The use of daily electronic prompts to help improve antimicrobial stewardship in a critical care unit

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Abstract

Introduction: Antimicrobial resistance (AMR) represents a growing threat to public health, with the potential to reverse many of the gains made in modern medicine. AMR is contributed to by both inappropriate choice of antibiotics and inappropriate antibiotic course durations.

Objectives: The objective of this audit was to determine if the introduction of antimicrobial prescribing electronic prompts in an electronic patient record had a positive impact on antimicrobial stewardship.

Methods: The audit examined the proportion of antibiotic prescriptions within a critical care unit in which both a valid stop date and indication were recorded. The audit was repeated on two occasions: first, after an education programme, and second, after the introduction of an electronic prompt within the patients' electronic patient record.

Results: Chi-square analyses indicated that significant improvements in both the recording of indications ($\chi^2(4) = 39.69$, $P < 0.0001$) and stop-dates ($\chi^2(4) = 42.10$, $P < 0.0001$) occurred across the three audits.

Conclusion: We conclude that the novel use of daily electronic prompts has a positive impact on antimicrobial stewardship.

Keywords

Antimicrobial resistance, multidrug resistance, antimicrobial stewardship, safe prescribing, infection control, infection prevention, critical care, electronic patient record

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Introduction

Antimicrobial resistance (AMR) is characterised by the survival of microorganisms following contact with agents known to previously inactivate them. The prevalence of infection with resistant organisms is increasing worldwide and AMR is now a recognised threat to global public health (World Health Organization, 2014). AMR is present in all parts of the world with new resistance mechanisms emerging and spreading globally (World Health Organization, 2014). The consequences of AMR and the resulting failure of standard treatments include increased disease prevalence, increased mortality, prolonged hospital stay and increased treatment costs (Cosgrove et al., 2003; Mauldin et al. 2010; World Health Organization, 2014). The regular use of antimicrobial drugs is widespread in many specialties, including general medicine, paediatrics, surgery, critical care, organ transplantation, haematology and oncology.

As AMR becomes increasingly common, the impact it will have on modern medicine will grow. Indeed, some experts have predicted a post-antibiotic era where numerous achievements of modern medicine could be reversed (World Health Organization, 2014).

AMR is a multifactorial phenomenon, contributed to largely by the inappropriate prescribing of antibiotics. For

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these reasons antimicrobial stewardship has been recognised as an important component in the fight to limit further development of antimicrobial resistance (Department of Health, 2011). Public Health England defines antimicrobial stewardship as ‘an organisational or healthcare-system-wide approach to promoting and monitoring judicious use of antimicrobial drugs to preserve their future effectiveness’ (Public Health England, 2013). The process is multi-faceted and includes, but is not limited to:

- Prescribing courses of antibiotics only when clinical evidence of bacterial infection is apparent;
- Utilising a ‘Start smart, then focus’ approach, which limits the extent of broad-spectrum antibiotic use by ensuring cultures are taken, and antibiotics are rationalised once cultures and clinical picture becomes more apparent (Department of Health, 2011);
- Ensuring indication and stop/review dates are transcribed on antimicrobial prescriptions;
- Adhering to up-to-date local antimicrobial policies;
- Avoiding where possible, practices such as antimicrobial prescribing over the phone.

Particular examples of inappropriate antibiotic prescribing that fall within the remit of antimicrobial stewardship include inappropriate use of broad spectrum antibiotics, inappropriately long course lengths, the failure of patients to complete set courses of antibiotics and the widespread use of antibiotics in the farming industry (Rosenblatt-Farrell, 2009).

Within critical care units, mortality is up to five times higher in patients with multidrug resistant infections (Vincent et al., 2009). Unfortunately, patients in these units have an increased susceptibility to AMR infections. The reasons for this increased susceptibility include the compromised clinical state of these patients, in addition to their exposure to numerous invasive procedures, many broad-spectrum antibiotics and to other patients colonised with AMR infections (Brusselsaers et al., 2011).

