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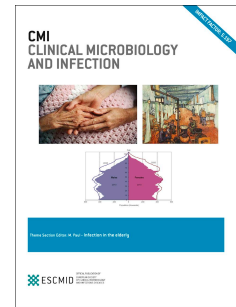
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Developing core elements and checklist items for global hospital antimicrobial stewardship programmes: a consensus approach

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1 CONSENSUS PAPER**2 Developing core elements and checklist items for global hospital antimicrobial
3 stewardship programmes: a consensus approach**

4

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49 **ABSTRACT**

50 **Objectives.** With increasing interest in hospital antimicrobial stewardship (AMS)
51 programmes globally, there is a strong demand for core elements of AMS to be clearly
52 defined based on principles of effectiveness and affordability. To date, efforts to identify such
53 core elements have been limited to Europe, Australia, and North America. The aim of this
54 study was to develop a set of core elements and their related checklist items for AMS
55 programmes that should be present in all hospitals, regardless of resource availability,
56 worldwide.

57 **Methods.** A literature review was performed by searching Medline and relevant websites to
58 retrieve a list of core elements and items that could be relevant globally. These core elements
59 and items were evaluated by an international group of AMS experts using a structured
60 modified Delphi consensus procedure, using two-phased online in-depth questionnaires.

61 **Results.** The literature review identified 7 core elements and their related 29 checklist items
62 from 48 references. Fifteen experts from 12 countries in 6 continents participated in the
63 consensus procedure. Ultimately, all 7 core elements were retained, as well as 28 of the initial
64 checklist items plus 1 that was newly suggested, all with $\geq 80\%$ agreement; 20 elements and
65 items were rephrased.

66 **Conclusions.** This consensus on core elements for hospital AMS programmes is relevant to
67 both high and low-to-middle income countries and could facilitate the development of
68 national AMS stewardship guidelines and adoption by healthcare settings worldwide.

69 **INTRODUCTION**

70 Antimicrobial resistance, particularly antibiotic resistance in bacteria, is a global
71 threat, making antimicrobial stewardship (AMS) programmes necessary in all hospitals
72 worldwide [1–3]. A recent review conducted by ESGAP (ESCMID Study Group for
73 Antimicrobial stewardship) authors found that many definitions exist for the abbreviation
74 AMS [2]. The authors suggested that it is best to view the collective daily actions within AMS
75 as a strategy, and they proposed the following definition: “Antimicrobial stewardship is a
76 coherent set of actions which promote using antimicrobials in ways that ensure sustainable
77 access to effective therapy for all who need them” [2]. The absence of a universal definition
78 for AMS combined with a lack of international guidance and standards are among the many
79 barriers to the implementation of these programmes globally, especially in low and middle-
80 income countries (LMICs) [2,4]. In North America, Europe, and Australia, collaborative
81 groups have identified, through a consensual approach, core elements considered essential for
82 successful AMS programmes [5–9]. These core elements, often bundled into checklists, offer
83 healthcare providers a pragmatic and measurable means of developing, implementing, and
84 measuring the impact of hospital AMS programmes. Their applicability, contextual relevance,
85 and value in other geographies, cultures, and resource settings, particularly LMICs, have not
86 been previously explored.

87 Our objective was to identify existing core elements for hospital AMS programmes
88 and assess their broader global relevance. This was done by undertaking a literature review
89 followed by a structured consensus procedure involving experts.

90 **METHODS**

91 Our objective was to identify a set of core elements and their related checklist items
92 [10], describing the essential and minimum standards for AMS programmes in hospitals
93 worldwide.

94

95 *Group of experts*

96 The steering committee (CP, FB, ASL, AT, SG, RL) invited 15 experts (all other
97 coauthors) to participate in this study. Experts from different backgrounds (infectious diseases
98 specialists, clinical microbiologists and clinical pharmacists) were selected based on their
99 recognized expertise in AMS across various geographic settings in six continents (North
100 America = 2, South America = 2, Europe = 5, Africa = 2, Asia = 3, Australia = 1), all having
101 extensive hands-on experience with AMS in LMICs and most of them serving as experts for
102 health authorities and policy-makers on the AMS topic.

103

104 *Literature review and website search*

105 In August–September 2017, the steering committee (six researchers) performed a
106 narrative literature review of PubMed with the following key words: (antibiotic or
107 antimicrobial) and stewardship and (review or guidelines or standard or core or checklist), in
108 addition to a website search (relevant agencies and organizations, such as World Health
109 Organization (WHO) or European Centre for Disease Prevention and Control (ECDC), to
110 search for existing core elements for hospital AMS programmes. Only reviews,
111 guidance/guidelines and consensus documents were included. Additional references were
112 identified by the 15 experts, with no language restriction (all authors assisted with translation
113 when required). Data was extracted by two junior researchers and double checked by two
114 senior researchers. Based on the final list of references [3–50], the steering committee

115 compiled summary tables (listing all core elements and checklist items found, with their
116 corresponding references), which were made available to the experts. CP and SG developed
117 an initial set of core elements and their related checklist items, to be assessed by the experts,
118 based on the summary tables, selecting the elements and items they thought might be relevant
119 worldwide. A core element was defined as a broad category of actions/a strategy within an
120 AMS programme (e.g. Education), whereas checklist items described specific
121 actions/interventions within a specific core element. Several checklist items were then listed
122 under each core element.

