



The effect of re-audit and education on antibiotic prescribing practice at Causeway Hospital, Northern Ireland

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Abstract

Background Antimicrobial resistance is a growing global problem. There has been increasing emphasis on promoting antimicrobial stewardship. Accurate completion of antibiotic prescriptions, such as documentation of clinical indication and a stop/review date, helps promote antimicrobial stewardship.

Aims To investigate the impact of educational interventions on the completeness of antibiotic prescriptions at Causeway Hospital surgical unit.

Methods Inpatient drug prescription charts were audited to monitor the completeness of antibiotic prescriptions on the surgical unit. Two educational interventions were implemented, with a subsequent prospective re-audit carried out.

Results The completion of (1) “Stop date/Review date”, (2) “What infection are you treating?”, (3) “Cultures sent?”, (4) “Printed name”, (5) “Professional number”, and (6) “Bleep number” fields within the inpatient drug charts increased noticeably in the re-audit. A paired *t* test, comparing all of the initial audit completion proportions with the re-audit completion proportions, demonstrated a statistically significant improvement ($p < 0.05$).

Conclusions Educational interventions led to an improvement in the completeness of antibiotic prescriptions. This highlights the important role that continued audit and education play in the promotion of antimicrobial stewardship.

Keywords Antibiotic · Antimicrobial resistance · Antimicrobial stewardship · Audit · Prescribing · Prescription

Introduction

Antibiotics are commonly prescribed to surgical inpatients. Globally, resistance to antimicrobial agents is increasing, and production of novel antibiotic agents has slowed in recent years [1].

There is an increasing prevalence of intra-abdominal infections caused by antibiotic-resistant organisms, with associated increased morbidity and mortality rates [2]. The Department of Health in Ireland has stated that, “The rise in antimicrobial resistance is thus one of the greatest potential threats to human health at global, European and national levels” [3].

Within Ireland, there has been an increase in antimicrobial resistant pathogens causing infections, alongside an increase in antimicrobial consumption [4]. The incidence of piperacillin/

tazobactam-resistant *E. coli* and *Klebsiella pneumoniae* bloodstream infections is increasing in Northern Ireland [5].

Great emphasis has therefore been placed on the concept of antimicrobial stewardship. The National Institute for Health and Care Excellence (NICE) defines antimicrobial stewardship as, “an organisational or healthcare-system-wide approach to promoting and monitoring judicious use of antimicrobials to preserve their future effectiveness”, and defines antimicrobial resistance as, “loss of effectiveness of any anti-infective medicine, including antiviral, antifungal, antibacterial and antiparasitic medicines” [6].

A 5-year national strategy in the UK for tackling antimicrobial resistance was published in 2013, and one of its key actions was to optimise antibiotic prescribing through stewardship [7]. The Transatlantic Task Force on Antimicrobial Resistance promotes co-operation on the issue of antimicrobial resistance between the European Union and the USA. It produced a list of indicators for hospital antimicrobial stewardship policies, for example, documentation of indication, procedure for a post-prescription review of antibiotic appropriateness, and communication of prescribing audit results

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with prescribers [8]. It is suggested that individuals who prescribe antibiotics in surgical units should be involved in antibiotic stewardship programmes, so that they are fully integrated into clinical practice [9].

Public Health England published an antimicrobial stewardship toolkit entitled, “Start smart – then Focus”, recommending its use in quality improvement. “Starting smart” advises prescribers to “document clinical indication (and disease severity if appropriate), drug name, dose and route on drug chart and in clinical notes”, “include review/stop date or duration”, and “obtain cultures prior to commencing therapy where possible (but do not delay therapy)”. “Then Focus” advises the importance of, “reviewing the clinical diagnosis and the continuing need for antibiotics at 48–72 hours and documenting a clear plan of action” [10].

For each antibiotic prescribed in the drug chart used in the Northern Health and Social Care Trust (NHSCT), there are fields for “Medicine”, “Dose”, “Route”, “Frequency”, “Start date”, “Stop date”, “Special Instructions”, “What infection are you treating?”, and “Cultures sent?”

