



## Barriers to implementing antimicrobial stewardship programmes in three Saudi hospitals: Evidence from a qualitative study

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### ABSTRACT

**Objectives:** This study explored antimicrobial stewardship programme (ASP) team members' perspectives regarding factors influencing the adoption and implementation of these programmes in Saudi hospitals. **Methods:** This was a qualitative study based on face-to-face semistructured interviews with healthcare professionals involved in ASPs and activities across three Ministry of Health (MoH) hospitals in Saudi Arabia ( $n = 18$ ). Interviews were also conducted with two representatives of a General Directorate of Health Affairs in a Saudi region and two representatives of the Saudi MoH ( $n = 4$ ) between January–February 2017.

**Results:** Despite the existence of a national strategy to implement ASPs in Saudi MoH hospitals, their adoption and implementation remains low. Hospitals have their own antimicrobial stewardship policies, but adherence to these is poor. ASP team members highlight that lack of enforcement of policies and guidelines from the MoH and hospital administration is a significant barrier to ASP adoption and implementation. Other barriers include disintegration of teams, poor communication, lack of recruitment/shortage of ASP team members, lack of education and training, and lack of health information technology (IT). Physicians' fears and concerns in relation to liability are also a barrier to their adoption of ASPs.

**Conclusion:** This is the first qualitative study exploring barriers to ASP adoption and implementation in Saudi hospitals from the perspective of ASP team members. Formal endorsement of ASPs from the MoH as well as hospital enforcement of policies and provision of human and health IT resources would improve the adoption and implementation of ASPs in Saudi hospitals.

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## 1. Introduction

The high prevalence of antimicrobial resistance (AMR) and the emergence of rare and multidrug-resistant bacterial strains are major public-health threats in Saudi Arabia and other Arab Gulf countries, where one of the largest expatriate populations resides and more than 10 million people travel annually for pilgrimage and Umrah [1,2]. A recent review by Zowawi highlighted the worrying reports of extended-spectrum  $\beta$ -lactamase-producing isolates among *Escherichia coli* and *Klebsiella pneumoniae* and the prevalence of carbapenem-resistant *Acinetobacter baumannii* [3]. With Saudi hospitals reporting soaring AMR rates, widespread misuse of antimicrobials and fears of resistance to last-resort antibiotics

[3,4], interventions are urgently required to curb inappropriate antimicrobial use and AMR rates. Implementing antimicrobial stewardship programmes (ASPs) in Saudi hospitals has been recommended to optimise the use of antimicrobials and to reduce AMR rates [4,5]. The potential of these interventions has been recognised by the Saudi Ministry of Health (MoH) through the introduction of a national antimicrobial stewardship plan as part of the Arab Gulf regional strategy to reduce the threat of AMR [6].

At a hospital level, evidence suggests the implementation of ASPs in some Saudi tertiary hospitals [7–9] and these ASPs are mainly led by infectious diseases (ID) consultants, with limited input from microbiologists and hospital pharmacists [7,8]. However, due to the shortage of ID consultants and microbiologists [2], these antimicrobial stewardship initiatives face sustainability challenges in tertiary care and are less likely to be implemented in secondary care where adoption of ASPs remains low [10]. Collaborations and the formation of ASP teams, including

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microbiologists, hospital pharmacists, physicians, nurses and infection control practitioners, could increase the capacity of hospitals to adopt ASPs and improve their implementation [11]. Although various studies have explored ASP team members' perspectives on programme adoption and implementation in healthcare systems where members' roles are well developed, data from healthcare systems such as Saudi Arabia, where ASP teams are novice, remain scarce. Understanding the experiences and perspectives of physicians, pharmacists, microbiologists, infection control practitioners, hospital managers, nurses and MoH personnel of ASP adoption could enhance the adoption of ASPs in Saudi hospitals. Therefore, this study aimed to explore the current ASP perspectives and experiences in Saudi MoH hospitals in order to identify factors influencing their adoption through a qualitative study.

## 2. Methods

A sequential mixed-methods project using both qualitative and quantitative methods was conducted; the results of the qualitative aspect of the project are presented here. This was the first part of the project and involved semistructured face-to-face interviews with healthcare professionals from three randomly selected MoH hospitals: a local 50-bed hospital; a regional 180-bed hospital; and a central 380-bed hospital. All three hospitals are located in a Saudi region (South of Saudi Arabia) or its outskirts. In each setting, ASP team members were identified and contacted. Representatives from the General Directorate of Health Affairs in the region (Infection Control Department and Pharmaceutical Care Department) and the Saudi MoH also participated in this study.

