



## Guidelines

## Human resources required for antimicrobial stewardship teams: a Dutch consensus report

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## ABSTRACT

**Scope:** Antimicrobial stewardship teams are responsible for implementing antimicrobial stewardship programmes (ASP). However, in many countries, lack of funding challenges this obligation. A consensus procedure was performed to investigate which structural activities need to be performed by Dutch stewardship teams and how much time (and thus full-time equivalent (FTE) labor) is needed to perform these activities.

**Methods:** In 2015, an electronic survey, based on a nonsystematic literature search and interviews with seven experienced stewardship teams, was sent to 21 stewardship teams that performed an ASP. This was followed by a semistructured face-to-face consensus meeting. Fourteen stewardship teams completed the survey (18% of Dutch acute-care hospitals), and 13 participated in the consensus meeting.

**Recommendations:** The hours needed each year are dependent on hospital size and number of stewardship objectives monitored. If all activities are performed at a minimal base (one stewardship objective; minimal staffing standard), time investment was estimated to be 1393 to 2680 hours annually in the early phase, corresponding with 0.87 (300 beds) to 1.68 FTE (1200 beds), with a further increase to minimally 1.25 to 3.18 FTE in the following years with three stewardship objectives monitored (optimal staffing standards during the first few years of implementing an ASP). This consensus on required human resources provides a directive for structural financial support of stewardship teams in the Dutch context. Some stewardship activities (and related time investments) might be specific to the Dutch context and hospital setting. To develop standards for other settings, our methodology could be applied. **J. ten Oever, Clin Microbiol Infect 2018;•:1**

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## Introduction

Antimicrobial stewardship may be defined as ‘a coherent set of actions designed to use antimicrobials in ways that ensure sustainable access to effective therapy for all who need them’ [1]. Three dimensions of stewardship can be recognized [2].

Stewardship encompasses firstly structural prerequisites that should be met when implementing an antimicrobial stewardship programme (ASP), such as the presence of a multidisciplinary antimicrobials stewardship team, ensuring the presence of local practice guidelines or information technology support. Secondly, stewardship objectives describe the recommended care that should be provided at the patient level, such as prescribing empirical antimicrobial therapy according to guidelines and timely switch from intravenous to oral administration [3]. To bridge the gap between recommended care and the actual care provided, many

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behavioural change interventions can be used by the antimicrobial stewardship team. This third dimension of antimicrobial stewardship, the stewardship improvement interventions, relates to strategies that should be performed for achieving the stewardship objectives [2,3]. Examples include the performance of prospective audit and feedback as well as preauthorization.

In Dutch hospitals, antimicrobial stewardship teams, consisting of at least an infectious disease specialist, a medical microbiologist and a hospital pharmacist, are responsible for implementing an ASP. As of 2014, all Dutch hospitals are required to have a stewardship team; the Dutch Healthcare Inspectorate supervises the establishment and performance of stewardship teams.

The Dutch Working Party on Antibiotic Policy (SWAB), consisting of representatives of the professional societies involved in stewardship (infectious disease physicians, medical microbiology, hospital pharmacy, intensive care medicine and paediatrics) supports the implementation of antimicrobial stewardship in Dutch hospitals on a national level. On the basis of a systematic review and meta-analysis [3], SWAB published a stewardship guideline that includes recommendations on appropriate antimicrobial use to guide the stewardship team's choice of potential stewardship objectives. In addition to this guideline, SWAB disseminated the 'Antimicrobial Stewardship Practice Guide for the Netherlands' providing practical support on how to embark on antimicrobial (antibiotic, antifungal and antiviral) stewardship. Furthermore, a yearly conference is organized to facilitate the exchange of best practices among stewardship teams [4].