For each prescription, there are also four fields for information to identify the prescriber, namely, “Sign”, “Print”, “Professional number”, and “Bleep”.

From observation on the surgical wards, it appeared that some of these fields were completed very well, but others were rarely completed.

The NHSCT policy states that prescribers should, “Document clinical indication (and disease severity if appropriate), dose and route on the drug chart and in the clinical notes”, and “Review the clinical diagnosis and the continuing need for antibiotics by 48–72 hours and make a clear plan of action - the ‘antimicrobial prescribing decision’” [11].

Quality improvement projects have previously been shown to improve prescribing documentation, for example documentation of the indication and treatment duration of an antibiotic prescription [12].

We hypothesised that the quality of completion of antibiotic prescriptions in drug charts would improve following educational interventions.

Methods

The standard that we chose to audit against was a completion rate of 100% for each of the following aspects of each antibiotic prescription:

“Medicine”, “Dose”, “Route”, “Frequency”, “Start date”, a documented review date or stop date, “What infection are you treating?”, “Cultures sent?”, “Sign”, “Print”, “Professional number”, and “Bleep”.

In the initial audit, inpatient drug charts were reviewed over a period of 11 days, between 27/10/2016 and 06/11/2016. The completion or non-completion of each of the above aspects of

the prescription was recorded for each antibiotic on each drug chart. On day 1, all of the drug charts on the two surgical wards were reviewed. On subsequent days, drug charts of newly admitted surgical patients on the two surgical wards were reviewed. Newly admitted patients were identified by daily review of a list of patients admitted over the previous 24 h on the surgical take, produced each morning by the on-call surgical team.

Following this initial audit period, two interventions were then introduced, in an attempt to improve completion of antibiotic prescriptions.

Firstly, the results of the initial audit were presented at a surgical teaching session, attended by doctors working on the surgical wards. This teaching session consisted of describing which proportion of drug charts reviewed had each of the information fields completed. Advice was also given on areas where most improvement could be achieved, namely documenting what infection was being treated, documenting a stop or review date, indicating whether or not cultures had been sent, and completing the four identification fields. The rationale behind the importance of this was emphasised.

Secondly, following the departmental teaching session, an email was sent to all of the doctors who work in the surgical unit. This email described the results of the initial audit, and also highlighted areas for improvement. It also described the importance of completing the various fields within the antibiotic prescription.

A re-audit was carried out over 11 days, between 22/11/2016 and 02/12/2016, using the same methods as the initial audit.

The proportion of each aspect completed in the initial audit was compared to the proportion of the corresponding aspect completed in the re-audit. A paired *t* test was used to make a statistical comparison. Data analysis was carried out using GraphPad Prism.

The results of the re-audit were presented at a surgical teaching session.

Results

Table 1 shows the proportion and number of antibiotic prescriptions that had each aspect completed, for both the initial audit and the re-audit.

As can be seen from Table 1, “Medicine”, “Dose”, “Route”, “Frequency” and “Signature” all had a 100% completion rate in both the initial audit and re-audit.

“Start date” showed a small reduction in completion in the re-audit compared to the initial audit.

The completion of “Stop date/Review date”, “What infection are you treating?”, “Cultures sent?”, “Printed name”, “Professional number”, and “Bleep number” increased noticeably in the re-audit compared with the initial audit.

Table 1 The proportion (and number) of antibiotic prescriptions with each aspect completed in the initial audit and re-audit

Aspect of prescription	Initial audit	Re-audit
“Medicine”	100% (33)	100% (47)
“Dose”	100% (33)	100% (47)
“Route”	100% (33)	100% (47)
“Frequency”	100% (33)	100% (47)
“Start date”	94% (31)	91% (43)
Stop date/Review date	30.3% (10)	53% (25)
“What infection are you treating?”	52% (17)	89% (42)
“Cultures sent?”	9.1% (3)	45% (21)
Signature	100% (33)	100% (47)
Printed name	33% (11)	85% (40)
Professional number	6.1% (2)	53% (25)
Bleep number	24.2% (8)	72% (34)

A paired *t* test, comparing the initial audit completion proportions with the re-audit completion proportions, was statistically significant with *p* < 0.05.

