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Antimicrobial stewardship markers and healthcare-associated pneumonia threshold criteria in UK hospitals: analysis of the MicroGuide™ application

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Background: To address antimicrobial resistance, antimicrobial stewardship (AMS) principles must be implemented and adhered to. Clinical decision aids such as the MicroGuide™ app are an important part of these efforts. We sought to evaluate the consistency of core AMS information and the diversity of classification thresholds for healthcare-associated pneumonia (HAP) in the MicroGuide app.

Methods: Guidelines in the MicroGuide app were extracted and analysed for content related to AMS and HAP. Guidelines were characterized according to HAP naming classification; community-acquired pneumonia (CAP) classifications were analysed to serve as a comparator group.

Results: In total, 115 trusts (119 hospitals) were included. Nearly all hospitals had developed MicroGuide sections on AMS ($n=112/119$, 94%) and sepsis management ($n=117/119$, 98%). Other AMS sections were outpatient parenteral antimicrobial therapy (47%), antifungal stewardship (70%), critical care (23%) and IV to oral switch therapy (83%). Only 9% of hospitals included guidance on the maximum six key AMS sections identified. HAP definitions varied widely across hospitals with some classifying by time to onset and some classifying by severity or complexity. The largest proportion of HAP guidelines based classification on severity/complexity ($n=69/119$, 58%). By contrast, definitions in CAP guidelines were uniform.

Conclusions: The high heterogeneity in HAP classification identified suggests inconsistency of practice in identifying thresholds for HAP in the UK. This complicates HAP management and AMS practices. To address HAP in alignment with AMS principles, a comprehensive strategy that prioritizes uniform clinical definitions and thresholds should be developed.

Introduction

Antimicrobial resistance (AMR) is a major threat to global health. Worldwide, drug-resistant infections are contributing to longer hospital stays, rising healthcare costs and increasing mortality.[1] In 2019 alone, over 1.2 million deaths worldwide were attributed to AMR bacterial infections.[2] Although the exact economic costs of AMR are difficult to calculate, as of 2016, the economic burden of AMR in Europe was estimated to be at least €1.5 billion.[3]

In response to this ongoing threat, in 2015, the WHO published a global action plan on antimicrobial resistance,[1] and many countries developed national action plans. In 2019, the UK developed an additional 5 year action plan for AMR that emphasized a commitment to innovation, reducing antimicrobial use and optimizing antimicrobial prescribing, with a specific target of reducing human antimicrobial use by 15% by 2024.[4,5] Despite these efforts, however, rates of AMR remain high for many pathogens.[6]

A critical component of safely reducing inappropriate antimicrobial use is the implementation of and adherence to antimicrobial stewardship (AMS) principles.[7–9] These principles help to ensure that the appropriate antimicrobials are prescribed at the right time and for the right diagnosis.[10] A lack of uniformity in how infections are classified can lead to inconsistency in empirical management and compromise AMS. Moreover, delays caused by ineffective treatment contribute to increased mortality.[11–13] Harmonization can help ensure consistency in diagnostic and prescribing practices, which in turn helps ensure appropriate antimicrobial use.

Clinical guidelines and decision aids that can help healthcare providers optimize their diagnostic and prescribing practices are an important part of harmonization efforts. In the UK, National Health Service (NHS) trusts can choose to host their local antimicrobial guidelines on a digital guideline platform called MicroGuide™ (Induction Healthcare Group plc). Although not all hospitals use MicroGuide and there is a fee to use the platform, it is used by most acute NHS trusts in the UK.[14] Guidelines are available via mobile devices and online and can be updated in real time locally when new recommendations are introduced or new practices are adopted at a hospital. Hospitals develop and customize their own guidelines and sections, choose which content is hosted on the app, and determine how this content will be classified. Standard AMS policy sections can be uploaded and viewed, and empirical and definitive prescribing advice can be accessed by navigating through body systems and infection type.