Despite these national efforts, the implementation of and commitment to an ASP—as illustrated in a yearly performed nationwide survey among Dutch stewardship teams—differs greatly among hospitals. Lack of stewardship personnel and funding is one of the barriers: only 39% of the hospital boards of directors provide a budget for the stewardship team [5]. This assessment, however, is probably an overestimation because non-responding stewardship teams may be less likely to receive a budget. Lack of staff and funding were previously described as the main obstacles in both the development and execution of an ASP [6]. A nationwide survey in the United States exploring the association between infrastructure and ASP implementation also found that salary support was predictive of full ASP implementation [7]. This is supported by a randomized clinical trial comparing the effect of ASP on reduction in total and broad-spectrum antibiotic use which found that only the most intensive ASP intervention had a positive outcome [8].

It is currently unclear what constitutes an acceptable staffing standard for stewardship teams to ensure dedicated time for their task. One study that summarizes the few available recommendations on staffing standards provides a figure varying between 2.0 and 6.7 full-time equivalent (FTE) workers per 1000 acute-care beds [9]. The study's authors conclude that there is a need for further studies to identify the minimum international staffing standards for stewardship teams.

To provide a directive to hospital boards of directors for structural financial support of stewardship teams, we investigated which structural activities need to be performed by stewardship teams (i.e. the minimal activities that are either performed continuously or recur annually), how much time is needed to perform these activities adequately and how many FTEs are needed. The current report complements a previous study performed in the Netherlands about a new staff standard for infection control, the other mainstay in the fight against antimicrobial resistance. For the organization, implementation and monitoring of infection and prevention programmes, ten key elements have been identified [10].

## Methods and sources

The study focused on stewardship activities performed by dedicated stewardship team members to measure and improve the appropriate use of antimicrobial agents in hospital. Baseline functions of infectious disease specialists, microbiologists and pharmacists are therefore not accounted for in the FTE staffing figures.

The study comprised three consecutive phases while working with experienced stewardship teams: (a) drafting a concept list of activities performed by stewardship teams, (b) performing a survey and (c) reaching consensus during a face-to-face meeting (Fig. 1).

### Concept list of activities

To get a first impression of activities stewardship teams perform and to pilot test the interview questions, an in-depth interview was held with a member of an experienced stewardship team. Thereafter, a nonsystematic literature search was performed in Google (stewardship team AND antibiotics (in Dutch)). We scrutinized the resulting documents to find stewardship teams tasks and/or activities. The 2012 SWAB vision document [11], created by the invitation of the Dutch Healthcare Inspectorate, describes the core elements of a hospital ASP and is based on various stewardship documents (e.g. the Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America guidelines [12], some EU projects and international stewardship publications). We also assessed the 2015 'Antimicrobial Stewardship Practice Guide for the Netherlands' [4] and the 2015 National Institute for Health and Care Excellence guideline 'Antimicrobial stewardship: systems and processes for effective antimicrobial medicine use' [13].

To translate tasks into concrete activities, semistructured interviews were held with one or two members of seven stewardship teams across the Netherlands. These teams were chosen on the basis of their well-established experience in antimicrobial stewardship. In this phase, the interviewer assessed all activities for which, according to the interviewees, a stewardship team and its different members are responsible, with a focus on activities directly aiming at the measurement and improvement of appropriate use of antimicrobial agents in the hospital, rather than activities inherently related to the specialty of the different stewardship team members, such as quantifying antimicrobial use (pharmacist), producing cumulative antimicrobial susceptibility reports (medical microbiologist) or performing bedside consultations (infectious disease specialist). The interviewer took notes

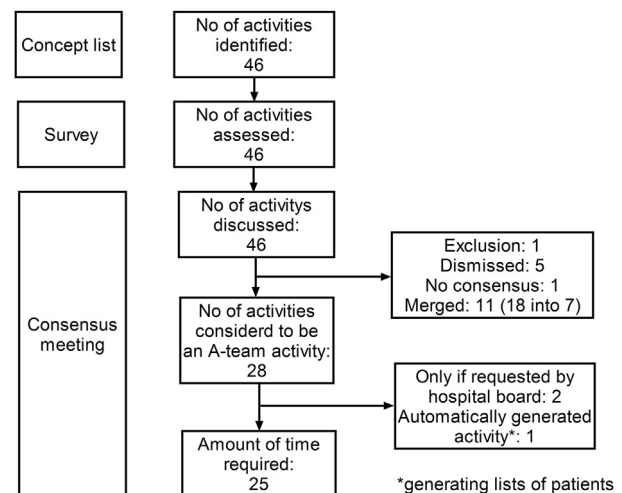


Fig. 1. Flowchart of stewardship activities identified and assessed in study survey and during consensus meeting.

