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ABSTRACT

Introduction: Inappropriate antibiotic use is a major cause of antibiotic resistance. Therefore, optimizing antibiotic usage is essential. In Belgium, optimization of antimicrobials for the fight against multidrug resistant organisms (MDROs) is followed up by national surveillance by public health authorities. To improve appropriate antimicrobial use in hospitals, an effective national Antimicrobial Stewardship (AMS) program should include indicators for measuring both the quantity and quality of antibiotic use.

Objectives: The aim of this study was to develop a set of process quality indicators (QIs) to evaluate and improve AMS in hospitals.

Methods: A RAND-modified Delphi procedure was used. The procedure consisted of a structured narrative literature review to select the QIs, followed by two online questionnaires and an intermediate multidisciplinary panel discussion with experts in infectious diseases from general and teaching hospitals in Belgium.

Results: A total of 38 QIs were selected after the RAND-modified Delphi procedure, from which 11 QIs were selected unanimously. These QIs address compliancy of antibiotic therapy and prophylaxis with local guidelines, documentation of the rationale for antibiotic treatment in the medical record, the availability of AMS Programs and Outpatient Parenteral Antibiotic Therapy, resistance patterns and antimicrobial prescribing during focused ward rounds.

Conclusion: Our study selected 38 relevant process QIs, from which 11 were unanimously selected. The QIs can contribute to the improvement of quality of antibiotic use by stimulating hospitals to present better outcomes and by providing a focus on how to intervene and to improve prescribing of antimicrobials.

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Antimicrobial Stewardship; quality indicators; hospital medicine

Introduction and objectives

The prevalence of infections caused by multidrug-resistant organisms (MDROs) is a global problem [1]. Direct consequences of such infections are prolonged duration of illness and increased mortality as well as prolonged stay in the hospital, leading to increased costs [2]. The increasing bacterial resistance towards currently available antimicrobials is promoted, mainly, by inappropriate antimicrobial use and overuse [3–5]. Collaboration of professionals across all sectors, namely human health (public health and healthcare facilities), animal health, environmental health and other areas of expertise is essential in the fight against antimicrobial resistance [6]. A crucial part of this 'One Health' approach is the optimization of antimicrobial usage. Furthermore, such optimizations protect patients from harmful effects of unnecessary antimicrobial usage and reduce costs [3,7–9]. The judicious use of antimicrobial agents is referred to as antimicrobial stewardship (AMS) [8,10].

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To improve appropriate antimicrobial use in hospitals, an effective AMS program should include indicators for measuring both the quantity and quality of antimicrobial use [3,11]. In order to develop such programs, the Belgian Antibiotic Policy Coordination Committee (BAPCOC) has supported the development of Antibiotic Management Teams (AMTs) in Belgian hospitals since 2002 [12]. The surveillance of antimicrobial consumption has been well established with first the 'Antibiotic Use in Hospitals' (ABUH) project, using consumption data, and since 2014, with the Belgian Hospitals – Surveillance of Antimicrobial Consumption (BeH-SAC) project, using reimbursement data [13]. These two projects support AMTs with the monitoring of quantitative antibiotic use in their hospitals [13].

Concerning quality indicators (QIs), BAPCOC implemented four QIs for hospitals following the strategic plan of 2014–2019 in which a target of 90% was defined (choice of therapeutic antimicrobials, documentation of the indication of antibiotic treatment and choice of and duration of antimicrobials for surgical prophylaxis) [2,14]. Furthermore, different audits were held to follow up antimicrobial use such as the Global Point Prevalence Survey of Antimicrobial Consumption and Resistance (Global – PPS) and audits to monitor surgical prophylaxis [2,14–18]. However, there is still room for improvement [19,20]. Nonetheless, QIs are expected to be helpful in providing the necessary understanding of the quality of antimicrobial prescribing [3]. They can furthermore be used for benchmarking purposes, which allows hospitals and even countries to assess their position in relation to other facilities with similar guidelines [3]. These QIs could trigger action and, in addition, provide help in finding areas in which intervention is needed [3].