Figure 1 illustrates the proportions of each aspect of the prescriptions completed in the initial audit and re-audit. Figure 2 represents the same data, showing the differences between the proportion of each aspect completed in the re-audit and initial audit.

Discussion

The thorough completion of antibiotic prescriptions is important from an antibiotic stewardship perspective. Documenting the infection being treated will help ensure that the most appropriate antibiotic has been prescribed and allows the

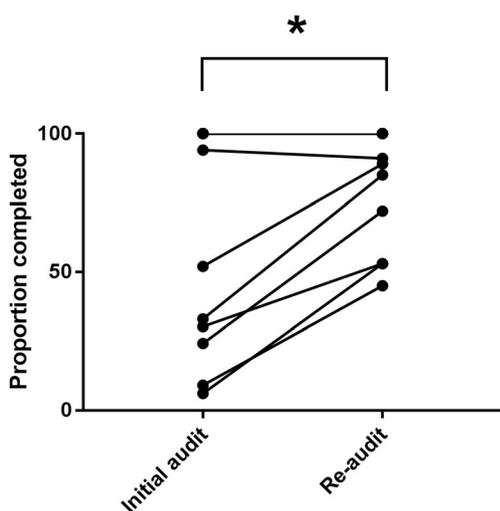


Fig. 1 The proportion of each aspect of the antibiotic prescriptions completed in the initial audit, and the corresponding proportion completed in the re-audit (**p* < 0.05)

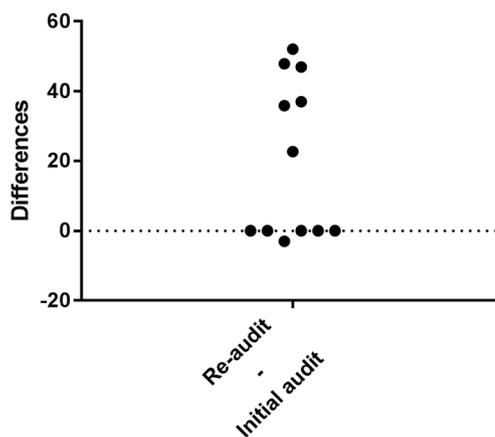


Fig. 2 The differences between the proportion of each aspect of the antibiotic prescriptions completed in the re-audit and the corresponding proportion completed in the initial audit

antibiotic choice to be reviewed by others, such as pharmacists and other doctors. Documentation of a stop date or review date will help ensure that antibiotics are not continued for an unnecessarily long period of time, and will provide a prompt for a date to consider stopping the antibiotics, performing an intravenous to oral switch, or changing to a different antibiotic such as a narrower-spectrum agent. Documenting whether cultures have been sent will provide a reminder to the prescribing doctor to ensure that cultures have been taken, and will also provide a reminder to subsequent reviewing doctors to chase up the culture results. Furthermore, accurate documentation of the identity of the prescriber allows easier clarification of queries about the prescription.

A study examining postoperative infections showed 25% of patients were treated with too broad a regimen of antibiotics, and 60% of patients were treated beyond the recommended duration, highlighting the importance of reviewing the antibiotic prescription [13]. *Clostridium difficile* infection rates are lower at hospitals where monitoring of antibiotic prescription reviews is carried out, with pharmacists believing that poor documentation of prescribing decisions prevents successful review of antibiotic prescriptions [14].

Our work follows Public Health England advice, which recommends monitoring adherence to “Start smart – then focus” principles, and emphasises the importance of audits, feedback, education, and engagement with junior doctors [10]. The lunchtime teaching session helped provide an educational focus targeted at junior doctors, and provided them with feedback on their prescribing.

