract screening

- In the first stage, titles and abstracts are screened against the eligibility criteria.
- At least two reviewers are involved where feasible, and disagreements are resolved through discussion or consultation with a third reviewer.
- A short calibration exercise on a small sample of records can be performed to ensure consistent application of the criteria.

Full-text screening

- In the second stage, full texts are obtained for records that are potentially eligible.
- The same eligibility criteria are applied in detail.
- For each excluded full-text article, the main reason for exclusion (e.g., wrong population, wrong concept, insufficient data, not within the defined context) is recorded.

Documentation and flow diagram

The number of records at each step (identified, after duplicates removed, screened, assessed in full text, and included) is documented and presented in a PRISMA-style flow diagram in the final review. This enhances transparency and allows readers to follow how the final set of included studies was obtained.

Templates for PRISMA flow diagrams (including PRISMA 2020 diagrams and related materials) can be downloaded from https://www.prisma-statement.org/prisma-2020-flow-diagram.

For scoping reviews, the PRISMA-ScR extension recommends reporting the flow of information in a similar way; existing PRISMA 2020 flow diagram templates may be adapted to reflect the scoping review process.

In the Figure 1 below, a PRISMA(-ScR) flow diagram from a scoping review conducted by OMFS-IMPATH research group is presented as an example of how records can be documented across the stages of identification, screening, eligibility, and inclusion.

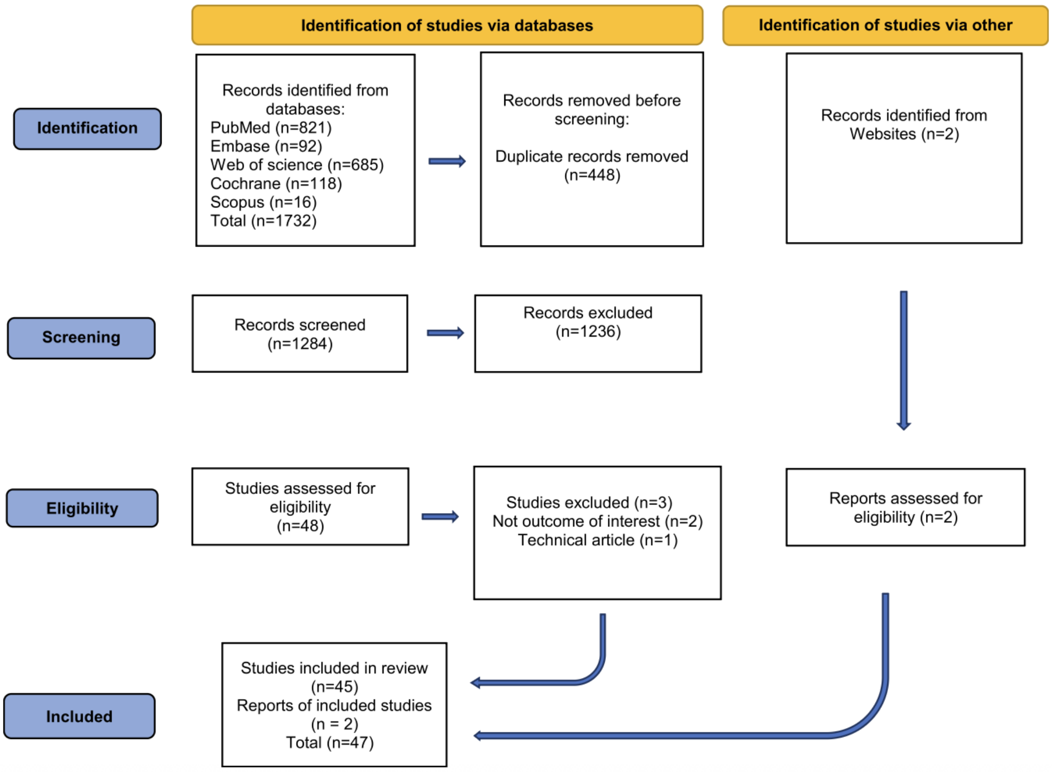

Figure 1. PRISMA flow diagram illustrating the study selection process in a scoping review, adapted from Elgarba et al. (2024).

Step 6. Data charting (extraction)

Data charting is the process of systematically extracting and organising key information from the included evidence sources. It provides a structured overview of the literature and forms the basis for the subsequent analysis and synthesis.

A standard data charting form (e.g., in Excel, REDCap, or a review platform) is developed before starting extraction. At minimum, it typically includes:

- Bibliographic information: First author, year of publication, journal, country.
- Study characteristics: Study design, setting, sample size.
- Population: Type of patients or specimens, key demographic or clinical characteristics.
- Concept / intervention / exposure
- Comparator (if applicable)
- Outcomes and main findings
- Additional notes

A clear way to provide the reader with a concise overview of the extracted data and main findings is through summary tables. The use of visual elements (e.g., icons, colour coding, or simple graphical indicators) can further enhance readability. Examples of such tabular and visual presentations can be found in Figures 2, 3, and 4, which are adapted from scoping reviews conducted within the OMFS-IMPATH research group.

