



Narrative review

How to start an antimicrobial stewardship programme in a hospital

M. Mendelson¹, A.M. Morris², K. Thursky³, C. Pulcini^{4,*}¹ Division of Infectious Diseases and HIV Medicine, Department of Medicine, Groote Schuur Hospital, University of Cape Town, Cape Town, South Africa² Division of Infectious Diseases, Department of Medicine, Sinai Health System, University Health Network, University of Toronto, Toronto, ONT, Canada³ NHMRC National Centre for Antimicrobial Stewardship, Royal Melbourne Hospital at the Doherty, Melbourne, VIC, Australia⁴ APEMAC, Université de Lorraine and Infectious Diseases Department, Université de Lorraine, CHRU-Nancy, Nancy, France

ARTICLE INFO

Article history:

Received 17 June 2019

Received in revised form

9 August 2019

Accepted 10 August 2019

Available online 22 August 2019

Editor: L Leibovici

Keywords:

Antibiotic

Antimicrobial

Implementation

Quality of care

Stewardship

ABSTRACT

Background: Antimicrobial stewardship (AMS) describes a coherent set of actions that ensure optimal use of antimicrobials to improve patient outcomes, while limiting the risk of adverse events (including antimicrobial resistance (AMR)). Introduction of AMS programmes in hospitals is part of most national action plans to mitigate AMR, yet the optimal components and actions of such a programme remain undetermined.

Objectives: To describe how health-care professionals can start an AMS programme in their hospital, the components of such a programme and the evidence base for its implementation.

Sources: National and society-led guidelines on AMS, peer-reviewed publications and experience of AMS experts conducting AMS programmes.

Content: We provide a step-by-step pragmatic guide to setting up and implementing a hospital AMS programme in high-income or low-and-middle-income countries.

Implications: Antimicrobial stewardship programmes in hospitals are a vital component of national action plans for AMR, and have been shown to significantly reduce AMR, particularly when coupled with infection prevention and control interventions. This step-by-step guide of 'how to' set up an AMS programme will help health-care professionals involved in AMS to optimally design and implement their actions. **M. Mendelson, Clin Microbiol Infect 2020;26:447**

© 2019 European Society of Clinical Microbiology and Infectious Diseases. Published by Elsevier Ltd. All rights reserved.

Introduction

National action plans to tackle antimicrobial resistance (AMR) exist in an increasing number of countries [1]. Antimicrobial stewardship (AMS), a coherent set of actions that promote the optimal use of antimicrobials in ways that ensure sustainable access to effective therapy for all in need, is one cornerstone of any national policy, and the foundation of a hospital's antimicrobial stewardship programme (ASP) to optimize antimicrobial use and patient outcomes [2,3].

Briefly, the general framework of an ASP has ideally three components [4,5] (a) There are system prerequisites (i.e. structures), that must be met before implementation (e.g. presence of

guidelines, AMS team, adequate diagnostic, human and IT resources) (b) What the AMS team wants to improve (i.e. the processes that need to be addressed), must be clearly defined (recommendations on appropriate use at the patient level, for example, duration of treatment compliant with guidelines). And finally, (c) how the AMS team will achieve these goals must be planned, that is, the improvement strategies that will be chosen and tailored based on the identified determinants and problems and performed by the team at the professional or institutional level (e.g. audit and feedback, education).

We present here practical, hands-on general principles on how to start or optimize an existing hospital ASP. This overview is based on key guidelines, recommendations and recently published reviews, as well as on the experience of the authors (all AMS experts in a wide range of settings). We will focus on the first 6 months of programme implementation, with a global perspective (both high-income and low-and-middle-income countries). We assumed here a scenario where no preparatory phase was possible before being asked to start an ASP with pre-defined (usually insufficient)

* Corresponding author. C. Pulcini, Centre Hospitalier Régional Universitaire de Nancy, Service de Maladies Infectieuses et Tropicales, Hôpital de Brabois, allée du Morvan, 54511, Vandœuvre-Lès-Nancy, France.

E-mail address: celine.pulcini@univ-lorraine.fr (C. Pulcini).

resources; in the case where a preparation phase is possible, several steps described here can be performed and negotiated beforehand.

Health systems and human resources to build ASPs will differ depending on the resource setting, and the general principles and timelines outlined here will probably need some adaptation to your own setting. We recognize the significant challenges faced in low- and middle-income countries, many of which have an extreme paucity of clinically and/or laboratory-trained infection specialists to lead ASPs. Indeed, although ASPs are usually led or co-led by prescribing doctors, microbiologists, or pharmacists, a nurse or community health worker may occasionally take the lead; there is no 'one size fits all' model. Poor laboratory infrastructure or support to an ASP is not in itself a reason to delay initiating a programme. Although laboratory support is instrumental in optimizing antibiotic choice, many of the early gains from starting stewardship activities come from reducing the use of unnecessary antibiotics. Hence, many antibiotic prescriptions can be stopped, purely on the basis of lack of clinical indication.