The importance of involving prescribing members of the surgical team in antimicrobial stewardship efforts, for example by auditing prescribing and giving feedback on prescriptions, has previously been emphasised. In this way, they can add to the important contributions that other healthcare professionals, such as pharmacists and microbiologists, make towards antimicrobial stewardship [15].

It has been suggested that “persuasive” interventions may garner more support than “restrictive” ones [9]. A Cochrane review found that interventions, such as enablement and providing feedback, are effective in increasing compliance with antibiotic policy and reducing duration of antibiotic treatment [16].

The improvements observed in our audit have potential financial benefits. As described above, thorough completion of antibiotic prescriptions will help ensure antibiotic courses are not continued for longer than necessary. In Causeway Hospital, a piperacillin/tazobactam 4.5 g vial costs £1.80, a co-amoxiclav 1.2 g vial costs £0.85, a gentamicin 360 mg infusion costs £4.20, a metronidazole 500 mg infusion costs £0.43, a teicoplanin 400 mg vial costs £6.60, and an aztreonam 2 g vial costs £18.82. These antibiotics are recommended for use in intra-abdominal infections in our unit [11]. Thus, ensuring that antibiotics are not continued for an unnecessarily long time could potentially make significant financial savings over the course of 1 year. Furthermore, ensuring that antibiotic choice and course lengths are appropriate helps to reduce the incidence of healthcare-associated infections, such as *C. difficile*. Our audit therefore also has the potential to reduce the amount of money which needs to be spent on treating *C. difficile* infections. Helping to ensure that antibiotic course lengths are not unnecessarily long, and helping to reduce the incidence of *C. difficile* infections will also potentially reduce the average length of stay in hospital.

There are many possible explanations for why some aspects of the antibiotic prescriptions were not being completed as often as was desirable. Doctors who prescribe the antibiotics are often under significant time pressure. The source of infection is not always clear when the antibiotic is being prescribed. Furthermore, many doctors may have become accustomed to leaving certain aspects of the antibiotic prescription incomplete, without reflecting on the importance of this.

In terms of the potential weaknesses of this study, it would have been useful to have carried out further data collection periods, to investigate whether the positive changes continued. Junior doctors change rotations every 4–6 months, and carrying out further cycles after the medical staff had changed would have provided an insight into whether the improvements could be sustained.

Future work could involve auditing other aspects of the “Start smart - then focus” guidelines, for example, whether the prescription complied with the local prescribing guidelines. Research has shown that compliance with “starting smart” was more commonly audited than “then focus”, and it would therefore be useful to specifically audit the occurrence and effectiveness of antibiotic prescription reviews [17].

It would also be important to implement further interventions to study whether the documentation of antibiotic prescriptions could be improved further. For example, perhaps making the spaces for these pieces of information more

prominent on the drug charts would help. Further educational interventions may also be beneficial, for example a study from a Northern Irish hospital found that interventions such as learning modules and a “safety notice board” reduced the number of prescribing errors, including antibiotic prescribing errors [18]. Furthermore, previous research showed that multifaceted interventions caused a sustained improvement in adherence to antibiotic treatment guidelines [19].

Individual behaviour plays a role in antibiotic prescribing, with interventions using behaviour science able to effect change [20]. Future work to investigate this, for example, asking doctors to reflect on their motivations when prescribing an antibiotic, may be worth exploring.

In conclusion, quality of antibiotic prescriptions increased in our unit following simple educational interventions. This highlights the importance of audit, feedback, and education in the promotion of antimicrobial stewardship.

Compliance with ethical standards

This article does not contain any studies with human participants or animals performed by any of the authors.

Conflict of interest The authors declare that they have no conflict of interest.