One of the authors (SA) conducted the interviews in January and February 2017 using a semistructured interview guide. This was developed based on a review of the literature and was validated by a committee of three ASP pharmacists and two ID consultants. It was then piloted in a convenience sample of 16 participants from three MoH hospitals. The guide comprises open-ended questions to explore the experience and perspectives of physicians, hospital pharmacists, microbiologists, infection control practitioners, nurses, hospital managers and MoH representatives in relation to the adoption and implementation of ASPs in Saudi MoH hospitals as well as the barriers influencing ASP implementation. Further probing questions may have been asked based on participants' responses. The identified factors influencing ASP adoption in Saudi MoH hospitals were further explored in the quantitative aspect of the project through a national hospital survey.

All interviews were transcribed verbatim and the transcripts were compared with the original tape to review for quality and accuracy. Data were analysed independently by two of the authors (SA and IB) and were subjected to various stages of inductive

coding for thematic development [12]. The coders met regularly to review coding and to derive themes. The study was approved by the Health and Human Sciences Ethics Committee of the University of Hertfordshire (Hatfield, UK). Official permission was obtained from participating hospitals, and all participants signed informed consent before taking part in the study.

## 3. Results

A total of 22 interviews were conducted. These included interviews with 5 physicians, 4 nurses, 3 hospital pharmacists, 2 infection control practitioners, 1 ID consultant, 1 microbiologist and 2 hospital managers representing the three Saudi MoH hospitals. The head of the Infection Control Department and the head of the Pharmaceutical Care Department in the General Directorate of Health Affairs in the Saudi region as well as 1 consultant clinical microbiologist and 1 clinical pharmacist representing the Saudi MoH departments of Infection Control and Pharmaceutical Care were also interviewed. The participants had a median of 9 years of practice (range 2–15 years). Interviews lasted up to 40 min. Details of the participating hospitals are summarised in Table 1 and details of the participants are summarised in Tables 2 and 3.

Several main themes emerged from the interviews, including the current state of ASPs in hospitals as well as barriers to ASP implementation in Saudi MoH hospitals; these were further divided into subthemes. This study suggests that formulary restriction is the main ASP strategy adopted in Saudi MoH hospitals. Furthermore, adoption and implementation of ASPs is hindered by three sets of barriers. First, sociopolitical context barriers, including lack of adherence to guidelines and legislation. Second, healthcare organisation-related barriers such as lack of management support, disintegration, poor communication, lack of recruitment/shortage of ASP team members, lack of education and training, and lack of health information technology (IT). And third, healthcare professionals' barriers relating to their fears and concerns. The following sections provide a detailed description of the emerging themes, which are summarised in Table 4.

### 3.1. Current state of antimicrobial stewardship programmes in hospitals: formulary restriction and adherence to guidelines

The front-end strategy of formulary restriction is the main ASP strategy adopted in all three hospitals. The hospitals' ASPs include an antimicrobial prescribing policy in which antimicrobials are classified into three categories (A, B and C) as follows.

- Category A antimicrobials: unrestricted availability of these antimicrobials; examples include amoxicillin, metronidazole and nystatin.

**Table 1**  
Characteristics of three hospitals included in the study.

Characteristic	Local hospital	Regional hospital	Central hospital
Bed capacity	50	180	380
Existence of ASP	<10 years	<10 years	<10 years
ASP strategies	Formulary restriction	Formulary restriction	Formulary restriction
ASP team	Infection control practitioner (nurse)	Pharmacist Infection control practitioner (nurse)	ID consultant Pharmacist Microbiologist Infection control practitioner (nurse)
ID input	No	No	Yes
Microbiology input	No	No	Yes
Pharmacy input	No	Yes	Yes
Management input	No	No	No

ASP, antimicrobial stewardship programme; ID, infectious diseases.

**Table 2**  
Details of antimicrobial stewardship programme team members interviewed (n = 18).

Team member	Local hospital	Regional hospital	Central hospital
ID consultant			1
Microbiologist			1
Pharmacist		1	2
Infection control practitioner (nurse)	1		1
Physician	1	2	2
Nurse	1	1	2
CEO/Medical Director	1		1

ID, infectious diseases; CEO, Chief Executive Officer.