ASPs contribute to medication and patient safety, infection management, and quality improvement in hospitals, and this should be reflected in the design and reporting structure.

Months 1 and 2—the planning phase

This initial phase will be ~80% planning, 20% implementation (but might depend on local factors, such as resources and readiness). We present a stepwise strategy; however, some of these can be undertaken concurrently.

Be prepared

Get sufficient training on AMS and infection management

As guiding examples, Infectious Diseases Society of America (IDSA)/Society for Healthcare Epidemiology of America guidance for AMS leaders exists, a core AMS curriculum for Infectious Diseases (ID) Fellows has been developed by the IDSA, and the WHO recently issued the AMR health-care professional competency framework [6–8]. Other, mostly freely available, educational resources for all health professionals already exist (Box 1). Try to

Box 1

A selection of useful freely available educational resources on antimicrobial stewardship and related topics

E-learning and Massive Online Open Courses (MOOC)	
ECDC Directory	https://ecdc.europa.eu/en/publications-data/directory-guidance-prevention-and-control/training-antimicrobial-stewardship
Antimicrobial Stewardship: Managing Antibiotic Resistance	https://www.futurelearn.com/courses/antimicrobial-stewardship
Antimicrobial Stewardship: A competency-based approach	https://openwho.org/courses/AMR-competency
Antimicrobial Stewardship for Africa	https://www.mooc-list.com/course/antimicrobial-stewardship-africa-futurelearn
Other resources	
E-Book [25]	http://www.bsac.org.uk/antimicrobial-stewardship-from-principles-to-practice-e-book/ebook-download/
Center for Infectious Diseases Research and Policy	http://www.cidrap.umn.edu/asp
JAC-AMR database	http://bsac-jac-amr.com/jac-amr-resources/

avoid 'single person failure'—expanding training to at least one other professional. All role players should understand the systems approach to AMS [9].

Prepare your toolbox

Antimicrobial stewards need practical resources/tools at their disposal (a selection is presented in Box 2). Do not hesitate to re-use and adapt existing resources for endorsement by your hospital, which will lead to greater recognition and ownership by clinicians.

Look for support

Seek advice from more expert stewardship teams or existing mentorship/observership programmes in other hospitals in your region/country, and share tools/resources/experiences that already exist [9]. Visiting established ASP and attending AMS ward rounds can provide insight into ASP development and implementation. Developing formal relationships within hospital networks or between small and large facilities might also be useful.

Be familiar with existing AMS core elements

Core elements and items of any hospital ASP have been published (Table 1) [10], enabling goal-setting and negotiation with your hospital director. Do not wait for all elements to be in place in your hospital before starting your ASP.

Be familiar with national/regional regulation and requirements

Regional or national regulatory stewardship frameworks may already exist in your country [9,11]. Understanding these will strengthen your hand in motivating your hospital administrator to adopt core elements/items mentioned above. Countries with hospital accreditation frameworks will have information around structure and deliverables (e.g. Australian, French, Canadian and US standards) [9,11–16].

Box 2

A selection of useful resources for antimicrobial stewards

Resources	<ul style="list-style-type: none"> • http://ecdc.europa.eu/en/healthtopics/Healthcare-associated_infections/guidance-infection-prevention-control/Pages/guidance-antimicrobial-stewardship.aspx • http://www.infectiologie.com/fr/toolbox.html • http://www.ateams.nl • https://www.reactgroup.org/toolbox/ • http://www.bsac-arc.com
Guidance	<ul style="list-style-type: none"> • https://www.nice.org.uk/guidance/ng15 • https://www.safetyandquality.gov.au/our-work/healthcare-associated-infection/antimicrobial-stewardship/book/ • https://ec.europa.eu/health/amr/sites/amr/files/amr_guidelines_prudent_use_en.pdf • https://www.isid.org/education/guide-to-infection-control-in-the-healthcare-setting/ • Guidelines for the prevention and containment of antimicrobial resistance in South African hospitals [48] • Implementing an antibiotic stewardship program: guidelines by the Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America [49] • Antibiotic stewardship in low- and middle-income countries: the same but different? [50] • Strategies to enhance rational use of antibiotics in hospital: a guideline by the German Society for Infectious Diseases [51] • Antimicrobial stewardship—a practical guide to implementation in hospitals [52]

*Assess the local situation**Observe and look at existing data*

Understand your local situation; you may, for example, use a SWOT (Strengths, Weaknesses, Opportunities, Threats) matrix to help you do so in a structured way.

- Learn how the system is organized: governance structures, laboratory capabilities and current stewardship initiatives.
- Become familiar with 'prescribing etiquette' and the culture of each department [17], including emergency departments, where the majority of empiric prescribing occurs.

