Transatlantic Taskforce on Antimicrobial Resistance (TATFAR)

Report on the modified Delphi process for common structure and process indicators for hospital antimicrobial stewardship programs

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Abbreviations

AMR: Antimicrobial Resistance
ASP: Antimicrobial Stewardship Program
CAP: Community-Acquired Pneumonia
CDC: Centers for Disease Control and Prevention
ECDC: European Centre for Disease Prevention and Control
EU: European Union
IPR: Interpercentile Range
IPRAS: Interpercentile Range adjusted for symmetry
RAND/UCLA: RAND Corporation / University of California Los Angeles
TATFAR: Transatlantic Task Force on Antimicrobial Resistance
UK: United Kingdom
US: United States
UTI: Urinary Tract Infection

Executive Summary

The Transatlantic Task Force on Antimicrobial Resistance (TATFAR) fosters cooperation between the European Union (EU) and the United States (US) on the issue of antimicrobial resistance. The first TATFAR recommendation refers to appropriate use of antimicrobials in human medicine through hospital Antimicrobial Stewardship Programs (ASPs) and, specifically, to the development of common structure and process indicators of ASP. These indicators should allow characterization of programs and comparisons among healthcare systems in EU and US.

To this end, a multidisciplinary expert group, coordinated by the European Centre for Disease Prevention and Control (ECDC) and US Centers for Disease Control and Prevention (CDC), was formed. The group consisted of 20 experts including representation of nine EU member states and six US states. The expert group participated in a structured consensus process (modified Delphi method) to facilitate the international collaboration and ensure the equal involvement of all experts. The process was conducted between March and May 2014 and was concluded by a group consensus meeting in June 2014. An initial list of indicators was developed based on previous indicators, available guidance and a review of the literature, including published systematic reviews. The domains assessed were: Governance and Management; Human Resources; Laboratory; Information Technology; Education; Policies for Appropriate Use; Guidelines, Activities and Interventions; and Monitoring of Appropriate Use. The indicators were rated for feasibility, clinical importance and relevance to minimizing antimicrobial resistance. Three rounds of rating followed by the in-person meeting led to a final set of 33 indicators. Among them 17 indicators were considered essential to characterize an ASP and therefore were included in a core set of indicators. The remaining 16 indicators were considered optional indicators and included in a supplemental set.

Implementation of the TATFAR-developed core indicators in multiple nations would contribute to a comprehensive, comparative description of infrastructure, policies, and practices of ASPs internationally. These findings could, in turn, lead to an understanding of best practices of ASPs through further investigation into the relation of different ASP approaches to antimicrobial use and resistance. Current public health surveillance systems or special studies may also be candidates for the addition of ASP questions to baseline surveys. Furthermore these indicators are envisaged as drivers for improvement and alignment with adoption of best practices. Piloting, implementation and evaluation of the impact of the indicators constitute important next steps for the optimization of antimicrobial use.

Background

TATFAR

The Transatlantic Taskforce on Antimicrobial Resistance (TATFAR) was established in 2009 following a European Union-United States (EU-US) summit declaration that acknowledged the growing global threat of antimicrobial resistance (AMR). The initial goal of TATFAR was to define specific areas where enhanced cooperation between EU civil servants and US government employees, with input from invited non-governmental expert consultants, could have the most significant impact on addressing AMR. Three key areas were identified: 1) appropriate therapeutic use of antimicrobial drugs in the medical and veterinary communities; 2) prevention of both healthcare and community-associated drug-resistant infections; 3) strategies for improving the development of new antimicrobial drugs. A set of 17 recommendations to be met through formal collaboration was adopted in September 2011 (Annex A).[1]

TATFAR Recommendation 1: Develop structure and process indicators for hospital antimicrobial stewardship programs

The first TATFAR recommendation focuses on supporting appropriate use of antimicrobial drugs in human medicine through antimicrobial stewardship programs (ASPs). A workgroup coordinated by European Centre for Disease Prevention and Control (ECDC) and the US Centers for Disease Control and Prevention (CDC) was charged to **develop common structure and process indicators for hospital ASPs (TATFAR recommendation 1)**. Common indicators that are feasible and relevant to both EU Member States and US would allow for meaningful characterization and comparisons of antimicrobial stewardship efforts among different nations and healthcare systems. Antimicrobial stewardship refers to a coordinated program that implements interventions to ensure appropriate antimicrobial prescribing to improve clinical efficacy of antimicrobial treatment, to limit AMR and to prevent *Clostridium difficile* infections. Antimicrobial stewardship contributes to high quality and effective healthcare through decreasing unnecessary antimicrobial-related morbidity and mortality and limiting selective pressure to minimize development of resistance to currently effective antibiotics.

Indicators are measures that are used to monitor and assess the quality of a particular healthcare process. Such indicators evaluate the organizational aspects of the process, including material and human resources (structural indicators), the actual care provided (process indicators) and the effects of the process (outcome indicators).[2]

In March 2014, workgroup members began regular meetings to develop a manageable set of indicators that would describe the structure and functions of ASPs across a variety of healthcare systems Relevant stakeholders representing hospitals with various levels of ASP infrastructure, experience provided their expert opinion to build upon previous and ongoing stewardship indicators work in the EU and the US.

Objectives

The objective of the project was to develop a set of structure and process indicators for hospital ASPs that would be evidence-based and applicable to both the EU member states and the US and that would promote effective antimicrobial stewardship activities and allow comparisons at international levels.

Methodology

Developing a set of process and structure indicators

An initial list of indicators was developed through a review of previously developed structure and process indicators, antimicrobial stewardship surveys and guidelines in the EU and US.[3-8] Indicators assessing all domains of ASPs were included in the initial list. These domains were: Governance and Management; Human Resources; Laboratory; Information Technology; Education; Policies for Appropriate Use; Guidelines, Activities and Interventions; and Monitoring of Appropriate Use. The proposed indicators were derived from the Cochrane systematic review of interventions to improve antimicrobial prescribing practices for hospital patients by Davey et al.[9], as well as a review of studies published from 2006 to 2013 A modified Delphi method was utilized as a structured consensus method to facilitate equal expert participation and collaboration, as well as to make this international collaboration logistically feasible.[10] The rating criteria considered relevant for the purpose of development of common indicators that would make sense in very different settings were: feasibility, clinical importance and relevance to minimization of resistance. These chosen criteria drew on the practical experience of the invited experts, most of whom lead antimicrobial stewardship efforts in clinical settings. Moreover, due to the large variability of the systems in terms of both infrastructure and activities between and within the EU and the US, we aimed at two sets of indicators: a “core” set, including indicators that would be considered essential and necessary to characterize an ASP, and a “supplemental” set of optional indicators, that may be chosen based on the characteristics of the each healthcare system. The modified Delphi process was conducted

over a period of three months between March and May 2014. All rounds were completed online using Microsoft Word documents and email. Participants received feedback via email. Two group calls with members of the expert panels and a trained CDC moderator took place after Round 2 was complete. A group consensus meeting took place after the conclusion of Round 3 at the end of the modified Delphi process.

The modified Delphi expert panel

A multidisciplinary group of EU and US experts were recruited to participate in the modified Delphi process. Purposive sampling was used to ensure that those asked to participate had the necessary expertise and experience for the development of the indicators, knowledge about clinical and/or public health practice, and could represent diversity in geography and healthcare systems. Participants in the expert panel were selected by ECDC and CDC based upon expertise and willingness to participate in the entire process. European experts were selected to participate by ECDC and US experts were selected to participate by CDC. Experts selected were sent letters of invitation to participate in the modified Delphi process via email. All 20 experts invited to participate accepted the invitation, with representation from nine EU member states and six US states; two of the participants on the expert panel also served as ECDC/CDC coordinators for the project (DP and LP).

The modified Delphi rounds

First Round

The initial list consisted of 53 indicators based on previous process and structure indicators used in the EU and the US. The goal of the first round was to make the list of proposed indicators more focused and manageable for the rating in Rounds 2 and 3. Participants were asked to either "Retain" or "Remove" indicators based on their ability and feasibility to characterize ASPs. Participants were also encouraged to propose modifications and additional indicators during this first round of the modified Delphi process. Responses were summated for total "Retain" and total "Remove" ratings. The denominator was adjusted for non-responses. Based on the median results, a 60.0% "Retain" cut-off was used to determine the retention of an indicator for the next round. Additional notes, comments, and revisions suggested by experts were reviewed for all indicators. For indicators which did not meet the retention cutoff, notes, comments and revisions were consulted to inform possible revision and retention into the next round.

Second Round

There were 44 indicators carried forward to Round 2. Participants were asked to rate each of the structure and process indicators on a Likert scale from 1 to 9 according to the three criteria on domains of **Feasibility** (i.e., it would be possible to implement and measure this indicator at a facility level); **Clinical Importance** (i.e., this indicator is important to optimizing the appropriateness of antimicrobial prescribing); and **Relevance to Minimizing AMR** (i.e., this indicator is relevant to reducing the development of antimicrobial resistance), where 1 indicates 'Strongly Disagree' and 9 indicates 'Strongly Agree' for the three domain criteria. Participants were also asked for any additional comments, and suggestions.

Median, mean, minimum and maximum ranges were determined for each item. The denominator was adjusted for non-responses. Additional notes, comments, and revisions suggested by experts were reviewed for all indicators to determine possible revision and retention into the next round. For each indicator, an overall median score was created from summations of the medians for feasibility, clinical importance, and relevance to minimizing AMR for each indicator. Because of low scores in the relevance to minimizing AMR domain, indicating lack of evidence for an effect of ASPs on antimicrobial resistance a modified median score was also determined as the sum of the medians for only feasibility and clinical importance for each indicator (Possible range 2-18).

Panel agreement was measured using the interpercentile range adjusted for symmetry (IPRAS) agreement score described in RAND/UCLA appropriateness method.[11] Instead of using RAND/UCLA 70/30 interpercentile range (IPR), a 90/10 IPR was used for better discriminating power. Based on the modified median scores for feasibility and clinical importance, a cut off of 14 was determined as the threshold for retaining an indicator, corresponding to individual indicators with median ratings in the upper third of the Likert scale (7-9). Participants were provided feedback on the aggregate, compiled responses and asked to participate in a group call to further discuss indicators with borderline scores and low agreement or disagreement.

Group Call

After Round 2 was complete and participants had received feedback, a group conference call to discuss questions, comments, and concerns related to the rating process was offered twice to maximize participation by accommodating the experts' schedules. A CDC behavioral scientist trained in group facilitation (RS) moderated both calls using the same semi-structured script to facilitate discussion. The one-hour call began with an overview of the scope and purpose of the TATFAR project. Questions and logistical information regarding the next round of input and the in-person meeting were addressed. Participants were given an overview of the methodology used during the second round including an overview on the RAND/UCLA appropriateness methods for the IPRAS score. Indicators with low agreement (IPRAS-IPR = 0-2) or disagreement (IPRAS < IPR) for the same indicator, borderline modified median scores (12-14) and modified median scores >14 with median ratings for clinical importance <7 were further discussed at the group call.

Third Round

In the third and final round, participants were asked to rate the remaining 38 structure and process indicators according to the two criteria below on a Likert scale from 1 (Strongly Disagree) to 9 (Strongly Agree) on the domains of **Feasibility** and **Clinical importance**. Participants were also asked to rate the **necessity** of each item (i.e., This indicator should be included as either a Core or Supplemental indicator, or removed).

Median, mean, minimum and maximum ranges were determined for each item. The denominator was adjusted for non-responses. An overall median score was created from summations of the individual medians for feasibility and clinical importance (possible range 2-18). The change in median scores (delta) from Round 2 to Round 3 was calculated for each indicator. The necessity ratings were presented as percentages of the participants who rated each indicator as Core, Supplemental, or Remove. Two options, "strict" and "liberal", were used to suggest cutoff points for including the indicator as Core, Supplemental, or removing the indicator. Cut-off points were based on the median split.

Strict criteria: If the remove "X" percentage was ≥ 20.0%, then the indicator was removed. If core "C" percentage was ≥ 70.0%, then that indicator was retained as a Core Indicator. The remaining indicators were retained as a Supplemental Indicators.

Liberal criteria: If the remove "X" percentage was ≥ 20.0%, then the indicator was removed, unless the supplemental "S" percentage was >=50% for the same indicator, then that indicator was retained as supplemental. If the core "C" percentage was ≥ 50.0%, then that indicator was kept as a Core Indicator. The remaining indicators were retained as a Supplemental Indicators.

Additional notes, comments, and revisions suggested by experts were reviewed for all indicators to determine possible revision and retention. Final decisions regarding classification of indicators were made by consensus at the in-person meeting.

The consensus meeting: Defining a final set of process and structure indicators

On June 18, 2014, an in-person meeting was held to review the ratings, expand upon comments from the previous rounds of input and collaboratively determine inclusion of indicators as Core and Supplemental. Thirteen of the experts who participated in the modified Delphi process (65%), representing nine countries attended; those who could not were forwarded the outcomes as a draft final report for comment. After briefly reviewing the background and goals of TATFAR, participants were reminded the objective was to develop a manageable number of indicators that could characterize and differentiate among ASPs, integrate with other assessment tools and be compared among different healthcare systems. The project coordinators (DP from ECDC and LP for CDC) facilitated a guided discussion informed by the results of the final round of input, the strict and liberal criteria for inclusion, and comments from all previous rounds to achieve consensus on the remaining 38 indictors being classified as Core or Supplemental, or be removed.

Results

First round

In Round 1 of the modified Delphi Process, participants were asked to choose to "Retain" or "Remove" 53 proposed structure and process indicators. There was a 100% response rate (20/20) from the expert group. Of the 53 proposed indicators, 36 were retained (10 with revision) and 17 were removed (Table 1).

Experts noted that proposed indicators were mostly focused on ASP staffing and activities (structure), but did not capture the extent of activity performance (process). In response, eight process indicators were added to the second round of rating (e.g., Does your facility measure the number of antimicrobial prescriptions that are consistent with the local treatment recommendations? If YES, are antimicrobial prescriptions compliant with facility-specific guidelines in >95% of sampled cases in your facility?). The threshold of 95% was chosen based on current indicators at national level. In response to comments, two separate indicators asking if there is an infection preventionist and a hospital epidemiologist on the stewardship team were merged together. Table 2 summarizes the results of Round 1.

