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Successful antibiotic stewardship in the electronic era

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A multi-faceted antimicrobial stewardship programme contributed to a 17.8% reduction in antibiotic consumption for our English NHS Trust. This dramatic achievement could be partially attributed to an empirical antibiotic guideline change, introduction of procalcitonin testing to guide in antibiotic decisions in SARS-CoV-2 inpatients and use of electronic antibiotic stewardship strategies.
In this article, we describe the multifaceted, step-by-step antibiotic stewardship approach that weathered the SARS-CoV-2 pandemic and led to this dramatic improvement. Also included for completeness are interventions that did not pass the plan, do, study, act (PDSA) cycle and were therefore discontinued.

Introduction

The requirement for NHS trusts to reduce annual antibiotic consumption by at least 1% from a 2018 baseline has been incorporated in the standard contracts from 2019/2020.[1] Submission of total antibiotic consumption data to the UK Health Security Agency (UKHSA) remains a requirement but is now part of the NHS standard contract. This is in line with the UK 2019 to 2024 five-year action plan on antimicrobial resistance.[2] Antibiotic consumption for each English Trust is published on the UKHSA fingertips website on a quarterly basis.[3] This is a useful online tool for comparisons between English trusts as well as monitoring performance trends. (Figure 1)

Great Western Hospitals NHS Trust antibiotic consumption in defined daily dose (DDD) per 1000 admissions improved from the fourth to the best quintile in England from 2018/2019 to 2020/2021.[4] There was a reduction in antibiotic consumption of 17.8% for the year ending after the first quarter of 2021. This was the biggest reduction in antibiotic consumption among NHS Trusts in the Southwest region of England. Although there was a general reduction in antibiotic consumption seen across most NHS hospitals in England and attributed to the SARS-CoV-2 pandemic,[5] a reduction relative to the regional and English quintile benchmark was remarkable.

In this article, we describe the multifaceted, step-by-step antibiotic stewardship approach that weathered the SARS-CoV-2 pandemic and led to this dramatic improvement. Also included for completeness are interventions that did not pass the plan, do, study, act (PDSA) cycle and were therefore discontinued.

Evidence-based and organism-specific empirical community-acquired pneumonia guidelines

Community-acquired pneumonia (CAP) is a common indication for antibiotics. It is also a common reason for escalation of the antibiotic spectrum if the most common causative organisms are not covered by initial empirical antibiotic choices. Regular UKHSA national respiratory pathogens antimicrobial susceptibility surveillance reports were used in the selection of antibiotic combinations that were most likely to cover causative organisms for CAP.[6] Clearly, tetracyclines are superior to macrolides for empirical cover for CAP. The most striking of these is the cover for *Haemophilus influenzae* where 98% are susceptible to tetracyclines, as opposed to 4% to macrolides. (Table 1). Therefore, first-line empirical antibiotic choice for moderate to severe CAP was changed from a clarithromycin- to a doxycycline-based regimen with urinary *Legionella pneumophila* testing as indicated. This intervention has the added benefit of using AWaRe access[7] antibiotics for the most common infective presentations.

An internal retrospective audit comparing outcomes of patients admitted on a clarithromycin-based regimen for CAP in May 2018 ($n=22$) and those started on a doxycycline-based regimen in May 2022 ($n=16$) showed better outcomes for the latter. Outcome measures were duration of hospital stay, need for antibiotic escalation during hospital stay and readmission within 7 days of discharge. Whereas patients on clarithromycin had an average of 8.1 days of hospital stay, those on doxycycline stayed for 6 days. Readmission rate for the clarithromycin arm was 9%