Table 1

Core elements and checklist items for global hospital antimicrobial stewardship programmes

Core element	Checklist item
Senior hospital management leadership towards antimicrobial stewardship	<ul style="list-style-type: none"> - Has your hospital management formally identified AMS as a priority objective for the institution and included it in its key performance indicators? - Is there dedicated, sustainable and sufficient budgeted financial support for AMS activities (e.g. support for salary, training, or information technology support)? - Does your hospital follow any (national or international) staffing standards for AMS activities (e.g. number of full-time equivalent per 100 beds for the different members of the AMS team)?
Accountability and responsibilities	<ul style="list-style-type: none"> - Does your hospital have a formal/written AMS programme/strategy accountable for ensuring appropriate antimicrobial use? - Does your hospital have a formal organizational multidisciplinary structure responsible for AMS (e.g. a committee focused on appropriate antimicrobial use, pharmacy committee, patient safety committee or other relevant structure)? - Is there a health-care professional identified as a leader for AMS activities at your hospital and responsible for implementing the programme? - Is there a document clearly defining roles, procedures of collaboration and responsibilities of the AMS team members? - Are clinicians, other than those part of the AMS team (e.g. from the ICU, Internal Medicine and Surgery) involved in the AMS committee? - Does the AMS committee produce regularly a dedicated report which includes, for example, antimicrobial use data and/or prescription improvement initiatives, with time-committed short-term and long-term measurable goals/targets for optimizing antimicrobial use? - Is there a document clearly defining the procedures of collaboration of the AMS team/committee with the infection prevention and control team/committee?
Available expertise on infection management	<ul style="list-style-type: none"> - Do you have access to laboratory/imaging services and to timely results to be able to support the diagnosis of the most common infections at your hospital? - In your hospital are there, or do you have access to, trained and experienced health-care professionals (medical doctor, pharmacist, nurse) in infection management (diagnosis, prevention and treatment) and AMS willing to constitute an AMS team?
Education and practical training	<ul style="list-style-type: none"> - Does your hospital offer a range of educational resources to support staff training on how to optimize antimicrobial prescribing? - Do the AMS team members receive regular training in antimicrobial prescribing and AMS?
Other actions aiming at responsible antimicrobial use	<ul style="list-style-type: none"> - Is a multidisciplinary AMS team available at your hospital (e.g. more than one trained staff member supporting clinical decisions to ensure appropriate antimicrobial use)? - Does your hospital support the AMS activities/strategy with adequate information technology services? - Does your hospital have an antimicrobial formulary (i.e. a list of antimicrobials that have been approved for use in a hospital, specifying whether the drugs are unrestricted, restricted (approval of an AMS team member is required) or permitted for specific conditions)? - Does your hospital have available and up-to-date recommendations for infection management (diagnosis, prevention and treatment), based on international/national evidence-based guidelines and local susceptibility (when possible), to assist with antimicrobial selection (indication, agent, dose, route, duration) for common clinical conditions? - Does your hospital have a written policy that requires prescribers to document an antimicrobial plan (includes indication, name, dosage, duration, route and interval of administration) in the medical record or during order entry for all antimicrobial prescriptions? - Does the AMS team review/audit courses of therapy for specified antimicrobial agents or clinical conditions at your hospital? - Is advice from AMS team members easily available to prescribers? - Are there regular infection-focused and antimicrobial-prescribing-focused ward rounds in specific departments in your hospital?
Monitoring and surveillance (on a continuous basis)	<ul style="list-style-type: none"> - Does your hospital monitor the quality/appropriateness of antimicrobial use at the unit and/or hospital-wide level? - Does your AMS programme monitor compliance with one or more of the specific interventions put in place by the AMS team (e.g. indication captured in the medical record for all antimicrobial prescriptions)? - Does your hospital monitor antibiotic susceptibility rates for a range of key bacteria? - Does your hospital monitor the quantity of antimicrobials prescribed/dispensed/purchased at the unit and/or hospital-wide level?
Reporting and feedback (on a continuous basis)	<ul style="list-style-type: none"> - Does your AMS programme share hospital-specific reports on the quantity of antimicrobials prescribed/dispensed/purchased with prescribers? - Does your AMS programme share facility-specific reports on antibiotic susceptibility rates with prescribers? - Are results of audits/reviews of the quality/appropriateness of antimicrobial use communicated directly with prescribers?

Abbreviations: AMS, antimicrobial stewardship; ICU, intensive care unit.

Adapted from Pulcini et al. [10].

- Analyse currently available antimicrobial consumption (quantity/volume), quality/appropriateness of use and resistance data. This information is critically important to plan your priority clinical areas, drugs, activities for your programme. If unavailable, plan to collect some data on a small scale to start.
 - o Antibiotic consumption is generally expressed for adults as daily defined doses with a denominator such as ‘per 1000 bed-days’ [18,19]. Dosing in children is highly age- and weight-dependent, so days of therapy is often used, and may also be a metric used for adults in some countries. This information is generally available from pharmacy dispensing programmes and electronic health records. Although less reliable and valid, purchasing data can be used.
 - o Antimicrobial appropriateness can be based on guideline compliance, or if guidelines are not available, on key elements of the prescription (e.g. choice based on likely or known pathogen, dose, charted indication). Quality of prescribing can be focused on target antimicrobials or target infections (e.g. community-acquired pneumonia) [20–23]. Hospital-wide point prevalence surveys are labour intensive to undertake but provide meaningful data for all antimicrobials across all clinical areas; WHO guidance is available on this topic [18]. However, targeted point prevalence surveys or smaller audits can be meaningful even with small sample sizes (e.g. 20–30 patients).
 - o For antimicrobial resistance, understanding the prevalence and risk groups for methicillin-resistant *Staphylococcus aureus*, extended-spectrum β -lactamase-producing Gram negative organisms, resistant *Candida* species will assist in empiric guideline (including surgical prophylaxis) development. Enlist the support of the microbiology department (if available) to generate an antibiogram (Box 2).