Two initiatives in which different members of the European Union took part, the Driving Reinvestment in Research and Development and Responsible Antibiotic Use (DRIVE-AB) project and the Transatlantic Taskforce on Antimicrobial Resistance (TATFAR), developed a set of QIs for antimicrobial stewardship in the inpatient setting [21,22]. Another study from Van den Bosch *et al*. developed a set of QIs in the Netherlands [23]. Because of the differences in legal requirements and available resources in different countries, interpretation and implementation of these sets in Belgium is challenging. To ensure relevance to local healthcare systems, the aim of our study was to develop a set of process QIs to evaluate and improve AMS, specifically applicable in Belgian hospitals.

Methods

RAND-modified delphi procedure

A RAND-modified Delphi procedure was used to develop a set of QIs. This method combines the existing scientific evidence with the collective knowledge of experts on the field [21,22,24–29]. The procedure used in this study consisted of a literature review and two online questionnaires with a panel discussion in between.

Literature review

Selection of articles and guidelines

To identify potential QIs, a structured narrative review was performed in Medline, using the PubMed® interface. The search strategy used for this review can be found as supplementary data (Table S1). In addition, the snowball method was used to find articles that may provide an added value to this project. Furthermore, websites containing frequently used guidelines were consulted. Data was collected until November 30th, 2020. Articles and guidelines were included if they covered the use of antimicrobials in hospitals, if QIs were discussed and if the aim of the study corresponded to the aim of this study. Other inclusion criteria were language (English, Dutch or French), publication after 2010, and conducted in Europe. Additionally, international guidelines were consulted.

Selection of indicators

From the selected articles and guidelines, indicators were extracted and included when valid. Useful indicators for this study were process indicators that can be used to assess the quality of antimicrobial therapy in hospitals. To ensure that the experts had the time to answer the questionnaires, a goal was set in cooperation with BAPCOC to start with a set of maximum 60 indicators. The indicators were divided into seven topics namely; 1) Antimicrobial Therapy (a. General; b. Indication; c. Dosing and pharmacokinetics/pharmacodynamics (PK/PD); d. Timing; e. Route of administration; f. Therapeutic Drug Monitoring (TDM); g. Duration; h. De-escalation), 2) Documentation, 3) Education, 4) Expertise & Resources, 5) Audit & Feedback, 6) Microbiological diagnostics and 7) Surgical prophylaxis.

Questionnaire one

Experts

The multidisciplinary expert panel consisted of 30 members of the BAPCOC hospital medicine working group (Infectious Diseases (ID) physicians ($n = 10$), hospital pharmacists ($n = 9$), microbiologists ($n = 4$), experts in Infection Prevention and Control (IPC) ($n = 1$) or scientific workers, specialized in ID ($n = 6$)), who are active in general and teaching hospitals. Before sending out the online questionnaires, using SurveyMonkey®, the willingness to participate was questioned during a meeting of the working group. Every member received the questionnaires in English, but only the participants who were willing to spend more time on the study were invited for the panel discussion. An introduction to the questionnaires explained what was expected of the experts and gave the estimated time necessary to complete the questionnaire (30–45 min). In the first part of the questionnaires, demographic characteristics of the experts were questioned.

Design of the questionnaire

This first questionnaire was used to evaluate the relevance of the obtained QIs, using a nine-point Likert scale (with 1 being 'highly irrelevant' and 9 being 'highly relevant'). Besides these nine points, the experts were given the option 'cannot assess' and could add comments. The questionnaire consisted of process QIs for AMS, defined as 'indicators that can be used to evaluate the care delivered to patients regarding the responsible use of antimicrobials'.

Selection of the QIs after the first questionnaire

The scores were interpreted as follows. The two used criteria were the median of the scores and the percentage of agreement, defined as ≥ 70 % of scores in the upper tertile (7–9). The QI was selected if it had a median score of ≥ 8 AND if there was an agreement between the experts. If the QI had a median score of ≥ 8, but there was no agreement, the QI was labelled for discussion. This was also the case for QIs with a median score of 7–7,9 with agreement. The QI was rejected if it had a median score of 7–7,9 with no agreement or a median score of < 7. The results were exported to Microsoft Excel (Microsoft Inc.) for data analysis.