123

124 *Consensus procedure*

125 The list of core elements and checklist items based on the literature review and the
126 website search (as well as the detailed summary tables) was presented to the group of 15
127 experts for a modified Delphi consensus procedure [51], consisting of two surveys (first and
128 second rounds). Invitation to participate in the survey was sent by email. A teleconference
129 was organised early November by the steering committee, to explain the objectives and
130 methods to all experts, and reply to their questions.

131 For the first round (November 2017), the list of core elements and checklist items
132 were converted into an internet-based questionnaire using SurveyMonkey (Palo Alto,
133 California, USA). Respondents were asked to select all core elements and checklist items they
134 felt were essential worldwide and should be part of AMS programmes in all hospitals and in
135 all countries, using a “yes/no” option; a “comments” box was provided for each element/item,
136 including suggestions for rephrasing. Elements and items were (1) selected if agreement was
137 $\geq 80\%$ (i.e., 12 experts or more); (2) held for reassessment during the second round if
138 agreement was between 70% and 79% (11 experts); (3) rejected if agreement was $< 70\%$
139 (fewer than 11 experts). Experts were also asked to suggest new elements and items for

140 further assessment, in addition to rephrasing. Newly suggested elements and items were
141 considered for inclusion in the second round if at least three experts made the same
142 suggestion.

143 During the second round (December 2017), all previously accepted, newly added, and
144 rephrased elements and items were presented in a second internet-based questionnaire, which
145 was sent to all experts who had participated in the first round. Experts were asked to rate the
146 newly suggested items and the items held for reassessment, as well as to choose the best
147 phrasing when appropriate (the selected phrasing was the one with >50% agreement). A
148 “comments” box for open-ended feedback was available for all elements and items.

149 **RESULTS**150 *Literature review and website search*

151 We identified 48 relevant references (written in Chinese, English, French or Spanish)
152 [3–50] and came up with an initial set of 7 core elements and 29 checklist items.

153

154 *Consensus procedure*

155 All 15 experts participated in the two rounds of the survey. During the first round, all
156 7 core elements were selected, as well as 27 out of the 29 checklist items, while 1 item was
157 held for reassessment, 1 was rejected, and 2 additional items were newly suggested by 3
158 experts. Rephrasing was suggested for 27 elements/items, and comments were added for 14 of
159 them. During the second round, 2 out of 3 items were selected, and the final phrasing was
160 decided upon (newly suggested phrasing was chosen in 20 out of 27 cases). The procedure is
161 summarised in Figure 1, with the final set of 7 core elements and 29 checklist items presented
162 in Boxes 1 to 7 (Appendix S1 presents the full details of the procedure). The core elements
163 were as follows: senior hospital management leadership towards AMS (Box 1, 3 checklist
164 items), accountability & responsibilities (Box 2, 7 items), available expertise on infection
165 management (Box 3, 2 items), education & practical training (Box 4, 2 items), other actions
166 aiming at responsible antimicrobial use (Box 5, 8 items), monitoring & surveillance (Box 6, 4
167 items), and reporting & feedback (Box 7, 3 items).

168 DISCUSSION

169 Based on a pragmatic literature review and a structured consensus procedure, we
170 developed minimum core elements and checklist items that could be relevant to hospital AMS
171 programmes worldwide. Even though most of these checklist items may not currently exist in
172 most hospitals in low-income countries, we included all of them on the list because our main
173 objective was to identify universally relevant, essential elements and items based on the best
174 available evidence. These 7 core elements and their related 29 checklist items could be
175 adapted and adopted locally depending on factors such as clinical setting and resource
176 availability. They provide a baseline of key elements required to start hospital AMS
177 programmes, and could be further modified and used for accreditation/certification,
178 benchmarking, or scrutiny/performance purposes [52,53]. We were purposely as generic as
179 possible in the phrasing of elements and items so that countries could adapt them to their own
180 situations, for example regarding the composition of AMS teams.

181 When comparing our 7 core elements and 29 checklist items with the list developed by
182 the Centers for Disease Control and Prevention (CDC) in the United States, we found that
183 both lists of core elements are very similar in content, even though the phrasing is different
184 [6]. The CDC also validated 7 core elements: leadership commitment, accountability, drug
185 expertise, action, tracking, reporting, and education [6]. The CDC developed a shorter list of
186 22 related checklist items [6], 12 of them being quite close to the checklist items we selected.
187 Our list of 29 checklist items is, however, both more comprehensive and more generic,
188 reflecting our objective of being relevant to any hospital worldwide.