Meet the people

A good situational analysis needs a meet-and-greet to introduce yourself and your team to all the significant stakeholders in your hospital. Depending on the setting, this may include combinations of clinical prescribers (ID specialists, intensivists, general physicians, surgeons, and/or other specialists), microbiologists, pharmacists, nurses, infection prevention and control practitioners, quality-of-care/patient-safety teams, hospital management, medical heads of departments, and information technology experts. Impart to them the need for a hospital-wide ASP, primarily focusing on appropriateness of use and patient safety. Presenting meaningful data at this meeting will help (e.g. antibiotic resistance data from the hospital, surgical prophylaxis audits, or guideline compliance).

It is important to:

- listen to their needs
- understand barriers and enablers to appropriate antibiotic use
- invite them to suggest stewardship interventions for their setting and
- explain that after this planning phase, you will present a plan of action in the coming months.

Try to identify one champion per department to help you implement the ASP in their setting. Choose an ‘early adopter’ type of person, who is a good leader, respected and trusted by their peers. Strong support from senior hospital leadership is critical.

Set up an AMS team and committee

The team

The core operational team of health-care professionals (led by the clinical leader) will implement the stewardship strategy, with daily contact and frequent meetings while working on the front lines. The stewardship committee is a distinct, larger, formal organizational structure that also includes other relevant professionals and administrators [10].

The team’s composition will vary depending on availability and context. Many low-and-middle-income countries do not have clinical pharmacists, ID specialists, or specialist physicians, intensivists or surgeons to create an AMS workforce [24]. Ideally, a multidisciplinary team that includes all the expertise needed to implement an ASP (prevention, diagnosis and treatment of infection (management) and stewardship expertise) is built. In high-resource settings, it might include an ID specialist, clinical pharmacist and microbiologist; some teams might include an infection prevention and control practitioner, whereas in other hospitals, distinct infection prevention and control and AMS teams will work closely together [10]. Team members must display excellent communication and interpersonal skills. In resource-limited settings or small hospitals, the team may comprise less specialized practitioners such as general physicians, non-clinical pharmacists, or fewer members; start small and try to build a more comprehensive team going forward, potentially co-opting expertise from larger hospitals or regional bodies. The role of nurses should be considered [25]. As indicated in Table 1, the team will identify a clinical leader, and define roles, procedures of collaboration and responsibilities of members. The clinical leader should have clinical credibility, and strong leadership and communication skills.

Work as a team

Deliver consistent recommendations to gain credibility and show that all members (including the junior ones) can be trusted [26–28]. Traceability of actions and transparent communication are crucial. Prescribing etiquette varies across health-care settings, and prescribing behaviours and the ability of non-prescribers such as pharmacists to impact on decisions made by senior clinicians are limited by professional dynamics. You may need to enlist a senior clinician (commonly an ID specialist) to help as a negotiator.

ID consult service and stewardship interventions

If a hospital already has an ID consult service, it is important that it works in harmony with the ASP, with agreed upon, consistent recommendations, and clearly defined roles/responsibilities from the outset.

The committee

A constituted committee, which sets and coordinates the ASP/strategy, can either be stand-alone or embedded into another committee structure (e.g. drug and therapeutics, infection control, clinical management, patient safety) [10]. Invite all champions and relevant stakeholders (see above) and meet regularly (e.g. every 2 months). The presence of a senior hospital executive who has both authority and a discretionary budget can be instrumental in achieving endorsement for key initiatives. Try to involve ‘consumers’ in committees as this assists with programme planning, canvassing patient perceptions, and reviewing materials and toolkits [29].

Start designing your action plan

The stewardship committee should write a context-specific action plan and accompanying charter, reviewed after the first few months, and adapted depending on progress. The charter should include ASP objectives, role players, in-scope and out-of-scope activities, risks, metrics and timelines. It should be signed off by all stakeholders to signify broad agreement. A menu of interventions that have some evidence-base for impact on AMR can be selected and tailored to the local resources, determinants of the problem and barriers/facilitators [4,30]. There is no magic bullet. Here are a few tips:

- Be familiar with the basics of implementation science and quality improvement [9,25].
- Start small and adopt easy targets, that is, interventions that have a very high chance of success and are easy to implement (low-hanging fruit), and do get help from the enthusiastic champions.
- Create demand and make yourself useful, providing added-value for clinicians to make their life easier. Focus discussions on patient care/outcomes, for example, systematic advice on complex infections (e.g. positive blood cultures), which may make the restrictive measures that are required, more acceptable.
- Be persistent, it will take a couple of years (three to five usually) to have a fully running ASP.
- Although not the primary aim, it may be beneficial to also target costly antimicrobials from the start, as you are likely to show a significant decrease in costs, that will help convince your hospital management that your ASP is a success. Do not exclusively focus on costs, however, as savings expectedly diminish over time.