**Table 3**  
Details of Ministry of Health representatives interviewed (n = 4).

Representative	Regional directorate	Ministry
Pharmacist	1	1
Infection control practitioner	1	
Microbiologist		1

- category B antimicrobials: restricted availability of these antimicrobials and approval of a specialist is required before they are dispensed. They are usually prescribed by consultants or their designees (specialist or resident) following the consultant's guidance. Examples of these antimicrobials include azithromycin, gentamicin and rifampicin.
- Category C antimicrobials: antimicrobials in this category are permitted only for specific conditions such as sepsis or serious infections caused by multidrug-resistant micro-organisms. They are usually prescribed by a consultant and this requires the completion of a justification form. Examples of these antimicrobials include colistin, meropenem and micafungin.

In addition to the antimicrobial prescribing policy, the hospitals front-end strategy also includes regimens for the treatment of common infections. Interestingly, there are no written rules for switching from intravenous to oral administration of antimicrobials; it is usually up to the treating physician to determine the duration of treatment and the route of administration.

### 3.2. Barriers to antimicrobial stewardship programme adoption and implementation in Saudi Ministry of Health hospitals (Table 4)

#### 3.2.1. Lack of adherence to guidelines

Despite the formal existence of this ASP strategy in the participating hospitals, interviewees stressed that lack of adherence to antimicrobial policies and guidelines as a significant barrier to ASP adoption and implementation in hospitals (T1 Q1–4). Lack of adherence to ASP policies and guidelines is due to three main factors. First, physicians are not always aware that such policies exist as this is not a routine part of their orientation programme (T2 Q1–2). Second, the ASP guidelines and policies are not always accessible electronically (T2 Q3) as the policies are distributed across the departments (by either the Infection Control Department or Pharmacy or both) often in a paper format that only a few staff members have direct access to. Third, poor enforcement and implementation of ASP policies is a significant contributing factor to the lack of adherence to this strategy. Participants suggested vertical enforcement by MoH and hospital management as a potential approach to improving engagement of physicians with the ASP strategy (T2 Q4–5).

#### 3.2.2. Lack of administrative/management support

The lack of management awareness of ASPs and strategies has been suggested to hinder the successful adoption and

implementation of ASPs in hospitals (T3 Q1–2). Furthermore, the management team is not convinced of the benefits of ASPs in relation to antimicrobial consumption, reducing rates of AMR and improving patient outcomes (T3 Q3). This is critical as the lack of top management support and commitment have been identified as significant barriers to ASP adoption and implementation in Saudi MoH hospitals (T3 Q4–5). Top management here can, among other initiatives, increase the visibility of the hospital ASP strategy and enforce adherence to its policies.

#### 3.2.3. Disintegration

Healthcare professionals involved in delivering antimicrobial stewardship are working in silos (T4 Q1–3), reflecting a disintegrated structure that hinders effective teamworking of antimicrobial stewardship teams. In addition to teams working in silos, many of the interviewed physicians further highlighted that 'silo mentality' exists even among themselves (T4 Q4–5). Furthermore, there appears to be the need for the pharmacy department and pharmacists to co-ordinate antimicrobial stewardship efforts among physicians and nurses (T4 Q6).

#### 3.2.4. Poor communication

Healthcare professionals also identified poor communication among the key antimicrobial stewardship players as a barrier to ASP adoption. Pharmacists in particular appear to be key initiators and co-ordinators of antimicrobial stewardship communication (T5 Q1–3). It is unclear whether this communication is a reason for the disintegrated teams or a consequence of such disintegration.

#### 3.2.5. Shortage of antimicrobial stewardship programme team members

The shortage of ASP team members has also been suggested as a significant barrier to ASP adoption and implementation in Saudi MoH hospitals. The lack of clinical pharmacists has been particularly blamed for the modest levels of adoption of ASPs in the participating hospitals. The participants particularly expressed that clinical pharmacists will be able to advise on the appropriate use of antibiotics and, most importantly, follow up on policy implementation and enhance prescribing practices (T6 Q1–4). The shortage of ID consultants has also been associated with poor adoption and implementation of ASP strategies, as not all MoH hospitals manage to recruit ID consultants, and the recruited few are often not retained or are inundated with allocated cases from neighbouring hospitals (T6 Q5–6). The lack of microbiologists and laboratory equipment can also be a barrier to implementing ASPs (T6 Q7). However, participants recognised that recruiting specialist staff will not be sufficient as these need to work together as a team to adopt and implement ASPs in hospitals (T6 Q8).