Second round

The response rate for Round 2 was 95% (19/20). The overall median score for feasibility, clinical importance, and relevance to resistance was 7.0, 8.0, 6.0, respectively (Table 3). Indicators related to cumulative susceptibility reports and guidelines were rated high for both feasibility and clinical importance; whereas those related to governance and management of ASPs and policies were rated higher for feasibility than clinical importance, and indicators related to ASP activities were rated higher for clinical importance than feasibility. For relevance to minimizing AMR, no indicator had a median score higher than 7 (on a 1-9 Likert scale) and there was low agreement on the scoring of relevance to minimizing AMR among the experts. Given the low scores and high disagreement, rating of relevance to minimizing AMR was not repeated in the final round. An overall modified median score was calculated by suming the median scores for feasibility and clinical importance and excluding relevance to minimizing AMR(Possible range 12-18). The median, mean, range, and overall median scores for each indicator were provided to all experts prior to a group call.

Fourteen (70%) experts participated in either one of two group calls to discuss divergent responses and comment on the proposed indicators. The first call had representation from seven EU countries and three US states and the second call had representation from one EU country and two US states. After an introduction and overview of the methods and results from Round 2, the discussion began with clarification of the "feasibility" rating, which may have been operationalized differently by raters. Participants remarked that agreement or disagreement in feasibility ratings might be related to differences in healthcare settings and systems more than to discordant expert opinion. The domain of Variation in the Information Technology (IT) capacity among healthcare systems (e.g., technical

equipment, electronic systems) led to discussion on whether or not to remove the IT indicators or refocus the domain in more general terms. Some experts expressed that IT indicators are drivers for improvement and should be retained to track growth in the future, even if all nations or systems may not yet have advanced IT capacity for ASPs. Feedback was sought on the measurement indicators, Days of Therapy (DOT) and by Defined Daily Dose (DDD). Because DDD is used in the European Union and DOT is used in the US, experts recommended combining these two indicators into a single indicator and asking about use of either one of these metrics.

After analysis of the Round 2 ratings and input from the expert group calls, 37 of the 44 proposed structure and process indicators were retained (26 as proposed and 11 with minor revisions)(Table 5). An indicator that previously combined assessment of compliance with community-acquired pneumonia (CAP) and urinary tract infection (UTI) guidelines was divided into two separate indicators, making a total of 38 indicators advancing to Round 3. The following indicators were removed: two human resources indicators (involvement of IT staff and quality improvement staff); two indicators related to IT (presence of an IT system for prescribing and its application to clinical decision support for antimicrobial prescribing); the indicator on routine use of antimicrobial order forms and the indicator about dedicated time for clinical teams to review antimicrobial orders. For the proposed process indicators 95% threshold was replaced by 80% after the experts indicated that the former threshold was not practical.

Third round

The response rate for the third round was 95% (19/20 experts). The average median scores for feasibility and clinical importance were 7.5 (6-9) and 7.8 (6-9), respectively. The average combined median score for feasibility and clinical importance was 15.0 (5-18). A summary of the Round 3 results are presented in Table 6. The indicators with highest agreement for feasibility among participants (as determined by IPRAS score) were the identification of a defined ASP, formulary, and surgical prophylaxis guidelines; whereas the indicators with lowest agreement on feasibility were process indicators that assessed if ">80% of sampled cases" had a documented indication or followed facility-specific guidelines (Table 7). For clinical importance, the indicators on physician and pharmacist leadership, information technology capability, facility-specific treatment guidelines, and post-prescription review and feedback had high agreement in scoring among participants; whereas the human resources indicators not related to leadership,

discontinuation of specified antimicrobial prescriptions after a pre-defined duration, and the capture of indication for treatment in the medical record had the lowest agreement scores.

Using the *strict* criteria based on the percent of experts rating the necessity of an indicator as "Core", "Supplemental" or to "Remove", 7 indicators would be considered Core indicators, 21 indicators would be Supplemental, and 9 indicators would be removed (Table 8). The core indicators under the *strict* criteria were:

1. Does your facility have a formally defined antimicrobial stewardship program for ensuring appropriate antimicrobial use? (78.9% experts rated this as a Core indicator)
2. Is an antimicrobial stewardship team available at your facility? (83.3%)
3. Is there a physician identified as a leader for stewardship activities at your facility (88.9%)
4. Is there a pharmacist responsible for working to improve antimicrobial use at your facility? (76.5%)
5. Does your facility produce a cumulative antimicrobial susceptibility report at least annually? (73.7%)
6. Is there a formal procedure for a physician, pharmacist, or other staff member to review the appropriateness of an antimicrobial after 48 hours from the initial order (post-prescription review)? (72.2%)
7. Does your facility monitor antimicrobial use by grams [Defined Daily Dose (DDD)] or counts [Days of Therapy (DOT)] of antimicrobial(s) by patients per day? (89.5%)

Most of the indicators that were contingency questions (i.e., If YES,...) met the strict criteria to be removed. Using the liberal criteria, 14 Core and 22 Supplemental indicators would be retained and 2 indicators would be removed (Table 8).

Expert consensus meeting following third round

At the final in-person meeting, the 13 experts in attendance were presented the above seven indicators which were deemed to be Core Indicators by ≥ 70.0% of participants in the third round of rating. There was consensus that these indicators should be Core Indicators in the assessment of hospital ASPs, with minor revisions to clarify definitions and capture accountability of stewardship efforts.

The moderators focused attention first on indicators that >20% of the experts recommended for removal in the third round of input. A majority of experts at the meeting recommended removal of the indicators that assessed compliance "with facility-specific guidelines in >80% of sampled cases" for

facility-specific CAP and UTI guidelines for the following reasons: disagreement on feasibility; collection of such data would increase workload; accurate quantification would be challenging; and the indicator may not reflect appropriateness of non-guideline concordant clinical decisions. Similarly, documentation of an indication for treatment in ">80% of sampled cases" was rejected. Some experts noted that monitoring other aspects of prescribing antimicrobials may be a more effective use of ASP time than attempting to quantify the compliance. In contrast to not recommending the assessment of compliance with CAP and UTI, monitoring of surgical prophylaxis as a Core indicator was strongly advocated for by EU participants. The feasibility of this indicator is supported by the fact it is already being measured in the US through Surgical Care Improvement Project measures.[12, 13] Therefore, the group recommended that audit or review of surgical prophylaxis choice and duration be reclassified from a Supplemental to a Core indicator and the quantification of guideline-concordant surgical prophylaxis becomes a Supplemental indicator. A majority of the experts recommended two more indicators for removal: 1) "a current susceptibility report has been distributed to prescribers" because this indicator does not assess the application of this information to patient care nor the ability of prescribers to interpret it; and 2) "does your facility have a defined formulary of antimicrobial agents?" because the term *formulary* was found to have different interpretations and diversity in prescribing may be considered an approach to prevention of antimicrobial resistance.[14-16]

The remaining indicators, those which were neither deemed Core nor removed at this point in the meeting, were presented and the expert group was asked to identify and discuss whether any of these indicators should be added to the Core Indicator list. Themes that emerged were necessity of support and accountability for stewardship activities, therefore questions related to an organizational structure responsible for antimicrobial stewardship, salary or dedicated time, and information technology support of activities were classified as Core. Core indicator 6 specified salary support to differentiate a higher level of support than mere inclusion of ASP responsibilities in job duties (i.e., Supplemental indicator 5) without salary support. When discussing an "antimicrobial stewardship team", experts' input reflected the importance of coordinated efforts of multidisciplinary staff, but also acknowledged that the specific composition of teams was highly variable by healthcare systems and among facilities within the same system. Therefore, indicators that asked about specific staff roles were retained as Supplemental rather than becoming Core indicators. Policies and practices added as Core indicators were: a general question on the presence of facility-specific treatment recommendations (recommendations for specific clinical scenarios such as surgical prophylaxis, CAP and UTI remained supplemental); a policy for documentation

of an indication coupled with monitoring of that policy, however experts did not endorse setting a threshold (e.g., >80% compliance); and pre-authorization of specified antimicrobial agents. Two indicators related to monitoring and feedback were moved to Core indicators: 1) review of surgical prophylaxis as discussed earlier; and 2) direct communication of antimicrobial audits or reviews to prescribers. Active feedback was felt to be more effective in changing prescribing practices compared to passive education of prescribers, which was therefore not included in the final indicator list. An annual report on antimicrobial stewardship was also included as a Core indicator as a marker of overall organization and function of the ASP. The annual report indicator and the indicator related to information technology capability were seen as "reach" goals – indicators that may be advanced for the current state of ASPs in a majority of facilities but important to differentiate ASPs and set a target for advanced achievement. Altogether, after the discussion, ten more indicators were added to the seven indicators identified as Core at the start of the meeting. At the conclusion of the in-person meeting, there were 17 Core indicators and 16 Supplemental indicators.

Final set of Core and Supplemental indicators for hospital antimicrobial stewardship programs

CORE Indicators for hospital antimicrobial stewardship programs		
Infrastructure	**1.**	Does your facility have a formal **antimicrobial stewardship program** accountable for ensuring appropriate antimicrobial use?
	2.	Does your facility have a **formal organizational structure** responsible for antimicrobial stewardship (e.g., a multidisciplinary committee focused on appropriate antimicrobial use, pharmacy committee, patient safety committee or other relevant structure)?
	3.	Is an antimicrobial stewardship **team** available at your facility (e.g., greater than one staff member supporting clinical decisions to ensure appropriate antimicrobial use)?
	4.	Is there a physician identified as a **leader** for antimicrobial stewardship activities at your facility?
	5.	Is there a **pharmacist** responsible for ensuring appropriate antimicrobial use at your facility?
	6.	Does your facility provide any **salary support** for dedicated time for antimicrobial stewardship activities (e.g., percentage of full-time equivalent (FTE) for ensuring appropriate antimicrobial use)?
	7.	Does your facility have the **IT capability** to support the needs of the antimicrobial stewardship activities?
Policy and Practice	**8.**	Does your facility have **facility-specific treatment recommendations** based on local antimicrobial susceptibility to assist with antimicrobial selection for common clinical conditions?
	9.	Does your facility have a written policy that requires prescribers to **document an indication** in the medical record or during order entry for all antimicrobial prescriptions?
	10.	Is it routine practice for specified antimicrobial agents to be approved by a physician or pharmacist in your facility (e.g., **pre-authorization**)?
	11.	Is there a formal procedure for a physician, pharmacist, or other staff member to review the appropriateness of an antimicrobial at or after 48 hours from the initial order (**post-prescription review**)?
Monitoring and Feedback	**12.**	Has your facility produced a **cumulative antimicrobial susceptibility report** in the past year?
	13.	Does your facility **monitor if the indication** is captured in the medical record for all antimicrobial prescriptions?
	14.	Does your facility audit or **review surgical antimicrobial prophylaxis** choice and duration?
	15.	Are results of antimicrobial audits or reviews **communicated directly** with prescribers?
	16.	Does your facility **monitor antimicrobial use** by grams [Defined Daily Dose (DDD)] or counts [Days of Therapy (DOT)] of antimicrobial(s) by patients per days?
	17.	Has an **annual report** focused on antimicrobial stewardship (summary antimicrobial use and/or practices improvement initiatives) been produced for your facility in the past year?

SUPPLEMENTAL Indicators for hospital antimicrobial stewardship programs

Infrastructure	**S1.** Does your facility have a named **senior executive officer with accountability** for antimicrobial leadership? (Core 3) Is an antimicrobial stewardship team available at your facility (e.g., greater than one staff member supporting clinical decisions to ensure appropriate antimicrobial use)? **S2.** If YES, Is an **infection preventionist or hospital epidemiologist** involved in stewardship activities? **S3.** If YES, Is a **microbiologist (laboratory staff)** involved in stewardship activities? **S4.** Is clinical **infectious disease (ID) consultation** available at your facility? (Core 4) Is there a physician identified as a leader for antimicrobial stewardship activities at your facility? **S5.** If YES, are stewardship **duties included in the job description** and/or annual review? **S6.** If YES, has this **physician had specialized training** in infectious diseases, clinical microbiology and/or antimicrobial stewardship? (Core 5) Is there a pharmacist responsible for ensuring antimicrobial use at your facility? **S7.** If YES, has this **pharmacist had specialized training** in infectious disease management or stewardship?
Policy and Practice	(Core 9) Does your facility have facility-specific treatment recommendations based on local antimicrobial susceptibility to assist with antimicrobial selection for common clinical conditions: **S8.** If YES, for **surgical prophylaxis**? **S9.** If YES, for **community-acquired pneumonia**? **S10.** If YES, for **urinary tract infection**? **S11.** If YES to any of the clinical conditions above, are these **treatment recommendations easily accessible** to prescribers on all wards (printed 'pocket guide' or electronic summaries at workstations)? (Core 11,12) Are any of the following actions implemented in your facility to improve antimicrobial prescribing? **S12.** Standardized criteria for changing from **intravenous to oral** antimicrobial therapy in appropriate situations? **S13.** **Dose optimization** (pharmacokinetics/pharmacodynamics) to optimize the treatment of organisms with reduced susceptibility? **S14.** Discontinuation of specified antimicrobial prescriptions after a **pre-defined duration**?
Monitoring	**S15.** Does your facility measure the **percentage of antimicrobial prescriptions that are consistent with the local treatment recommendations** for either UTI or CAP? (Core 15) Does your facility audit or review surgical antimicrobial prophylaxis choice and duration? **S16.** If YES, are antimicrobial prescriptions for **surgical prophylaxis compliant with facility-specific guidelines** in >80% of sampled cases in your facility?

Summary: Response to TATFAR Recommendation 1

Based on available evidence, standardized methodology, and professional experience, an international group of experts in antimicrobial stewardship developed a set of core and supplemental indicators to characterize the infrastructure and activities of hospital ASPs. The final set of 17 core and 16 supplemental indicators reflects the input and agreement of clinical and public health professionals with diverse perspectives and experiences in antimicrobial stewardship and indicator development. This activity addresses the TATFAR recommendation to develop common structure and process indicators for hospital ASPs. It also achieves intangible TATFAR goals of increased EU-US awareness of activities and capabilities to address antimicrobial resistance and an exchange of ideas and best practices in antimicrobial stewardship.