References	Purpose	Objective	Train datasets	Test datasets	Accuracy	Image type	2D/3D	Type AI	Conclusion
Li et al [15]		Develop automated classification of 14 orthodontic images	12,999	1,420	99%		2D		DL model improved accuracy, speed, and efficiency
Ryu et al [20]		Develop automated classification of 9 clinical orthodontic images	3,548	900	98%		2D		CNN model can classify intra- and extraoral images successfully
Guo et al [21]		Develop CNN-based method and compare with the manual method.	9,231	1026	92%-96%		2D		Compared to manual methods, the end-to-end CNN models perform better.
Amasya et al [22]		Develop ANN-based method and compare with manual method.	647	n.a.	58%		2D		In CVM analysis, the ANN model created, performed closed to human researchers.
Amasya et al [23]		Compare 5 AI machine learning models.	647	n.a.	93%		2D		ANN network showed the best result in predicting the cervical vertebrae morphology
Atici et al [24]		Compare 4 DL models with and without the use of directional filters.	761	257	75%		2D		Highest accuracy was obtained by the custommade CNN model with directional filters.
Kim et al [25]		Identify with ML-based method on cephalograms.	480	120	63%		2D		3-step based segmentation model had the highest accuracy
Kök et al [26]		Compare 7 AI algorithms.	300	n.a.	97%		2D		ANN network is preferred in determining the CMS.
Li et al [27]		Compare 4 CNN models.	4,253	914	67%		2D		RESNET5 achieved the highest accuracy.
Liao et al [28]		Develop a CNN model.	720	180	84%		2D		The model achieves a superior performance for staging the CVM.
Radwan et al [29]		Develop CNN and unsupervised learning model.	1,201	150	80%		2D		This CNN model is able to classifie the CVM stage with a good level of success
Seo et al [30]		Develop CNN-based method on LC.	480	120	94%		2D		DL models showed an accuracy of more than 90% in determining CVM stages.
Zhou et al [31]		Develop new AI-based method.	980	100	71%		2D		AI algorithm is accurate and useful for describing skeletal maturation and stages.
Atici et al [32]		Develop automated CVM stage detection and classification with pre-processing layer	823	189	82% (female), 75% (male)		2D		CNN with the pre-processing layer produce higher accuracy in CVM stages determination
Khazaei et al [33]		Develop CNN-based maturation stage classification	1,846	449	82% (3 class), 93% (2 class)		2D		CNN can classify CVM images with high accuracy
Mohammad-Rahimi et al [34]		Evaluate DL model CVM and growth spurt stage determination	692	99	62% (6 class) 83% (3 class)		2D		Current model had fair accuracy and needs more improvement
Aljabri et al [35]		Develop DL model to make a canine impaction classification	57	211	93%		2D		Efficient DL model with high accuracy was developed to assess canine impaction, shown that there is still too little automation in canine impaction assessment.
Vranckx et al [36]		Automatic third molar segmentation and predict eruption potential	588	250	Segment: 90% Angle: 80%		2D		The network can predict the third molar angulation with high accuracy
Talaat et al [6]		Assess malocclusions on intraoral scans using a CNN network model.	460	116	99%		2D		Deep CNN networks are valid to detect dental problems on intraoral scans. New AI technique can accurately locate malocclusions.
Aksoy et al [37]		Compare 3 ML algorithms for diagnosing skeletal class III malocclusion.	337	113	76%		2D		ML was the most effective method
Nan et al [38]		Develop DL-based method for automatic skeletal malocclusion classification	1,613	na	91% (cephalometric radiograph) 84% (Profile photographs)		2D		CNN successfully learns the discriminative representation of the lateral cephalograms and profile photographs
Yim et al [39]		Develop CNN to determine skeletal discrepancies with 1-step orthodontic diagnosis.	1,522	652	82%-89%		2D		Model created by the researchers on the basis of CNN network showed good results for clinical usability.
Yu et al [40]		Develop CNN-based skeletal diagnostics on lateral cephalograms	3,827	765	96%		2D		Study indicates that orthodontic diagnosis is easily possible automatically through RX inputs.
Zhang et al [41]		Develop DL model for mandibular growth prediction	256	40	85%		2D		DL model could predict the growth trend for children with anterior crossbite
Ali et al [42]		Develop neural network-based prediction to estimate the size of premolars and canines.	66	28	ICC 0.97-0.99		2D		Prediction of unerupted teeth (size) was accurately evaluated via a new neural network AI method.
Budiman [43]		Develop ANN networks to determine arch dimensions from pre-existing orthodontically treated malocclusion models.	114	76	76%		3D		ANN used to study the arch form, which can correctly capture the arch form.
Jeong et al [17]		Evaluate upper airway obstruction based on DL using lateral cephalograms	1099	120	F1 Score 0.88		2D		CNN model can detect upper airway obstruction with higher accuracy and more time-efficiency.
Shujaat et al [44]		Automatic segmentation of the pharyngeal airway space	48	25	DSC: 97%		3D		3D uNet model proposed an accurate and time-efficient automatic segmentation method
Dong et al [45]		Develop DL-based method for upper airway assessment on CBCT	700	170	F1 Score 0.90		3D		The proposed model showed good performance and faster detecting time for adenoid hypertrophy.