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References

- Owens RC Jr (2008) Antimicrobial stewardship: concepts and strategies in the 21st century. *Diagn Microbiol Infect Dis* 61(1):110–128. <https://doi.org/10.1016/j.diagmicrobio.2008.02.012>
- Sartelli M, Catena F, di Saverio S, Ansaloni L, Coccolini F, Tranà C, Kirkby-Bott J (2015) The challenge of antimicrobial resistance in managing intra-abdominal infections. *Surg Infect* 16(3):213–220. <https://doi.org/10.1089/sur.2013.262>
- Department of Health. (2017) Ireland's National Action Plan on Antimicrobial Resistance 2017–2020. https://health.gov.ie/wp-content/uploads/2017/10/iNAP_web-1.pdf Accessed 18 December 2018
- Hospital Antimicrobial Stewardship Working Group. (2017) Recommendations for Implementation of Antimicrobial Stewardship Restrictive Interventions in Acute Hospitals in Ireland. <https://www.hse.ie/eng/about/who/qid/nationalsafetyprogrammes/hcaiamr/recommendations-for-restricted-antimicrobials%202017.pdf> Accessed 18 December 2018
- Public Health Agency (2017) Surveillance of Antimicrobial Use and Resistance in Northern Ireland, Annual Report, 2017. http://www.publichealth.hscni.net/sites/default/files/AMR_annual_report_final_1.pdf Accessed 18 December 2018
- National Institute for Health and Care Excellence (NICE). (2015) Antimicrobial stewardship: systems and processes for effective antimicrobial medicine use. <https://www.nice.org.uk/guidance/ng15/resources/antimicrobial-stewardship-systems-and-processes-for>