during the interview. Afterwards, the notes were systematically searched for activities. Information from the individual interviews was combined while removing overlap in activities mentioned.

### Survey

An electronic survey was conducted in October 2015 among 21 stewardship teams (26% of all acute-care Dutch hospitals). These stewardship teams were included because these had been registered with the Netherlands Society of Medical Microbiology and the Netherlands Association of Internal Medicine as performing an ASP at the time of the survey. The concept list of stewardship activities was sent with the request to judge whether or not an activity belongs to the stewardship team's tasks and to add missing activities. Stewardship teams were asked to assess how much time each stewardship member spent on these activities. It was recommended to measure the time spent on each activity, but estimations were allowed. We also asked whether they received financial support, and if so, how much. Reminders were sent to those who did not respond. We summarized with descriptive statistics (mean and range) in SPSS 22 software (IBM, Armonk, NY, USA) and Excel (Microsoft, Redmond, WA, USA).

### Consensus meeting

The results of the survey were discussed in a face-to-face semi-structured consensus meeting (November 2015) with the survey respondents. The results of the survey were presented per stewardship activity ([Supplementary Table S1](#)) by the chairman until consensus on each activity was reached. Goals of the meeting were to reach consensus on (a) whether a stewardship activity should be an activity of the stewardship team, the antimicrobial formulary committee or the individual professionals, (b) whether the amount of time spent on this activity is independent or dependent on parameters like hospital type (university, teaching or general hospital) or number of beds and (c) the required amount of time. For the latter, the assessment of the amount of time spent on each activity by the stewardship teams was used as starting point for the consensus meeting. The final recommendation on the time required could deviate from this assessment. For example, it could be higher if the time allotted was regarded as insufficient or lower if it was expected that gaining experience would influence the time required.

Subsequently, related types of activities were combined. This was done, for example, for all subactivities' prospective audit and feedback, for education and for stewardship improvement interventions. FTEs were calculated per activity, where 1 FTE equals 1600 hours (assuming 40 working weeks of 40 hours per year).

## Results

### Concept list of stewardship activities

The group of stewardship team members interviewed consisted of four infectious disease specialists, four medical microbiologists

and two hospital pharmacists working in seven hospitals (three university hospitals, three teaching hospitals and one general hospital). Together with the information from the literature, 46 activities were identified ([Supplementary Table S1](#) and [Supplementary Fig. S1](#)) and included in the survey.

### Survey

The response rate was 67% (14 of 21 invited stewardship team responded, for an overall 18% of all Dutch acute-care hospitals), representing four university hospitals (50% of all university hospitals), seven teaching hospitals (17% of all teaching hospitals) and three general hospitals (10% of all general hospitals) ([Table 1](#)). Each stewardship team consisted of at least one infectious disease specialist, one medical microbiologist and one hospital pharmacist. All teams except one consisted of other professionals; the two largest teams consisted of nine professionals ([Table 2](#)).

No stewardship activities were added to the concept list ([Fig. 1](#)). [Table 2](#) provides details on the stewardship team composition and the financial support they received. Four of the 14 stewardship teams did not receive any budget specifically allocated to stewardship activities, six stewardship teams were financially supported by the hospital board of directors, three stewardship teams were financed by reallocation of departmental money to them and for one stewardship team no information was received on this topic. For the six stewardship teams that were financially supported by the hospital board of directors, salary support was provided for a mean of 23 hours per week per team (range, 1–47 hours), unequally divided among the team members.