Panel discussion

The panel discussion was held in English, on March 11th, 2021 and moderated by SL. Due to COVID-19 restrictions, the meeting was held online. During the discussion, the indicators that were selected for discussion after the first questionnaire were debated in order to reach a consensus. Furthermore, QIs for which at least six experts left a comment and additional QIs that were suggested by an expert during the first questionnaire, were clarified. This clarification was important to give an unambiguous answer in the second questionnaire and to have a pertinent outcome of the process.

Questionnaire two

The second questionnaire combined two different sorts of questions depending on the results of the previous rounds;

- The QIs selected in the first questionnaire were again submitted to the experts who had to answer the question, 'Should the indicator be selected for development of a set of QIs for AMS?', with yes or no. The indicators were selected if > 70% of the experts agreed.
- The newly suggested QIs were presented to the experts. The experts were asked to score the relevance of these indicators on a nine-point Likert scale. The selection of the QIs followed the same method as used for questionnaire one.

For all the QIs, experts were given the option 'cannot assess' and were allowed to leave comments.

Results

Literature review

Selection of articles and guidelines

The search strategy resulted in 871 records. After exclusion based on language, publication date and origin, 139 records remained. Most of the articles (*n* = 78) were excluded based on the title and abstract. However, in cases of doubt, the full text was consulted to make sure no relevant QIs were lost (21 excluded). Three articles were added using the snowball method. A total of 43 articles were included. An overview of the selection of articles is shown in a PRISMA flowchart (Figure 1). Seven guidelines were selected (e.g. The European Society of Clinical Microbiology and Infectious Diseases (ESCMID), The Society for Healthcare Epidemiology of America (SHEA)), which are also available as supplementary data (Table S2) [8–10,30–33].

Selection of indicators

An overview of the process of selection of indicators during the whole Delphi procedure is displayed in a flowchart in Figure 2. A total of 438 indicators were extracted from the 43 selected articles. Structure QIs, outcome QIs and duplicate QIs were excluded, after which 58 process QIs remained. An overview of the articles (*n* = 26) from which process QIs were selected are shown as supplementary data (Table S3), as well as the data extracted from these articles during the literature review [21–23,26,27,33–55].

Questionnaire one

General information

The response rate of the first questionnaire was 50%, with 15 responses out of 30 experts. The average time spend for the first questionnaire was 46 minutes for 64 questions, with a completion rate of 93 % (14 complete responses). The demographic characteristics of the experts who answered the questionnaire are shown in Table 1.