If your committee is very large, consider forming dedicated working parties to address individual interventions, with regular feedback on updates. Enlist other key stakeholders as necessary (e.g. anaesthetists or surgeons).

Monitoring and evaluating your ASP

Select a set of measures (ideally structure, process and outcome measures) adapted to the interventions you are planning to implement [31]. Selection for reporting may differ, depending on your target: prescribers, AMS committee or hospital management. An example is presented in Table 2.

Monitoring must be feasible, because you need time for analysis, strategic planning and reporting. Some data can be monitored using extracts from existing IT systems, if available, such as pathology,

microbiology or electronic medical management. Other data will require manual auditing. Simple manual measurement, often using quality improvement methods, is very achievable and rewarding, so do not wait for an IT solution to start monitoring. Try to select measures for which data collection is straightforward and routine as part of the AMS service, for example, post-prescription review data.

When you are able to report to prescribers: (a) have real-time feedback, as delayed feedback impacts very little on practice; and (b) include both explicit targets and an action plan [32]. Your strategy can be modified as results of your implementation activities progress.

Months 3 and 4—early implementation phase

This period is ~40% planning, 60% implementation.

Get more expertise on implementation science and quality improvement

Some resources

Implementation science is defined as the study of methods and strategies to promote the uptake of interventions that have proven effective into routine practice, with the aim of improving population health, whereas quality improvement is a systematic approach to making changes in processes that lead to better patient outcomes; more specialized publications exist [30,33,34]. Enlist help from colleagues such as Quality improvement teams who use implementation science in daily practice [35]. The Institute for Healthcare Improvement has a suite of tools and worksheets to assist with the planning [36].

Stepwise approach

Plan your ASP around the targets that you identified during your situational analysis. Assess intervention impacts, trying to understand why it did or did not work, and adapt accordingly, increasing scale, while tailoring the intervention to the setting, its specific barriers and enablers. Celebrate and advertise successes and make them those of your partners rather than your own, they will make people less reluctant to accept your interventions, and will foster ongoing and future collaboration. Feedback should be worded differently depending on the audience and it should be concise but demonstrate the value of the programme.

Adopt the right culture-appropriate communication attitude: non-judgemental, friendly, respectful and helpful. People must feel they can trust you and that you make their life easier.

Table 2
Example of a set of measures within the antimicrobial stewardship programme

Measure	Data collection method	Feedback to prescribers	Reporting to hospital management
Number of AMS committee meetings per year (S)	Manual	No	Yes
Proportion of prescribers who have participated in educational sessions on infection management and AMS (S)	Manual	No	Yes
Number of times the electronic guidelines have been consulted (P)	Automated	No	No
Proportion of restricted antimicrobials with post-authorization by the AMS team (P)	Automated	No	Yes
Proportion of antibiotic prescriptions compliant with guidelines for a specific infection (O)	Manual (e.g. point-prevalence survey)	Yes	Yes
Quantity of antimicrobials prescribed, in Defined Daily Doses or Days-of-Therapy (O)	Automated	Yes	Yes

Abbreviations: AMS, antimicrobial stewardship; S, Structure measure (What we need to have in place); P, Process measure (What we are doing); O, Outcome measure (What we are achieving).

All measures are reported back to the AMS committee.

Where to start?

Plan a hospital-wide communication strategy

Probably the most important planning will be the 'branding' of your ASP in your hospital, tailored to local resources—for example, grand round, a web page on your hospital intranet with links to important resources or guidelines, a local mobile app, or even a simple poster. Use any hospital media and communications staff. Overcommunicate, rather than the opposite.

Identifying patients prescribed antimicrobials

When feasible, put a system in place to rapidly identify when an antimicrobial is prescribed; having details on the indication, dose, route of administration and duration is also desirable. In high-income settings with electronic prescribing or with electronic approval systems, this may occur in real-time, whereas in low-and-middle-income countries, delayed manual review of an antimicrobial order is a more common scenario.

Which interventions?

Some general principles, adaptable to your context.

- It is often more acceptable to start with persuasive and educative measures.
- Do not put too much energy into education and guidelines, as their impact is usually modest (they are necessary but not sufficient), especially if knowledge is not the main barrier to appropriate prescribing. Re-use and adapt existing guidelines or educational resources.
- Carefully consider feasibility of introducing an IT system to support your programme [37,38].
- Consider early restrictive measures if there are mandatory requirements in your region/country, or if there is specific use that needs rapid correction [39]; the initial focus is often on restricted antibiotics (post-authorization) and reduced durations of treatment.
- Give systematic advice on optimization of the diagnostic process (thorough history and clinical examination, investigations and imaging when appropriate), including optimizing blood culture technique and interpretation of positive cultures [40,41].
- Start ward rounds in high prescribing departments, involving your selected champions and the clinicians managing the patients; give real-time feedback on prescriptions and contextualized teaching; ensure that everyone on the rounds has a voice and becomes involved in the discussions, to transfer of skills. Team members bring their own expertise to an ASP, and all have an important role to play.
- Surgical prophylaxis (indication, choice, timing, duration) is low-hanging fruit.
- Be available to clinicians, for advice on request.

