REVIEW

A framework for formulating research questions. A narrative review of theoretical approach and practical implementation

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ABSTRACT

Background: A well-defined research question is essential for any research endeavor. Studies indicate that a large percentage of research questions are not well-defined.

Aim: This study seeks to identify a framework for the creation of high-quality research questions and assess its practical application.

Methods: The electronic databases used were PubMed, Scopus and Google Scholar without time and language limit. Materials included original articles, reviews, editorials, letters to the editor and conference proceedings.

Results: The PICO framework (population, intervention, comparator, outcome) was the most prominent and frequently suggested among those found. The PICO method, when applied effectively, yields strong research questions. The PICO strategy has been subject to criticism, particularly for its limited applicability. Boolean operators and controlled terms can resolve the problems inherent in applying a PICO search strategy. A case study helps demonstrate the implementation process in practice**.**

Conclusion: Despite shortcomings, the PICO strategy can be beneficial in creating a highly effective research approach for valuable data collection.

Keywords: PICO, evidence-based medicine, delivery of health care, information storage and retrieval, bibliographic databases, primary health care

INTRODUCTION

The use of evidence-based practice is essential in providing high-quality care that results in improved patient outcomes [1]. The practice of evidence-based medicine involves using the most current and trustworthy evidence to make patient care decisions [2]. During the implementation of evidence-based medicine, challenges emerge, including dealing with large volumes of information, insufficient expertise to search effectively, and inadequate time [3–5]. Hence, optimizing the process of searching and locating information in the literature is thought to be crucial to promote evidence-based medicine.

According to evidence-based medicine, clinical decisions must be grounded on available evidence, and systematic reviews provide the most robust evidence for clinical decision making. The systematic reviews and meta-analyses are the most highly regarded types of research [6]. Systematic review methods are designed to be systematic, explicit, and reproducible, and can be employed in almost any type of study [7].

The primary aspects of a systematic review are a well-defined set of aims, an explicit, reproducible methodology and a systematic search that attempts to identify all studies that meet the eligibility criteria [8]. In the absence of a well-focused question, identifying relevant sources and seeking an answer becomes more challenging and time-consuming [9].

A well-defined research question is fundamental to any research undertaking. It directs researchers through objective setting, methodological planning, data analysis, and conclusion drawing [10]. Flawed research questions render methodological rigor and researcher reasoning immaterial; the research is inherently flawed [11].

Studies have shown that a significant portion of the research questions were poorly formulated: 65% failed to convey the researcher's intended information and 30% required revisions [12]. Another paper indicates that nearly half of the research questions were poorly or inadequately formulated, a trend that may lead to wasted research efforts [13].

This study seeks to identify a framework for the creation of high-quality research questions and assess the practical application. Researchers should familiarize themselves with the framework, its limitations, and potential solutions, and observe its practical application for direct implementation. This paper guides readers in evaluating research questions and offer insights to novice researchers on writing them [11].

This study will address the following research questions:
- Which framework reliably helps in formulating research questions?
- What are the implementation's potential problems, and what are their solutions?
- How does this function in practice?

MATERIAL AND METHODS

This review is registered [14]. The electronic databases used was PubMed, Scopus and Google Scholar without time and language limit. Google and DuckDuckGo, among other generic search engines, were consulted to gather relevant information. The predefined

search terms used was "formulating clinical questions", "research question formulation" and "search strategy". For this paper included original articles and reviews, as well as editorials, letters to the editor, and conference proceedings. Animal studies were excluded. Relevant papers were selected and assessed according to the research questions.

RESULTS

Various models were found. Amongst the existing models are the PICO (Population, Intervention, Comparator, Outcome), SPIDER (sample, phenomenon of interest, design, evaluation, and research type) and SPICE (setting, perspective, intervention, comparison, evaluation) [15]. We'll discuss the PICO model below, as it's the most frequently used in healthcare [16] and recommended model [17] for structuring clinical questions.

The PICO strategy

The PICO strategy is a valuable tool in framing the question effectively. An approach that can be employed to integrate evidence-based medicine into clinical practice is the utilization of the PICO strategy. The process is systematic and aims to convert information needs and problems into answerable questions [18]. The Cochrane handbook for systematic reviews of interventions advocates for the use of PICO as a framework for creating a review question, which guarantees the inclusion of the relevant elements of the question [17].

The PICO acronym denotes the framework's constituent components, which are the population, intervention, comparator, and outcome of interest [19]. Letter P

(Population) can either refer to a singular individual or a group of individuals sharing a common health condition or problem. The intervention of interest, which may involve therapeutic, preventive, diagnostic, prognostic, administrative, or economic issues, is represented by the letter I(Intervention). The Letter C (Comparator) is defined as the standard intervention, which is the most frequently utilized. The letter O (Outcome) is the outcome that is expected.