Aim

The aim of this audit was to test and, if necessary, improve the compliance of a critical care unit at a large hospital in the south-west of England with the current standard defined in the local antimicrobial policy. This policy states that all antimicrobial prescriptions should have an indication and review/stop date recorded. Sequential strategies to improve compliance were introduced between performing repeat audits.

Methods

The Critical Care Department in question is a 19-bed, predominantly adult unit that deals with medical and surgical patients. In addition, the unit is also responsible for the

temporary management of more specialist patients until emergency transfers to tertiary centres can be organised. These cases include but are not limited to paediatrics and those with severe burns or trauma.

The Critical Care Department utilises the Phillips CareVue electronic patient record and prescribing system. This software is delivered as a standard setup, but is highly customisable for the evolving requirements of the department and the Trust.

Antimicrobial stop date and indication was targeted as the hospital’s antimicrobial policy is written to coincide with national guidance on the requirement for antimicrobial indication and stop/review date transcription. This guidance is from The National Institute for Health and Care Excellence Quality Standard QS61 (National Institute for Health and Care Excellence, 2014). Furthermore, the hospital is audited on its compliance to this standard, but because of the use of an isolated clinical system in the Critical Care Department, it had up until this point been omitted from the monthly audit data for the hospital.

The audit itself was undertaken by way of the completion of three discrete data audits. Sequential strategies to improve compliance were implemented after the first and second rounds of data audits. All three audits were undertaken retrospectively, and the clinicians on the critical care unit were not aware of the dates of the subsequent re-audits. The audits looked solely at the number of antimicrobial prescriptions with or without an indication and stop/review date, and did not follow the prescribing practices of individual clinicians.

The first data audit was performed prior to any intervention for June, July and August 2013. These data reflected baseline antimicrobial prescribing habits. The second data audit was undertaken for January and February 2014 during a period when the Trust was undertaking a campaign to promote antibiotic stewardship. The campaign consisted of three main aspects. The first was the dissemination of regular emails highlighting the importance of antimicrobial stewardship to all Trust clinicians. The second was a practice of encouraging the ward pharmacists to challenge and clarify erroneous antimicrobial prescribing. The third aspect involved the Trust Pharmacy Department auditing all ward-based clinicians individually on their antibiotic prescribing on a monthly basis to assess if they had written an indication and stop/review date. A threshold of >90% of antimicrobial prescriptions with an indication and stop/review date transcribed for those that undertook two or more antimicrobial prescriptions per month was required to meet the target. A spreadsheet detailing the antimicrobial practices of all prescribing clinicians in a department was sent to the head of that particular department on a monthly basis. Those who fell short of this threshold were invited to a 30-min presentation on antimicrobial stewardship, given by the lead clinician for infection control. This presentation was a non-confrontational review of recent antimicrobial

Figure 1. A diagrammatic representation illustrating the electronic prompt in the electronic patient record.

CARE BUNDLES	
Stop date/reason for prescription, added to all abx	
Head of Bed Elevation >30°	☐ <Clear Entry>
Stress Ulcer Prophylaxis	☐ Yes
VTE Prophylaxis	☐ Not Applicable

resistance evidence and statistics, with an emphasis on the importance of adhering to the trust's policy on antimicrobial prescriptions to reduce the risk of the development of antimicrobial resistance. Those individuals that continued to fall below the specified threshold despite the presentation were brought before either their clinical supervisors or heads of department and received a verbal warning. Of note, the third aspect of the Trust's antimicrobial stewardship campaign did not apply to the clinicians on the Critical Care Unit. This was because the Critical Care Unit utilised a different electronic prescribing system to that of the rest of the Trust, and the Trust Pharmacy Department was unable to audit the antimicrobial prescribing practices in the same manner. For this reason, it is likely that the threat of sanctions applied to the ward-based clinicians would have had less of an impact on the critical care clinicians, because they were not having their antimicrobial prescribing habits subjected to a continuous and formal audit process.