#### 3.2.6. Need for education and training

Education and training have been suggested by participants as major contributors to successful ASP adoption and

**Table 4**

Barriers to antimicrobial stewardship programme (ASP) adoption and implementation in Saudi Ministry of Health hospitals.

Barrier	
T1: Lack of adherence to guidelines	'No monitoring, no implementation of any guidelines' Q1 'They (doctors) are not checking the policies' Q2 'There is guideline and this guideline exists and the strategy of using it exists but the implementation is very weak' Q3 'The lack of strict follow up in the hospital; I mean policy is made but it was never followed up' Q4
T2: Reasons for lack of adherence to guidelines	'The guidelines of the hospital are not fully clear to me' Q1 'We lack full awareness of these guidelines' Q2 'The availability of the guidelines, sometimes are not on the computer' Q3 'If it is implemented through the Ministry, sure everybody will follow' Q4 'Because of no control, no check . . . No one can ask a physician why you have used such combinations relating to antibiotics' Q5 'The management of the hospital should be aware of the topic to follow it . . . The hospital director should follow up the programme and be aware of it' Q1 'The administration has no awareness about this' Q2 'The administration must be convinced with the programme and support it' Q3 ' . . . and to have a good supervision and commitment from the top management' Q4 'The difficulties we might face are getting no support from the management' Q5
T3: Lack of administrative/management support	'There is a gap between the medical directorate, the hospital administration and the technical administrations' Q1 'There should be some combined meetings, some combined platform for all physicians, nurses, technicians, pharmacists . . . ' Q2 'Nurses are one department, pharmacy another one department, the doctors are one department—we need teamwork from everybody' Q3 'Every doctor works alone' Q4 'Doctors are not discussing with each other' Q5 'There should be co-operation between staff and pharmacy' Q6
T4: Disintegration	'There is no communication between the pharmacy and doctors as there is with infection control' Q1 'If there is any memo from pharmacy, especially for the—if this medicine is not available or sometimes this medicine is—they are not sending anything regarding the antibiotic policy' Q2 'Communication is very difficult' Q3
T5: Poor communication	'We don't have clinical pharmacists' Q1 'Members in the (ASP) team are infection control and clinical pharmacy . . . there should be such team in the hospital' Q2 'It is supposed that every department has an infection control nurse, and clinical pharmacist whose role is to follow up the antibiotic use. This idea should be applied in every department, not in only one department' Q3 'The clinical pharmacist, this is a new job for us, we need to increase the number of infectious disease staff . . . because we only have one doctor for the whole hospital' Q4 'We want an ID consultant, and it is preferred that he remains in his position for a long time' Q5 'The ID's role is active, but we have only one ID in the hospital. So it is difficult to follow up all matters. You need the IDs and you need ID pharmacists' Q6 'We don't have micro-pathologists . . . peripheral hospitals don't have culture . . . there is lack of infrastructure of labs' Q7 'All of us should be involved. All of us have our own responsibility and accountability. It should not be like, only the nurses should do it, also doctors, at the same time microbiologists and pharmacy' Q8
T6: Shortage of ASP team members	'You need a lot of training and education before the programme starts correctly' Q1 'There is need for awareness, there should be regular workshops. There should be some compulsory workshops that should be arranged and everyone should be attending' Q2 'We (doctors) need more training and ongoing education programmes that are related to antibiotics' Q3 'You want guideline, monitoring and educated staff to implement the (ASP) programme' Q4 'They (doctors) need to have a good orientation regarding the antibiotic policy' Q5 'Increase the awareness not only within the healthcare team, but also with the family and patient' Q6
T7: Need for education and training	'Most hospitals don't have e-systems so they can't tell us about their consumption' Q1 '60% of hospitals don't have a good IT system. Out of 20 hospitals, 60% do not have electronic prescription' Q2 'The IT system is useless because it dispenses antibiotics without any identification . . . if the IT system is effective so you insist that the prescription should not be completed unless the diagnosis, viral, is written in. If there is viral infection the programme itself won't respond to give you antibiotics' Q3 'You need a good system . . . the IT system that we count on in all the communication between departments, between the ID and the pharmacy, and we depend on it' Q4 'We cannot apply antibiotic stewardship if we don't have a good IT system and we have good internal communication system between the concerned departments: the ID, the pharmacy and the ward' Q5
T8: Lack of health information technology (IT)	'The patient improves so I don't want to change this antibiotic, because I am afraid that the patient can relapse' Q1 'I am worried about my patient, if the patient dies, I'm responsible for the patient' Q2 'In the end, doctors here fear to be accused of negligence' Q3 'I need the motivation and empowerment of the physicians. Because they are afraid if they have any problems, they will not be protected from top management' Q4 'They don't consider the future, all they consider is the short term effect . . . I used three antibiotics, so I have covered the patient, and this patient will get better' Q5 'Some doctors refuse to be challenged. He will say I have read about the topic and I know what I am doing' Q6 'Because surgeons are not so good with antibiotics' Q7
T9: Physicians' fears and concerns	