### Consensus meeting

Thirteen stewardship teams participated in the consensus meeting, ten of whom also took part in the previous phase. Four teaching hospitals that participated in the survey were not able to attend the consensus meeting. Three university hospitals only participated in the consensus meeting. As shown in [Fig. 1](#), a total of 28 of the 46 activities were considered to be stewardship team activities ([Supplementary Table S1](#)). Of the 46 activities, 18 were merged into seven activities, and five activities were dismissed (drafting antibiotic practice guidelines, measuring quantity of antibiotic use, measuring local antibiotic resistance rates, performing bedside consultations, assessing customer satisfaction) because these were covered by standard professional activities of the specialties involved. One activity was not specific enough and therefore excluded (other policy meetings), and no consensus was reached on one activity (drafting local protocols). Two of the 28 remaining activities were considered only mandatory if requested by of the hospital board (performing a pilot study and making a business case). One (aggregated) activity, referring to generating various lists of patients, only required time in the preparatory phase because these lists are preferably generated automatically. As a result, consensus on the amount of time required was sought and reached for 25 activities ([Table 3](#)).

**Table 1**  
Characteristics of 14 hospitals included in survey

Characteristic	All hospitals (n = 14)	University hospitals (n = 4)	Teaching hospitals (n = 7)	General hospitals (n = 3)
No. of beds, mean (range)	817 (270–1.339)	1.012 (715–1.339)	821 (478–1.249)	550 (270–825)
No. of clinical inpatient days, mean (range)	168.620 (8.160–307.420)	217.369 (155.470–307.420)	166.553 (134.380–240.523)	106.376 (8.160–188.987)
Annual admissions, mean (range)	30.968 (22.486–44.880)	30.276 (27.207–34.671)	31.608 (27.293–44.880)	30.608 (22.486–36.893)
Years since team establishment, median (range)	2 (1–6)	2 (2–3)	1 (1–6)	3 (2–3)
No. of burn units	0	0	0	0
No. of solid organ transplantation programmes	4	4	0	0
No. of stem cell transplantation programmes	4	4	0	0

**Table 2**  
Composition and funding of 14 stewardship teams

Specialty	Teams with specialty represented in stewardship team, n (%)	Teams with specialty funded for stewardship by hospital, n (%)	Members of this specialty in 14 teams	Funding, hours per week, mean (range)
Infectious diseases physician	14 (100)	6 (43) <sup>a</sup>	19	5.5 (2–11)
Internist	1 (7)	0 (0)	1	
Infectious diseases physician-intensivist	1 (7)	0 (0)	1	
Medical microbiologist	14 (100)	4 (29) <sup>b</sup>	16	5.4 (2–12)
Hospital pharmacist	14 (100)	4 (29) <sup>b</sup>	14	5 (2.5–12)
Other hospital pharmacy employee <sup>b</sup>	2 (14)	0 (0)	2	
Fellow/resident/PhD student	8 (57)	2 (25)	12	25
Paediatrician—infectious diseases specialist	5 (36)	2 (40)	5	3 (2–4)
Secretary/management assistant	4 (29)	2 (50)	4	2 (1–3)
Nurse practitioner	3 (21)	2 (67)	4	17 (8–24)
Infection control practitioner	2 (14)	1 (50)	2	24
Information technology specialist <sup>c</sup>	2 (14)	2 (100)	2	11 (4–18)
Quality of care professional	1 (7)	1 (100)	1	4

<sup>a</sup> Data missing for one hospital.<sup>b</sup> One clinical pharmaceutical analyst and one unknown, but other than hospital pharmacist.<sup>c</sup> One data manager and one automation expert.**Table 3**  
Consensus on 25 minimum activities to be performed and time required by stewardship teams