The third data audit was undertaken in March and April 2014, following the addition of a daily prompt in the electronic patient record that reminded clinicians to check that all antimicrobial prescriptions have both an indication and stop/review date recorded. This prompt was added to the daily electronic ward round document. The prompt had to be completed each day on this document in order for the system to allow the user to save the document. A diagrammatic representation illustrating this electronic prompt is displayed in Figure 1.

A list of all of the patients that had been admitted to the critical care unit between the dates of the proposed data audits was produced. The medical records of each of these patients were then reviewed on CareVue and a revised list was produced containing only those patients who had had an antimicrobial prescribed. For these patients the following information was recorded: name of antibiotic(s), route of administration, dose, frequency, any order instructions, start date, stop/review date, indication and whether an amendment had occurred within the prescription since its initial creation. This allowed recording of how many of the antimicrobial prescriptions had a stop/review date or an indication added either at the time of the initial prescription or added at a later time.

It should be noted that the first data audit was performed on 3 months of prescribing data, but the second and third data audits were performed on only 1 month of data in

order to more rapidly assess the impacts of the sequential interventions. This is demonstrated by the lower n-value for the second and third audits compared to the first audit.

The author's goal was to implement a system that achieved an antimicrobial indication and stop/review date transcription rate on antimicrobial prescriptions of greater than the 90% cutoff the Trust had set as part of their wider Antimicrobial Stewardship campaign.

Results

Descriptive statistics indicated a sequential improvement in the recording of both indication and stop/review dates across each separate data audit as demonstrated numerically in Table 1 and graphically in Figure 2. Initial compliance recorded during the first audit was poor with only 57% (n = 178) and 60% (n = 187) of prescriptions having an indication or stop/review date recorded respectively. Audit two, performed following Trust-wide activities to raise awareness of antibiotic stewardship, demonstrated an increase in the recording of both indications 78% (n = 46) and stop date 84.7% (n = 50). These rates further increased at audit three, performed following the introduction of a daily prompt in the electronic patient record, with 96% (n = 50) of patients having both an indication and stop/review date recorded.

Chi-square analyses indicated that significant improvements in both the recording of indications ($\chi^2(4) = 39.69$, $P < 0.0001$) and stop dates ($\chi^2(4) = 42.10$, $P < 0.0001$) occurred across the three audits. For both the recording of indication and stop date, significant improvements were seen between audits one and two (Indication: $\chi^2(2) = 13.76$, $P < 0.001$, Stop date: $\chi^2(2) = 17.66$, $P < 0.0001$) with improvements being due to a higher proportion of patients having information recorded both at the time of initial prescription and in retrospect. A further significant improvement was observed for the recording of indications ($\chi^2(2) = 8.33$, $P = 0.015$) but not stop dates ($\chi^2(2) = 4.03$, $P = 0.133$) between audits two and three despite both showing numerical increases in the percentage of recorded information. Improvements seen between audits two and three appeared to be primarily a function of an increase in the proportion of patients in whom information was recorded at the time of initial prescription, rather than amendments performed at a later time.

Table 1. Table demonstrating changes in transcription of indication and stop date/review date over the 3 audit periods.

	Audit 1	Audit 2	Audit 3
Total antibiotic prescriptions	N = 312	N = 59	N = 52
Total with indication	57% (178/312)	78% (46/59)	96% (50/52)
Indication added initially	49% (153)	58% (34)	77% (40)
Indication added in retrospect	8% (25)	20% (12)	19% (10)
Indication not added	43% (134)	22% (13)	4% (2)
Total with stop date/review date	60% (187/312)	85% (50/59)	96% (50/52)
Stop date added initially	54% (168)	68% (40)	77% (40)
Stop date added in retrospect	6% (19)	17% (10)	19% (10)
Stop date not added	40% (125)	15% (9)	4% (2)

Figure 2. Graphs demonstrating improvements in the level of recording of both indication and stop date across three successive interrogations.

There was significant debate over the most appropriate statistical test to use for our data. McNemar's test was considered, but would have required significant re-processing of our original data in order to run the analysis. As a result, a Chi-square analysis was deemed the most appropriate form of statistical analysis. It should be noted that if we were to undertake a repeat measures analysis using a McNemar's test, the statistical significance already demonstrated by the Chi-square analysis would be augmented as opposed to diminished.