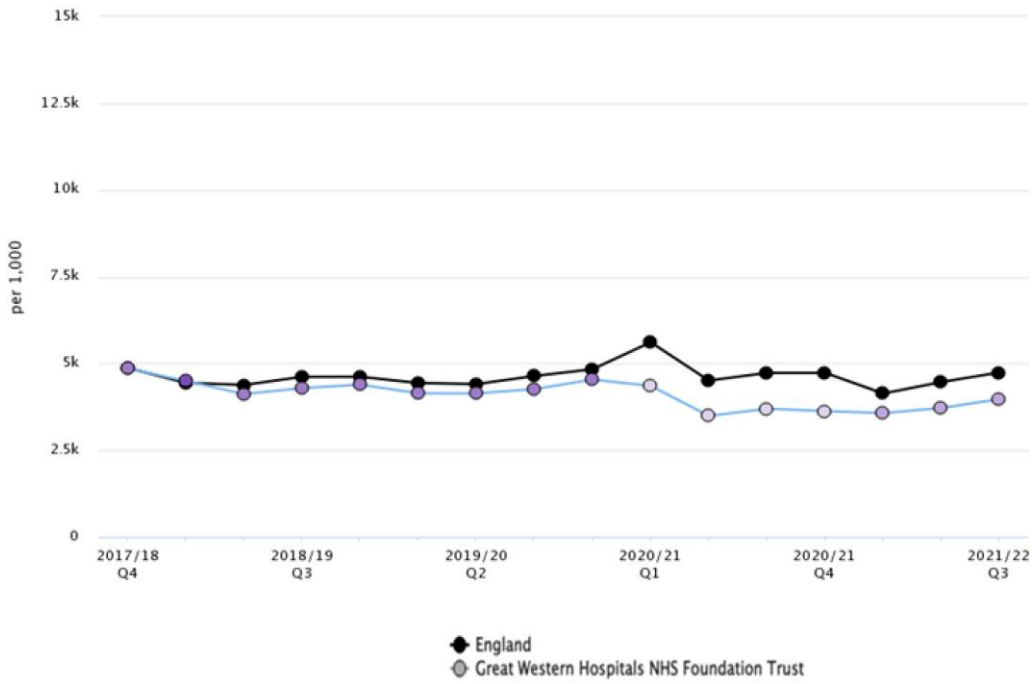

Figure 1. Total antibiotic prescribing DDDs per 1000 admissions, by quarter and trust for Great Western Hospitals NHS Foundation Trust. Source: UKHSA fingertips website.

Table 1. Antimicrobial susceptibility in the 12 weeks up to 28 October 2018

Organism	Antibiotic	Number tested	Susceptible (%)
Streptococcus pneumoniae	Penicillin	2827	89
	Macrolides	3050	82
	Tetracycline	2992	84
H. influenzae	Amoxicillin/ampicillin	11 224	69
	Co-amoxiclav	12 077	83
	Macrolides	2849	4
	Tetracyclines	12 101	98
Staphylococcus aureus	Methicillin	6031	90
	Macrolides	6757	66
MRSA	Clindamycin	430	44
	Tetracycline	573	78
MSSA	Clindamycin	3840	78
	Tetracycline	5034	93

Source: UKHSA national surveillance of influenza and other respiratory illnesses. The choice of antibiotics reflects the British Thoracic Society empirical guidelines.
Macrolides = erythromycin, azithromycin and clarithromycin.

whereas for the doxycycline arm it was 0%. Thirty-six percent had an antibiotic escalation on the clarithromycin arm, mainly to piperacillin/tazobactam, while 31% did on the doxycycline arm, mainly to amoxicillin/clavulanic acid. However, several factors may affect the outcome measures mentioned, therefore larger studies are needed to tease out a more accurate interpretation.

The 5 day electronic antibiotic prescriptions hard stop

Great Western Hospitals was one of the English NHS trusts selected to take part in the Antibiotic Review Kit for Hospitals (ARK-Hospital)[8] antibiotic stewardship research project. As part of this research project, a hospital specific 5 day antibiotic electronic hard stop was introduced. The hospital Electronic Prescribing and Medicines Administration (EPMA) system[9] was modified to include a 5 day hard-stop option for antibiotic prescriptions. After education and reassurance, 99% of prescribers select this option for antibiotic prescriptions, as shown in an internal pharmacy audit. This hard stop forces the clinician to review the need for antibiotics. So far, there have been no serious adverse effects reported from this intervention.