Months 5 and 6—implementation and monitoring

This period is ~70% implementation, 30% monitoring, analysing and reporting.

Continue all actions previously discussed

Present your action plan to the antimicrobial stewardship committee

The stewardship team should now have designed a mature action plan. Present it for discussion and validation to the committee. Review the action plan on an annual basis.

Present your core set of measures to the hospital management

Hospital management buy-in for the ASP is critical from the start. Ideally, each party commits itself to a set of actions, with corresponding measures and targets. Review periodically.

Include carefully selected, achievable measures (Table 2) that are relevant to hospital management. Promising to decrease antibiotic resistance (e.g. the prevalence of third-generation cephalosporin-resistant *Escherichia coli* bacteraemia) is a risky commitment, as it depends on multiple, difficult to control factors, for example, admission of high-risk patients and infection prevention and control measures; moreover, impacting resistance through AMS and other measures can be a long-term goal commonly with a time lag of several (usually 2–5) years. Manage expectations; the quantity of antimicrobial prescriptions is likely to decrease by at least 10%–20% during the first 2 years, but will then probably reach a plateau; however, discontinuing the ASP will bring antimicrobial use back to its pre-intervention level.

ASPs require sufficient and sustained funding. Here are some tips to accrue extra resources from your hospital management for an understaffed programme.

- Build a business case [42,43]. Try to demonstrate cost savings (e.g. reduced length of stay, reduced antimicrobial costs, or reduction in antimicrobial adverse events).
- Present the programme as a patient safety initiative; including a patient story might also be very meaningful to executives.
- Avoid over-promising to mitigate executive expectations regarding savings. Costs may not be entirely in your control (e.g. an outbreak of a drug-resistant pathogen, or a drug shortage).
- Benchmark your ASP to other programmes and use the existing literature to highlight staffing needs and motivate for more human resources [44–47]. Use your set of measures to demonstrate this.
- Be persistent.

Present your data to prescribers and clinical staff

Give feedback on antimicrobial use, both appropriateness and quantity (and resistance data if available) in selected wards and/or units. Dashboards or quality control charts are useful tools. Benchmarking units/wards can create a healthy competition for quality improvement.

Build up your implementation programme slowly, ensuring focused action on low-hanging fruits and key problem areas. This may include expanding the range of interventions with a mix of persuasive and restrictive actions. Communicate early successes.

Conclusions

We have briefly summarized the main steps to developing a hospital ASP. Many of the recommendations can be adopted by ASPs that are already in their early phases, or if yours is not working, can be used as a helpful guide to where things may be going wrong. We hope that you will find this overview useful. Good luck!

Transparency declaration

All authors have stated that there are no conflicts of interest to declare.

Funding

No external funding was received.

Contribution

CP initiated the review and wrote the first draft. All authors improved the manuscript, that was finalized by MM and CP.