Comparison to previously developed ASP assessments

The selection of candidate indicators built upon the development and implementation of similar efforts to assess the ASP organization and activities in the hospital setting. In **France**, a standardized questionnaire has been used to assess antibiotic policy in hospitals at the national level since 2006 and was updated in 2013. Annual reporting from individual facilities to the Ministry of Health has been mandated since 2007, from which a composite score for antibiotic policies ("ICATB" indicator) based on 13 questions is calculated for public reporting and ASP evaluation.[17] To take into account progress made and identification of new key elements for ASP in the French context, an updated version of ICATB indicator is being used in 2014, comprising 27 questions to calculate a score reflecting ASP implementation. Analysis of this data has been able to show the growth in ASPs and the association of antibiotic policy and antibiotic consumption.[5, 18] In 2006, the European Commission sponsored the **Antibiotic Strategy International** project to develop and pilot ASP structure indicators in four European Union countries. This project identified 58 indicators, including 10 key structure indicators, to assess the activities and capacity of ASPs.[3] The **UK** has had an Antimicrobial Stewardship Subgroup as part of the Antimicrobial Resistance and Healthcare-Associated Infection Advisory Committee since 2003.[19] In 2010, an Antimicrobial Stewardship Self Assessments Tool (ASAT) became available online followed by the dissemination of ASP guidance for primary care and hospitals entitled *Start Smart, Then Focus* in 2011. [6, 19] The tool asks a series of questions on antimicrobial management, policies, practices and education, which are given a weighted scoring. This allows Trusts to identify areas for improvement or focus and deploy resources as appropriate as part of their integrated ASP. The tool is available to all NHS

Trusts in the UK and is currently being redeveloped for easier access via a web portal. In **Germany** where a formal hospital ASP training program started in 2010 a recently released national guideline for hospital ASP recommends to use at least 3 structural and 3 process of care quality indicators out of list of 21 structural and 21 process of care indicators that were evaluated and agreed upon among a large panel of hospital physicians and pharmacists having completed the ASP training.[20, 21] In the **US,** there have been surveys on ASPs conducted by some state health departments and large healthcare systems. [22-25] These efforts provided insight into stewardship infrastructure and practices, but were not comparable. To support a more standardized assessment, CDC released a checklist of core elements for hospital ASPs in 2014.[26]

Experts that were involved in the development, implementation, and analysis of many of these ASP assessment efforts contributed greatly to the TATFAR indicators by sharing their experience regarding which indicators were most feasible, useful, and applicable to ASP evaluation. By design, the TATFAR core indicators are a smaller number of items that correspond with each of these efforts such that items on previously developed and implemented assessment tools could be analyzed, shared, and compared. There are similarities and differences among these tools that were developed individually, but share a common goal of measuring ASPs in hospital settings. A comparison of the TATFAR antimicrobial stewardship indicators to previously developed indicators are summarized in Tables 9 and 10.

Potential for implementation

Implementation of the TATFAR-developed core indicators in multiple nations would contribute to a comprehensive, comparative description of infrastructure, policies, and practices of ASPs internationally. These findings could, in turn, lead to an understanding of best practices of ASPs through further investigation into the relation of different ASP approaches to antimicrobial use and resistance. Current public health surveillance systems or special studies that may be candidates for the addition of ASP questions to baseline surveys are the European Surveillance of Antimicrobial Consumption Network (ESAC-Net) administered by ECDC, the National Healthcare Safety Network (NHSN) administered by the US CDC , or point prevalence surveys of antimicrobial use done by both ECDC and CDC. At the national or state level the indicators could be incorporated into surveys such as the aforementioned assessments in EU member states, or assessments of facilities within large health systems within the US, such as the Veterans Health Administration and Healthcare Corporation of America. Given the international scope

of this task, the specific wording of indicators may require modification to be best understood, relevant, and align with currently administered assessments. There will be a need to balance flexibility versus consistency in definitions of the indicators and to accept the similar indicators that are used in existing surveys. Instructions on the target audience of respondents intended to complete the assessment along with accompanying interpretive guidance should be given to ensure proper administration and valid responses by each country willing to use these indicators. To prove the validity, reliability, and feasibility of these TATFAR indicators, a multi-site demonstration project at country or multi-state level under the auspices of TATFAR is a needed next step to confirm applicability and further refine the indicators. In addition, countries and systems that are interested in comparing data can collaborate on a protocol to share data, align timelines, and plan analyses.

Strengths and limitations

The modified Delphi process to solicit input on the feasibility and clinical importance of each proposed indicators ensured equal representation among the expert group members. The strengths of this approach are that it is a widely used, standardized method in healthcare quality indicator development that allows for input and collective consensus across diverse geographic locations. Participants in the expert group were provided feedback after each round and given the opportunity for meaningful exchange on the interpretation and reasoning of each other's responses. Potential limitations were that all rating rounds and meetings were conducted in English which may have created a cultural bias or limited the participation of those who did not feel most comfortable exchanging views in English. In addition, the self-reported responses could be biased to personal and/or institutional experience. However, expert input based on experience in the field of AS is informative where there is limited high-quality evidence and results are difficult to interpret and extrapolate. In addition, the in-person meeting contributed greatly to developing a common understanding and reaching final consensus. Although the final meeting at which key decisions were made did not include all participants and judgments from the group in attendance may not have been representative of the entire group, all experts were given an opportunity to review and comment on the outcome of the meeting. Finally, the literature review informing the initial selection of indicators was not exhaustive and was highly dependent on a systematic review which was being updated at the time. The evidence base for individual indicators is limited and challenging to establish, especially the relation of infrastructure (e.g., staffing, organizational

structure) to activities and ultimately outcomes, because most stewardship interventions reported in the literature are multifaceted and involve a combination of clinical practice factors to attain results.

Strengths of the process were that the highly convergent scores reflected consensus among the expert group and the focus on feasibility and clinical importance of each indicator ensured that the final indicators are likely to be practical in diverse settings and meaningful to quality of care. In addition, there were multiple opportunities for clarification and revision through the reiterative process of rating and soliciting comments. A majority of the final indicators are structure rather than process indicators, which we believe reflects both the critical importance of staffing, baseline capacity, and support for ASPs as well as the early stage of ASP implementation in healthcare. Although some experts expressed that specific measurements of adherence (e.g., what percent of antimicrobial prescriptions are compliant with facility-specific guidelines?) may not be feasible or the most efficient use of antimicrobial stewardship team time, some institutions have successfully implemented such measures,[27] thus such indicators may become more feasible and relevant as ASPs advance.

Ensuring appropriate antimicrobial use is recognized as a key strategy to addressing antimicrobial resistance and a primary goal of TATFAR. In the modified Delphi process, ratings on relevance to minimizing AMR among the experts were highly divergent and reflected that, although individual indicators may impact antimicrobial resistance in certain settings, the research evidence on the impact of many of the proposed indicators on minimizing AMR is sparse. Establishing the relationship of ASPs and interventions on antimicrobial resistance is challenging because, in addition to selective pressure, other factors, such as underlying resistance in the community and transmission among patients, impact the development of resistance. The time lag and relationship of changes in hospital antimicrobial use to resistance patterns are inconsistent and not recommended to reliably evaluate ASP interventions.[28] There are, however, other markers of ASP success. Measurement of antimicrobial use along with other patient-focused outcomes is critical to demonstrate impact of ASPs and should be considered. Outcome indicators for ASPs were not evaluated as part of this project because establishment of standards for measuring antimicrobial use in hospital settings is the objective of a separate TATFAR recommendation.

Conclusion

The Core and Supplemental indicators developed through a modified Delphi process represent features of ASPs that a multinational group of highly experienced experts deemed to be essential elements to ensuring appropriate use of antimicrobials in the hospital setting. The collaborative development of these indicators for TATFAR contributed to mutual understanding of the capacity and vision for hospital ASPs in member states of the EU and the US. Future directions to advance the field include integration of prescribing practice improvement into infection control, fostering accountability for both facilities and prescribers, and understanding behavioral factors that influence prescribing practices. A better understanding of effective ASP practices will stimulate replication or adaption of successful interventions from one setting into another, including across the continuum of care into outpatient and long-term care settings. The selection and recommendation of structure and process indicators contributed to defining clear expectations for hospital ASPs, but will not directly impact practice without continued refinement through piloting, implementation and, eventually, formal evaluation of impact on patient outcomes and antimicrobial resistance.

Annexes (Appendices)/Tables

A. TATFAR recommendations for future collaboration between the EU and the US (2011)

TATFAR recommendations for future collaboration	
I. Appropriate therapeutic use in human and veterinary medicine	
Opportunity for collaboration	**Recommendation**
Antimicrobial stewardship in human medicine	Develop common structure and process indicators for hospital antimicrobial stewardship programmes
Surveillance of antimicrobial use in human and veterinary communities	Convene a joint EU/US working group to propose standards for measuring antimicrobial use in hospital settings
	Collaborate in collection of data on sales and use of veterinary antimicrobials in food-producing animals
Risk analysis on foodborne antimicrobial resistance	Collaborate on implementation of the Guidelines for Risk Analysis of Foodborne Antimicrobial Resistance prepared by Codex Alimentarius
	Enhance information sharing on approaches to promoting appropriate use in veterinary communities
Campaigns to promote appropriate use in human medicine	Establish an EU–US working group to assess the evidence for effectiveness of communications tools in promoting behaviour change to increase appropriate use and to develop joint priorities
II. Prevention of drug-resistant infections	
Surveillance of drug resistance	Consultation and collaboration on a point-prevalence survey for healthcare-associated infections (HAIs)
	Develop a process for transatlantic communication of critical events that may signify new resistance trends with global public health implications
	Encourage efforts to harmonise, to the extent possible, epidemiological interpretive criteria for susceptibility reporting of bacterial isolates across surveillance programmes in the US and EU
Prevention strategies	Convene a workshop bringing together public health experts from the US and EU to develop consensus evaluation tools for hospital infection control programmes
	Develop a transatlantic strategy to facilitate vaccine development for HAIs
III. Strategies for improving the pipeline of new antimicrobial drugs	
Incentives to stimulate the development of new antibacterial drugs in human medicine	Policymakers should strongly consider the establishment of significant incentives to stimulate antibacterial drug development
Research to support the development of new antibacterials	Increase communication between US and EU research agencies to identify common scientific challenges that may represent opportunities for collaboration
	Publicise funding opportunities to EU, US research communities
Regulatory approaches for antibacterial products	FDA and EMA intend to discuss ways to facilitate the use of the same clinical development programme to satisfy regulatory submissions to both Agencies
	Establish regular meetings between FDA and EMA to discuss common issues in antibacterial drug development and regulation
	Exchange information on possible approaches to drug development for bacterial diseases where limited drugs are available

B. Rating Criteria for Second and Third Rounds

Feasibility: It would be possible to implement **and** measure this indicator at a facility level.

1 = Strongly disagree (cannot be implemented **and** measured regardless of resources available)

5= Neutral (not certain this can be implemented **and** measured, increase in available resources would be needed)

9 = Strongly agree (definitely feasible, this can be implemented **and** measured with resources presently available)

Clinical importance: This indicator is important to optimising the appropriateness of antimicrobial prescribing.

1 = Strongly disagree (unlikely to have impact on appropriate prescribing, basic research needed)

5= Neutral (potential impact on a majority of patients, indeterminable research evidence available)

9 = Strongly agree (potential for widespread impact, confident about effectiveness, no further research needed)

Relevance to minimizing resistance: This indicator is relevant to reducing the development of antimicrobial resistance.

1 = Strongly disagree (unlikely to have an impact on reducing antimicrobial resistance, basic research needed)

5= Neutral (may impact on resistance in a certain settings, indeterminable research evidence available)

9 = Strongly agree (potential for widespread impact on reducing resistance, no further research needed)

C. Summary of results for modified Delphi process rounds

Table 1. Round 1 Results: Remove or Retain

No	Indicator	Retain	%	Result
	Structure indicators			
	Governance and management			
1	Does your facility have a formal mandate for ensuring appropriate antimicrobial use (antimicrobial stewardship)?	14	70.0	Retain
2	Does your facility have a multidisciplinary committee focused on appropriate antimicrobial use? (e.g., antimicrobials stewardship team)	17	85.0	Retain
3	If YES, Does this stewardship team meet regularly (at least twice a year)?	8	40.0	Remove
4	If YES, Are minutes from the stewardship team meetings sent to executive leadership?	8	40.0	Remove
5	Has an annual report focused on antimicrobial stewardship (summary antimicrobial use and/or practices improvement initiatives) been produced for your facility in the past year?	16	80.0	Retain
6	Does your facility receive any budgeted financial support for antibiotic stewardship activities (e.g., support for salary, training, or IT support)?	17	85.0	Retain
	Human Resources			
7	Is clinical infectious disease (ID) consultation available at your facility?	14	70.0	Retain
8	Is a full-time pharmacist available on site at your facility?	11	55.0	Remove
9	Does your facility perform the majority of its microbiology testing on site?	7	35.0	Remove
10	Is there a physician identified as a leader for stewardship activities at your facility?	20	100.0	Retain
11	If YES, does this physician receive any direct salary support for this role?	15	75.0	Retain
12	If YES, Is this physician trained in infectious diseases?	13	68.4	Retain
13	Is there a pharmacist leader responsible for working to improve antibiotic use at your facility?	16	80.0	Retain
14	If YES, are stewardship duties included in the job description and/or annual review?	11	55.0	Remove
15	If YES, has the lead pharmacist had specialized training in infectious disease management or stewardship?	12	60.0	Retain
	Are any of the staff below members of the stewardship team at your facility?			
16	Microbiologist (Laboratory)	15	79.0	Retain
17	Infection preventionist	14	75.0	Retain
18	Hospital epidemiologist	10	60.0	Remove (merged with 17)
19	Information Technology (IT) staff member	13	70.0	Retain
	Laboratory			
20	Does your facility produce an antibiogram (cumulative antimicrobial susceptibility report) at least annually?	19	95.0	Retain
21	Is antimicrobial selection for the guidelines informed by the current antibiogram?	11	57.9%	Remove