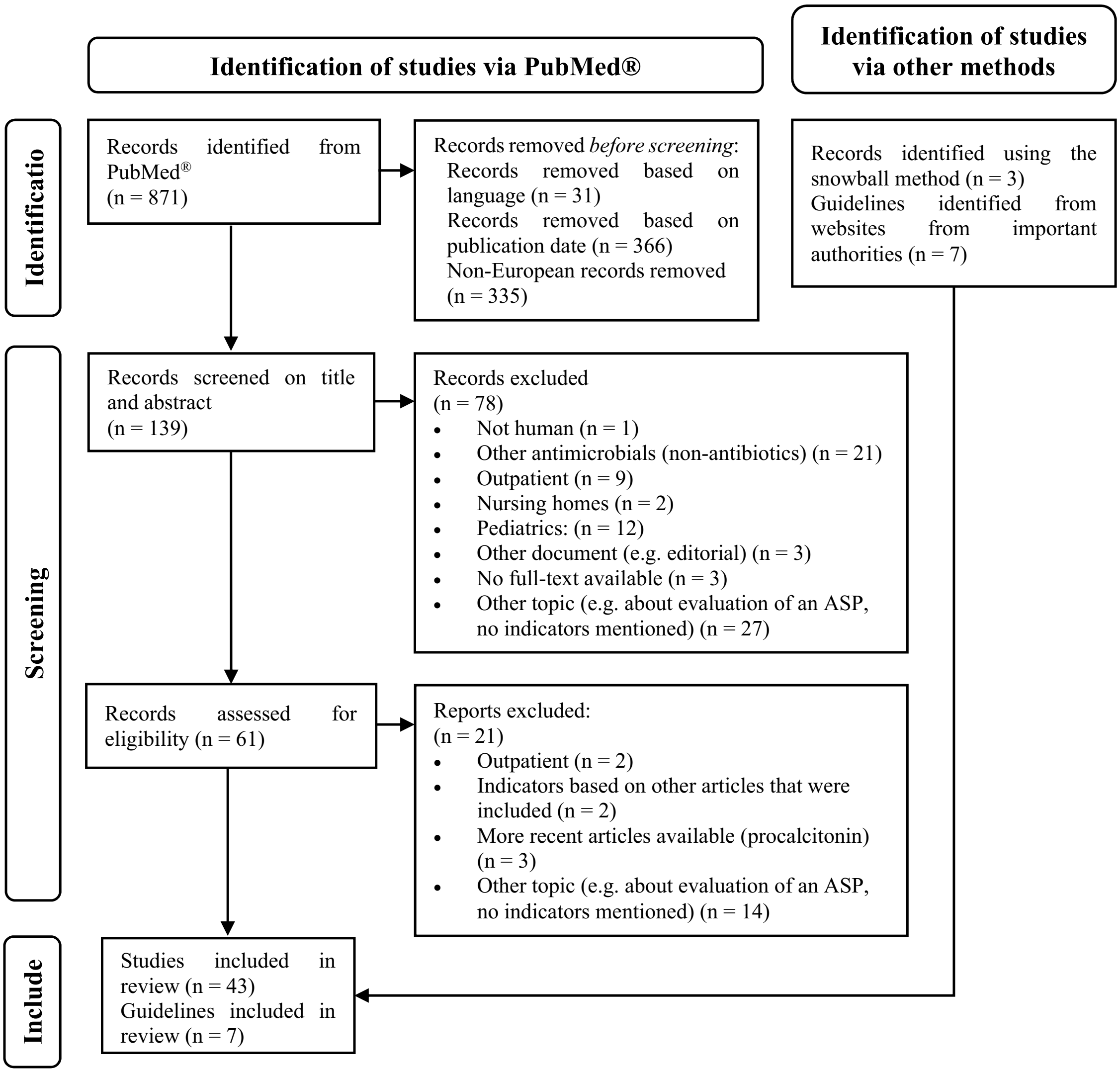

Figure 1. PRISMA flowchart of the literature review.

Evaluation of the indicators

A summary of the results of the first questionnaire is available as supplementary data (Table S4). Based on the median of the scores given by the experts and the percentage of agreement, 37 QIs were selected, nine QIs were labelled for discussion and twelve QIs were rejected. Additionally, five QIs had at least six comments, for which they were also labelled for discussion. Three new process QIs were suggested (newly suggested indicators 1, 2 and 4), for which two articles were added to the review (reference 5 and 16 in Table S3). Comments about the phrasing of the indicator were taken into account for the next rounds. Other comments were about the feasibility and difficulty to measure some of the QIs (e.g. QI 13, 27 and 52).

Panel discussion

The panelists present ($n = 11$) were ID physicians ($n = 3$), hospital pharmacists ($n = 5$), microbiologists ($n = 1$), experts in IPC ($n = 1$) or scientific workers, specialized in ID ($n = 1$), from which seven worked at a university hospital. More details about the demographic characteristics of the experts can be found in Table 1. The results of this panel discussion are displayed as supplementary materials (Table S4).

Of the nine QIs that were selected for discussion after the first questionnaire, four QIs were rephrased and five QIs were rejected. The rephrased QIs can be recognized in the summary table (Table S4) by an 'a' after the number of the QI (e.g. QI5 was rephrased into QI5a). Of the rejected QIs, QI 21 was considered equal to QI 20 and QI 27 was included in QI 28. The changes that resulted from this merge were underlined in the original QI (e.g. QI 28).