Procalcitonin testing for SARS-CoV-2 inpatients

Procalcitonin is an inflammatory marker specific for bacterial infection[10] and therefore a useful decision aid in avoiding unnecessary antibiotic use for viral and other non-bacterial infections.

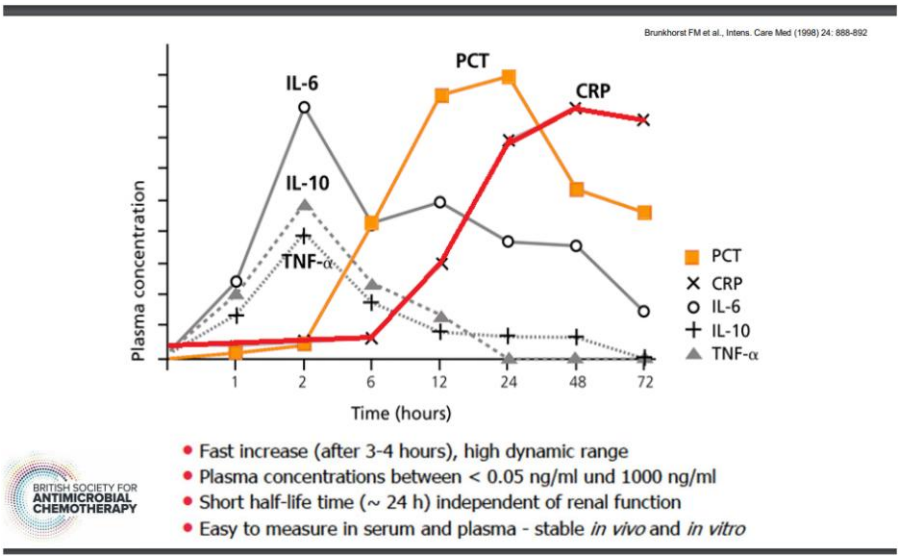

Figure 2. Inflammatory marker dynamics during an acute infection. Source: British Society for Antimicrobial Chemotherapy.

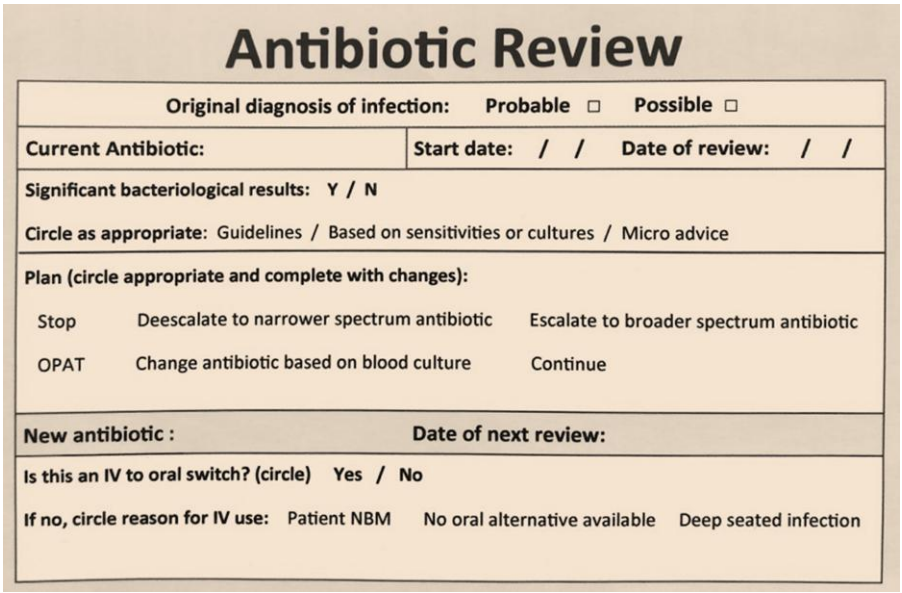

Figure 3. Great Western Hospitals antibiotic review sticker.

A combination of clinical assessment, procalcitonin testing and following a well-defined patient treatment algorithm has the potential to improve the management of patients with suspected bacterial infection and therefore improve antibiotic stewardship.