189 Implementing AMS programmes in hospitals is one aspect of the comprehensive One
190 Health strategy needed to tackle antimicrobial resistance [1]. The importance of having such
191 programmes in the community or primary care setting, that are aligned with hospital
192 programmes, cannot be underestimated [53]. Implementing a hospital AMS programme is

193 also not possible without a strong commitment from policymakers, senior leadership, and
194 national initiatives to guarantee access to good-quality, equitably priced essential
195 antimicrobials [54]. In addition, education for the public and health professionals is a
196 necessary prerequisite to initiating strong and lasting AMS programmes.

197 Our work has several limitations. We did not conduct a systematic literature review
198 but are confident we have not missed significant references, as we have included recent
199 systematic reviews on the topic, and additional references were identified by a large panel of
200 AMS experts, with no language restriction [3]. The number of experts involved in the
201 consensus procedure was relatively small, even though the number was close to previously
202 published consensus procedures [5,55]. Like all consensus procedures, ours was biased by the
203 opinions of the experts, who all primarily had the perspective of the steward. Experts who
204 serve in administrative roles in healthcare and thus represent more of the perspective of a
205 hospital might have had different answers.

206 In conclusion, we propose here an evaluation framework for hospital AMS
207 programmes that could be relevant across both resource-rich and resource-limited contexts.
208 Evaluating its value and then its feasibility and measurability in a range of geographic and
209 resource settings, with a broader stakeholder group should be the next step.

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215

216 TRANSPARENCY DECLARATIONS

217 There is no conflict of interest to declare for any of the authors.

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223 The opinions expressed in this article are those of the authors and do not necessarily reflect
224 the views of the Centers for Disease Control and Prevention.

225 **REFERENCES**

- 226 [1] World Health Organization. Global action plan on antimicrobial resistance.
227 http://www.wpro.who.int/entity/drug_resistance/resources/global_action_plan_eng.pdf
- 228 [2] Dyar OJ, Huttner B, Schouten J, Pulcini C. What is antimicrobial stewardship? Clin
229 Microbiol Infect 2017;23(11):793–798.
- 230 [3] Hulscher MEJL, Prins JM. Antibiotic stewardship: does it work in hospital practice? A
231 review of the evidence base. Clin Microbiol Infect 2017;23(11):799–805.
- 232 [4] Cox JA, Vlieghe E, Mendelson M, Wertheim H, Ndegwa L, Villegas MV et al. Antibiotic
233 stewardship in low- and middle-income countries: the same but different? Clin Microbiol
234 Infect 2017;23(11):812–818.
- 235 [5] Transatlantic Taskforce on Antimicrobial Resistance (TATFAR): summary the modified
236 Delphi process for common structure and process indicators for hospital antimicrobial
237 stewardship programs. 2015.
238 https://www.cdc.gov/drugresistance/pdf/summary_of_tatfar_recommendation_1.pdf
- 239 [6] Centers for Disease Control and Prevention. Core elements of hospital antibiotic
240 stewardship programs. Atlanta, GA: US Department of Health and Human Services, CDC;
241 2014. <https://www.cdc.gov/getsmart/healthcare/implementation/core-elements.html>
- 242 [7] Joint Commission on Hospital Accreditation. New Antimicrobial Stewardship Standard. Jt
243 Comm Perspect. 2016 Jul;36(7):1, 3–4, 8.
244 https://www.jointcommission.org/assets/1/6/New_Antimicrobial_Stewardship_Standard.pdf
- 245 [8] Australian Commission on Safety and Quality in Health Care. Antimicrobial stewardship
246 in Australian hospitals; 2011. [https://www.safetyandquality.gov.au/our-work/healthcare-](https://www.safetyandquality.gov.au/our-work/healthcare-associated-infection/antimicrobial-stewardship/book/)
247 [associated-infection/antimicrobial-stewardship/book/](https://www.safetyandquality.gov.au/our-work/healthcare-associated-infection/antimicrobial-stewardship/book/)
- 248 [9] European Centre for Disease Prevention and Control. Proposals for EU guidelines on the
249 prudent use of antimicrobials in humans. Stockholm: ECDC; 2017.