Another five QIs were discussed because they had six or more comments during the first questionnaire (one selected (QI 37) and four rejected during the first questionnaire (QIs 3, 7, 19 and 45)). Three of these were rephrased during the panel discussion and selected for the second questionnaire (QIs 19, 37 and 45).

During the panel discussion, three other QIs were debated (QI 51, 52 and 53). Although they were not withheld for discussion in the first questionnaire, they

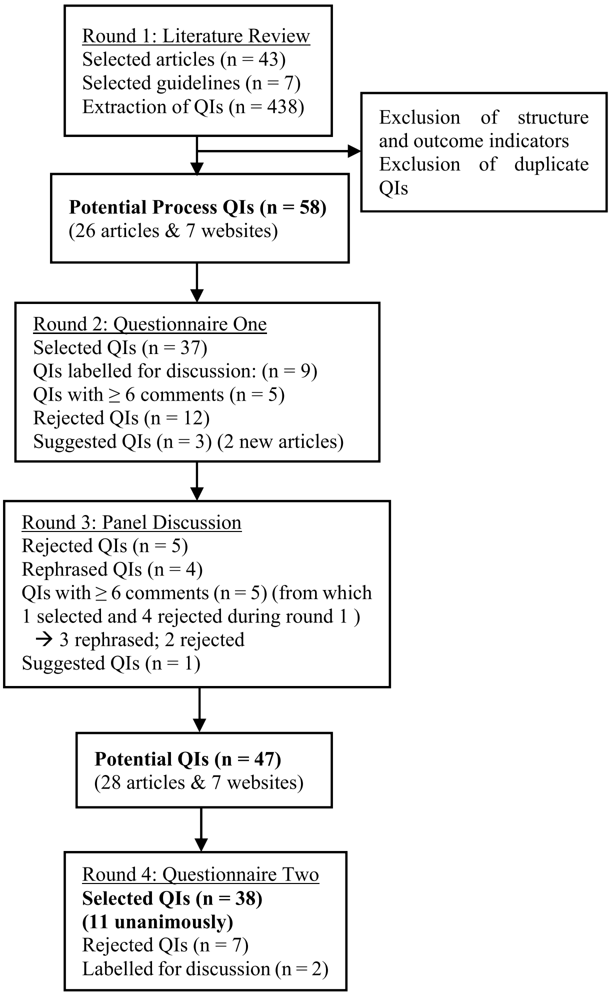

Figure 2. Overview of the selection of indicators during the delphi procedure. Abbreviation: QIs, Quality Indicators.

proved unclear during the meeting. A consensus was reached for these indicators during the panel discussion. Two QIs were rephrased (QI 51 & 53) and one remained unchanged (QI 52). Another indicator was suggested by one of the experts present (newly suggested indicator 3).

General remarks that were made by the experts during the discussion were that the indicators were mainly good practices and that the biggest challenge would be how to measure the QIs with the often few available resources. Experts expressed their concern about the lack of time and financial support.

Questionnaire two

General information

The response rate of the second questionnaire was 57%, with 17 responses. The second questionnaire had a completion rate of 65 % (11 complete responses), although the average time of completion was 22 minutes for 53 questions. The demographic characteristics of the experts who completed the questionnaire are shown in Table 1.

The second questionnaire consisted of a total of 47 QIs, from which four were newly suggested indicators, suggested during the first questionnaire and the panel discussion. Of the 43 QIs that were included after the first two rounds of the procedure, 36 QIs were selected and seven were rejected. Two of the newly suggested indicators were selected immediately and two indicators need to be discussed. The results of the second

Table 1. Characteristics of the experts.