Although MicroGuide has been received positively by users and has fulfilled an important need in making empirical guidance more accessible,[15] the fact that each hospital develops its own content can lead to variation in how each institution represents AMS policy and manages the same syndrome. Although local context and epidemiology are principal factors in treatment decisions,[16] differences in clinical guidelines can introduce inconsistency in these decisions. This is particularly important when considering that in the UK, training-grade doctors, who undertake the majority of inpatient prescribing, are peripatetic, rotating between different NHS trusts every 6–12 months as part of their residency.

Healthcare-associated pneumonia (HAP) is a common nosocomial infection that contributes to significant mortality and morbidity[17–19] and is frequently included in national and international guidelines. Due to causative pathogens, HAP is distinct from community-acquired pneumonia (CAP) in that it refers specifically to pneumonia that was contracted at least 48 h after hospital admission.[20,21] However, as no standardized definition of HAP exists, the ways in which it is classified and defined vary considerably.

The true burden of HAP is difficult to establish because of inconsistent surveillance methods and the difficult nature of its diagnosis.[22] This challenge stems in part from similarities in clinical presentation among HAP and other respiratory diseases (which may present with fever, cough and dyspnoea),[21] nonspecific and subjective diagnostic criteria,[18] and the fact that sputum samples that are used to identify the causative pathogen(s) are often difficult to obtain.[23] In addition, whereas the CURB-65 score has been validated to help clinicians evaluate the severity of CAP, no such widely accepted severity measure has been adopted for HAP.[20] This unintended heterogeneity in the definitions and management of HAP compromises AMS, as HAP is often treated with broad-spectrum antimicrobials, including antipseudomonal penicillins, cephalosporins and carbapenems, reductions in the use of which are important targets for many AMS programmes.

The objectives of the present study were to evaluate the consistency of core AMS policy information and to evaluate the diversity of HAP classification thresholds in UK NHS trusts using the MicroGuide platform. From our findings, we also sought to describe sources of heterogeneity that could be detrimental to AMS.

Methods

MicroGuide guidelines from acute NHS trusts in the UK were retrieved cross-sectionally over 12 days (21 October 2022 to 2 November 2022) and analysed. Acute NHS trusts are public healthcare organizations that provide secondary or tertiary care and may include one or more hospital sites. All acute NHS trusts with active guidance shared and available on the MicroGuide app were eligible for inclusion in this study. Where a trust had separate guidance for its different hospital sites, data from each hospital were analysed separately. Information was extracted on: trust name, postcode, Integrated Care System region, days since last update, date reviewed and the version number for the local MicroGuide update (site specific).

Each hospital's guidelines were also assessed for content sections relating to AMS. First, as the NICE recommends that all healthcare organizations establish an AMS programme,[24] the number of hospitals that had an 'AMS' section in the MicroGuide app were analysed. Next, guidelines were assessed for the inclusion of sections deemed by the study team to be of interest in promoting AMS. Ultimately, the following exhaustive list of AMS-related sections was developed and analysed:

(i) Outpatient parenteral antimicrobial therapy (OPAT): because at-home treatment options are increasingly promoted in the UK to reduce the risk of healthcare-associated infections,[25,26] the inclusion of OPAT in our analysis would allow identification of trusts that are currently prioritizing this approach.
(ii) IV to oral switch therapy (IVOST): IVOST is an important part of AMS in healthcare settings and has shown lower rates of healthcare-associated infections and shorter length of stay.[27] Decision aids for IVOST have shown substantial improvements in appropriate antimicrobial switching,[27] offering a compelling rationale for the inclusion of IVOST sections in our analysis.
(iii) Sepsis management, antifungal stewardship and critical care antimicrobial prescribing: these areas have all been identified as important components of AMS in healthcare settings[28–30] and were deemed of interest by the study team. Each section was analysed separately.

To evaluate the diversity of HAP classification thresholds, the contents of each hospital's guidelines were qualitatively analysed to identify patterns in classification of HAP guidelines. Each hospital's CAP guidelines were also analysed as a comparator.