ID, infectious diseases.

implementation. Workshops to raise awareness of AMR, and education and training related to antimicrobial policies and guidelines as well as good antimicrobial stewardship need to be part of the adoption and implementation strategy (T7 Q1–4). Furthermore, physicians highlighted that orientation programmes for new starters and locums do not include local antimicrobial

policies guidelines and this has contributed to the often inappropriate prescribing of antimicrobials (T7 Q5). The participants, particularly nurses, also emphasised that raising awareness of AMR as well as education on the appropriate use of antimicrobials should also be targeting patients in recognition of the patient and public contribution to AMR (T7 Q6).

### 3.2.7. Lack of health information technology

The lack of health IT in Saudi MoH hospitals has been suggested as a significant barrier to ASP adoption. Absence of electronic prescribing prevents monitoring of antimicrobial prescribing and antimicrobial consumption data capture (T8 Q1–2). Furthermore, even if health IT is integrated in hospitals, lack of a specialised electronic antimicrobial approval system hinders the adoption of antimicrobial stewardship (T8 Q3). A sophisticated IT system is also needed for efficient communication between the various departments and personnel involved in antimicrobial stewardship (T8 Q4–5); this may reduce the disintegration of teams and improve their communication.

### 3.2.8. Physicians' fears and concerns

One interesting barrier to ASP adoption in Saudi MoH hospitals is physicians' fears and concerns. One of the physicians' main concerns is the considerable liability pressure. Physicians are often reluctant to change antimicrobials prescribing or to reduce the length of treatment as per guidelines fearing that the patient may deteriorate. In which case, the physician is resorting to defensive prescribing in fear of legal or administrative proceedings (T9 Q1–4). Another concern is that the risks and benefits of antimicrobial prescribing are only considered for current patients and not future patients (T9 Q5). The participants also highlighted that influencing physicians' prescribing of antimicrobials can be a difficult path, either due to poor enforcement of guidelines, the liability pressure on physicians, or their personal traits and behaviours (T9 Q6–7).

## 4. Discussion

National and regional legislation can improve the adoption and implementation of ASPs in hospitals [13]. However, despite the introduction of a national ASP strategy in 2014, adoption and implementation in Saudi MoH hospitals remains low and slow (the progress of implementation has recently been reviewed by Alomi [6]). The national ASP strategy of 2014 has so far been merely 'academic' and it has not been accompanied by any enforcement measures. Furthermore, the lack of national surveillance for antimicrobial use and AMR rates in Saudi Arabia [10,14] decreases motivation to reduce inappropriate antimicrobial use and marginalises the issue of resistance.

In addition to the lack of enforcement at a central level, the same is happening at hospital level. Antimicrobial guidelines and policies exist but prescribers are either unaware of them, cannot easily access them or are not required to adhere to them. The lack of knowledge of standard treatment guidelines and poor enforcement efforts foster inappropriate antimicrobial use and increase the prevalence of AMR [15]. A qualitative study by Algahtani et al. [16] found that accreditation [17] improved the process and implementation of change in hospitals and, in turn, improved the delivery of healthcare services and quality of care.

Lack of top management support has been identified as a significant barrier to ASP adoption. Hospital managers are responsible for organising healthcare services and ensuring ultimate safe practices through their actions, goals and behaviours [18]. In Saudi hospitals, managers tend to be mainly reactive rather than proactive and their role largely involves response to and ensuring compliance with rules and regulations set out by government [19]. Like in the case of IT innovation adoption, for example, managers who are aware of the seriousness of AMR and with previous experience of ASPs are more likely to adopt the innovation [20]. Without management support, the adoption, implementation and continuation of ASPs can be affected, as shown in previous studies [21,22].