	Questionnaire 1	Panel discussion	Questionnaire 2
Number of complete responses (Questionnaires) Number of participants (Panel discussion)	14	11	11
Specialty			
ID physicians	5 (35,7%)	3 (27,3%)	2 (18,2%)
Microbiologists	2 (14,3%)	1 (9,1%)	1 (9,1%)
IPC specialists	1 (7,1%)	1 (9,1%)	1 (9,1%)
Hospital pharmacists	4 (28,6%)	5 (45,5%)	6 (54,5%)
Scientific workers, specialized in ID	2 (14,3%)	1 (9,1%)	1 (9,1%)
Gender			
Females	10 (71,4%)	6 (54,5%)	6 (54,5%)
Males	4 (28,6%)	5 (45,5%)	5 (45,5%)
Age			
<30y	0 (0,0%)	N/A	1 (9,1%)
30-39y	3 (21,5%)		2 (18,2%)
40-49y	5 (35,7%)		3 (27,3%)
50-59y	3 (21,5%)		5 (45,5%)
≥ 60y	1 (7,1%)		0 (0,0%)
Unknown	2 (14,2%)		0 (0,0%)
Years of experience in AMS			
<10y	2 (14%)	N/A	2 (18%)
10-19y	6 (43%)		6 (54,5%)
≥ 20y	6 (43%)		3 (27,5%)
Native language			
French	N/A	4 (36,4%)	N/A
Dutch		7 (63,6%)	
German		0 (0,0%)	

Abbreviations: ID, Infectious Diseases. IPC, Infection Prevention and Control. AMS, Antimicrobial Stewardship.

Table 2. Final set of process quality indicators for hospital antimicrobial stewardship programs.

QI 2. Up-to-date local guidelines for infection management (diagnosis, prevention and treatment) are based on international/national evidence-based guidelines and adapted to local susceptibility. Note: The guidelines assist with antimicrobial selection (indication, agent, dose, route of administration, duration) for common clinical conditions.
QI 4. An antimicrobial stewardship (AMS) program is in place at the healthcare facility for ensuring appropriate antimicrobial use (e.g. antibiotic prescribing control program and/or antibiotic prescribing policy).
QI 9. Dosage and dosing interval of the antibiotic are compliant with local guidelines.
QI 15.The route of administration is compliant with local guidelines.
QI 20. Duration of antibiotic therapy is compliant with local guidelines.
QI 35. The rationale for treatment with empirical antibiotics is recorded in the medical record.
QI 41a. When the hospital has an Outpatient Parenteral Antibiotic Therapy service, it should be part of the AMS program.
QI 42. Regular infection and antimicrobial prescribing focused ward rounds are performed in specific departments (e.g. ICU).
QI 46.The AMT gives feedback on antimicrobial resistance patterns to prescribers.
QI 48. Surveillance of antibiotic use (e.g. for specified antimicrobial agents or clinical conditions) and monitoring of resistance patterns of common organisms is performed at least once a year.
QI 58. Surgical antibiotic prophylaxis is compliant with local guidelines. This includes choice of antibiotic, timely administration, duration.

Abbreviations: AMS, Antimicrobial Stewardship. AMT, Antibiotic Management Team. ICU, Intensive Care Unit.

questionnaire are displayed as supplementary data (Table S4). Of the 38 selected QIs, 11 were unanimous (Table 2).

Discussion

In this study we used a RAND-modified Delphi procedure to develop a set of 38 process QIs, of which 11 QIs were selected unanimously. Based on the comments in the different rounds we can conclude that panel members found the initial 58 indicators to be mainly 'good practices of antibiotic therapy', however different QIs were deemed difficult to measure. Compared with point prevalence surveys carried out since 2015, several QIs are similar, e.g. the compliance with guidelines, the documentation in the notes of the stop/review date and the rationale for antibiotic treatment [14,15,17]. Another observation is that the QIs implemented by BAPCOC in the strategic plan of 2014–2019 are also QIs selected in this study [2]. This might be explained by the similarity between the purposes of this study and the strategic plan, set up by partially the same experts.