Data on HAP classifications were collected by the investigators using an iterative process. No categories were defined a priori. All HAP and CAP definitions entered into the MicroGuide app by each participating trust were recorded and then grouped according to common themes that emerged. To ensure consistency, classification was moderated by a second reviewer. This moderation process was performed for the square root of the total number of hospitals +2 (i.e. 13).[31]

For CAP, data were collected similarly for each hospital with respect to classification and CURB-65 score threshold. The number of hospitals that posted ventilator-associated pneumonia guidance on the MicroGuide app was also recorded, but these data were not analysed further.

Descriptive statistics were generated to summarize the nature of HAP guideline classification and AMS guideline sections across trusts.

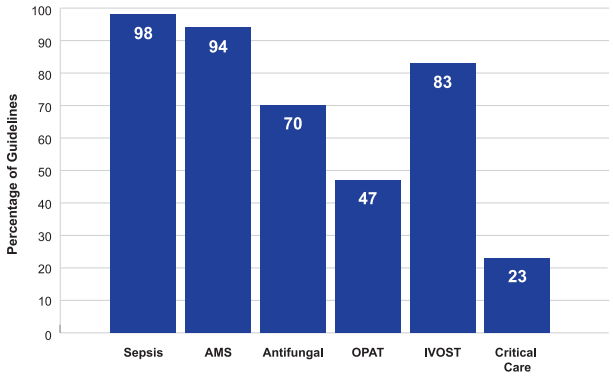

Figure 1. Inclusion of key AMS-related guideline sections. AMS, antimicrobial stewardship; IVOST, IV to oral switch treatment; OPAT, outpatient antimicrobial therapy.

Proportions were calculated to indicate the number of guidelines that fell under each HAP classification and the frequency with which descriptors appeared within HAP section titles. Although data were captured on both HAP and CAP guidelines, the findings were not compared statistically, as they represent different populations.

Results

Of 162 NHS acute trusts that existed at the time of analysis, 115 (71%) had guidelines on the MicroGuide app and were therefore eligible for inclusion in this study. The final sample size included 119 hospitals: 111 trusts had one hospital each, whereas 4 had two hospitals each. Approximately half of the hospitals ($n=62$/119; 52%) had updated their guidelines in the MicroGuide app ≤2 months prior to analysis. Nearly all hospitals ($n=115$/119; 97%) had updated their guidelines in the app within 1 year of the analysis.

In terms of the key AMS sections (Figure 1), nearly all hospitals included a section on sepsis management ($n=117$/119; 98%) and AMS ($n=112$/119; 94%). The majority of hospitals had an IVOST section ($n=99$/119, 83%) and/or an antifungal section ($n=83$/119, 71%). Just under half of the hospitals (56/119, 47%) had a section on OPAT, whereas only 23% of hospitals ($n=27$/119) included a critical care section. Only 9% of hospitals ($n=11$/119) included guidance on all six key AMS sections.

All hospitals included at least one HAP guideline section. Within these guidelines, four broad approaches to HAP classification became evident:

(i) Severity/complexity (severe/non-severe; complex/non-complex): This was used for HAP guidelines or definitions that referenced the severity of the HAP infection by a severity score or with words used to identify severity including: 'severe', 'resistance', 'complex' and 'life threatening'.
(ii) Early/late (based on time to onset): This was used when a guideline exclusively defined HAP severity according to time to onset since hospital admission.
(iii) Early/late + severity (combined classification): This referred to HAP guidelines or definitions that classified HAP according to both time to onset and infection severity.
(iv) No classification [not otherwise specified (NOS)]: This described guidelines that did not provide any definition or qualification for its guideline beyond 'HAP'.

Table 1. Frequency of healthcare-associated pneumonia descriptors used within the MicroGuide section guidelines and titles ($N=119$ hospitals surveyed)

Descriptor	*n* (%)
Terms used in MicroGuide section title	
'Hospital Acquired'	109 (91.6)
'Healthcare Associated'	10 (8.4)
'Severe'	81 (68.1)
Elements in MicroGuide HAP guideline content	
'Severity' defined	73 (61.3)
Sepsis/SIRS/severity scores/HDU support	8 (6.7)
Resistance/recent abx/*Pseudomonas* risk	15 (12.6)
Recent ventilation	3 (2.5)
Time to onset since admission	36 (30.3)
'Late' not otherwise specified	7 (5.9)
≥5 days	24 (20.2)
≥4 days	2 (1.7)
≥3 days	1 (0.8)
≥2 days	2 (1.7)

abx, antibiotics; HAP, healthcare-acquired pneumonia; HDU, high-dependency unit; SIRS, systemic inflammatory response syndrome.