Figure 2. Example of a structured data-charting table summarising the main characteristics of the included studies, adapted from Gracea, et al. (2025).

Relevant data input and automated steps within each implant planning program.

Step / Software	3D image acquisition	Anatomical landmark segmentation	Multimodal image registration	Bone volume measurement	Digital wax-up	Implant dimensions	Implant location	Surgical guide design
A	*CBCT + IOS*	Semi-automatic	Automated	Manual	Automated	Manual	Manual	Semi-automatic
B	*CBCT + IOS*	Automated	Automated	Manual	Manual	Manual	Semi-automatic	Semi-automatic
C	*CBCT + IOS*	Automated	Automated	Manual	-	Manual	Manual	Semi-automatic
D	*CBCT + IOS*	Semi-automatic	Manual	Manual	Manual	Manual	Manual	Semi-automatic
E	*CBCT + IOS + Face scan*	Semi-automatic	Semi-automatic	Manual	Semi-automatic	Semi-automatic	Manual	Semi-automatic
F	*CBCT + IOS*	Automated	Automated	Manual	Automated	Semi-automatic	Manual	-
G	*CBCT + IOS + Face scan*	Semi-automatic	Semi-automatic	Manual	Semi-automatic	Manual	Manual	Semi-automatic
H	*CBCT + IOS*	Semi-automatic	Semi-automatic	Manual	Semi-automatic	Manual	Manual	Semi-automatic
I	*CBCT + IOS + Face scan*	Automated	Automated	Manual	Manual	Semi-automatic	Manual	Semi-automatic
J	*CBCT + IOS*	Semi-automatic	Semi-automatic	Manual	Semi-automatic	Manual	Manual	Automated
K	*CBCT + IOS + Face scan*	Semi-automatic	Semi-automatic	Manual	Manual	Semi-automatic	Manual	Semi-automatic
L	*CBCT + IOS*	Semi-automatic	Semi-automatic	Manual	Manual	Manual	Manual	Semi-automatic

Software codes are defined in Table 4.

= Manual approach, = Semi-automatic approach, and = Automated approach.

Figure 3. Example of a structured data-charting table summarising the main characteristics of the included softwares, adapted from Elgarba, et al. (2024).

Step 7. Collating, summarising, and analysing the results

After data charting, the next step is to collate and summarise the extracted information in a structured and transparent way. In a scoping review, the emphasis is on providing an overview of the available evidence rather than on statistical pooling or formal effect estimation.

A first level of analysis is a descriptive numerical summary of the included evidence sources. This often includes the number of included sources, their distribution by year of publication and by country or region, types of study designs and evidence sources, and an overview of populations, concepts, and contexts addressed.

Where appropriate, descriptive findings shall be organised into themes or categories that align with the objectives and review questions, such as types of interventions or approaches and methodological trends.

Step 8. Reporting and presenting the scoping review

The final step is to report the scoping review in a clear, transparent, and structured way, in line with PRISMA-ScR and journal or institutional requirements. As far as applicable, reporting should follow the PRISMA-ScR checklist, and can be found in the link below:
https://www.prisma-statement.org/scoping

A typical structure for a scoping review article includes:

1. Title
2. Abstract
3. Introduction
    - Background and rationale in the specific clinical context.
    - Explanation why a scoping review is appropriate.
    - Aim and research question(s), linked to PCC/PICO.
4. Methods
    - Design and reference to PRISMA-ScR and/or JBI guidance.
    - Research question with the PCC/PICO framework.
    - Eligibility criteria.
    - Information sources and search strategy.
    - Study selection process, including use of a PRISMA(-ScR) flow diagram.
    - Data charting process and key variables.
5. Results
    - PRISMA(-ScR) flow diagram.
    - Descriptive numerical summary (study numbers, designs, indications, imaging modalities, countries, etc.).
    - Thematic or conceptual presentation of results, structured according to clinical indications, imaging techniques, outcomes, or other relevant themes.
    - Summary tables and illustrative figures.
6. Discussion
    - Summary of the main results and how they answer the review questions and objectives. Discuss how the findings contribute to current knowledge, and highlight possible knowledge gaps.
    - Strengths and limitations of the scoping review (including methodological constraints and gaps in the evidence base).
    - Implications for clinical practice, research, and, where relevant, education or policy.

7. Conclusion
    - Concise statement of what the scoping review adds to the field and the main knowledge gaps or priorities for future studies.
8. References

Practical tip – librarian support

KU Leuven Libraries provide dedicated support for literature searches and review projects. Information about these services and contact details are available on the KU Leuven Libraries research support page:

https://bib.kuleuven.be/2bergen/mgas/onderzoeksondersteuning

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