Activity	Time required (hours)	Item number <sup>a</sup>
<b>Start-up investment</b>		
Setup of information technology support	40–60	10
Drafting action plan	16	41
Assessing current monitoring	14	3
Defining list of restricted antimicrobials <sup>b</sup>	5–10	5
Defining list of limited prescription antimicrobials <sup>c</sup>	5–10	6
Defining critical prescriptions <sup>d</sup>	5–10	7
Selection of quality indicators	15	9
Total	100–135	
Activity	Time required per year <sup>b</sup>	Item number <sup>5</sup>
<b>Continuous activities</b>		
Measurement activities		
Point prevalence survey	120	15
Measuring quality indicators	150	17
Additional monitoring		
Performing audits	150 per audit	23
Improvement activities (stewardship improvement interventions)		
Prospective audit and feedback	per objective: 300 + 100 per 100 beds > 300 beds <sup>e</sup>	20/21/22/25
Educational outreach visit	80–240 <sup>f</sup>	24
Educational meetings	160–240	27/28
Performing and participating in scientific research	40	43/44/45
Performing improvement project (using nonspecified stewardship improvement intervention and developing supporting material)	200 per project	26/29
Reporting and planning		
Reporting of measurements	30	18
Drafting annual report	8	40
Drafting annual plan <sup>g</sup>	8	41
Meetings (3–6 professionals per team)		
Policy meetings of stewardship team with Antibiotic formulary committee/hospital formulary committee	36–72	30/39
Hospital infection committee	12–24	31
Hospital infection committee	12–24	32
Prescribers (not patient-related)	45–90	33
Hospital board of directors	3–6	34
Medical hospital staff	3–6	35
Other hospitals	12–24 <sup>e</sup>	36/37
National stewardship conferences	24–48	46
Total (minimal, one stewardship objective)	1.39 [–2.680 (0.87–1.68 FTE)]	

Two stewardship team activities that are only performed at request of hospital board (1 and 2) are not included. FTE, full-time equivalent.

<sup>a</sup> Corresponds with item number in [Supplementary Table S1](#).<sup>b</sup> Drugs that only should be prescribed for microorganisms that are resistant to usual drugs.<sup>c</sup> Drugs that are indicated for some indications but should not be used in other situations.<sup>d</sup> Prescriptions for which advice (or another intervention) by an expert is deemed necessary.<sup>e</sup> For example, monitoring one stewardship objective in 300-bed hospital requires 300 hours per year and monitoring three stewardship objectives in a 1000-bed hospital requires  $[3 \times (300 + 700)] = 1000$  hours per year.<sup>f</sup> Times required dependent on number of beds; for other activities for which ranges are provided, more precise recommendation could not be made.<sup>g</sup> This activity is included twice, both as one-time investment for establishment of stewardship team and as annual activity.

No activity turned out to be dependent on hospital type. The consensus was that providing specifications for the individual stewardship team members was too speculative and moreover was felt to be undesirable because many activities can be performed by all core disciplines. Therefore, the recommendations refer to the team as a whole, and the budget allocated should be divided on the basis of local preferences. The establishment of a stewardship team requires a one-time investment of 100 to 135 hours. Measuring quality of antimicrobial use, by performing point prevalence studies and audits, costs minimally 420 hours each year. The main activity of stewardship teams, prospective audit and feedback (i.e. monitoring whether stewardship objectives are met in individual patients and, if necessary, providing advice to the prescriber—for example, on timely switch from intravenous to oral administration, and prescribing according to guidelines) takes at least 300 hours per year per objective (Table 3). Given the correlation of number of hospital beds and time spent on prospective audit and feedback, an extra 100 hours was calculated to be required per 100 beds over 300 beds. For performing other stewardship interventions to improve the quality of antimicrobial use, excluding prospective audit and feedback, a stewardship team needs about 480 to 720 hours each year. Drafting reports takes 46 hours (more hours are needed for the first report). Meetings and consultations ask 174 to 294 hours per year.