The usage of PICO is deemed to have a triple purpose: Initially, it compels the inquirer to concentrate on the patient's foremost concern and objective. Secondly, it promotes the computerized search by directing the inquirer to choose the terms to be utilized in the search. Thirdly, it leads the inquirer to clearly state the issue, intervention, and outcomes associated with the specific care given to a patient [18].

PICO has a number of variations: PICOS (S = study design), PICOTT (T = type of question asked, T = type of study design), PICOT (T = time), PICO-D Man (D = Duration Man = Management), ML PICO(ML = Machine Learning PICO) [20–22], incorporating PICO as a fundamental component, supplemented by some extension or addition.

The PICO strategy has been subject to criticism. Its best application is for questions that require a comparison between two options, and it is less pertinent for questions that seek to know what, when, how, and why of a matter. Additionally, there is limited documentation available regarding the effectiveness of PICO as a tool for evidence-based practice [20] Also, it does not meet the required level of expressiveness and is not practical for nursing education purposes [23].
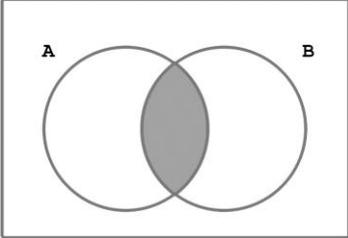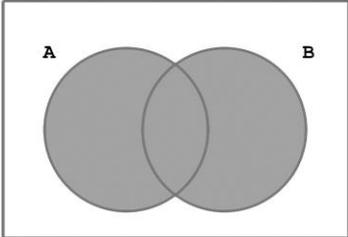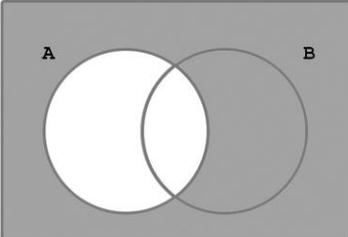
A AND B	A ∩ B The intersecion of A and B	The elements of both sets A and B	
A OR B	A ∪ B The union of A and B	Any element in set A or set B	
NOT A	A' The complement of A	Any element not in A	

Table 1. Boolean operators. This image provides a visual representation of the functioning of Boolean operators.

The PubMed database has integrated the PICO tool [24]. Moreover, there is a mobile application named "PubMed for Handhelds" available on both Apple iOS and Android OS platforms.

Implementation: Problems and solutions

A PICO-refined research question may result in a significant number of initial records. Receiving numerous records is time-consuming and the data is difficult to manage. Better search strings can quicken the process and result in fewer yet relevant outcomes [25]. One can achieve this through the utilization of Boolean operators (Table 1), including AND, OR, and NOT, which enable the combination of terms. The logical operator AND imposes restrictions, while OR is cumulative and NOT represents exclusion. To be more specific, the operator AND concatenates words and generates results that comprise all the keywords linked with the logical operator AND. The result generated by the OR operator includes either one or all of the keywords. To exclude a keyword from the search results, the operator NOT is utilized. The utilization of quotation marks is to conduct a precise search for a particular expression (keywords enclosed in quotation marks are regarded as a complete word) and the purpose of brackets is to group multiple search strings and establish priorities.

An excess of irrelevant search results may necessitate the implementation of controlled search terms. The term "controlled"

Vocabulary	Database	Site
MeSH (Medical Subject Headings)	MEDLINE/PubMed	https://www.ncbi.nlm.nih.gov/mesh/
DeCS (Descritores em Ciências da Saúde)	BIREME	https://decs.bvsalud.org/
Emtree	Embase	https://ovidsp.dc1.ovid.com/ovid-new-b/ovidweb.cgi
CINAHL Subject Headings	CINAHL	https://www.ebsco.com/products/research-databases/cinahl-database

Table 2. Important vocabularies. The vocabularies that often used in medical publications

refers to the containment of words within a specific vocabulary.

MeSH (MEDLINE/PubMed) takes center stage, despite the fact that other options are also utilized (Table 2). The terms are non-controlled when they are synonyms, spelling variations and acronyms and are not included in the vocabularies [26].

A case study

To produce the search strategy, the recommended procedure is to express the topic in natural language (Table 3). For example:
In children with tonsillitis, what is the effect of Clarithromycin on symptom duration compared with Penicillin?