Procalcitonin has the additional benefit of rising before the C-reactive protein (CRP) during an acute infection and reduces faster in response to therapy (Figure 2). This means shorter antibiotic courses could be prescribed for patients where procalcitonin is monitored as opposed to CRP alone.

Routine procalcitonin testing was introduced for all SARS-CoV-2 patients who were hospitalized on the basis of oxygen and other respiratory support requirements. A procalcitonin pathway was agreed upon. A 'COVID' bloods test request set was set up to include procalcitonin testing. This aimed to ensure that all patients in the required category got a procalcitonin test on admission. Antibiotics could be stopped if procalcitonin was normal and the clinical picture did not suggest secondary bacterial infection. Repeat procalcitonin testing is recommended at 72 h of admission.

Results from audits carried out on the SARS-CoV-2 admission units showed a reduction in antibiotics prescriptions from 70% of confirmed patients in December 2020 to 36.5% in October 2021. The antibiotic stop rate after a low procalcitonin of less than 0.25 units was 32%.

Although there is still room for improvement, the data show that procalcitonin has been a successful decision-aid tool in affecting clinician attitude to non-bacterial infections such as SARS-CoV-2.

Procalcitonin is also used as an antibiotic decision-aid tool for all patients requiring antibiotics on the ICU.

Reduction in size of to-take-out (TTO) antibiotic packs to a 5 day supply

Antibiotic TTO packs were reduced from a 7 day supply to a 5 day pack. When prescribers were asked if their patient needed a bigger supply of antibiotics to take home, the majority found that a 5 day pack was sufficient. Longer antibiotic courses are given on infection specialist advice.

Weekly automatically generated lists for all patients on carbapenem antibiotics

The benefit of electronic prescribing was maximized by setting up weekly carbapenem alerts on the EPMA. Lists of all patients on carbapenems are generated and distributed to microbiologists and pharmacists for review. This enables easy review of those ready for oral switches or antibiotic stops. This list has now been extended to a daily list of all patients on antibiotics. This strategy also focuses the antimicrobial stewardship team to problem areas.

'Low-hanging fruit' electronic alerts—more than 7 days, more than three antibiotics

Electronic alerts set up on the EPMA to pick up on 'low-hanging' stewardship fruit such as patients on more than three antibiotics or those who have been on antibiotics for more than 7 days.

Trust guidelines on MicroGuide app

The MicroGuide app has enabled prescribers to easily access the Trust guidelines on their mobile phones and has improved guideline adherence.

This bespoke Great Western Antibiotic review sticker (Figure 3) was initially used for review of all sepsis patients. This worked well with antibiotic reviews of up to 100% on internal audit. However, this required sepsis nurses reminding doctors to fill them in. The sticker was again used as part of the ARK research project. Stakeholders were educated on the medical wards, through an online training-tracker and ward champions. The fill-in rate for the review stickers ranged from 74% in Week 1 to 0% in Week 12. The fill-in rate increased if doctors were reminded each and every time. Therefore, although the sticker works well for small patient groups whilst requiring large numbers of antimicrobial stewardship staff to monitor their use, it does not work well with large patient groups. Apart from being labour intensive, it was not a useful stewardship tool, especially during a pandemic, and was difficult to embed.

Discussion

Antibiotic stewardship tools that did not require the prescriber to go out of their routine were more successful. Other methods that required physical gathering of groups to make antibiotic decisions did not yield favourable results. Stewardship strategies that relied on team-based patient care were more difficult to embed in the more modern ward-based clinical teams. Therefore, antimicrobial stewardship tools that enable the clinician to make antibiotic decisions on seeing a patient for the first time are better received and more effective. In 2 years, new antibiotic prescribers will have their birth-date within this millennium, the electronic age. Stewardship methods such the electronic antibiotic drop are better received by the younger generation. Electronic monitoring of antibiotic prescriptions enables the antimicrobial stewardship team to focus scarce human resources where they are needed most.

Funding

Data generated as the routine antimicrobial stewardship programme for the Trust have been partially included.

Transparency declarations

The 5 day electronic antibiotic drops were introduced as part of the ARK-Hospital stewardship research project.

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