	Information Technology			
	Which of the following information technology (IT) systems are currently available and used in your facility:			
22	Electronic medical or health record?	10	50.0	Remove
No	**Indicator**	**Retain**	**%**	**Result**
23	IT system for prescribing (Computerized Order Entry)?	15	75.0	Retain
24	IT system for medication dispensing or administration?	8	40.0	Remove
25	IT capability to electronically link pharmacy, laboratory, and medical records?	13	65.0	Retain
26	Does the computer order entry system support clinical decision making for prescribing antimicrobial agents?	14	70.0	Retain
	Education			
27	Has your facility given an educational presentation on improving antibiotic prescribing within the last year?	11	55.0	Remove
28	Do prescribers ever receive direct, personalized communication about how they can improve their antibiotic prescribing?	17	85.0	Retain
29	Has a current antibiogram been distributed to prescribers at your facility in the last year?	14	73.7	Retain
30	Does your facility have a training strategy to promote appropriate antimicrobial use?	11	55.0	Remove
31	Are patients or their legal guardian routinely given information about antimicrobials they have received (indication, course length, possible risks, what to do if side effects develop at home etc.)?	3	15.0	Remove
	Process indicators			
	Policies for appropriate use			
32	Does your facility have a defined formulary of antimicrobial agents?	16	80.0	Retain
33	Is there a written policy for approval of new antimicrobial agents onto the formulary?	5	26.3	Remove
34	Does your facility have a written policy that requires prescribers to document in the medical record or during order entry a dose, duration, and indication for all antibiotic prescriptions?	18	90.0	Retain
	Guidelines			
	Does your facility have facility-specific treatment recommendations, based on national guidelines and local susceptibility, to assist with antibiotic selection for the following common clinical conditions:			
35	Surgical prophylaxis	18	90.0	Retain
36	Community-acquired pneumonia	16	80.0	Retain
37	Urinary tract infection	16	80.0	Retain
38	If YES to any, are these treatment recommendations reviewed annually?	10	50.0	Remove
39	If YES to any, are these treatment recommendations easily accessible to all wards and prescribers (printed 'pocket guide' or electronic summaries at workstations)	18	94.7	Retain
	Protocols			
	Are any of the following actions implemented in your facility to improve antibiotic prescribing?			
40	Automatic changes from intravenous to oral antibiotic therapy in appropriate situations?	15	79.0	Retain

41	Dose optimization (pharmacokinetics/pharmacodynamics) to optimize the treatment of organisms with reduced susceptibility?	14	70.0	Retain
42	Automatic alerts in situations where therapy might be unnecessarily duplicative?	9	43.4	Remove
43	Time-sensitive automatic stop orders for specified antibiotic prescriptions?	13	65.0	Retain
No	**Indicator**	**Retain**	**%**	**Result**
	Activities and interventions			
44	Do prescribers in your facility routinely use antimicrobial ordering forms (printed or electronic)?	13	65.0	Retain
45	Is it routine practice for specified antimicrobial agents to be approved by a physician or pharmacist prior to dispensing (pre-authorization) in your facility?	18	90.0	Retain
46	Is it routine practice for a physician or pharmacist to review incoming prescriptions for specified antimicrobial agents (pre-authorization)?	9	45.0	Remove
47	Is there dedicated time during which the clinical team reviews antimicrobial orders for their assigned patients (antimicrobial ward rounds)?	13	65.0	Retain
48	Is there a formal procedure for a physician or pharmacist or other staff member to review the appropriateness of an antimicrobial after 48 hours from the initial order (post-prescription review)?	16	80.0	Retain
49	Are results of antimicrobial audits or reviews provided directly to prescribers through in-person, telephone, or electronic communication?	17	85.0	Retain
	Monitoring appropriate use			
	Does your facility monitor antibiotic use (consumption) at the unit and/or facility wide level by one of the following metrics:			
50	By counts of antibiotic(s) administered to patients per day (Days of Therapy; DOT)?	15	79.0	Retain
51	By number of grams of antibiotics used (Defined Daily Dose, DDD)?	19	95.0	Retain
52	By direct expenditure for antibiotics (purchasing costs)?	11	55.0	Remove
53	Are adverse drug events associated with antimicrobials reported to an antimicrobial stewardship team?	11	55.0	Remove

Table 2. Summary Round 1 Results

Results	#	(%)
Indicators rated in round 1	53	
Indicators Retained without Revision	26	(49.0%)
Indicators Retained and Revised	10	(18.9%)
Indicators Removed	17	(32.1%)
Indicators Added	8	
Total Indicators remaining after round 1	44	

Table 3. Round 2 Median Score Results: Rating on Feasibility, Clinical Importance and Relevance to Minimizing Resistance

	INDICATORS	Feasibility Median (Mean, Range)	Clinical Importance Median (Mean, Range)	Relevance to Minimizing Resistance Median (Mean, Range)	OVERALL MEDIAN SCORE (max 27)	MODIFIED MEDIAN SCORE* (Max 18)
	Governance and Management					
1	Does your facility have a formally defined antimicrobial stewardship program for ensuring appropriate antimicrobial use?	9 (7.9, 2-9)	8 (8.1, 5-9)	7 (6.8, 5-9)	24	17
2	Does your facility have a formal reporting structure responsible for antimicrobial stewardship (e.g. a multidisciplinary committee focused on appropriate antimicrobial use, pharmacy committee, patient safety committee or other relevant structure)?	9 (7.8, 4-9)	7 (7.0, 5-8)	7 (5.9, 1-8)	23	16
3	Does your facility have a named senior executive officer with accountability for antimicrobial leadership?	9 (8.2, 5-9)	6 (6.5, 5-9)	5 (5.1, 1-8)	20	15
4	Has an annual report focused on antimicrobial stewardship (summary antimicrobial use and/or practices improvement initiatives) been produced for your facility in the past year?	9 (8.1, 4-9)	7 (6.5, 5-9)	6 (5.9, 2-8)	22	16
5	Is there any budgeted financial support for antimicrobial stewardship activities at your facility (e.g., support for salary, training, or IT support)?	8 (7.4, 1-9)	7 (7.3, 5-9)	5 (5.7, 1-8)	20	15
	Human Resources					
6	Is an antimicrobial stewardship team available at your facility?	8 (7.7, 4-9)	9 (8.0, 4-9)	7 (6.6, 4-9)	24	17
7	Is clinical infectious disease (ID) consultation available at your facility?	7 (7.1, 3-9)	8 (7.7, 5-9)	7 (6.5, 5-8)	22	15
8	Is there a physician identified as a leader for stewardship activities at your facility?	8 (7.9, 4-9)	7 (7.5, 5-9)	7 (6.1, 1-8)	22	15
9	If YES, Are stewardship duties included in the job description and/or annual review?	9 (7.9, 5-9)	7 (6.8, 4-9)	5 (4.9, 1-7)	21	16
10	If YES, Is this physician trained in infectious diseases, clinical microbiology and/or antimicrobial stewardship?	7 (7.2, 2-9)	8 (7.9, 7-9)	6 (6.1, 1-9)	21	15
11	Is there a pharmacist responsible for working to improve antimicrobial use at your facility?	8 (7.8, 4-9)	8 (7.8, 5-9)	6 (5.8, 1-7)	22	16
12	If YES, has this pharmacist had specialized training in infectious disease management or stewardship?	7 (6.9, 2-9)	8 (7.6, 5-9)	5 (5.6, 1-8)	20	15
	Are any of the staff below members involved in stewardship activities at your facility?					
13	Microbiologist (Laboratory)	8 (7.2, 2-9)	8 (7.3, 5-9)	6 (6.1, 1-9)	22	16
14	Infection preventionist or hospital epidemiologist	7 (7.1, 2-9)	7 (6.6, 4-9)	6 (6.3, 1-9)	20	14
15	Information Technology (IT) staff member	6 (6.4, 2-9)	6 (6.3, 4-9)	5 (4.7, 1-6)	17	12
16	Quality improvement staff member	7 (6.6, 2-9)	6 (5.6, 3-7)	5 (4.3, 1-6)	18	13
	Laboratory					
17	Does your facility produce a cumulative antimicrobial susceptibility report at least annually?	9 (8.4, 6-9)	8 (7.6, 5-9)	7 (6.8, 5-9)	24	17

	INDICATORS	Feasibility Median (Mean, Range)	Clinical Importance Median (Mean, Range)	Relevance to Minimizing Resistance Median (Mean, Range)	OVERALL MEDIAN SCORE (max 27)	MODIFIED MEDIAN SCORE* (Max 18)
18	If YES, has a current susceptibility report been distributed to prescribers at your facility in the last year?	9 (8.1, 5-9)	8 (7.3, 4-9)	7 (6.7, 4-8)	24	17
	Information Technology **Which of the following information technology (IT) systems are currently available and used in your facility:**					
19	IT system for prescribing (Computerized Order Entry)?	7 (6.5, 2-9)	7 (6.6, 2-9)	5 (5.3, 2-8)	19	14
20	If YES, Does the computer order entry system support clinical decision making for prescribing antimicrobial agents?	5 (5.4, 2-9)	7 (6.9, 2-9)	6 (5.9, 2-8)	18	12
21	IT capability to electronically link pharmacy, laboratory, and medical records?	6 (6.2, 3-9)	8 (7.5, 5-9)	6 (5.9, 1-9)	20	14
	Policies for appropriate use					
22	Does your facility have a defined formulary of antimicrobial agents?	9 (8.7, 7-9)	7 (7.1, 2-9)	6 (6.5, 2-9)	22	16
23	Does your facility have a written policy that requires prescribers to document in the medical record or during order entry a dose, duration, and indication for all antimicrobial prescriptions?	8 (7.2, 4-9)	8 (7.4, 5-9)	6 (5.9, 1-8)	22	16
	Guidelines **Does your facility have facility-specific treatment recommendations, based on national guidelines and local susceptibility, to assist with antimicrobial selection for the following common clinical conditions:**					
24	Surgical prophylaxis	9 (8.4, 6-9)	9 (8.2, 5-9)	7 (6.5, 4-8)	25	18
25	Community-acquired pneumonia	9 (8.2, 6-9)	8 (7.7, 5-9)	6 (6.3, 5-8)	23	17
26	Urinary tract infection	9 (8.1, 6-9)	8 (7.9, 5-9)	7 (6.4, 1-9)	24	17
27	If YES to any of the clinical conditions above, are these treatment recommendations easily accessible to prescribers on all wards (printed 'pocket guide' or electronic summaries at workstations)	9 (8.0, 5-9)	8 (7.8, 5-9)	7 (6.3, 1-9)	23	17
	Protocols **Are any of the following actions implemented in your facility to improve antibiotic prescribing?**					
28	Standardized criteria for changing from intravenous to oral antimicrobial therapy in appropriate situations?	8 (7.7, 5-9)	7 (7.0, 4-9)	3 (3.8, 1-9)	18	15
29	Dose optimization (pharmacokinetics/pharmacodynamics) to optimize the treatment of organisms with reduced susceptibility?	7 (6.5, 3-9)	8 (7.6, 5-9)	6 (6.3, 3-9)	21	15
30	Discontinuation of specified antimicrobial prescriptions after a pre-defined duration?	7 (6.8, 5-9)	8 (7.3, 1-9)	7 (6.6, 3-9)	22	15

	INDICATORS	Feasibility Median (Mean, Range)	Clinical Importance Median (Mean, Range)	Relevance to Minimizing Resistance Median (Mean, Range)	OVERALL MEDIAN SCORE (max 27)	MODIFIED MEDIAN SCORE* (Max 18)
	Activities and Interventions					
31	Do prescribers in your facility routinely use antimicrobial ordering forms (printed or electronic)?	7 (7.2, 4-9)	6 (5.8, 3-8)	5 (5.1, 1-7)	18	13
32	Is it routine practice for specified antimicrobial agents to be approved by a physician or pharmacist prior to dispensing (pre-authorization) in your facility?	7 (6.7, 5-9)	8 (7.6, 5-9)	7 (6.5, 5-8)	22	15
33	Is there dedicated time during which the clinical team reviews antimicrobial orders for their assigned patients (antimicrobial ward rounds)?	6 (5.8, 1-9)	8 (7.5, 3-9)	7 (6.0, 1-8)	21	14
34	Is there a formal procedure for a physician, pharmacist, or other staff member to review the appropriateness of an antimicrobial after 48 hours from the initial order (post-prescription review)?	7 (6.6, 3-9)	8 (7.9, 5-9)	7 (6.8, 5-8)	22	15
35	Are results of antimicrobial audits or reviews provided directly to prescribers through in-person, telephone, or electronic communication?	7 (6.6, 3-9)	8 (7.8, 6-9)	7 (6.5, 5-8)	22	15
36	Do prescribers ever receive direct, personalized communication about how they can improve their antimicrobial prescribing?	6 (6.1, 3-9)	8 (7.6, 5-9)	7 (6.6, 5-9)	21	14
	Monitoring appropriate use					
37	Does your facility monitor antimicrobial use by counts of antimicrobial(s) administered to patients per day (Days of Therapy; DOT)?	6 (6.3, 1-9)	7 (6.7, 2-9)	6 (5.9, 1-9)	19	13
38	Does your facility monitor antimicrobial use by number of grams of antimicrobials used (Defined Daily Dose, DDD)?	8 (7.9, 4-9)	7 (7.0, 5-9)	6 (6.2, 1-9)	21	15
39	Does your facility monitor whether the indication for treatment is recorded in clinical case notes?	6 (6.3, 3-9)	7 (7.2, 5-9)	6 (5.8, 1-9)	19	13
40	If YES, is the indication for treatment is recorded in clinical case notes in >95% of sampled cases in your facility?	6 (6.4, 3-9)	8 (7.4, 5-9)	6 (5.8, 1-9)	20	14
41	Does your facility measure the number of antimicrobial prescriptions that are consistent with the local treatment recommendations?	6 (5.7, 3-9)	8 (7.7, 5-9)	6 (6.5, 5-8)	20	14
42	If YES, are antimicrobial prescriptions compliant with facility-specific guideline in >95% of sampled cases in your facility?	6 (5.4, 1-9)	8 (7.6, 1-9)	6 (6.2, 4-8)	20	14
43	Does your facility measure the duration of surgical antimicrobial prophylaxis?	7 (7.2, 3-9)	8 (7.7, 5-9)	7 (6.7, 5-9)	22	15
44	If YES, are antimicrobial prescriptions compliant with facility-specific guideline in >95% of sampled cases in your facility?	7 (7.1, 3-9)	8 (7.7, 5-9)	7 (6.3, 5-8)	22	15