- 250 <https://ecdc.europa.eu/sites/portal/files/media/en/publications/Publications/EU-guidelines->
251 [prudent-use-antimicrobials.pdf](https://ecdc.europa.eu/sites/portal/files/media/en/publications/Publications/EU-guidelines-prudent-use-antimicrobials.pdf)
- 252 [10] European Centre for Disease Prevention and Control. EU Guidelines for the prudent use
253 of antimicrobials in human health. Stockholm: ECDC; 2017.
254 https://ec.europa.eu/health/amr/sites/amr/files/amr_guidelines_prudent_use_en.pdf
- 255 [11] Barlam TF, Cosgrove SE, Abbo LM, MacDougall C, Schuetz AN, Septimus EJ, *et al.*
256 Implementing an antibiotic stewardship program: guidelines by the Infectious Diseases
257 Society of America and the Society for Healthcare Epidemiology of America. *Clin Infect Dis*
258 2016;62(10):e51–e77.
- 259 [12] Davey P, Marwick CA, Scott CL, Charani E, McNeil K, Brown E, *et al.* Interventions to
260 improve antibiotic prescribing practices for hospital inpatients. *Cochrane Database Syst Rev*
261 2017;2:CD003543.
- 262 [13] Schuts EC, Hulscher MEJL, Mouton JW, Verduin CM, Stuart JWTC, Overdiek HWPM,
263 *et al.* Current evidence on hospital antimicrobial stewardship objectives: a systematic review
264 and meta-analysis. *Lancet Infect Dis* 2016;16(7):847–856.
- 265 [14] de With K, Allerberger F, Amann S, Apfalter P, Brodt HR, Eckmanns T, *et al.* Strategies
266 to enhance rational use of antibiotics in hospital: a guideline by the German Society for
267 Infectious Diseases. *Infection* 2016;44(3):395–439.
- 268 [15] NICE Guidelines: Antimicrobial stewardship: systems and processes for effective
269 antimicrobial medicine use. 2015. <https://www.nice.org.uk/guidance/ng15>
- 270 [16] Dyar OJ, Tebano G, Pulcini C. Managing responsible antimicrobial use: perspectives
271 across the healthcare system. *Clin Microbiol Infect* 2017;23(7):441–447.
- 272 [17] SWAB Guidelines for Antimicrobial Stewardship. 2016.
273 [http://www.swab.nl/swab/cms3.nsf/uploads/DBDCF976C0F7A4D8C125802B006BCA7D/\\$F](http://www.swab.nl/swab/cms3.nsf/uploads/DBDCF976C0F7A4D8C125802B006BCA7D/$F)

- 274 [ILE/20160909%20Concept%20SWAB%20Guidelines%20for%20Antimicrobial%20Steward](#)
275 [ship.pdf](#)
- 276 [18] Practical Guide Antimicrobial Stewardship in the Netherlands work group. The Practical
277 guide antimicrobial stewardship in the Netherlands. [http://esgap.escmid.org/wp-](http://esgap.escmid.org/wp-content/uploads/2015/11/SWAB_guideline_ABS_hospitals.pdf)
278 [content/uploads/2015/11/SWAB_guideline_ABS_hospitals.pdf](http://esgap.escmid.org/wp-content/uploads/2015/11/SWAB_guideline_ABS_hospitals.pdf)
- 279 [19] Public Health England. Start Smart – Then Focus antimicrobial stewardship toolkit for
280 English hospitals. 2015.
281 [https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/417032/Start_S](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/417032/Start_Smart_Then_Focus_FINAL.PDF)
282 [mart_Then_Focus_FINAL.PDF](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/417032/Start_Smart_Then_Focus_FINAL.PDF)
- 283 [20] SARI Hospital Antimicrobial Stewardship Working Group. Guidelines for antimicrobial
284 stewardship in hospitals in Ireland. 2009. [https://www.hpsc.ie/a-](https://www.hpsc.ie/a-z/microbiologyantimicrobialresistance/infectioncontrolandhai/guidelines/File,4116,en.pdf)
285 [z/microbiologyantimicrobialresistance/infectioncontrolandhai/guidelines/File,4116,en.pdf](https://www.hpsc.ie/a-z/microbiologyantimicrobialresistance/infectioncontrolandhai/guidelines/File,4116,en.pdf)
- 286 [21] Bailey C, Tully MP, Pampaka M, Cooke J. Rasch analysis of the antimicrobial self-
287 assessment toolkit for National Health Service (NHS) trusts (ASAT v17). *J Antimicrob*
288 *Chemother* 2017;72(2):604–613.
- 289 [22] Bailey C, Tully M, Cooke J. An investigation into the content validity of the
290 antimicrobial self-assessment toolkit for NHS trusts (ASAT v15a) using cognitive interviews
291 with antimicrobial pharmacists. *J Clin Pharm Ther* 2015;40(2):208–212.
- 292 [23] Cooke J, Alexander K, Charani E, Hand K, Hills T, Howard P, *et al.* Antimicrobial
293 stewardship: an evidence-based, antimicrobial self-assessment toolkit (ASAT) for acute
294 hospitals. *J Antimicrob Chemother* 2010;65(12):2669–2673.
- 295 [24] DRIVE-AB. Quality indicators & quantity metrics of antibiotic use (DRIVE-AB
296 WP1A). 2016. [http://drive-ab.eu/wp-content/uploads/2014/09/WP1A_Final-QMs-](http://drive-ab.eu/wp-content/uploads/2014/09/WP1A_Final-QMs-QIs_final.pdf)
297 [QIs_final.pdf](http://drive-ab.eu/wp-content/uploads/2014/09/WP1A_Final-QMs-QIs_final.pdf)