In 2002, Sobczak reviewed integration and disintegration within organisations including healthcare. While integration refers to collaboration and co-operation within joint programmes and projects, disintegration relates to fragmentation and lack of co-operation [23]. The latter has been suggested to hinder quality improvement initiatives in Saudi hospitals [24]. Furthermore, the importance of interdepartmental collaboration within hospitals has been recognised in response to epidemics affecting Saudi Arabia and other countries in the region, including the outbreak of Middle East respiratory syndrome coronavirus [25].

The lack of interdepartmental collaboration within Saudi hospitals is related to communication, which has also been identified as poor, and a significant organisation cultural barrier to quality improvement initiatives within Saudi hospitals [24] and others [22,26]. IT can potentially improve interdepartmental communication and improve patient safety in hospitals [27]. Moreover, the use of sophisticated IT systems that include computerised clinical decision support systems can improve antimicrobial prescribing practices and reduce the rates of healthcare-associated *Clostridium difficile* infection [28]. Moreover, IT systems that support the integration of electronic healthcare records (EHRs) can enhance the adoption and implementation of ASPs in healthcare settings [29].

Interestingly, lack of financial resources to fund IT infrastructure was not identified as a factor in the study by Hasanain et al. [30] and was unclear in the study by Aldosari [31]. The size of the hospital, however, significantly affected the adoption of EHRs and sophisticated IT infrastructure [31]. In relation to ASPs, tertiary hospitals in Saudi Arabia are more likely to have reliable microbiology facilities and to recruit ID physicians and clinical pharmacists, probably due to the availability of resources (financial and human). However, the remaining Saudi hospitals continue to report understaffing and/or shortage of ASP team members, a barrier shared with hospitals in several other countries [32]. These teams will be responsible for co-ordinating education and training of healthcare professionals within the hospital. This education and training role is a key strategy to tackle the inappropriate antimicrobial prescribing behaviours of physicians [33]. This can be done, as part of a hospital-wide multifaceted approach, through dissemination of educational material [34], audit and feedback on performance [35], and manual and automated reminders [36].

In the absence of enforcement of antimicrobial guidelines as well as lack of support from the hospital administration, physicians in Saudi MoH hospitals perceive that they have the sole responsibility for patients' safety and well-being. Thus, physicians resort to prescribing broad-spectrum antimicrobials to prevent deterioration and complications. Similar practices have been reported in other countries [37]. Leadership from the MoH to enforce antimicrobial stewardship guidelines, and their enforcement from the hospital administration, are likely to address physicians' fears and concerns. Prescribers are likely to consider the risks and benefits of antimicrobial prescribing for current as well as future patients [38].

To our knowledge, this is the first qualitative study regarding ASP adoption in Saudi Arabia and the whole Gulf Cooperation Council region. However, there are limitations to this study. Although different healthcare professionals involved in antimicrobial stewardship were interviewed, the sample was composed of staff who are aware of ASPs and thus there is a possibility that the results portrayed do not reflect the views of healthcare professionals who lack experience of ASPs. Furthermore, the study was based on a small number of hospitals ( $n = 3$ ) that were not geographically representative of all Saudi MoH hospitals. A national survey, which forms the quantitative part of this project, involving all MoH hospitals would improve our

understanding of the state and the factors affecting ASPs adoption at a national level.

## 5. Conclusion

Several barriers to ASP adoption and implementation in Saudi MoH hospitals were identified, including factors relating to the sociopolitical context of hospitals, organisational characteristics and healthcare professionals' barriers. The emphasis on enforcement of antimicrobial stewardship guidelines could not be more explicit; ASP adoption and implementation in Saudi hospitals must be formally endorsed by the MoH and enforced and supported by the hospital administration to relieve physicians' liability pressures and to improve their antimicrobial stewardship practices. The lack of human and health IT resources to support antimicrobial stewardship must be addressed before the benefits of ASP adoption and implementation can be realised.

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## Competing interests

None declared.

## Ethical approval

This study was approved by the Health and Human Sciences Ethics Committee of the University of Hertfordshire (Hatfield, UK) [protocol no. LMS/PGR/UH/02344]. Official permission was obtained from participating hospitals, and all participants signed informed consent before taking part in the study.

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