References

- [1] World Health Organization. Antimicrobial resistance national action plans. Available at: <https://www.who.int/antimicrobial-resistance/national-action-plans/en/>.
- [2] Davey P, Marwick CA, Scott CL, Charani E, McNeil K, Brown E, et al. Interventions to improve antibiotic prescribing practices for hospital inpatients. *Cochrane Database Syst Rev* 2017;2:CD003543.
- [3] Dyar OJ, Huttner B, Schouten J, Pulcini C. What is antimicrobial stewardship? *Clin Microbiol Infect* 2017;23:793–8.
- [4] Hulscher MEJL, Prins JM. Antibiotic stewardship: does it work in hospital practice? A review of the evidence base. *Clin Microbiol Infect* 2017;23:799–805.
- [5] Kallen MC, Ten Oever J, Prins JM, Kullberg BJ, Schouten JA, Hulscher MEJL. A survey on antimicrobial stewardship prerequisites, objectives and improvement strategies: systematic development and nationwide assessment in Dutch acute care hospitals. *J Antimicrob Chemother* 2018;73:3496–504.
- [6] Cosgrove SE, Hermesen ED, Rybak MJ, File Jr TM, Parker SK, Barlam TF. Guidance for the knowledge and skills required for antimicrobial stewardship leaders. *Infect Control Hosp Epidemiol* 2014;35:1444–51.
- [7] Luther VP, Shnekendorf R, Abbo LM, Advani S, Armstrong WS, Barsoumian AE, et al. Antimicrobial stewardship training for infectious Diseases Fellows: program directors identify a curriculum need. *Clin Infect Dis* 2018;67:1285–7.
- [8] World Health Organization. WHO competency framework for health workers' education and training on antimicrobial resistance. Available at: <https://www.who.int/hrh/resources/WHO-HIS-HWF-AMR-2018.1/en/>.
- [9] Dyar OJ, Tebano G, Pulcini C. Managing responsible antimicrobial use: perspectives across the healthcare system. *Clin Microbiol Infect* 2017;23:441–7.
- [10] Pulcini C, Binda F, Lamkang AS, Trett A, Charani E, Goff DA, et al. Developing core elements and checklist items for global hospital antimicrobial stewardship programmes: a consensus approach. *Clin Microbiol Infect* 2019;25:20–5.
- [11] Beović B, Pulcini C, Dumartin C, Béraud G, Nerat B, Maurel C, et al. Legal framework of antimicrobial stewardship in hospitals (LEASH): a European Society of Clinical Microbiology and Infectious Diseases (ESCMID) cross-sectional international survey. *Int J Antimicrob Agents* 2018;52:616–21. https://www.jointcommission.org/assets/1/6/New_Antimicrobial_Stewardship_Standard.pdf; 2016.
- [13] <https://www.safetyandquality.gov.au/sites/default/files/2019-04/National-Safety-and-Quality-Health-Service-Standards-second-edition.pdf>; 2017.
- [14] <https://www.safetyandquality.gov.au/our-work/clinical-care-standards/antimicrobial-stewardship-clinical-care-standard>.
- [15] Accreditation Canada. Required Organizational Practices (ROP) Handbook. <https://accreditation.ca/required-organizational-practices/>; 2017.
- [16] <https://healthstandards.org/public-reviews/antimicrobial-stewardship/>; 2019.
- [17] Charani E, Castro-Sánchez E, Holmes A. The role of behavior change in antimicrobial stewardship. *Infect Dis Clin North Am* 2014;28:169–75.
- [18] World Health Organization. WHO methodology to measure antibiotic use in hospitals. Available at: https://www.who.int/medicines/access/antimicrobial_resistance/meth-to-measure-antibiotic-use/en/.
- [19] Stanic Benic M, Milanic R, Monnier AA, Gyssens IC, Adriaenssens N, Versporten A, et al. Metrics for quantifying antibiotic use in the hospital setting: results from a systematic review and international multidisciplinary consensus procedure. *J Antimicrob Chemother* 2018;73:vi50–8.
- [20] Dresser LD, Bell CM, Steinberg M, Ferguson ND, Lapinsky S, Lazar N, et al. Use of a structured panel process to define antimicrobial prescribing appropriateness in critical care. *J Antimicrob Chemother* 2018;73:246–9.
- [21] Spivak ES, Cosgrove SE, Srinivasan A. Measuring appropriate antimicrobial use: attempts at opening the black box. *Clin Infect Dis* 2016;63:1639–44.
- [22] James R, Upjohn L, Cotta M, Luu S, Marshall C, Buising K, et al. Measuring antimicrobial prescribing quality in Australian hospitals: development and evaluation of a national antimicrobial prescribing survey tool. *J Antimicrob Chemother* 2015;70:1912–8.
- [23] Monnier AA, Schouten J, Le Maréchal M, Tebano G, Pulcini C, Stanic Benic M, et al. Quality indicators for responsible antibiotic use in the inpatient setting: a systematic review followed by an international multidisciplinary consensus procedure. *J Antimicrob Chemother* 2018;73:vi30–9.
- [24] Charani E, Smith I, Skodvin B, Perozziello A, Lucet JC, Lescure FX, et al. Investigating the cultural and contextual determinants of antimicrobial stewardship programmes across low-, middle- and high-income countries—a qualitative study. *PLoS One* 2019;14:e0209847.
- [25] British Society for Antimicrobial Chemotherapy. Antimicrobial stewardship. From principles to practice. Available at: <http://www.bsac.org.uk/antimicrobial-stewardship-from-principles-to-practice-e-book/ebook-download/>.
- [26] Pulcini C, Botelho-Nevers E, Dyar OJ, Harbarth S. The impact of infectious disease specialists on antibiotic prescribing in hospitals. *Clin Microbiol Infect* 2014;20:963–72.