The DRIVE-AB project developed a set of 51 generic QIs, which is comparable with the set of 38 QIs selected during our study [22]. The DRIVE-AB project identifies five QIs that have 'the highest relevance scores', in which two QIs correspond to QI 2 (*Up-to-date local guidelines for infection management are based on international/national evidence-based guidelines and adapted to local susceptibility*.) and 4 (*An antibiotic stewardship program is in place at the healthcare facility.)* of our study [22]. Remarkably, one of the QIs with a high relevance score in the DRIVE-AB project in which an antibiotic plan should be documented in the medical record, was rejected during the last round in our study (QI 28, 64% of agreement in questionnaire 2) [22]. The study of TATFAR, by Pollack *et al*., focused on structure indicators as well as process indicators, which let to 17 core indicators and 16 supplemental indicators. A difference with these core indicators, compared to the set in this study, is that TATFAR focuses on the availability of local guidelines for different infections [21] whereas, in our final set, QIs 9, 15, 20 and 58 follow up the compliance to local guidelines.

In both the DRIVE-AB project and the study of TATFAR, QI 41a (*When the hospital has an Outpatient Parenteral Antibiotic Therapy service, it should be part of the AMS program.)* an QI 46 (*The AMT gives feedback on antimicrobial resistance patterns to prescribers.)* are not part of the developed set of indicators [21,22]. Concerning QI 46, these studies focus more on the surveillance of the resistance patterns itself, whereas our study adds the importance of feedback of these resistance patterns to prescribers. In a survey of Emilie *et al*. a lot of differences were found in the management of delivery of parenteral antimicrobials in non-inpatient settings [56]. Only 35,3 % of the participating European countries reported to have a dedicated service for OPAT [56], which could be a reason for the absence of a QI for OPAT in the literature.

In comparison with Van den Bosch *et al*., some of the indicators overlap. Different QIs of their final set were also selected during the RAND-modified Delphi procedure, but were not part of our 11 unanimously selected QIs (e.g. QI 1, 2, 10, 11, 25, 28, 51a) [23]. This can be due to the selection procedure of the second questionnaire, were in the study of Van den Bosch *et al*. every expert was asked to select a personal top five, after which the QIs in this top five were given different scores, depending on the ranking that was given [23]. Another possible reason is that for the study of Van den Bosch *et al*. experts from different countries participated [23].

Overall, in the different studies, a similar result is seen when a generic set of indicators is compared. The difference lies within the choice for a smaller set of QIs in which different groups of experts focus on different aspects of AMS. In this study, inviting only Belgian experts is an advantage because the aim was to develop a set of QIs that is useful with the currently available resources in Belgian hospitals.

The strength of a RAND-modified Delphi method is the combination of a literature review, a face-to-face meeting and the possibility to reach more experts by using questionnaires [24,28]. Our number of panelist ($n = 11$) was within the recommended range according to the RAND/UCLA appropriateness method user's manual of size that permits sufficient diversity, while ensuring that all have a chance to participate [29]. The goal of the questionnaires and the panel discussion was to have a panel with a heterogeneous distribution in area of expertise. The presence of representatives of all AMT members (an ID physician, a hospital pharmacist, a microbiologist and a specialist in IPC) was the most crucial criterion for the composition of the panel, which was met for every round of the procedure.

However, our study had a few potential limitations. A limitation of the project is the previously defined maximum of 60 QIs for the first questionnaire. If more QIs were allowed, structure and outcome QIs could also have been investigated. However, this was decided to ensure that the experts would have the time to finish the questionnaire. This resulted in a set of 58 process QIs focused on the quality of care of patients. Moreover, Belgian hospitals already have to report to the government on most of the structural organization in the annual reports of AMTs [2]. Another limitation was the search strategy that was carried out in one database, using MeSH terms. Thereby AMS is a relatively new term, which was the reason to exclude articles written before 2010. Moreover, only European articles were selected. However, to ensure that no valuable indicators were missed during the literature review, international guidelines were consulted. Additionally, the panel members were encouraged to suggest new indicators.