- 298 [25] Haute Autorité de Santé. Indicateurs de qualité et de sécurité des soins. Thème infection
299 associée aux soins (IAS) – Grille de recueil, consignes de remplissage et éléments de preuves
300 – Indicateur composite de bon usage des antibiotiques ICATB 2. 2016. [https://www.has-](https://www.has-sante.fr/portail/upload/docs/application/pdf/2016-4/2016_has_grille_de_recueil_icatb_2.pdf)
301 [sante.fr/portail/upload/docs/application/pdf/2016-4/2016_has_grille_de_recueil_icatb_2.pdf](https://www.has-sante.fr/portail/upload/docs/application/pdf/2016-4/2016_has_grille_de_recueil_icatb_2.pdf)
- 302 [26] Australian Commission on Safety and Quality in Health Care. Safety and quality
303 improvement guide standard 3: preventing and controlling healthcare associated infections
304 (October 2012). Sydney. ACSQHC, 2012. [https://www.safetyandquality.gov.au/wp-](https://www.safetyandquality.gov.au/wp-content/uploads/2012/10/Standard3_Oct_2012_WEB.pdf)
305 [content/uploads/2012/10/Standard3_Oct_2012_WEB.pdf](https://www.safetyandquality.gov.au/wp-content/uploads/2012/10/Standard3_Oct_2012_WEB.pdf)
- 306 [27] Thern J, de With K, Strauss R, Steib-Bauert M, Weber N, Kern WV. Selection of
307 hospital antimicrobial prescribing quality indicators: a consensus among German antibiotic
308 stewardship (ABS) networkers. *Infection* 2014;42(2):351–362.
- 309 [28] Ministerial Advisory Committee on Antimicrobial Resistance National Department of
310 Health Affordable Medicines Directorate. Guidelines on implementation of the antimicrobial
311 strategy in South Africa: One Health approach & governance. 2017. [http://nahf.co.za/wp-](http://nahf.co.za/wp-content/uploads/Antimicrobial-Stewardship-Guidelines-Governance_June2017.pdf)
312 [content/uploads/Antimicrobial-Stewardship-Guidelines-Governance_June2017.pdf](http://nahf.co.za/wp-content/uploads/Antimicrobial-Stewardship-Guidelines-Governance_June2017.pdf)
- 313 [29] van den Bosch CM, Geerlings SE, Natsch S, Prins JM, Hulscher ME. Quality indicators
314 to measure appropriate antibiotic use in hospitalized adults. *Clin Infect Dis* 2015;60(2):281–
315 291.
- 316 [30] Morris AM. Antimicrobial stewardship programs: appropriate measures and metrics to
317 study their impact. *Curr Treat Options Infect Dis* 2014;6(2):101–112.
- 318 [31] National Quality Forum. National Quality Partners playbook: antibiotic stewardship in
319 acute care. 2016.
320 [http://www.qualityforum.org/Publications/2016/05/National_Quality_Partners_Playbook_A](http://www.qualityforum.org/Publications/2016/05/National_Quality_Partners_Playbook_Antibiotic_Stewardship_in_Acute_Care.aspx)
321 [ntibiotic Stewardship in Acute Care.aspx](http://www.qualityforum.org/Publications/2016/05/National_Quality_Partners_Playbook_Antibiotic_Stewardship_in_Acute_Care.aspx)

322 [32] Goff DA, Kullar R, Bauer KA, File TM Jr. Eight habits of highly effective antimicrobial
323 stewardship programs to meet the Joint Commission standards for hospitals. *Clin Infect Dis*
324 2017;64(8):1134–1139.

325 [33] Ontario Agency for Health Protection and Promotion (Public Health Ontario). Getting
326 started: a gap analysis tool for antimicrobial stewardship programs. Toronto, ON: Queen's
327 Printer for Ontario; 2016.
328 [https://www.publichealthontario.ca/fr/eRepository/Getting%20started%20-](https://www.publichealthontario.ca/fr/eRepository/Getting%20started%20-%20An%20ASP%20gap%20analysis%20checklist.pdf)
329 [%20An%20ASP%20gap%20analysis%20checklist.pdf](https://www.publichealthontario.ca/fr/eRepository/Getting%20started%20-%20An%20ASP%20gap%20analysis%20checklist.pdf)

330 [34] Dik JW, Hendrix R, Poelman R, Niesters HG, Postma MJ, Sinha B, *et al.* Measuring the
331 impact of antimicrobial stewardship programs. *Expert Rev Anti Infect Ther* 2016;14(6):569–
332 575.

333 [35] Akpan MR, Ahmad R, Shebl NA, Ashiru-Oredope D. A review of quality measures
334 assessing the impact of antimicrobial stewardship programs in hospitals. *Antibiotics (Basel)*
335 2016;13;5(1).