- [27] Broom A, Plage S, Broom J, Kirby E, Adams J. A qualitative study of hospital pharmacists and antibiotic governance: negotiating interprofessional responsibilities, expertise and resource constraints. *BMC Health Serv Res* 2016;16:43.
- [28] Broom A, Broom J, Kirby E, Scambler G. The path of least resistance? Jurisdictions, responsibility and professional asymmetries in pharmacists' accounts of antibiotic decisions in hospitals. *Soc Sci Med* 2015;146:95–103.
- [29] Hall AE, Bryant J, Sanson-Fisher RW, Fradgley EA, Proietto AM, Roos I. Consumer input into health care: time for a new active and comprehensive model of consumer involvement. *Health Expect* 2018;21:707–13.
- [30] Flottorp SA, Oxman AD, Krause J, Musila NR, Wensing M, Godycki-Cwirko M, et al. A checklist for identifying determinants of practice: a systematic review and synthesis of frameworks and taxonomies of factors that prevent or enable improvements in healthcare professional practice. *Implement Sci* 2013;8:35.
- [31] Solberg LI, Mosser G, McDonald S. The three faces of performance measurement: improvement, accountability, and research. *Jt Comm J Qual Improv* 1997;23:135–47.
- [32] Ivers N, Jamtvedt G, Flottorp S, Young JM, Odgaard-Jensen J, French SD, et al. Audit and feedback: effects on professional practice and healthcare outcomes. *Cochrane Database Syst Rev* 2012;6:CD000259.
- [33] Grol R. Beliefs and evidence in changing clinical practice. *BMJ* 1997;315:418–21.
- [34] Heath C, Heath D. *Switch: how to change things when change is hard*. New York: Broadway Books; 2010.
- [35] Michie S, van Stralen MM, West R. The behaviour change wheel: a new method for characterising and designing behaviour change interventions. *Implement Sci* 2011;6:42.
- [36] Institute for Healthcare Improvement. Science improvement—implementing changes. Available at: <http://www.ihl.org/resources/Pages/HowtoImprove/ScienceofImprovementImplementingChanges.aspx>.
- [37] Kuper KM, Nagel JL, Kile JW, May LS, Lee FM. The role of electronic health record and "add-on" clinical decision support systems to enhance antimicrobial stewardship programs. *Infect Control Hosp Epidemiol* 2019;40:501–11.
- [38] Baysari MT, Lehnbohm EC, Li L, Hargreaves A, Day RO, Westbrook JL. The effectiveness of information technology to improve antimicrobial prescribing in hospitals: a systematic review and meta-analysis. *Int J Med Inform* 2016;92:15–34.
- [39] Tamma PD, Avdic E, Keenan JF, Zhao Y, Anand G, Cooper J, et al. What is the more effective antibiotic stewardship intervention: preprescription authorization or postprescription review with feedback? *Clin Infect Dis* 2017;64:537–43.
- [40] Ntusi N, Aubin L, Oliver S, Whitelaw A, Mendelson M. Guideline for the optimal use of blood cultures. *S Afr Med J* 2010;100:839–43.
- [41] Morency-Potvin P, Schwartz DN, Weinstein RA. Antimicrobial stewardship: how the microbiology laboratory can right the ship. *Clin Microbiol Rev* 2016;30:381–407.
- [42] Morris AM, Rennert-May E, Dalton B, Daneman N, Dresser L, Fanella S, et al. Rationale and development of a business case for antimicrobial stewardship programs in acute care hospital settings. *Antimicrob Resist Infect Control* 2018;7:104.
- [43] Spellberg B, Bartlett JG, Gilbert DN. How to pitch an antibiotic stewardship program to the hospital C-suite. *Open Forum Infect Dis* 2016;3:ofw210.
- [44] Pulcini C, Morel CM, Tacconelli E, Beović B, de With K, Goossens H, et al. Human resources estimates and funding for antibiotic stewardship teams are urgently needed. *Clin Microbiol Infect* 2017;23:785–7.
- [45] Ten Oever J, Harmsen M, Schouten J, Ouwens M, van der Linden PD, Verduin CM, et al. Human resources required for antimicrobial stewardship teams: a Dutch consensus report. *Clin Microbiol Infect* 2018;24:1273–9.
- [46] Echevarria K, Groppi J, Kelly AA, Morreale AP, Neuhauser MM, Roselle GA. Development and application of an objective staffing calculator for antimicrobial stewardship programs in the Veterans Health Administration. *Am J Health Syst Pharm* 2017;74:1785–90.
- [47] Stenehjem E, Hersh AL, Buckel WR, Jones P, Sheng X, Evans RS, et al. Impact of implementing antibiotic stewardship programs in 15 small hospitals: a cluster-randomized intervention. *Clin Infect Dis* 2018;67:525–32.
- [48] Department of Health, Republic of South Africa. Guidelines for the prevention and containment of antimicrobial resistance in South African hospitals. 2018. Available at: <http://www.health.gov.za/index.php/antimicrobial-resistance#>.
- [49] Barlam TF, Cosgrove SE, Abbo LM, MacDougall C, Schuetz AN, Sepitimus EJ, et al. Implementing an antibiotic stewardship program: guidelines by the infectious Diseases society of America and the society for healthcare Epidemiology of America. *Clin Infect Dis* 2016;62:e51–77.
- [50] Cox JA, Vlieghe E, Mendelson M, Wertheim H, Ndegwa L, Villegas MV, et al. Antibiotic stewardship in low- and middle-income countries: the same but different? *Clin Microbiol Infect* 2017;23:812–8.
- [51] de With K, Allerberger F, Amann S, Apfalter P, Brodt HR, Eckmanns T, et al. Strategies to enhance rational use of antibiotics in hospital: a guideline by the German society for infectious diseases. *Infection* 2016;44:395–439.
- [52] Antimicrobial Stewardship—a practical guide to implementation in hospitals. *JAC-Antimicrob Resist* 2019;1:dlz005.