The largest proportion of HAP guidelines classified HAP according to severity/complexity ($n=69$/119, 58%). Then, 10% ($n=12$/119) classified HAP as early/late, and 25% ($n=30$/119) classified HAP according to both severity/complexity and time to onset. The remaining 7% of guidelines (8/119) did not define HAP further.

Descriptors and definitions of HAP varied widely across hospital guidelines (Table 1). The majority of guidelines ($n=109$/119, 92%) included the term 'hospital acquired' in the title, whereas 8% ($n=10$/119) used the term 'healthcare associated'. Over two-thirds of guidelines ($n=81$/119, 68%) used the term 'severe' in the title, and over half the guidelines ($n=73$/119, 61%) further defined the term 'severity'. Approximately one-fifth of guidelines ($n=24$/119, 20%) included HAP classifications with a time to onset of ≥5 days.

Although there was substantial heterogeneity in the HAP guideline classifications, CAP definitions in the MicroGuide app were uniform and consistent. Nearly all hospitals ($n=116$/119, 91%) defined 'severity' in their CAP guidelines. Similarly, CURB-65 thresholds were provided by all but four hospitals ($n=115$/119, 97%).

Discussion

In our analysis of data extracted from the MicroGuide app, nearly all hospitals had developed guidelines for AMS. However, the inclusion of key AMS domains was highly variable; although nearly all hospitals had sections for sepsis management, less common was dedicated information on IVOST, antifungal stewardship, OPAT and critical care, reflecting a lack of harmonization within

AMS guidelines across the UK. Similar issues with harmonization were noted in our analysis of HAP classification within the MicroGuide app, and this may reflect a disparity in how HAP is considered, diagnosed and treated across UK hospitals.

Our analysis demonstrates high uptake of the MicroGuide app in UK hospitals. Further, the high rate of recent updates within 1 year of analysis suggests that MicroGuide is being actively used and maintained. This app may be a key source of AMS information for prescribers in a hospital. However, the high heterogeneity in HAP classification identified in our analysis may complicate efforts to monitor and analyse HAP management and engagement in AMS across the UK health system, due to the lack of comparability between clinical practices. Unfortunately, the lack of uniformity in available guidance for HAP in the MicroGuide application is consistent with the lack of consensus for HAP management in other clinical guidelines.[17,32–34]

Similarly, although the presence of sepsis guidelines at nearly all hospitals is encouraging, these guidelines alone may not be indicative of engagement in AMS. As with HAP, AMS is challenging in the context of sepsis, given the need to treat patients urgently, combined with diagnostic and treatment guidelines that are inconsistent and subjective.[35] These issues illustrate the need for comprehensive AMS efforts that go beyond the introduction of guidelines and prioritize clear definitions and harmonized clinical practice.

By contrast, our analysis suggested that CAP has more homogeneous classifications. Indeed, nearly all guidelines included thresholds for CURB-65 scores, as is commonly seen in other clinical practice guidelines.[36,37] However, it is important to note that CURB-65 is not a tool that can inform AMS and treatment selection. To promote AMS principles, further guidance should be developed for CAP that can enable greater harmonization in prescribing practice among institutions while still accounting for local epidemiology. A pathway approach is most practical. For example, the UK Paediatric Antimicrobial Stewardship (UK-PAS) outlines a harmonized national pathway for a number of infections, including pneumonia.[38] A similar approach for harmonized UK practice could be adopted for pneumonia in adults. Indeed, work on a new iteration of MicroGuide is underway, and this version will incorporate a decision support approach.[39]

Limitations

Our study has some limitations. First, as the MicroGuide app can be changed at any time, the guidelines included in this study may have changed since the analysis. We sought to address this by downloading copies of the guidelines to ensure our analyses and interpretations were based on guidance as written at the time of the study. Second, what constituted a substantial change to the guidelines in our analysis of the time since last update was subjective, which may impact the reliability of our findings.