336 [36] Simões AS, Gregório J, Póvoa P, Lapão LV. Practical guide for the implementation of
337 antibiotic stewardship programs. 2015. [http://3dmfsx6ameqwfd31pu5rjxq.wpengine.netdna-](http://3dmfsx6ameqwfd31pu5rjxq.wpengine.netdna-cdn.com/wp-content/uploads/2015/10/policy-paper-eng.pdf)
338 [cdn.com/wp-content/uploads/2015/10/policy-paper-eng.pdf](http://3dmfsx6ameqwfd31pu5rjxq.wpengine.netdna-cdn.com/wp-content/uploads/2015/10/policy-paper-eng.pdf)

339 [37] Pan American Health Organization. Monitoring and evaluation of the Global Action Plan
340 on Antimicrobial Resistance (AMR): regional expert consultation on monitoring and
341 evaluation of AMR interventions. Washington, DC, 26–27 January 2017.
342 [http://www.paho.org/hq/index.php?option=com_content&view=article&id=13040%3Aexpert](http://www.paho.org/hq/index.php?option=com_content&view=article&id=13040%3Aexpert-consultation-on-monitoring-and-evaluation-of-antimicrobial-resistance-amr-interventions&catid=4228%3Aamr-pages&Itemid=42280&lang=en)
343 [-consultation-on-monitoring-and-evaluation-of-antimicrobial-resistance-amr-](http://www.paho.org/hq/index.php?option=com_content&view=article&id=13040%3Aexpert-consultation-on-monitoring-and-evaluation-of-antimicrobial-resistance-amr-interventions&catid=4228%3Aamr-pages&Itemid=42280&lang=en)
344 [interventions&catid=4228%3Aamr-pages&Itemid=42280&lang=en](http://www.paho.org/hq/index.php?option=com_content&view=article&id=13040%3Aexpert-consultation-on-monitoring-and-evaluation-of-antimicrobial-resistance-amr-interventions&catid=4228%3Aamr-pages&Itemid=42280&lang=en)

- 345 [38] Strengthening Pharmaceutical Systems. 2012. How to investigate antimicrobial use in
346 hospitals: selected indicators. Arlington, VA: Management Sciences for Health.
347 <http://apps.who.int/medicinedocs/en/d/Js21031en/>
- 348 [39] Centers for Disease Control and Prevention. Implementation of antibiotic stewardship
349 core elements at small and critical access hospitals. Atlanta, GA: US Department of Health
350 and Human Services, CDC. [https://www.cdc.gov/getsmart/healthcare/implementation/core-](https://www.cdc.gov/getsmart/healthcare/implementation/core-elements-small-critical.html)
351 [elements-small-critical.html](https://www.cdc.gov/getsmart/healthcare/implementation/core-elements-small-critical.html)
- 352 [40] Chinese Ministry of Health. Regulations on clinical applications of antimicrobials. No.
353 84. 2012. <http://www.nhfpc.gov.cn/mohzcfgs/s3576/201205/54645.shtml>
- 354 [41] Villegas MV, Esparza G, Zurita J, Bavestrello L, García Cañete P, Cuellar L, *et al.* Guía
355 para la implementación de un Programa de Optimización de Antimicrobianos a nivel
356 hospitalario. Comité de Antimicrobianos y Resistencia, Asociación Panamericana de
357 Infectología. 2017. [http://www.apinfectologia.com/wp-content/archivos/manual-](http://www.apinfectologia.com/wp-content/archivos/manual-PROA_2016.pdf)
358 [PROA_2016.pdf](http://www.apinfectologia.com/wp-content/archivos/manual-PROA_2016.pdf)
- 359 [42] Rodríguez-Baño J, Paño-Pardo JR, Alvarez-Rocha L, Asensio A, Calbo E, Cercenado E,
360 *et al.* Programs for optimizing the use of antibiotics (PROA) in Spanish hospitals: GEIH-
361 SEIMC, SEFH and SEMPSPH consensus document. *Enferm Infecc Microbiol Clin*
362 2012;30(1):22.e1–22.e23.
- 363 [43] Ghafur A, Mathai D, Muruganathan A, Jayalal JA, Kant R, Chaudhary D, *et al.* The
364 Chennai Declaration: a roadmap to tackle the challenge of antimicrobial resistance. *Indian J*
365 *Cancer* 2013;50(1):71–73.
- 366 [44] Wertheim HFL, Chandna A, Vu PD, Pham CV, Nguyen PDT, Lam YM, *et al.* Providing
367 impetus, tools, and guidance to strengthen national capacity for antimicrobial stewardship in
368 Viet Nam. *PLoS Medicine* 2013;10(5):e1001429.