On the basis of the data in Table 3, to perform an ASP, and focusing on one stewardship objective, for the whole stewardship team, 0.87 to 1.11 FTE is required for a 300-bed hospital, 1.15 to 1.39 FTE for a 750-bed hospital and 1.43 to 1.68 FTE for a 1200-bed hospital, in addition to 100 to 135 hours necessary for the startup, with the assumption that stewardship teams perform only one audit and one stewardship improvement intervention annually. This constitutes the minimal recommendation for stewardship teams in the initiation phase. For more experienced stewardship teams, it can be expected that prospective audit and feedback are extended to (at least) three stewardship objectives (and only one audit and intervention), resulting in minimally 1.25 to 1.49 FTE (300 beds), 2.09 to 2.33 FTE (750 beds) and 2.93 to 3.18 FTE (1200 beds) needed per year. During the first few years of implementing a national ASP, such as in the Netherlands, three stewardship objectives might be considered optimal and manageable [14].

## Discussion

By combining various research methods (literature study, interviews, survey and consensus procedure), we defined and assessed stewardship activities and reached consensus on the human resources required to perform antimicrobial stewardship activities in Dutch hospitals. Our method may be applicable for other countries to calculate their staffing needs (Box 1). The consensus was that the continuous activities (prospective audit and feedback, measurement activities, additional monitoring, improving quality of antimicrobial use, reporting and planning and meetings) require 0.87 to 1.68 FTE in the early phase (minimal staffing standards), with a further increase to minimally 1.25 to 3.18 FTE in the following years of implementing a national ASP, depending on hospital size and number of stewardship objectives monitored (optimal staffing standards). In addition, the assessment took an initiation phase into account, during which the stewardship teams can focus on developing their ASP. This preparatory work requires a one-time investment of 100 to 135 hours.

The consensus that antimicrobial stewardship costs time and thus money is supported by the recent literature [9,15–18]; however, only three studies from two countries (France and the United States) have based their recommendations on an estimation and/or assessment of time spent on stewardship activities in a sample of

## Box 1

Methods to assess human resources required for effective antimicrobial stewardship programme

1. Identify experienced stewardship teams, preferably based on an up-to-date national stewardship team registry or a survey.
2. Define a list of stewardship activities based on:
  - a. A (systematic) review of the literature (e.g., [22,23]).
  - b. Survey among stewardship teams in your specific setting to identify additional activities performed by these teams.
3. Perform (or ask the stewardship teams to perform) time studies for the individual activities, preferably by repeated and careful time measurement of the task with a time measuring instrument and preferably in hospitals with a fully implemented and successful antimicrobial stewardship programme [18].
4. Perform a consensus meeting with a representative part of the stewardship teams to reach consensus on:
  - a. Whether the activity is a task of the stewardship team.
  - b. Whether the amount of time spent is fixed or variable (e.g., on hospital type or number of acute-care beds).
  - c. Amount of time required with the results of the time and motion studies as starting point, but taking into account that understaffing may have affected these results.
  - d. Detailed figures for each member of the stewardship team (optional).
5. Calculate full-time equivalent.

all national hospitals. These human resources estimates vary between 2.0 to 6.7 FTE per 1000 acute-care beds [9,16,17]. One study of US Veterans Health Administration facilities recommends ten pharmacist FTEs per 1000 occupied acute-care and long-term care beds [18]. These estimates are partly higher than ours. Our Dutch staffing figures, however, anticipate an increasing number of stewardship objectives to be monitored and thereby an increasing number of FTE required once a stewardship team has gained experience. The target population may intrinsically differ for the individual stewardship objectives, suggesting differences in time required. However, the target population and time required per prescription or patient is also determined by the local quality of antimicrobial use. It is known that the quality of different aspects of antimicrobial use between hospitals varies significantly and that all hospitals have aspects (albeit different) which show room for improvement [19]. Therefore, the consensus was not to differentiate the time required per stewardship objective.