Implications

We have demonstrated, at the time of our analysis, that MicroGuide has been adopted in most UK hospitals and that this platform provides exposure to AMS policy and principles. However, the current iteration of this app does not use a decision support approach, and the content displayed varies across hospitals.

The findings of our analysis underscore the need for uniform HAP classification guidelines that can help clinicians optimize antimicrobial prescribing practices for HAP, as overprescribing and inappropriate prescribing continue to be major drivers of AMR in the UK.[40,41] Classification of HAP, and indeed all health conditions, is essential in order to adopt a pathway- or evidence-based approach. The high rate of compliance for CURB-65 classification of CAP demonstrates the capacity of the UK health system to work uniformly in defining a threshold of disease. However, this homogeneous approach for CAP still does not incorporate rigorous AMS principles, which may ultimately influence how CAP is managed.

Consistent with efforts to manage AMR in the UK, developing uniform classifications that can promote AMS principles and optimize infection management remains urgent. A 2023 study examining the appropriateness of antibiotic prescribing for community-acquired infections in 2016 reported that 26% of prescriptions for pneumonia were inappropriate.[42] Similarly, a study of healthcare-associated infections from 2011 and 2016 suggested that 29% of cases in which an antibiotic was prescribed for a clinically suspected infection did not meet the case definition for a healthcare-associated infection.[43] These findings underscore the need for more robust diagnostic stewardship that is driven by consistent and uniform disease definitions and classifications. For example, there is some ambiguity in the diagnosis of early, lower-risk HAP (low risk of *Pseudomonas* spp. and methicillin-resistant *Staphylococcus aureus*, or AMR but with low clinical complexity). Indeed, some trusts suggest considering such cases as 'hospitalised CAP' or employing a simple algorithm to differentiate between CAP and low-risk HAP. These borderline cases would likely benefit from next-generation decision-support tools or their own defined coding.[39] As we embark on a future of digital application and refined clinical pathways, it will be essential to ensure that coding and naming of clinical syndromes is improved and that we make advances in pathogen-directed infection management.

Additionally, the development of uniform guidelines across the UK could benefit health equity. Currently, the burden of resistant infections in the UK is disproportionately borne by those with the lowest incomes. Data from the 2022 English Surveillance Programme for Antimicrobial Utilisation and Resistance report indicate that the rates of carbapenemase-producing Gram-negative bacteria were considerably higher among patients from the most deprived 10% of the country than among those from the least deprived 10% of the country (6.8 per 100 000 versus 2.8 per 100 000).[6] Harmonized clinical practice across the UK may help to reduce this gap.

Despite the potential value of clinical guidelines, our analysis also demonstrates the challenges associated with developing clinical decision aids. Within the hospital guidelines we reviewed, it could be difficult to determine which guidelines are applicable to individual patients and those with an infection from an undefined source. Moreover, as many physicians practise at multiple locations, the lack of uniformity among guidelines across institutions can introduce confusion and inconsistency in prescribing practices. Although clinical judgement is always a factor in clinical practice, definitions and thresholds for specific infections should be as clear as possible to help reduce subjectivity in diagnoses. To facilitate this process, mobile decision aids should be evaluated from a user experience perspective to ensure they are well aligned with real-world situations.[44]

Conclusion

Developing a uniform classification system for HAP for use in antimicrobial prescribing guidelines is an important first step in optimizing management and AMS practices in the UK. This optimization is in the best interest of both individual patients and public health more broadly, as reductions in inappropriate prescribing would help improve treatment outcomes and slow rates of AMR. Although clinical practice guidelines are a key step in the AMS pathway, guidelines alone are insufficient. In order to address HAP in a way that aligns with the principles of AMS, a comprehensive strategy that prioritizes uniform clinical definitions and thresholds should be developed and deployed to existing and emerging decision support systems.

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