Table 4. Round 2 IPRAS Appropriateness Score: Rating on Feasibility, Clinical Importance and Relevance to Minimizing Resistance

	Indicators	90/10* Feasibility	Clinical Importance	Relevance to Minimizing Resistance
	Governance and management			
1	Does your facility have a formally defined antimicrobial stewardship program for ensuring appropriate antimicrobial use?	1	4.85	1.35
2	Does your facility have a formal reporting structure responsible for antimicrobial stewardship (e.g. a multidisciplinary committee focused on appropriate antimicrobial use, pharmacy committee, patient safety committee or other relevant structure)?	1.35	3	0.05
3	Does your facility have a named senior executive officer with accountability for antimicrobial leadership?	4.15	1.35	0.3
4	Has an annual report focused on antimicrobial stewardship (summary antimicrobial use and/or practices improvement initiatives) been produced for your facility in the past year?	3.1	1.8	1.85
5	Is there any budgeted financial support for antimicrobial stewardship activities at your facility (e.g., support for salary, training, or IT support)?	-0.75	1.55	0.2
	Human Resources			
6	Is an antimicrobial stewardship team available at your facility?	2.75	2.75	1.55
7	Is clinical infectious disease (ID) consultation available at your facility?	1	4.5	1.6
8	Is there a physician identified as a leader for stewardship activities at your facility?	4.15	2.75	1.85
9	If YES, Are stewardship duties included in the job description and/or annual review?	2.75	1.55	-1.95
10	If YES, Is this physician trained in infectious diseases, clinical microbiology and/or antimicrobial stewardship?	1.35	4.85	1.55
11	Is there a pharmacist responsible for working to improve antimicrobial use at your facility?	1.35	3.1	1.85
12	If YES, has this pharmacist had specialized training in infectious disease management or stewardship?	1.35	4.5	1.85
	Are any of the staff below members involved in stewardship activities at your facility?			
13	Microbiologist (Laboratory)	1	1.35	1.55
14	Infection preventionist or hospital epidemiologist	1.35	1.55	1.55
15	Information Technology (IT) staff member	1	1.55	2.15
16	Quality improvement staff member	0.825	1.325	1.35
	Laboratory			
17	Does your facility produce a cumulative antimicrobial susceptibility report at least annually?	4.85	3.1	1.6
18	If YES, has a current susceptibility report been distributed to prescribers at your facility in the last year?	4.325	1.35	1.6
	Information Technology **Which of the following information technology (IT) systems are currently available and used in your facility:**			
19	IT system for prescribing (Computerized Order Entry)?	0.65	1.35	1.35
20	If YES, Does the computer order entry system support clinical decision making for prescribing antimicrobial agents?	-0.3	1.55	1.45
21	IT capability to electronically link pharmacy, laboratory, and medical records?	1.35	3.3	1.6
	Policies for appropriate use			

22	Does your facility have a defined formulary of antimicrobial agents?	6.6	2.75	0.65
			90/10*	
	Indicators	Feasibility	Clinical importance	Relevance to resistance
	Guidelines **Does your facility have facility-specific treatment recommendations, based on national guidelines and local susceptibility, to assist with antimicrobial selection for the following common clinical conditions:**			
24	Surgical prophylaxis	4.85	4.85	1.6
25	Community-acquired pneumonia	4.85	4.85	1.85
26	Urinary tract infection	4.5	4.85	1.6
27	If YES to any of the clinical conditions above, are these treatment recommendations easily accessible to prescribers on all wards (printed 'pocket guide' or electronic summaries at workstations)	3.1	4.85	1.6
	Protocols **Are any of the following actions implemented in your facility to improve antibiotic prescribing?**			
28	Standardized criteria for changing from intravenous to oral antimicrobial therapy in appropriate situations?	2.75	2.75	0.65
29	Dose optimization (pharmacokinetics/ pharmacodynamics) to optimize the treatment of organisms with reduced susceptibility?	1.55	2.75	1.25
30	Discontinuation of specified antimicrobial prescriptions after a pre-defined duration?	1.35	1.35	1.55
	Activities and interventions			
31	Do prescribers in your facility routinely use antimicrobial ordering forms (printed or electronic)?	3.1	0.1	-0.25
32	Is it routine practice for specified antimicrobial agents to be approved by a physician or pharmacist prior to dispensing (pre-authorization) in your facility?	3.5	3.1	1.6
33	Is there dedicated time during which the clinical team reviews antimicrobial orders for their assigned patients (antimicrobial ward rounds)?	-0.5	4.15	-2.6
34	Is there a formal procedure for a physician, pharmacist, or other staff member to review the appropriateness of an antimicrobial after 48 hours from the initial order (post-prescription review)?	1	4.15	1.6
35	Are results of antimicrobial audits or reviews provided directly to prescribers through in-person, telephone, or electronic communication?	1.25	4.85	1.8
36	Do prescribers ever receive direct, personalized communication about how they can improve their antimicrobial prescribing?	-0.55	4.15	1.8
	Monitoring appropriate use			
37	Does your facility monitor antimicrobial use by counts of antimicrobial(s) administered to patients per day (Days of Therapy; DOT)?	0.85	1.55	0.55
38	Does your facility monitor antimicrobial use by number of grams of antimicrobials used (Defined Daily Dose, DDD)?	4.5	3.35	1.6
39	Does your facility monitor whether the indication for treatment is recorded in clinical case notes?	1	1.35	1.8
40	If YES, is the indication for treatment is recorded in clinical case notes in >95% of sampled cases in your facility?	1.35	2.4	0.9
41	Does your facility measure the number of antimicrobial prescriptions that are consistent with the local treatment recommendations?	0.1	4.5	1.6
42	If YES, are antimicrobial prescriptions compliant with facility-specific guideline in >95% of sampled cases in your facility?	-3.3	4.85	1.6
43	Does your facility measure the duration of surgical antimicrobial prophylaxis?	1	2.75	1.8
44	If YES, are antimicrobial prescriptions compliant with facility-specific guideline in >95% of sampled cases in your facility?	1.35	2.75	1.85

* IPRAS-IPR (+=agreement)

Table 5. Summary Round 2 Results

Results	#	(%)
Indicators rated in round 2	44	
Indicators Retained without Revision	26	59.1
Indicators Retained and Revised	11	25.0
Indicators Removed	6	13.6
Indicators Added	1	2.3
Total Indicators remaining after round 2	38	

Table 6. Round 3 Results: Rating on Feasibility, Clinical Importance and Necessity

	Indicators	**Feasibility** Median (Mean, Range)	**Clinical importance** Median (Mean, Range)	Median Score	n	**% of Core, Supplemental, Remove** C%	S%	X%
	Governance and management							
1	Does your facility have a formally defined antimicrobial stewardship program for ensuring appropriate antimicrobial use?	9 (8.5, 5-9)	8 (8.2, 5-9)	17	19	78.9	15.8	5.3
2	Does your facility have a formal reporting structure responsible for antimicrobial stewardship (e.g. a multidisciplinary committee focused on appropriate antimicrobial use, pharmacy committee, patient safety committee or other relevant structure)?	8 (7.9, 5-9)	7 (7.1, 5-9)	15	18	55.6	38.9	5.6
3	Does your facility have a named senior executive officer with accountability for antimicrobial leadership?	8 (7.9, 5-9)	6 (6.2, 4-8)	14	19	21.1	68.4	10.5
4	Has an annual report focused on antimicrobial stewardship (summary antimicrobial use and/or practices improvement initiatives) been produced for your facility in the past year?	8 (7.9, 5-9)	7 (6.5, 5-9)	15	19	42.1	52.6	5.3
5	Does your facility provide any salary support for dedicated time for antimicrobial stewardship activities?	7 (7.1, 3-9)	7 (7.4, 5-9)	15	18	42.1	47.4	10.5
	Human Resources							
6	Is an antimicrobial stewardship team available at your facility?	8 (7.7, 5-9)	9 (8.4, 5-9)	17	18	83.3	11.1	5.6
7	If YES, Is an infection preventionist or hospital epidemiologist involved in stewardship activities?	7 (7.1, 5-9)	7 (6.8, 3-9)	14	19	0.0	63.2	36.8
8	If YES, Is a microbiologist (laboratory staff) involved in stewardship activities?	8 (7.4, 5-9)	8 (7.1, 5-9)	16	17	11.8	64.7	23.5
9	Is clinical infectious disease (ID) consultation available at your facility?	7 (6.6, 3-9)	8 (7.8, 5-9)	15	17	29.4	52.9	17.6
10	there a physician identified as a leader for stewardship activities at your facility?	8 (8.1, 6-9)	8 (8.1, 7-9)	16	18	88.9	11.1	0.0
11	If YES, Are stewardship duties included in the job description and/or annual review?	8 (7.4, 3-9)	7 (6.9, 5-9)	15	17	17.6	58.8	23.5
12	If YES, Is this physician trained in infectious diseases, clinical microbiology and/or antimicrobial stewardship?	7 (7.1, 3-9)	8 (7.7, 5-9)	15	18	16.7	72.2	11.1
13	Is there a pharmacist responsible for working to improve antimicrobial use at your facility?	8 (7.8, 5-9)	8 (8.0, 5-9)	16	17	76.5	23.5	0.0
14	If YES, has this pharmacist had specialized training in infectious disease management or stewardship?	6 (6.6, 4-9)	7 (7.4, 5-9)	14	17	11.8	76.5	11.8
	Laboratory							
15	Does your facility produce a cumulative antimicrobial susceptibility report at least annually?	9 (8.2, 5-9)	8 (7.8, 5-9)	17	19	73.7	26.3	0.0
16	If YES, has a current susceptibility report been distributed to prescribers at your facility?	8 (7.4, 2-9)	(7.2, 5-9)	15	18	22.2	50.0	27.8
	Information Technology							
17	Does your facility have the IT capability to electronically link pharmacy records, microbiology results, and medical records?	6 (5.9, 4-9)	8 (7.6, 6-9)	14	19	26.3	63.2	10.5

	Indicators	**Feasibility** Median (Mean, Range)	**Clinical importance** Median (Mean, Range)	Median Score	n	**% of Core, Supplemental, Remove** C%	S%	X%
	Policies for appropriate use							
18	Does your facility have a defined formulary of antimicrobial agents?	9 (8.5, 5-9)	7 (7.3, 5-9)	16	18	44.4	33.3	22.2
19	Does your facility have a written policy that requires prescribers to document in the medical record or during order entry a dose, duration, and indication for all antimicrobial prescriptions?	7 (7.0, 2-9)	8 (7.6, 5-9)	15	18	50.0	38.9	11.1
	Guidelines **Does your facility have <u>facility-specific</u> treatment recommendations, based on national guidelines and local susceptibility, to assist with antimicrobial selection for the following common clinical conditions:**							
20	Surgical prophylaxis	9 (8.6, 7-9)	9 (8.3, 5-9)	18	18	66.7	33.3	0.0
21	Community-acquired pneumonia	8 (8.3, 7-9)	8 (7.9, 5-9)	16	18	50.0	50.0	0.0
22	Urinary tract infection	8 (8.3, 6-9)	8 (8.0, 5-9)	16	18	44.4	55.6	0.0
23	<u>If YES to any of the clinical conditions above</u>, are these treatment recommendations easily accessible to prescribers on all wards (printed 'pocket guide' or electronic summaries at workstations)	8 (7.4, 2-9)	8 (8.1, 5-9)	16	18	22.2	66.7	11.1
	Protocols **Are any of the following actions implemented in your facility to improve antibiotic prescribing?**							
24	Standardized criteria for changing from intravenous to oral antimicrobial therapy in appropriate situations?	8 (7.4, 5-9)	7 (7.1, 5-9)	15	18	38.9	38.9	22.2
25	Dose optimization (pharmacokinetics/pharmacodynamics) to optimize the treatment of organisms with reduced susceptibility?	7 (6.7, 2-9)	8 (7.5, 3-9)	15	19	26.3	63.2	10.5
26	Discontinuation of specified antimicrobial prescriptions after a pre-defined duration?	7 (6.7, 5-9)	8 (7.2, 1-9)	15	18	38.9	44.4	16.7
	Activities and interventions							
27	Is it routine practice for specified antimicrobial agents to be approved by a physician or pharmacist prior to dispensing (pre-authorization) in your facility?	7 (6.9, 5-9)	8 (7.9, 5-9)	15	18	38.9	55.6	5.6
28	Is there a formal procedure for a physician, pharmacist, or other staff member to review the appropriateness of an antimicrobial after 48 hours from the initial order (post-prescription review)?	7 (6.6, 3-9)	8 (8.1, 5-9)	15	18	72.2	27.8	0.0
29	Are results of antimicrobial audits or reviews provided directly to prescribers through in-person, telephone, written or electronic communication?	7 (6.7, 3-9)	8 (8.1, 7-9)	15	19	57.9	31.6	10.5
30	Do prescribers receive education about how they can improve their antimicrobial prescribing?	7 (7.2, 3-9)	8 (7.7, 4-9)	15	17	64.7	29.4	5.9
	Monitoring appropriate use							
31	Does your facility monitor antimicrobial use by grams [Defined Daily Dose (DDD)] or counts [Days of Therapy (DOT)] of antimicrobial(s) by patients per day?	8 (7.9, 6-9)	8 (7.8, 5-9)	16	19	89.5	10.5	0.0