Discussion

Baseline compliance with some of the key aspects of antimicrobial stewardship within the Critical Care Unit was poor. These results are likely to reflect practice both throughout this trust and nationally (Public Health England, 2013; Public Health England, 2015). A Trust-wide antimicrobial stewardship campaign to raise awareness about the importance of antimicrobial stewardship coincided with an improvement in both the proportion of antibiotic prescriptions in which an indication and stop/review date were recorded. As illustrated by Figure 2, the major change seen at this time was that prescriptions were being reviewed

retrospectively, and that this information was being added some time after the initial prescription was written. Due to the broad remit of the campaign, it is difficult to ascertain what, if any of the particular constituents of the campaign contributed to the improvement in antimicrobial prescribing practices.

Compliance was later found to have significantly improved following the introduction of an electronic prompt to the electronic patient record which, on a daily basis, alerted the medical staff on the ward round to ensure that all current antibiotic prescriptions had both an indication and a review/stop date recorded. The clinicians had to sign this box to say that they had reviewed the prescription chart and were unable to save the wider document until they had done so. The improvements seen in antimicrobial prescribing practice observed following the introduction of this prompt did not result from retrospective changes made to already active prescriptions. Instead these improvements were largely due to an increase in the proportion of antibiotic prescriptions where this information was recorded at the time of initially writing the prescription. This is an important factor, as it demonstrates that the implemented alterations have changed the behaviour of clinicians to the extent that they are now more adequately fulfilling the

wider concept of antimicrobial stewardship by writing the prescriptions correctly initially, as opposed to requiring a prompt to amend their prescriptions retrospectively. It is difficult to determine the underlying cause for this change given the number of confounding factors; however, one possible explanation could be that the daily repetition of an electronic prompt on each patient during a ward round has altered behaviour by repeatedly bringing antimicrobial stewardship to the forefront of the attending clinician's mind.

This audit has demonstrated that the innovative use of a daily prompt within an electronic patient record can contribute to greatly improving compliance in recording both the indication and stop/review date for all antimicrobial therapy. These data support the widespread implementation of a prescription system where daily reminders or even compulsory data entry columns are integrated in an effort to improve compliance with antimicrobial stewardship. A growing number of Critical Care Units are moving towards using electronic patient records with integrated electronic prescribing. The auditors only have experience with the Phillips CareVue electronic patient record; however, in this instance, the implementation of this addition to the electronic prescribing module was relatively easy. The time taken from inception of the idea to completion and integration was a number of days. It required a discussion with the manufacturer, and a brief system reset of approximately 5 min to upload the new add-on.

The main strength of the audit is that it has demonstrated that both Trust-driven campaigns to improve antimicrobial stewardship and the implementation of an electronic prompt within the electronic patient record contribute to improving antimicrobial prescribing practices. The audit compliments a growing body of recommendation that encourages the introduction of electronic prescribing systems because of their benefits in improving antimicrobial stewardship (National Institute of Health and Care Excellence, 2015). The UK 5-year Antimicrobial Resistance Strategy identifies electronic prescribing systems as a mechanism to aid antimicrobial stewardship at the present time. In addition, it goes on to say that electronic prescribing offers significantly improved opportunities for data reporting and subsequent research on antibiotic use, resistance and clinical outcomes, as well as potentially serving as a conduit for future antimicrobial stewardship campaigns and policies that could be directly linked with the software (Department of Health, 2013).

The authors have tried to undertake the audit to a high standard, but acknowledge that there are weaknesses. First, due to the fragmentation of the clinical systems in use in the Hospital Trust, it was unfeasible to collect all of the demographic and comorbidity data that could have been used to further highlight key subcategories requiring improved antimicrobial prescribing practices.

Second, with clinician rotations occurring every 4 months, it was deemed impractical to follow the antimicrobial prescribing habits of individual clinicians. However, this approach may have highlighted different practices between sub-groups of clinicians, which could then be used to more accurately focus antimicrobial stewardship processes.