The PICO strategy is implemented:
P= *child with tonsillitis*

I = *clarithromycin administration*

C = *penicillin administration*

O = *symptom duration*

Next, auxiliary verbs, definite articles, conjunctions, and other similar words must be removed to obtain the keywords.
P= *child tonsillitis*

I = *clarithromycin*

C = *penicillin*

O = *symptom duration*

A list comprising of synonyms and related words is compiled for each term. The synonyms of the word "child" are "youth", "juvenile" and "kid" For the word "tonsillitis" the synonym is "amygdalitis".
The logical operator "AND" is used to link keywords while "OR" is used to link synonyms and related words. Thus,
P= *(child OR youth OR juvenile OR kid) AND (tonsillitis OR amygdalitis)*
I = *clarithromycin*
C = *penicillin*
O = *symptom duration*
The exclusion of unwanted keywords can be accomplished through the application of the NOT operator, while priorities can be established by using parentheses [25].

Question in plain language	PICO strategy	Research strategy
In children with tonsillitis, what is the effect of Clarithromycin on symptom duration compared with Penicillin?	P= Child with tonsillitis I = Clarithromycin administration C = Penicillin administration O = Symptom duration	(child[MeSH] OR youth OR juvenile OR kid) AND (tonsillitis[MeSH] OR amygdalitis) AND clarithromycin[MeSH] AND penicillin[MeSH] AND symptom duration

Table 3. From question to research strategy. A model for developing a research strategy.

The aforementioned search strategy may be incorporated into the PubMed's PICO tool. Alternatively, the components of PICO can be combined using the AND operator
(P) AND (I) AND (C) AND (O)
Consequently,
(child OR youth OR juvenile OR kid) AND (tonsillitis OR amygdalitis) AND clarithromycin AND penicillin AND symptom duration

This search strategy should be introduced in the search box to extract studies of interest.

CONCLUSION

Although the PICO strategy is not without its flaws, it can aid in formulating a highly effective research approach to obtain valuable data.

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ΑΝΑΣΚΟΠΗΣΗ

Πλαίσιο για τη διατύπωση ερευνητικών ερωτημάτων. Αφηγηματική ανασκόπηση θεωρητικής προσέγγισης και πρακτικής εφαρμογής

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ΠΕΡΙΛΗΨΗ

Υπόβαθρο: Σε κάθε ερευνητική προσπάθεια είναι απαραίτητο ένα καλά καθορισμένο ερευνητικό ερώτημα. Η έρευνα δείχνει ότι ένα μεγάλο ποσοστό ερευνητικών ερωτημάτων δεν ήταν καλά καθορισμένα.

Σκοπός: Η παρούσα μελέτη επιδιώκει να προσδιορίσει ένα πλαίσιο για τη δημιουργία ερευνητικών ερωτημάτων υψηλής ποιότητας και να αξιολογήσει την πρακτική εφαρμογή του.

Μέθοδοι: Οι ηλεκτρονικές βάσεις δεδομένων που χρησιμοποιήθηκαν ήταν οι PubMed, Scopus και Google Scholar χωρίς χρονικό ή γλωσσικό περιορισμό. Το υλικό που χρησιμοποιήθηκε περιλαμβάνει πρωτότυπα άρθρα, ανασκοπήσεις, άρθρα σύνταξης, επιστολές προς τον εκδότη, και πρακτικά συνεδρίων.

Αποτελέσματα: Το πλαίσιο PICO (πληθυσμός, παρέμβαση, συγκριτής, αποτέλεσμα) ήταν το πιο δημοσφιλές και συχνά προτεινόμενο μεταξύ αυτών που βρέθηκαν. Η μέθοδος PICO, όταν εφαρμόζεται αποτελεσματικά, παράγει ισχυρά ερευνητικά ερωτήματα. Η στρατηγική PICO έχει δεχθεί επικρίσεις, ιδίως για την περιορισμένη εφαρμογή της. Οι τελεστές Boolean και οι ελεγχόμενοι όροι μπορούν να περιορίσουν τα προβλήματα που ενυπάρχουν στην εφαρμογή της στρατηγικής αναζήτησης PICO. Μια μελέτη περίπτωσης συμβάλλει στην επίδειξη της διαδικασίας εφαρμογής στην πράξη.

Συμπέρασμα: Παρά τις ελλείψεις, η στρατηγική PICO μπορεί να είναι επωφελής για τη δημιουργία μιας εξαιρετικά αποτελεσματικής ερευνητικής προσέγγισης για τη συλλογή πολύτιμων δεδομένων.

Λέξεις ευρετηρίου: PICO, τεκμηριωμένη ιατρική- παροχή υγειονομικής περίθαλψης- αποθήκευση και ανάκτηση πληροφοριών- βιβλιογραφικές βάσεις δεδομένων- πρωτοβάθμια υγειονομική περίθαλψη

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