	Indicators	**Feasibility** Median (Mean, Range)	**Clinical importance** Median (Mean, Range)	Median Score	n	**% of Core, Supplemental, Remove** C%	S%	X%
32	Does your facility monitor whether the indication for treatment is captured in the medical record?	6 (6.3, 4-9)	7 (7.2, 5-9)	13	18	27.8	61.1	11.1
33	If YES, is the indication for treatment is captured in the medical record in >80% of sampled cases in your facility?	6 (5.9, 1-8)	8 (7.4, 5-9)	14	17	5.9	70.6	23.5
34	Does your facility measure the number of antimicrobial prescriptions that are consistent with the local treatment recommendations for either UTI or CAP?	6 (6.3, 4-9)	8 (7.7, 5-9)	14	18	38.9	50.0	11.1
35	If YES, are antimicrobial prescriptions for UTI compliant with facility-specific guideline in >80% of sampled cases in your facility?	7 (6.3, 3-8)	8 (7.7, 5-9)	15	17	0.0	76.5	23.5
36	If YES, are antimicrobial prescriptions for CAP compliant with facility-specific guideline in >80% of sampled cases in your facility?	6 (6.2, 3-9)	8 (7.6, 59)	15	17	5.9	70.6	23.5
37	Does your facility review surgical antimicrobial prophylaxis?	7 (7.3, 3-9)	8 (7.9, 5-9)	15	18	50.0	50.0	0.0
38	If YES, are antimicrobial prescriptions compliant with facility-specific guidelines in >80% of sampled cases in your facility?	7 (7.1, 3-9)	8 (7.8, 5-9)	15	17	29.4	52.9	17.6

Table 7. Round 3 IPRAS Appropriateness Score: Rating on Feasibility and Clinical Importance

	Indicators	90/10 * IPRAS-IPR (+=agreement)	
		Feasibility	Clinical Importance
	Governance and management		
1	Does your facility have a formally defined antimicrobial stewardship program for ensuring appropriate antimicrobial use?	5.9	6.2
2	Does your facility have a formal reporting structure responsible for antimicrobial stewardship (e.g. a multidisciplinary committee focused on appropriate antimicrobial use, pharmacy committee, patient safety committee or other relevant structure)?	2.7	1.5
3	Does your facility have a named senior executive officer with accountability for antimicrobial leadership?	4.8	1.6
4	Has an annual report focused on antimicrobial stewardship (summary antimicrobial use and/or practices improvement initiatives) been produced for your facility in the past year?	4.8	1.8
5	Does your facility provide any salary support for dedicated time for antimicrobial stewardship activities?	2.0	2.7
	Human Resources		
6	Is an antimicrobial stewardship team available at your facility?	3.1	6.6
7	If YES, Is an infection preventionist or hospital epidemiologist involved in stewardship activities?	2.7	1.6
8	If YES, Is a microbiologist (laboratory staff) involved in stewardship activities?	2.6	1.3
9	Is clinical infectious disease (ID) consultation available at your facility?	1.0	1.3
10	Is there a physician identified as a leader for stewardship activities at your facility?	4.8	4.8
11	If YES, Are stewardship duties included in the job description and/or annual review?	2.6	1.3
12	If YES, Is this physician trained in infectious diseases, clinical microbiology and/or antimicrobial stewardship?	3.3	3.1
13	Is there a pharmacist responsible for working to improve antimicrobial use at your facility?	2.6	4.8
14	If YES, has this pharmacist had specialized training in infectious disease management or stewardship?	1.3	2.6

	Indicators	90/10 * IPRAS-IPR (+=agreement)	
		Feasibility	Clinical Importance
	Laboratory		
15	Does your facility produce a cumulative antimicrobial susceptibility report at least annually?	4.8	4.5
16	If YES, has a current susceptibility report been distributed to prescribers at your facility?	1.3	2.9
	Information Technology		
17	Does your facility have the IT capability to electronically link pharmacy records, microbiology results, and medical records?	1.4	4.8
	Policies for appropriate use		
18	Does your facility have a defined formulary of antimicrobial agents?	6.2	2.7
19	Does your facility have a written policy that requires prescribers to document in the medical record or during order entry a dose, duration, and indication for all antimicrobial prescriptions?	1.3	4.8
	Guidelines **Does your facility have <u>facility-specific</u> treatment recommendations, based on national guidelines and local susceptibility, to assist with antimicrobial selection for the following common clinical conditions:**		
20	Surgical prophylaxis	6.2	4.8
21	Community-acquired pneumonia	4.8	4.8
22	Urinary tract infection	4.8	4.8
23	<u>If YES to any of the clinical conditions above</u>, are these treatment recommendations easily accessible to prescribers on all wards (printed 'pocket guide' or electronic summaries at workstations)	2.6	4.8
	Protocols **Are any of the following actions implemented in your facility to improve antibiotic prescribing?**		
24	Standardized criteria for changing from intravenous to oral antimicrobial therapy in appropriate situations?	4.1	1.5
25	Dose optimization (pharmacokinetics/pharmacodynamics) to optimize the treatment of organisms with reduced susceptibility?	1.5	4.3
26	Discontinuation of specified antimicrobial prescriptions after a pre-defined duration?	1.5	1.3

	Indicators	90/10 * IPRAS-IPR (+=agreement)	
		Feasibility	Clinical Importance
	Activities and interventions		
27	Is it routine practice for specified antimicrobial agents to be approved by a physician or pharmacist prior to dispensing (pre-authorization) in your facility?	3.1	4.5
28	Is there a formal procedure for a physician, pharmacist, or other staff member to review the appropriateness of an antimicrobial after 48 hours from the initial order (post-prescription review)?	3.0	4.8
29	Are results of antimicrobial audits or reviews provided directly to prescribers through in-person, telephone, written or electronic communication?	1.8	4.8
30	Do prescribers receive education about how they can improve their antimicrobial prescribing?	1.3	3.8
	Monitoring appropriate use		
31	Does your facility monitor antimicrobial use by grams [Defined Daily Dose (DDD)] or counts [Days of Therapy (DOT)] of antimicrobial(s) by patients per day?	4.8	3.1
32	Does your facility monitor whether the indication for treatment is captured in the medical record?	1.5	1.3
33	If YES, is the indication for treatment is captured in the medical record in >80% of sampled cases in your facility?	1.1	2.6
34	Does your facility measure the number of antimicrobial prescriptions that are consistent with the local treatment recommendations for either UTI or CAP?	1.5	2.7
35	If YES, are antimicrobial prescriptions for UTI compliant with facility-specific guideline in >80% of sampled cases in your facility?	1.1	2.6
36	If YES, are antimicrobial prescriptions for CAP compliant with facility-specific guideline in >80% of sampled cases in your facility?	-0.2	2.6
37	Does your facility review surgical antimicrobial prophylaxis?	2.7	4.1
38	If YES, are antimicrobial prescriptions compliant with facility-specific guidelines in >80% of sampled cases in your facility?	0.8	2.6

* IPRAS-IPR (+=agreement)

Table 8. Indicator changes from Round 1 to Round 3

ROUND 1	ROUND 2	ROUND 3	FINAL SET	
Governance and management			Strict criteria*	Liberal criteria**
1. Does your facility have a formal mandate for ensuring appropriate antimicrobial use (antimicrobial stewardship)?	1. Does your facility have a formally defined antimicrobial stewardship program for ensuring appropriate antimicrobial use?	1. Does your facility have a formally defined antimicrobial stewardship program for ensuring appropriate antimicrobial use?	**Core**	**Core**
2. Does your facility have a multidisciplinary committee focused on appropriate antimicrobial use? (e.g., antimicrobials stewardship team)	2. Does your facility have a formal reporting structure responsible for antimicrobial stewardship (e.g. a multidisciplinary committee focused on appropriate antimicrobial use, pharmacy committee, patient safety committee or other relevant structure)?	2. Does your facility have a formal reporting structure responsible for antimicrobial stewardship (e.g. a multidisciplinary committee focused on appropriate antimicrobial use, pharmacy committee, patient safety committee or other relevant structure)?	**Supplemental**	**Core**
3. If YES, Does this stewardship team meet regularly (at least twice a year)?				
	3. Does your facility have a named senior executive officer with accountability for antimicrobial leadership?	3. Does your facility have a named senior executive officer with accountability for antimicrobial leadership?	**Supplemental**	**Supplemental**
4. If YES, Are minutes from the stewardship team meetings sent to executive leadership?				
5. Has an annual report focused on antimicrobial stewardship (summary antimicrobial use and/or practices improvement initiatives) been produced for your facility in the past year?	4. Has an annual report focused on antimicrobial stewardship (summary antimicrobial use and/or practices improvement initiatives) been produced for your facility in the past year?	4. Has an annual report focused on antimicrobial stewardship (summary antimicrobial use and/or practices improvement initiatives) been produced for your facility in the past year?	**Supplemental**	**Supplemental**
6. Does your facility receive any budgeted financial support for antibiotic stewardship activities (e.g., support for salary, training, or IT support)?	5. Is there any budgeted financial support for antimicrobial stewardship activities at your facility (e.g., support for salary, training, or IT support)?	5. Does your facility provide any salary support for dedicated time for antimicrobial stewardship activities?	**Supplemental**	**Supplemental**
Human Resources				
	6. Is an antimicrobial stewardship team available at your facility?	6. Is an antimicrobial stewardship team available at your facility?	**Core**	**Core**
7. Is clinical infectious disease (ID) consultation available at your facility?	7. Is clinical infectious disease (ID) consultation available at your facility?	9. Is clinical infectious disease (ID) consultation available at your facility?	**Supplemental**	**Supplemental**
8. Is a full-time pharmacist available on site at your facility?				
9. Does your facility perform the majority of its microbiology testing on site?				

ROUND 1	ROUND 2	ROUND 3	FINAL SET	
			Strict criteria*	Liberal criteria**
10. Is there a physician identified as a leader for stewardship activities at your facility?	8. Is there a physician identified as a leader for stewardship activities at your facility?	10. Is there a physician identified as a leader for stewardship activities at your facility	**Core**	**Core**
	9. If YES, Are stewardship duties included in the job description and/or annual review?	11. If YES, Are stewardship duties included in the job description and/or annual review?	**Remove**	**Supplemental**
11. If YES, does this physician receive any direct salary support for this role?	[Governance and management] 5. Is there any budgeted financial support for antimicrobial stewardship activities at your facility (e.g., support for salary, training, or IT support)?	[Governance and management] 5. Does your facility provide any salary support for dedicated time for antimicrobial stewardship activities?	**[Supplemental in Governance and management]**	**[Supplemental in Governance and management]**
12. If YES, Is this physician trained in infectious diseases?	10. If YES, Is this physician trained in infectious diseases, clinical microbiology and/or antimicrobial stewardship?	12. If YES, Is this physician trained in infectious diseases, clinical microbiology and/or antimicrobial stewardship?	**Supplemental**	**Supplemental**
13. Is there a pharmacist leader responsible for working to improve antibiotic use at your facility?	11. Is there a pharmacist responsible for working to improve antimicrobial use at your facility?	13. Is there a pharmacist responsible for working to improve antimicrobial use at your facility?	**Core**	**Core**
14. If YES, are stewardship duties included in the job description and/or annual review?				
15. If YES, has the lead pharmacist had specialized training in infectious disease management or stewardship?	12. If YES, has this pharmacist had specialized training in infectious disease management or stewardship?	14. If YES, has this pharmacist had specialized training in infectious disease management or stewardship?	**Supplemental**	**Supplemental**
Are any of the staff below members of the stewardship team at your facility?	Are any of the staff below members involved in stewardship activities at your facility?			
16. Microbiologist (Laboratory)	13. Microbiologist (Laboratory)	8. If YES, Is a microbiologist (laboratory staff) involved in stewardship activities?	**Remove**	**Supplemental**
17. Infection preventionist	14. Infection preventionist or hospital epidemiologist	7. If YES, Is an infection preventionist or hospital epidemiologist involved in stewardship activities?	**Remove**	**Supplemental**
18. Hospital epidemiologist				
19. Information Technology (IT) staff member	15. Information Technology (IT) staff member			
	16. Quality improvement staff member			

ROUND 1	ROUND 2	ROUND 3	FINAL SET	
			Strict criteria*	Liberal criteria**
Laboratory				
20. Does your facility produce an antibiogram (cumulative antimicrobial susceptibility report) at least annually?	17. Does your facility produce a cumulative antimicrobial susceptibility report at least annually?	15. Does your facility produce a cumulative antimicrobial susceptibility report at least annually?	**Core**	**Core**
21. Is antimicrobial selection for the guidelines informed by the current antibiogram?				
	18. If YES, has a current susceptibility report been distributed to prescribers at your facility in the last year?	16. If YES, has a current susceptibility report been distributed to prescribers at your facility?	**Remove**	**Supplemental**
Information Technology				
Which of the following information technology (IT) systems are currently available and used in your facility:	Which of the following information technology (IT) systems are currently available and used in your facility:			
22. Electronic medical or health record?				
23. IT system for prescribing (Computerized Order Entry)?	19. IT system for prescribing (Computerized Order Entry)?			
24. IT system for medication dispensing or administration?				
25. IT capability to electronically link pharmacy, laboratory, and medical records?	21. IT capability to electronically link pharmacy, laboratory, and medical records?	17. Does your facility have the IT capability to electronically link pharmacy records, microbiology results, and medical records?	**Supplemental**	**Supplemental**
26. Does the computer order entry system support clinical decision making for prescribing antimicrobial agents?	20. If YES, Does the computer order entry system support clinical decision making for prescribing antimicrobial agents?			
Education				
27. Has your facility given an educational presentation on improving antibiotic prescribing within the last year?				
28. Do prescribers ever receive direct, personalized communication about how they can improve their antibiotic prescribing?	[Activities and intervention] 36.Do prescribers ever receive direct, personalized communication about how they can improve their antimicrobial prescribing?	[Activities and interventions] 30. Do prescribers receive education about how they can improve their antimicrobial prescribing?	**[Core in Activities and interventions)**	**[Core in Activities and interventions)**