Third, the n-value for the second and third audits is much lower than the first audit. The second and third audits were undertaken following the clear failure to comply with the antimicrobial guidelines demonstrated in the first audit. Following discussion, the authors decided that 1 month of antimicrobial prescribing data as opposed to 3 months of data would be sufficient to demonstrate any changing trends in antimicrobial stewardship and serve as a mechanism to more rapidly improve antimicrobial prescribing habits on the unit. The n-value for the second and third audits is also proportionally lower than that of the first audit when reviewed on an antimicrobial prescription per month basis. The reasoning for this is unclear, but is likely to at least in part involve the dramatic surge in demand experienced by the hospital during the summer months due to the influx of holidaymakers to the region, many of whom have significant co-morbidity. The authors feel it is unlikely that the burden of workload attributed to this annual surge in demand would alter the intrinsic quality of the antimicrobial prescribing in the Critical Care Unit, but this cannot be entirely discounted.

Conclusion

We have described an audit that has demonstrated that antibiotic prescribing can be significantly improved by the use of an electronic prompt in the electronic patient record. Adequate recording of indication and stop/review dates of antimicrobial therapy are important components of antibiotic stewardship programmes, which themselves are an important method for combating the worrying increase in antimicrobial resistance.

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Ethics statement

The ethical ramifications of the audit were discussed prior to implementation. Ethical approval from the local ethics committee was not required to undertake this project as it was a retrospective audit that did not involve patients, their care, or the healthcare professionals caring for them.

Peer review statement

Not commissioned; blind peer-reviewed.

References

- Brusselsaers N, Vogelaers D and Blot S. (2011). The rising problem of antimicrobial resistance in the intensive care unit. *Annals of Intensive Care* 1: 47.
- Cosgrove SE, Sakoulas G, Perencevich EN, Schwaber MJ, Karchmer AW and Carmeli Y. (2003) Comparison of mortality associated with methicillin-resistant and methicillin-susceptible *Staphylococcus aureus* bacteremia: a meta-analysis. *Clinical Infectious Diseases* 36: 53–59.
- Department of Health. (2011) *Antimicrobial Stewardship: Start smart – then focus*. London: Department of Health.
- Department of Health. (2013) *UK Five Year Antimicrobial Resistance Strategy 2013–2018*. London: Department of Health.
- Mauldin PD, Salgado CD, Hansen IS, Durup DT and Bosso JA. (2010) Attributable hospital cost and length of stay associated with health care-associated infections caused by antibiotic-resistant gram-negative bacteria. *Antimicrobial Agents and Chemotherapy* 54: 109–115.
- National Institute for Health and Care Excellence. (2015). *Antimicrobial stewardship: systems and processes for effective antimicrobial medicine use*. London: NICE.
- National Institute for Health and Care Excellence. (2014) *Infection prevention and control NICE quality standard [QS61]*. London: NICE. Available at: <https://www.nice.org.uk/guidance/qs61/chapter/quality-statement-1-antimicrobial-stewardship>
- Public Health England. (2013). *Antimicrobial prescribing and stewardship competencies*. London: Public Health England.
- Public Health England. (2015) *Behaviour change and antibiotic prescribing in healthcare settings: Literature review and behavioural analysis*. London: Public Health England.
- Rosenblatt-Farrell N. (2009) The landscape of antibiotic resistance. *Environmental Health Perspectives* 117: A244–A250.
- Vincent JL, Rello J, Marshall J, Silva E, Anzueto A, Martin CD, Moreno R, Lipman J, Gomersall C, Sakr Y and Reinhart K; EPIC II Group of Investigators. (2009). International study of the prevalence and outcomes of infection in intensive care units. *Journal of the American Medical Association* 302: 2323–2329.
- World Health Organization. (2014) *Antimicrobial Resistance Global Report on Surveillance*. Geneva: WHO. Available at: http://apps.who.int/iris/bitstream/10665/112642/1/9789241564748_eng.pdf.