Another limitation was the lack of complete responses to the questionnaires, nevertheless, every area of expertise was represented, even after dropout. For the second questionnaire 54,5% of the experts were hospital pharmacists (Table 1), however the survey results by Doernberg et al. [57] showed that a 1:3 physician-to-pharmacist ratio allows for the highest-value use of resources in ASPs [57], which emphasizes the importance of pharmacist support in ASPs. As Belgium has three different official languages (Dutch, French and German), it is important to note that the native language of the experts was French or Dutch, no native German speaking experts took part in the Delphi procedure, however the representation of languages was similar to the Belgian population [58].

The most remarkable problem was the feasibility of the QIs and the possibility to measure them with the currently available resources in hospitals [20]. Since antibiotic resistance has been a major issue over the last couple of years, AMS will only get more important [26,59]. However, a survey of 2021 of the French speaking association of Belgian hospitals (AFPHB), based on an international consensus of Pulcini *et al*. [60], showed that AMS is not a priority for the hospital management in the majority of the hospitals (77 % of participating hospitals) [60]. This survey confirms the findings of the Belgian Health Care Knowledge Center (KCE) report of 2019 and the report from the European Centre for Disease Prevention and Control (ECDC), which underlines a lack of support for the AMTs from their hospital management and a low number of dedicated full time equivalents (FTEs) for IPC and AMS [19,20]. Consequently, AMTs have difficulties to improve AMS [19,20]. However, as a part of the 'One Health' approach, the BAPCOC established a pilot project in 2021, the Hospital Outbreak Support Teams (HOST), which are aimed to support AMTs and IPC teams by working in networks of different hospitals [61].

Besides the final set of 11 QIs, QIs on other themes such as TDM, education and microbiological diagnostics were also judged meaningful. Further steps are essential to differentiate the indicators according to measurability and feasibility in Belgian hospitals [62]. Van den Bosch *et al*. investigated the clinimetric properties of their final set of QIs [62]. Seven of their eleven QIs were proved applicable [62], these correspond to QI 1 *(Antibiotic prescribing is compliant with local guidelines.)*, QI 2 *(Up-to-date local guidelines for infection management are based on international/national evidence-based guidelines and adapted to local susceptibility.)*, QI 16 *(Switch from intravenous (IV) to oral antibiotic therapy is done within 48–72 h, according to local guidelines.)*, QI 28 *(An antibiotic plan is documented in the medical records at the start of the antibiotic treatment and after review of the antibiotic therapy.)*, QI 51a *(Cultures from suspected sites of infection are collected before antibiotic administration, as clinically possible.)* of our final set of QIs.

When developing QIs it is important to keep in mind patient's outcomes, adverse events and costs [3,7–9]. In 2016, a systematic review on evidence on hospital antimicrobial stewardship objectives by Schuts et al. [63] investigated the effects on patient's clinical outcomes of 14 objectives and found evidence for nine objectives. These nine objectives can be associated with QIs of our study. For every QI from the review mentioned in this paragraph, the QI from our study that can be associated is mentioned in brackets. From the 11 QIs from our final set, QI 42 correlates with the objective 'bedside consultation', which showed significant benefits for clinical outcomes, adverse events and costs [63]. Also reduced mortality was associated with bedside consultation, although it was not significant [63]. Although the quality of evidence was low, significant benefits for clinical outcomes, adverse events and costs, were also found for five other objectives, 'use of empirical therapy according to guidelines' (QI 1), 'de-escalation of therapy from a broad-spectrum to a narrower-spectrum antibiotic' (QI 25), 'switch from IV to oral therapy' (QI 16), TDM (QI 17 &18), 'use of a list of restricted antibiotics' (as an example for QI 40) [63].

In conclusion, the obtained QIs give an understanding of the relevant process QIs that can contribute to AMS in Belgian hospitals by providing a focus on how to intervene and to improve prescribing of antimicrobials. Although many indicators are crucial, selecting a few relevant, clear and applicable indicators is essential. Therefore, the QIs should be tested in practice in order to acquire a representative set of indicators, which can also be used for benchmarking. This, in turn, will lead to an improvement in the quality of antibiotic use, by stimulating hospitals to present better outcomes [3].

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