ROUND 1	ROUND 2	ROUND 3	FINAL SET	
			Strict criteria*	Liberal criteria**
29. Has a current antibiogram been distributed to prescribers at your facility in the last year?	[Laboratory] 18. If YES, has a current susceptibility report been distributed to prescribers at your facility in the last year?	[Laboratory] 16. If YES, has a current susceptibility report been distributed to prescribers at your facility?	**[Remove in Laboratory]**	**[Supplemental in Laboratory]**
30. Does your facility have a training strategy to promote appropriate antimicrobial use?				
31. Are patients or their legal guardian routinely given information about antimicrobials they have received (indication, course length, possible risks, what to do if side effects develop at home etc.)?				
Policies for appropriate use				
32. Does your facility have a defined formulary of antimicrobial agents?	22. Does your facility have a defined formulary of antimicrobial agents?	18. Does your facility have a defined formulary of antimicrobial agents?	**Remove**	**Remove**
33. Is there a written policy for approval of new antimicrobial agents onto the formulary?				
34. Does your facility have a written policy that requires prescribers to document in the medical record or during order entry a dose, duration, and indication for all antibiotic prescriptions?	23. Does your facility have a written policy that requires prescribers to document in the medical record or during order entry a dose, duration, and indication for all antimicrobial prescriptions?	19. Does your facility have a written policy that requires prescribers to document in the medical record or during order entry a dose, duration, and indication for all antimicrobial prescriptions?	**Supplemental**	**Core**
Guidelines				
Does your facility have facility-specific treatment recommendations, based on national guidelines and local susceptibility, to assist with antibiotic selection for the following common clinical conditions:	Does your facility have facility-specific treatment recommendations, based on national guidelines and local susceptibility, to assist with antimicrobial selection for the following common clinical conditions:	Does your facility have facility-specific treatment recommendations, based on national guidelines and local susceptibility, to assist with antimicrobial selection for the following common clinical conditions:		
35. Surgical prophylaxis	24. Surgical prophylaxis	20. Surgical prophylaxis	**Supplemental**	**Core**
36. Community-acquired pneumonia	25. Community-acquired pneumonia	21. Community-acquired pneumonia	**Supplemental**	**Core**
37. Urinary tract infection	26. Urinary tract infection	22. Urinary tract infection	**Supplemental**	**Supplemental**
38. If YES to any, are these treatment recommendations reviewed annually?				

ROUND 1	ROUND 2	ROUND 3	FINAL SET	
			Strict criteria*	Liberal criteria**
39. If YES to any, are these treatment recommendations easily accessible to all wards and prescribers (printed 'pocket guide' or electronic summaries at workstations)	27. If YES to any of the clinical conditions above, are these treatment recommendations easily accessible to prescribers on all wards (printed 'pocket guide' or electronic summaries at workstations)	23. If YES to any of the clinical conditions above, are these treatment recommendations easily accessible to prescribers on all wards (printed 'pocket guide' or electronic summaries at workstations)	**Supplemental**	**Supplemental**
Protocols				
Are any of the following actions implemented in your facility to improve antibiotic prescribing?	Are any of the following actions implemented in your facility to improve antibiotic prescribing?	Are any of the following actions implemented in your facility to improve antibiotic prescribing?		
40. Automatic changes from intravenous to oral antibiotic therapy in appropriate situations?	28. Standardized criteria for changing from intravenous to oral antimicrobial therapy in appropriate situations?	24. Standardized criteria for changing from intravenous to oral antimicrobial therapy in appropriate situations?	**Remove**	**Remove**
41. Dose optimization (pharmacokinetics/pharmacodynamics) to optimize the treatment of organisms with reduced susceptibility?	29. Dose optimization (pharmacokinetics/pharmacodynamics) to optimize the treatment of organisms with reduced susceptibility?	25. Dose optimization (pharmacokinetics/pharmacodynamics) to optimize the treatment of organisms with reduced susceptibility?	**Supplemental**	**Supplemental**
42. Automatic alerts in situations where therapy might be unnecessarily duplicative?				
43. Time-sensitive automatic stop orders for specified antibiotic prescriptions?	30. Discontinuation of specified antimicrobial prescriptions after a pre-defined duration?	26. Discontinuation of specified antimicrobial prescriptions after a pre-defined duration?	**Remove**	**Remove**
Activities and interventions				
44. Do prescribers in your facility routinely use antimicrobial ordering forms (printed or electronic)?	31. Do prescribers in your facility routinely use antimicrobial ordering forms (printed or electronic)?			
45. Is it routine practice for specified antimicrobial agents to be approved by a physician or pharmacist prior to dispensing (pre-authorization) in your facility?	32. Is it routine practice for specified antimicrobial agents to be approved by a physician or pharmacist prior to dispensing (pre-authorization) in your facility?	27. Is it routine practice for specified antimicrobial agents to be approved by a physician or pharmacist prior to dispensing (pre-authorization) in your facility?	**Supplemental**	**Supplemental**
46. Is it routine practice for a physician or pharmacist to review incoming prescriptions for specified antimicrobial agents (pre-authorization)?				

ROUND 1	**ROUND 2**	**ROUND 3**	**FINAL SET**	
			Strict criteria*	Liberal criteria**
47. Is there dedicated time during which the clinical team reviews antimicrobial orders for their assigned patients (antimicrobial ward rounds)?	33. Is there dedicated time during which the clinical team reviews antimicrobial orders for their assigned patients (antimicrobial ward rounds)?			
48. Is there a formal procedure for a physician or pharmacist or other staff member to review the appropriateness of an antimicrobial after 48 hours from the initial order (post-prescription review)?	34. Is there a formal procedure for a physician, pharmacist, or other staff member to review the appropriateness of an antimicrobial after 48 hours from the initial order (post-prescription review)?	28. Is there a formal procedure for a physician, pharmacist, or other staff member to review the appropriateness of an antimicrobial after 48 hours from the initial order (post-prescription review)?	**Core**	**Core**
49. Are results of antimicrobial audits or reviews provided directly to prescribers through in-person, telephone, or electronic communication?	35. Are results of antimicrobial audits or reviews provided directly to prescribers through in-person, telephone, or electronic communication?	29. Are results of antimicrobial audits or reviews provided directly to prescribers through in-person, telephone, written or electronic communication?	**Supplemental**	**Core**
	36. Do prescribers ever receive direct, personalized communication about how they can improve their antimicrobial prescribing?	30. Do prescribers receive education about how they can improve their antimicrobial prescribing?	**Supplemental**	**Core**
Monitoring appropriate use				
Does your facility monitor antibiotic use (consumption) at the unit and/or facility wide level by one of the following metrics:				
50. By counts of antibiotic(s) administered to patients per day (Days of Therapy; DOT)?	37. Does your facility monitor antimicrobial use by counts of antimicrobial(s) administered to patients per day (Days of Therapy; DOT)?	31. Does your facility monitor antimicrobial use by grams [Defined Daily Dose (DDD)] or counts [Days of Therapy (DOT)] of antimicrobial(s) by patients per day?	**Core**	**Core**
51. By number of grams of antibiotics used (Defined Daily Dose, DDD)?	38. Does your facility monitor antimicrobial use by number of grams of antimicrobials used (Defined Daily Dose, DDD)?	[37 and 38 merged above]31. Does your facility monitor antimicrobial use by grams [Defined Daily Dose (DDD)] or counts [Days of Therapy (DOT)] of antimicrobial(s) by patients per day?	**[Core merged with 31]**	**[Core merged with 31]**
52. By direct expenditure for antibiotics (purchasing costs)?				

ROUND 1	**ROUND 2**	**ROUND 3**	**FINAL SET**	
			Strict criteria*	Liberal criteria**
53. Are adverse drug events associated with antimicrobials reported to an antimicrobial stewardship team?				
	39. Does your facility monitor whether the indication for treatment is recorded in clinical case notes?	32. Does your facility monitor whether the indication for treatment is captured in the medical record?	**Supplemental**	**Supplemental**
	40. If YES, is the indication for treatment is recorded in clinical case notes in >95% of sampled cases in your facility?	33. If YES, is the indication for treatment is captured in the medical record in >80% of sampled cases in your facility?	**Remove**	**Supplemental**
	41. Does your facility measure the number of antimicrobial prescriptions that are consistent with the local treatment recommendations?	34. Does your facility measure the number of antimicrobial prescriptions that are consistent with the local treatment recommendations for either UTI or CAP?	**Supplemental**	**Supplemental**
	42. If YES, are antimicrobial prescriptions compliant with facility-specific guideline in >95% of sampled cases in your facility?	35. If YES, are antimicrobial prescriptions for UTI compliant with facility-specific guideline in >80% of sampled cases in your facility?	**Remove**	**Supplemental**
		36. If YES, are antimicrobial prescriptions for CAP compliant with facility-specific guideline in >80% of sampled cases in your facility?	**Remove**	**Supplemental**
	43. Does your facility measure the duration of surgical antimicrobial prophylaxis?	37. Does your facility review surgical antimicrobial prophylaxis?	**Supplemental**	**Core**
	44. If YES, are antimicrobial prescriptions compliant with facility-specific guideline in >95% of sampled cases in your facility?	38. If YES, are antimicrobial prescriptions compliant with facility-specific guidelines in >80% of sampled cases in your facility?	**Supplemental**	**Supplemental**

*Strict criteria: If the remove "X" percentage was ≥ 20.0%, then the indicator was removed. If core “C” percentage was ≥ to 70.0%, then that indicator was retained as a Core Indicator. The remaining indicators were retained as a Supplemental Indicator.

**Liberal criteria: If the remove "x" percentage was ≥ 20.0%, then the indicator was removed, unless the supplemental "S" percentage was >=50% for the same indicator, then that indicator was retained as supplemental. If the core “C” percentage was ≥ 50.0%, then that indicator was kept as a Core Indicator. The remaining indicators were retained as a Supplemental Indicators.

D. Comparison of TATFAR antimicrobial stewardship indicators to other previously developed assessments

Table 9. TATFAR indicators compared to ASP assessments in EU member states

TATFAR Core Indicators: **17 core structure and process indicators for hospital antimicrobial stewardship programs**	**Antibiotic Strategy International (ABI)** **58 indicators developed,** **10 identified as 'minimal set of key indicators' (bolded)**	**Annual French hospital survey CCLIN Sud-Ouest** **24 questions,** **13 questions included in the national mandatory composite indicator on prudent use of antibiotics mandatory(bolded)**	**UK Antimicrobial Stewardship Assessment Tool (ASAT)** **82 questions, embedded scoring** **No prioritization of questions**
Does your facility have a formal antimicrobial stewardship program accountable for ensuring appropriate antimicrobial use?	***Formal mandate for hospital multi-disciplinary antibiotic management team (AMT) existing** Formal mandate for AB officer existing		Does the Trust have a written strategy for ensuring the quality of antimicrobial use? Is antimicrobial stewardship addressed within the Trust Infection Control Strategy? Does the DIPC have antimicrobial stewardship included within their job description? Does the Trust have an antimicrobial committee or equivalent accountable to the IC/DT Committee?* How often does it meet? Does it have minutes or an action list?
Does your facility have a formal organizational structure responsible for antimicrobial stewardship (e.g., a multidisciplinary committee focused on appropriate antimicrobial use, pharmacy committee, patient safety committee or other relevant structure)?	***AB officer or AMT member is member of the drugs and therapeutics committee** AMT (multi-disciplinary antibiotic management team) meetings performed at least bi-monthly AB policy and progress report disseminated to medical director by AMT/AB officer (also to infection control committee and drugs and therapeutics committee)	**Does your hospital have a local multidisciplinary antibiotic committee?** If yes, number of meetings held last year:	
Is an antimicrobial stewardship team available at your facility (e.g., greater than one staff member supporting clinical decisions to ensure appropriate antimicrobial use)?	***Bedside expert consultant advice regarding antibiotics by microbiologist/infectious disease specialist/antibiotic officer on request available on the same day** ***Regular ward rounds by members of the AMT (multi-disciplinary antibiotic management team) performed (at least weekly)**	Is there a multidisciplinary antimicrobial team?	

Is there a physician identified as a leader for antimicrobial stewardship activities at your facility?		**Does your hospital have one or several antibiotic advisors?** **If yes, specify their specialty** If yes, specify their diploma If yes, time spent by the antibiotic advisor in no. days / week: What time is dedicated by the pharmacist to antibiotic dispensation (in no. hours per week)?	
Is there a pharmacist responsible for ensuring antimicrobial use at your facility?			Is there a substantive AM pharmacist post in place?
Does your facility provide any salary support for dedicated time for antimicrobial stewardship activities (e.g., percentage of full-time equivalent (FTE) for ensuring appropriate antimicrobial use)?	Time resources for AMT defined Time resources for AB officer defined		What WTE AM Pharmacy staff/500 beds is spent on antimicrobial duties?
Does your facility have the IT capability to support the needs of the antimicrobial stewardship activities?	*Computerised antibiotic prescription/order form/system available*	**Does your hospital have information technology support for prescribing antibiotics?** Does your hospital have information technology support for pharmaceutical analysis of antibiotic prescriptions? **Does your hospital have computerized link between pharmacy, laboratory and clinical wards?**	
Does your facility have facility-specific treatment recommendations based on local antimicrobial susceptibility to assist with antimicrobial selection for common clinical conditions?	Local clinical practice guidelines/ guide for microbiologically documented therapy available **[As above] updated biannually** ***Local clinical practice guidelines/guide for empirical therapy available** **[As above] updated biannually** ***Local clinical practice guidelines/guide for surgical antibiotic prophylaxis available**	**Are there local guidelines for antibiotic surgical prophylaxis, endorsed by the antibiotic committee, based on nationally agreed guidelines?** **Are there local guidelines for first line antibiotic treatment for main infections, endorsed by the antibiotic committee?**	Are peer-reviewed, evidence-based, guidelines available for treatment of common infections?** Are peer-reviewed, evidence-based, surgical prophylaxis guidelines available for the common procedures? Is selection for the guidelines informed by local microbiological sensitivity patterns?