- 369 [45] Charani E, Holmes AH. Antimicrobial stewardship programmes: the need for wider
370 engagement. *BMJ Qual Saf* 2013;22(11):885–887.
- 371 [46] Allerberger F, Gareis R, Jindrák V, Struelens MJ. Antibiotic stewardship implementation
372 in the EU: the way forward. *Expert Rev Anti Infect Ther* 2009;7(10):1175–1183.
- 373 [47] MacDougall C, Polk RE. Antimicrobial stewardship programs in health care systems.
374 *Clin Microbiol Rev* 2005;18:638–656.
- 375 [48] Quet F, Vlieghe E, Leyer C, Buisson Y, Newton PN, Naphayvong P, *et al.* First national
376 workshop on antibiotic resistance in Cambodia: Phnom Penh, Cambodia, 16–18 November
377 2011. *J Glob Antimicrob Resist* 2013;1(1):31–34.
- 378 [49] Barbé B, Yansouni CP, Affolabi D, Jacobs J. Implementation of quality management for
379 clinical bacteriology in low-resource settings. *Clin Microbiol Infect* 2017;23(7):426–433.
- 380 [50] Ombet S, Ronat JB, Walsh T, Yansouni CP, Cox J, Vlieghe E, *et al.* Clinical
381 bacteriology in low-resource settings: today's solutions. *Lancet Infect Dis.* 2018 Mar 5. pii:
382 S1473-3099(18)30093-8.
- 383 [51] Fitch K, Bernstein SJ, Aguilar MD, Burnand B, LaCalle JR, Lázaro P, *et al.* The
384 RAND/UCLA appropriateness method user's manual.
385 https://www.rand.org/content/dam/rand/pubs/monograph_reports/2011/MR1269.pdf
- 386 [52] NHS Improvement. English surveillance programme for antimicrobial utilisation and
387 resistance (ESPAUR). [https://improvement.nhs.uk/resources/english-surveillance-](https://improvement.nhs.uk/resources/english-surveillance-programme-antimicrobial-utilisation-and-resistance-espaur/)
388 [programme-antimicrobial-utilisation-and-resistance-espaur/](https://improvement.nhs.uk/resources/english-surveillance-programme-antimicrobial-utilisation-and-resistance-espaur/)
- 389 [53] Mölsted S, Löfmark S, Carlin K, Erntell M, Aspevall O, Blad L, *et al.* Lessons learnt
390 during 20 years of the Swedish strategic programme against antibiotic resistance.
391 http://www.who.int/bulletin/online_first/BLT.16.184374.pdf

- 392 [54] Pulcini C, Beovic B, Béraud G, Carlet J, Cars O, Howard P, *et al.* Ensuring universal
393 access to old antibiotics: a critical but neglected priority. *Clin Microbiol Infect*
394 2017;23(9):590–592.
- 395 [55] Le Marechal M, Tebano G, Monnier AA, Adriaenssens N, Gyssens IC, Huttner B, *et al.*
396 Quality indicators assessing antibiotic use in the outpatient setting: a systematic literature
397 review followed by a global consensus procedure. *J Antimicrob Chemother* 2018 [e-published
398 ahead of print].
- 399 [56] Pulcini C, Morel CM, Tacconelli E, Beovic B, de With K, Goossens H, *et al.* Human
400 resources estimates and funding for antibiotic stewardship teams are urgently needed. *Clin*
401 *Microbiol Infect* 2017;23(11):785–787.
- 402 [57] World Health Organization Regional Office for Africa. Stepwise laboratory quality
403 improvement process towards accreditation (SLIPTA) checklist version 2:2015: for clinical
404 and public health laboratories. [http://who.int/nam/sites/default/files/pdf/slipta-](http://who.int/nam/sites/default/files/pdf/slipta-checklist0711.pdf)
405 [checklist0711.pdf](http://who.int/nam/sites/default/files/pdf/slipta-checklist0711.pdf)

406 **Box 1. Core element 1: Senior hospital management leadership towards antimicrobial**
407 **stewardship**

Accompanying comment: *This section relates to governance of the programme by hospital executives, and specifies how senior hospital management supports the antimicrobial stewardship programme.*

Checklist item 1.1:

Has your hospital management formally identified antimicrobial stewardship as a priority objective for the institution and included it in its key performance indicators?

Checklist item 1.2:

Is there dedicated, sustainable and sufficient budgeted financial support for antimicrobial stewardship activities (e.g., support for salary, training, or IT (information technology) support)?

Checklist item 1.3:

Does your hospital follow any (national or international) staffing standards for antimicrobial stewardship activities (e.g. number of full-time equivalent (FTE) per 100 beds for the different members of the antimicrobial stewardship team)?

Accompanying comment: *These staffing standards should ideally be set at national level.[56]*

408

409 **Box 2. Core element 2: Accountability & responsibilities**

Checklist item 2.1:

Does your hospital have a formal/written antimicrobial stewardship programme/strategy accountable for ensuring appropriate antimicrobial use?

Accompanying comment: *This should be based on existing national/international guidelines and/or an existing national strategy.*

Checklist item 2.2:

Does your hospital have a formal organizational multidisciplinary structure responsible for antimicrobial stewardship (e.g., a committee focused on appropriate antimicrobial use, pharmacy committee, patient safety committee or other relevant structure)?

Accompanying comment: *This antimicrobial stewardship committee can be either stand-alone or embedded into another committee structure (e.g. pharmacy committee, patient safety committee or other relevant structure). In all cases, this antimicrobial stewardship committee is explicitly in charge of setting and coordinating the antimicrobial stewardship programme/strategy in its mandate/terms of reference.*

Checklist item 2.3:

Is there a healthcare professional identified as a leader for antimicrobial stewardship activities at your hospital and responsible for implementing the programme?

Checklist item 2.4:

Is there a document clearly defining roles, procedures of collaboration and responsibilities of the antimicrobial stewardship team members?