It is important to stress that ongoing activity is crucial because deintensifying antimicrobial stewardship may lead to a reversal of the intervention effect [20]. In addition, the Dutch staffing figure does not include some baseline functions of infectious disease physicians, microbiologists and pharmacists, such as providing bedside consultations and individual therapy advice, because they are considered standard of care in the Netherlands. In the absence of a stewardship team, these aspects of antimicrobial stewardship are performed by the three core specialties, but the nature of it is reactive (prescriber-initiated consultation or culture driven) rather than proactive, and it lacks structural documentation, thus hampering providing feedback to prescribers.

Our study does not only provide staffing figures. We also drew up, from the literature and from interviews with experienced

stewardship teams, a list of antimicrobial stewardship activities. During the meeting, consensus was reached on whether each suggested activity was a stewardship team activity. This resulted in a list of 25 ASP activities. Most activities focused on the measurement of appropriate use and feeding that information back to prescribing professionals. Four broadly defined activities were related to the second basic task of stewardship teams: the improvement of appropriate use [21]. Improvement activities asked for quite a time investment (e.g. 'performing a stewardship improvement intervention project and developing supporting material' comprised 200 hours per project, and 'educational meetings' 160 to 240 hours per year). Such ASP activities aim to change the behaviour of individual prescribers so that patients actually receive appropriate antimicrobial treatment. In a Cochrane review, Davey et al. [20] conclude that in the process of selecting potential effective intervention components, experts in implementation and behavioural sciences might be important to develop more impactful stewardship programmes. It therefore might be considered to also include behavioural or implementation experts in (or supporting) a stewardship team. At a local hospital level, this could be a member of the quality and safety hospital team (e.g. a hospital quality advisor), which includes personnel who are usually well trained in quality improvement processes. It is currently unclear how adding such expertise influences staffing figures. With regard to improvement strategies, our study differs from a publication about core elements of ASP [22]. We explicitly mention stewardship improvement interventions in general and leave it to stewardship teams to choose the best behavioural change interventions on the basis of the determinants of poor antimicrobial use [2], in line with the US Centers for Disease Control and Prevention (CDC) core elements of hospital ASPs [23] and a French study on the human resources that are required [16]. An advantage of our list of stewardship activities is that it is detailed. A recent publication [22] as well as the CDC core elements of hospital ASP also include structural prerequisites, such as leadership, accountability, responsibilities and available expertise, whereas we focused on activities only.

The strength of this study is the mixed-methods approach to draw up a list of core antimicrobial stewardship activities and the consensus procedure involving experienced stewardship teams to estimate a staffing figure. Although the nonsystematic literature search may have missed some publications describing antimicrobial stewardship activities, our list of activities was comprehensive and contained all CDC core elements [23]. Also, the survey revealed no additional activities performed by the stewardship teams. In the Netherlands, acute healthcare is provided by university, teaching and general hospitals. We included all types of hospitals, but unfortunately university hospitals were overrepresented. The sample size was relatively small. However, almost 20% of all Dutch hospitals participated, which is significantly more than in a similar recent French study. Preference was given to hospitals with a (developing) ASP because these could estimate the time spent on antimicrobial stewardship and contribute to a consensus meeting while relying on their experience. We asked stewardship teams to assess the time spent on each activity, preferably by actually measuring it. A potential limitation of our study is that it is not possible to identify which activities were actually measured versus estimated. Finally, the external validity of our study is limited in settings with fewer standard professional activities performed by the medical specialties involved and in settings with a high prevalence of multidrug resistance.

In conclusion, on the basis of an inventory of activities performed by stewardship teams and a consensus meeting, we determined the human resources required for a functional ASP in Dutch hospitals. The study provides a directive for structural

financial support of stewardship teams. This helps stewardship teams to negotiate protected time for stewardship activities with hospital boards of directors. Some stewardship activities – and related time investments might be specific to the Dutch context and the hospital setting. To develop standards for other settings, our methodology could be applied to calculate setting specific staffing needs.

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### Transparency declaration

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### Appendix A. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.cmi.2018.07.005>.

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