			Do AM guidelines provide guidance on typical duration of treatment for each indication? Do AM guidelines provide guidance on choice, dose, route, IV switch for each indication as appropriate?
Does your facility have a written policy that requires prescribers to document in the medical record or during order entry a dose, duration, and indication for all antimicrobial prescriptions?			Does the AM policy stipulate that indication should be recorded before AMs are prescribed? Does the AM Policy stipulate that course length or review date is recorded on the prescription chart at time of prescribing?
Is it routine practice for specified antimicrobial agents to be approved by a physician or pharmacist in your facility (e.g., pre-authorization)?	Special request/order form for (selected) antimicrobial drugs available	**Are there specific requirements for the dispensation of some antibiotics? (restricted antibiotics / controlled dispensation)** **If yes, are restricted antibiotics dispensed for a limited duration allowing assessment after 2-3 days (prescriptions with stop-order)?** If yes, are restricted antibiotics dispensed only if clinical information is provided? If yes, are restricted antibiotics dispensed only if microbiologic information is provided? If yes, are restricted antibiotics dispensed if prior approval by the antibiotic advisor?	Is there a system for restricted access to certain Formulary antimicrobials within the trust? Is there a system for reporting unauthorised prescribing?

Is there a formal procedure for a physician, pharmacist, or other staff member to review the appropriateness of an antimicrobial after 48 hours from the initial order (post-prescription review)?	Clinical audit by AB officer for evaluation of prescribers' Time-limited drug delivery/automatic stop order available compliance with streamlining drugs on days 2–3		Does the AM Policy stipulate that appropriate de-escalation of therapy takes place?
Has your facility produced a cumulative antimicrobial susceptibility report in the past year?	Antibiotic resistance data regarding MRSA analysed and written report provided at least 1×/year [As above] regarding ESBL [As above] other than MRSA and ESBL	Does your hospital monitor antimicrobial resistance?	
Does your facility monitor if the indication is captured in the medical record for all antimicrobial prescriptions?			Is there an AM audit strategy/program? Is compliance with AM Prescribing Policy audited and fed back in each specialty at least once a year?
Does your facility audit or review surgical antimicrobial prophylaxis choice and duration?			Is adherence to pertinent surgical prophylaxis guidelines audited and fed back in each specialty at least once a year?
Are results of antimicrobial audits or reviews communicated directly with prescribers?	***Clinical audit of prescribers' compliance with local clinical guidelines/guide performed by AMT/AB officer** ***Prescriber education by personalised interactive methods (like daily ward rounds) performed** ABS-related formal exchange of experiences (e.g. meeting) of AMT with general practitioners min. 1×/year performed AB consumption feedback to the ward at least 1×/year	**Did your hospital carried out prescribing practice audit last year?** If yes, did you perform feedback to prescribers?	Are incident reports of AM usage fed back to the AM committee or other group?

Does your facility monitor antimicrobial use by grams [Defined Daily Dose (DDD)] or counts [Days of Therapy (DOT)] of antimicrobial(s) by patients per days?	Drug use Total annual antibacterial (ATC J01) consumption for monitoring local temporal trend Annual analysis of AB consumption data (in DDD or RDD) -by drug class -available on department level (i.e. by discipline) -available on ward level	**Does your hospital monitor antibiotic consumption expressed in number of Defined Daily Doses (DDD) per 1000 patient-days?**	Is antimicrobial consumption monitored eg DDDs per activity? Is antimicrobial consumption reported to clinical specialties?
Has an annual report focused on antimicrobial stewardship (summary antimicrobial use and/or practices improvement initiatives) been produced for your facility in the past year?	AB policy plan with quantitative objectives for performance indicators published annually by AMT/AB officer Prospective drug use evaluation on the wards by AB officer at least 1 drug/annually	**Did your hospital carried out prescribing practice audit last year?** If yes, were results discussed during an antibiotic committee?	Does the Trust board including non-Exec directors receive an annual report pertaining to AM stewardship? Are incident reports of AM usage fed back to the AM committee or other group?

TATFAR Supplemental Indicators: structure and process indicators for hospital antimicrobial stewardship programs	Antibiotic Strategy International (ABI) **58 indicators developed, 10 identified as 'minimal set of key indicators' (bolded)**	Annual French hospital survey **CCLIN Sud-Ouest** **24 questions, 13 questions included in the national mandatory composite indicator on prudent use of antibiotics mandatory(bolded)**	UK Antimicrobial Stewardship Assessment Tool (ASAT) **82 questions, embedded scoring No prioritization of questions**
Does your facility have a named senior executive officer with accountability for antimicrobial leadership?			
Is an antimicrobial stewardship team available at your facility (e.g., greater than one staff member supporting clinical decisions to ensure appropriate antimicrobial use)?			

If YES, Is an infection preventionist or hospital epidemiologist involved in stewardship activities?			
If YES, Is a microbiologist (laboratory staff) involved in stewardship activities?			
Is clinical infectious disease (ID) consultation available at your facility?			Is advice from a medical microbiologist/ID physician available by telephone?
Is there a physician identified as a leader for antimicrobial stewardship activities at your facility? **If YES, Are stewardship duties included in the job description and/or annual review?**			
If YES, Is this physician trained in infectious diseases, clinical microbiology and/or antimicrobial stewardship?			
Is there a pharmacist responsible for ensuring antimicrobial use at your facility? **If YES, has this pharmacist had specialized training in infectious disease management or stewardship?**			Does the lead AM pharmacist have > 3 years experience in this specialist role? Does the lead AM pharmacist have a higher qualification than first degree (e.g. Diploma/MSc)? Does the lead AM pharmacist have specialist training in infection management /antimicrobial use
Does your facility have facility-specific treatment recommendations based on local antimicrobial susceptibility to assist with antimicrobial selection for common clinical conditions: **If YES, for surgical prophylaxis?**			

If YES, for community-acquired pneumonia?			
If YES, for urinary tract infection			
If YES to any of the clinical conditions above, are these treatment recommendations easily accessible to prescribers on all wards (printed 'pocket guide' or electronic summaries at workstations)			
Are any of the following actions implemented in your facility to improve antibiotic prescribing? **Standardized criteria for changing from intravenous to oral antimicrobial therapy in appropriate situations?**	Guidelines/guides for iv–oral switch available [As above] updated biannually		Are there IV to Oral switch guidelines?
Dose optimization (pharmacokinetics/pharmacodynamics) to optimize the treatment of organisms with reduced susceptibility?			Is there guidance on dosing optimisation for AMs with a narrow therapeutic index?
Discontinuation of specified antimicrobial prescriptions after a pre-defined duration?	Time-limited drug delivery/automatic stop order available		
Does your facility measure the percentage of antimicrobial prescriptions that are consistent with the local treatment recommendations for either UTI or CAP?		**Did your hospital carried out prescribing practice audit last year?** If yes, were results discussed during an antibiotic committee? If yes, were results discussed during an infection control committee? If yes, did you perform feedback to prescribers?	Is adherence to pertinent treatment guidelines audited in each specialty and fed back at least once a year?
Does your facility audit or review surgical antimicrobial prophylaxis choice and duration?			

If YES, are antimicrobial prescriptions compliant with facility-specific guidelines in >80% of sampled cases in your facility?			

Table 10. TATFAR indicators compared to CDC Core Elements of Hospital ASPs checklist

TATFAR Core Indicators (17 Questions)	CDC Checklist (39 questions)
Does your facility have a formal antimicrobial stewardship program accountable for ensuring appropriate antimicrobial use?	
Does your facility have a formal organizational structure responsible for antimicrobial stewardship (e.g., a multidisciplinary committee focused on appropriate antimicrobial use, pharmacy committee, patient safety committee or other relevant structure)?	*Does your facility have a formal, written statement of support from leadership that supports efforts to improve antibiotic use (antibiotic stewardship)?*
Is an antimicrobial stewardship team available at your facility (e.g., greater than one staff member supporting clinical decisions to ensure appropriate antimicrobial use)?	Does any of the staff below work with the stewardship leaders to improve antibiotic use? Clinicians Infection Prevention and Healthcare Epidemiology Quality Improvement Microbiology (Laboratory) Information Technology (IT) Nursing
Is there a physician identified as a leader for antimicrobial stewardship activities at your facility?	Is there a physician leader responsible for program outcomes of stewardship activities at your facility?
Is there a pharmacist responsible for ensuring antimicrobial use at your facility?	Is there a pharmacist leader responsible for working to improve antibiotic use at your facility?
Does your facility provide any salary support for dedicated time for antimicrobial stewardship activities (e.g., percentage of full-time equivalent (FTE) for ensuring appropriate antimicrobial use)?	Does your facility receive any budgeted financial support for antibiotic stewardship activities (e.g., support for salary, training, or IT support)?
Does your facility have the IT capability to support the needs of the antimicrobial stewardship activities?	*Above questions incorporates IT*
Does your facility have facility-specific treatment recommendations based on local antimicrobial susceptibility to assist with antimicrobial selection for common clinical conditions?	Does your facility have facility-specific treatment recommendations, based on national guidelines and local susceptibility, to assist with antibiotic selection for common clinical conditions?

Does your facility have a written policy that requires prescribers to document in the medical record or during order entry a dose, duration, and indication for all antimicrobial prescriptions?	Does your facility have a policy that requires prescribers to document in the medical record or during order entry a dose, duration, and indication for all antibiotic prescriptions?
Is it routine practice for specified antimicrobial agents to be approved by a physician or pharmacist in your facility (e.g., pre-authorization)?	Do specified antibiotic agents need to be approved by a physician or pharmacist prior to dispensing (i.e., pre-authorization) at your facility?
Is there a formal procedure for a physician, pharmacist, or other staff member to review the appropriateness of an antimicrobial after 48 hours from the initial order (post-prescription review)?	Is there a formal procedure for all clinicians to review the appropriateness of all antibiotics 48 hours after the initial orders (e.g. antibiotic time out)?
Has your facility produced a cumulative antimicrobial susceptibility report in the past year?	Does your facility produce an antibiogram (cumulative antibiotic susceptibility report)? Has a current antibiogram been distributed to prescribers at your facility?
Does your facility monitor if the indication is captured in the medical record for all antimicrobial prescriptions?	Does your stewardship program monitor adherence to a documentation policy (dose, duration, and indication)?
Does your facility audit or review surgical antimicrobial prophylaxis choice and duration?	
Are results of antimicrobial audits or reviews communicated directly with prescribers?	Does a physician or pharmacist review courses of therapy for specified antibiotic agents (i.e., prospective audit with feedback) at your facility? (No communication wording) Does you stewardship program share facility-specific reports on antibiotic use with prescribers? Do prescribers ever receive direct, personalized communication about how they can improve their antibiotic prescribing? Does your stewardship program provide education to clinicians and other relevant staff on improving antibiotic prescribing?
Does your facility monitor antimicrobial use by grams [Defined Daily Dose (DDD)] or counts [Days of Therapy (DOT)] of antimicrobial(s) by patients per days?	Does your facility monitor antibiotic use (consumption) at the unit and/or facility wide level by one of the following metrics: By counts of antibiotic(s) administered to patients per day (Days of Therapy; DOT)? By number of grams of antibiotics used (Defined Daily Dose, DDD)?

	By direct expenditure for antibiotics (purchasing costs)?
Has an annual report focused on antimicrobial stewardship (summary antimicrobial use and/or practices improvement initiatives) been produced for your facility in the past year?	Does you stewardship program share facility-specific reports on antibiotic use with prescribers?

TATFAR Supplemental Indicators (16 questions)	**CDC Checklist**
Does your facility have a named senior executive officer with accountability for antimicrobial leadership?	
Is an antimicrobial stewardship team available at your facility (e.g., greater than one staff member supporting clinical decisions to ensure appropriate antimicrobial use)? If YES, Is an infection preventionist or hospital epidemiologist involved in stewardship activities?	Does any of the staff below work with the stewardship leaders to improve antibiotic use? Clinicians Infection Prevention and Healthcare Epidemiology Quality Improvement Microbiology (Laboratory) Information Technology (IT) Nursing
If YES, Is a microbiologist (laboratory staff) involved in stewardship activities?	See above
Is clinical infectious disease (ID) consultation available at your facility?	
Is there a physician identified as a leader for antimicrobial stewardship activities at your facility? If YES, Are stewardship duties included in the job description and/or annual review?	
If YES, Is this physician trained in infectious diseases, clinical microbiology and/or antimicrobial stewardship?	
Is there a pharmacist responsible for ensuring antimicrobial use at your facility? If YES, has this pharmacist had specialized training in infectious disease management or stewardship?	
Does your facility have facility-specific treatment recommendations based on local antimicrobial susceptibility to assist with antimicrobial selection for common clinical conditions:	Does your facility have specific interventions in place to ensure optimal use of antibiotics to treat the following common infections?

If YES, for surgical prophylaxis? If YES, for community-acquired pneumonia? If YES, for urinary tract infection If YES to any of the clinical conditions above, are these treatment recommendations easily accessible to prescribers on all wards (printed 'pocket guide' or electronic summaries at workstations)	Community-acquired pneumonia Urinary tract infection Skin and soft tissue infections Surgical prophylaxis Empiric treatment of Methicillin-resistant *Staphylococcus aureus* (MRSA) Non-*C. difficile* infection (CDI) antibiotics in new cases of CDI Culture-proven invasive (e.g., blood stream) infections Does your stewardship program monitor compliance with one of more of the specific interventions in place?
Are any of the following actions implemented in your facility to improve antibiotic prescribing? Standardized criteria for changing from intravenous to oral antimicrobial therapy in appropriate situations?	Automatic changes from intravenous to oral antibiotic therapy in appropriate situations?
Dose optimization (pharmacokinetics/pharmacodynamics) to optimize the treatment of organisms with reduced susceptibility?	Automatic changes from intravenous to oral antibiotic therapy in appropriate situations? Dose adjustments in cases of organ dysfunction?
Discontinuation of specified antimicrobial prescriptions after a pre-defined duration?	Time-sensitive automatic stop orders for specified antibiotic prescriptions?
Does your facility measure the percentage of antimicrobial prescriptions that are consistent with the local treatment recommendations for either UTI or CAP?	Does your stewardship program monitor adherence to facility-specific treatment recommendations?
Does your facility audit or review surgical antimicrobial prophylaxis choice and duration? If YES, are antimicrobial prescriptions compliant with facility-specific guidelines in >80% of sampled cases in your facility?	

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