Accompanying comment: *We refer here to the core operational team of healthcare professionals (led by the clinical leader) who will implement the antimicrobial stewardship strategy 'daily on the ground'. This is different from the antimicrobial stewardship committee, which is a larger formal organizational structure that includes antimicrobial stewardship team members and other relevant professionals and administrators. In resource-limited settings or small hospitals, although desirable, it is sometimes difficult to have an antimicrobial stewardship team; in that case, the antimicrobial stewardship clinical leader will implement the antimicrobial stewardship programme. The composition of the (usually multidisciplinary) antimicrobial stewardship team is flexible and should be based on existing international recommendations and adapted to the local context.*

Checklist item 2.5:

Are clinicians, other than those part of the antimicrobial stewardship team (e.g. from the ICU, Internal Medicine and Surgery) involved in the antimicrobial stewardship committee?

Checklist item 2.6:

Does the antimicrobial stewardship committee produce regularly [indicate minimum time] a dedicated report which includes e.g. antimicrobial use data and/or prescription improvement initiatives, with time-committed short term and long term measurable goals/targets for optimising antimicrobial use?

Checklist item 2.7:

Is there a document clearly defining the procedures of collaboration of the antimicrobial stewardship team/committee with the infection prevention and control team/committee?

411 **Box 3. Core element 3: Available expertise on infection management**

Checklist item 3.1:

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?

Accompanying comment: *A separate checklist on laboratory capacity and presence of quality assurance should be developed at national/international level. [49,57] These services can be onsite or not.*

Checklist item 3.2:

In your hospital are there, or do you have access to, trained and experienced healthcare professionals (medical doctor, pharmacist, nurse ...) in infection management (diagnosis, prevention and treatment) & stewardship willing to constitute an antimicrobial stewardship team?

412

413 **Box 4. Core element 4: Education & practical training**

Checklist item 4.1:

Does your hospital offer a range of educational resources to support staff training on how to optimise antimicrobial prescribing?

Accompanying **comment**: *These resources can be developed locally or not, and can use multiple formats.*

Checklist item 4.2:

Do the antimicrobial stewardship team members receive regular training in antimicrobial prescribing and stewardship?

Accompanying comment: *This training is usually not offered at the hospital level, but likely to be at a regional, national or international level. The hospital should however ensure that members of the antimicrobial stewardship team are adequately trained, according to local/regional/national requirements.*

414

415 **Box 5. Core element 5: Other actions aiming at responsible antimicrobial use**

Checklist item 5.1:

Is a multidisciplinary antimicrobial stewardship team available at your hospital (e.g., greater than one trained staff member supporting clinical decisions to ensure appropriate antimicrobial use)?

Checklist item 5.2:

Does your hospital support the antimicrobial stewardship activities/strategy with adequate information technology services?

Accompanying comment: *The level of requirement needs to be defined at local/regional/national level. This could include, for example, measurement of antimicrobial use.*

Checklist item 5.3:

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 antimicrobial stewardship team member is required] or permitted for specific conditions)?

Accompanying comment: *This might be based on national recommendations, or the WHO Essential Medicines List.*

Checklist item 5.4:

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?

Checklist item 5.5:

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?

Checklist item 5.6:

Does the antimicrobial stewardship team review/audit courses of therapy for specified antimicrobial agents or clinical conditions at your hospital?

Checklist item 5.7:

Is advice from antimicrobial stewardship team members easily available to prescribers?

Checklist item 5.8:

Are there regular infection and antimicrobial prescribing focused ward rounds in specific departments in your hospital?

417 **Box 6. Core element 6: Monitoring & surveillance (on a continuous basis)**

Checklist item 6.1:

Does your hospital monitor the quality of antimicrobial use at the unit and/or hospital wide level?

Accompanying comment: *This can be done for example by undertaking point prevalence surveys or audits, assessing appropriateness of infection management and antimicrobial prescription (e.g. indication, choice and duration of antibiotic therapy in pneumonia or surgical prophylaxis according to policy/guidance).*

Checklist item 6.2:

Does your stewardship programme monitor compliance with one or more of the specific interventions put in place by the stewardship team (e.g. indication captured in the medical record for all antimicrobial prescriptions)?

Checklist item 6.3:

Does your hospital monitor antibiotic susceptibility rates for a range of key bacteria?

Checklist item 6.4:

Does your hospital monitor the quantity of antimicrobials prescribed/dispensed/purchased at the unit and/or hospital wide level?

418

419 **Box 7. Core element 7: Reporting & feedback (on a continuous basis)**

Accompanying comment: *All these reports should also be shared with the hospital management leadership.*

Checklist item 7.1:

Does your stewardship programme share hospital-specific reports on the quantity of antimicrobials prescribed/dispensed/purchased with prescribers?

Checklist item 7.2:

Does your stewardship programme share facility-specific reports on antibiotic susceptibility rates with prescribers?

Checklist item 7.3:

Are results of audits/reviews of the quality/appropriateness of antimicrobial use communicated directly with prescribers?

420

421 **Figure 1. The Delphi consensus procedure: Flow chart**