- [effective-antimicrobialmedicine-use-1837273110469](#) Accessed 18 December 2018
7. Johnson AP, Ashiru-Oredope D, Beech E (2015) Antibiotic stewardship initiatives as part of the UK 5-year antimicrobial resistance strategy. *Antibiotics (Basel)* 4(4):467–479. <https://doi.org/10.3390/antibiotics4040467>
 8. Pollack LA, Plachouras D, Gruhler H et al. (2015) Summary the modified Delphi process for common structure and process indicators for hospital antimicrobial stewardship programs. https://www.cdc.gov/drugresistance/pdf/summary_of_tatfar_recommendation_1.pdf Accessed 18 December 2018
 9. Sartelli M, Duane TM, Catena F, Tessier JM, Coccolini F, Kao LS, de Simone B, Labricciosa FM, May AK, Ansaloni L, Mazuski JE (2016) Antimicrobial stewardship: a call to action for surgeons. *Surg Infect* 17(6):625–631. <https://doi.org/10.1089/sur.2016.187>
 10. Public Health England. (2015) Start smart - then focus antimicrobial stewardship toolkit for English hospitals. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/417032/Start_Smart_Then_Focus_FINALPDF Accessed 18 December 2018
 11. Farren D, Nagar A, Dorgan E et al. (2017) Antibiotic Therapy (First-line Empirical) In Hospitalised Adults. Available on NHSC Intranet. Accessed 23 December 2018
 12. Yeo JM (2016) Antimicrobial stewardship: improving antibiotic prescribing practice in a respiratory ward. *BMJ Qual Improv Rep* 5(1):w3570. <https://doi.org/10.1136/bmjquality.u206491.w3570>
 13. Leeds IL, Fabrizio A, Cosgrove SE, Wick EC (2017) Treating wisely: the surgeon's role in antibiotic stewardship. *Ann Surg* 265(5):871–873. <https://doi.org/10.1097/SLA.0000000000002034>
 14. Llewelyn MJ, Hand K, Hopkins S, Walker AS (2015) Antibiotic policies in acute English NHS trusts: implementation of 'Start Smart-Then Focus' and relationship with *Clostridium difficile* infection rates. *J Antimicrob Chemother* 70(4):1230–1235. <https://doi.org/10.1093/jac/dku515>
 15. Sartelli M, Labricciosa FM, Barbadoro P, Pagani L, Ansaloni L, Brink AJ, Carlet J, Khanna A, Chichom-Mefire A, Coccolini F, di Saverio S, May AK, Viale P, Watkins RR, Scudeller L, Abbo LM, Abu-Zidan FM, Adesunkanmi AK, al-Dahir S, al-Hasan MN, Alis H, Alves C, Araujo da Silva AR, Augustin G, Bala M, Barie PS, Beltrán MA, Bhangu A, Bouchra B, Brecher SM, Cainzos MA, Camacho-Ortiz A, Catani M, Chandy SJ, Jusoh AC, Cherry-Bukowiec JR, Chiara O, Colak E, Cornely OA, Cui Y, Demetrashvili Z, de Simone B, de Waele JJ, Dhingra S, di Marzo F, Dogjani A, Dorj G, Dortet L, Duane TM, Elmagory MM, Enani MA, Ferrada P, Esteban Foianini J, Gachabayov M, Gandhi C, Ghnam WM, Giamarellou H, Gkiokas G, Gomi H, Goranovic T, Griffiths EA, Guerra Gronerth RI, Haidamus Monteiro JC, Hardcastle TC, Hecker A, Hodonou AM, Ioannidis O, Isik A, Iskandar KA, Kafil HS, Kanj SS, Kaplan LJ, Kapoor G, Karamarkovic AR, Kenig J, Kerschaefer I, Khamis F, Khokha V, Kiguba R, Kim HB, Ko WC, Koike K, Kozlovskaya I, Kumar A, Lagunes L, Latifi R, Lee JG, Lee YR, Leppänen A, Li Y, Liang SY, Lowman W, Machain GM, Maegele M, Major P, Malama S, Manzano-Nunez R, Marinis A, Martinez Casas I, Marwah S, Maseda E, McFarlane ME, Memish Z, Mertz D, Mesina C, Mishra SK, Moore EE, Munyika A, Mylonakis E, Napolitano L, Negoi I, Nestorovic MD, Nicolau DP, Omari AH, Ordonez CA, Paiva JA, Pant ND, Parreira JG, Pędziwiatr M, Pereira BM, Ponce-de-Leon A, Poulakou G, Preller J, Pulcini C, Pupelis G, Quiodettis M, Rawson TM, Reis T, Rems M, Rizoli S, Roberts J, Pereira NR, Rodríguez-Baño J, Sakakushev B, Sanders J, Santos N, Sato N, Sawyer RG, Scarpelini S, Scoccia L, Shafiq N, Shelat V, Sifri CD, Siribumrungwong B, Søreide K, Soto R, de Souza HP, Talving P, Trung NT, Tessier JM, Tumbarello M, Ulrych J, Uranues S, van Goor H, Vereczkei A, Wagenlehner F, Xiao Y, Yuan KC, Wechsler-Fördös A, Zahar JR, Zakrisson TL, Zuckerbraun B, Zuidema WP, Catena F (2017) The Global Alliance for Infections in Surgery: defining a model for antimicrobial stewardship-results from an international cross-sectional survey. *World J Emerg Surg* 12:34. <https://doi.org/10.1186/s13017-017-0145-2>
 16. Davey P, Marwick CA, Scott CL, Charani E, McNeil K, Brown E, Gould IM, Ramsay CR, Michie S, Cochrane Effective Practice and Organisation of Care Group (2017) Interventions to improve antibiotic prescribing practices for hospital inpatients. *Cochrane Database Syst Rev* 2:CD003543. <https://doi.org/10.1002/14651858.CD003543.pub4>
 17. Ashiru-Oredope D, Budd EL, Bhattacharya A, Din N, McNulty CAM, Micallef C, Ladenheim D, Beech E, Murdan S, Hopkins S (2016) Implementation of antimicrobial stewardship interventions recommended by national toolkits in primary and secondary healthcare sectors in England: TARGET and Start Smart Then Focus. *J Antimicrob Chemother* 71(5):1408–1414. <https://doi.org/10.1093/jac/dkv492>
 18. Donnelly P, Lawson S, Watterson C (2015) Improving paediatric prescribing practice in a district general hospital through implementation of a quality improvement programme. *BMJ Qual Improv Rep* 4(1):w3769. <https://doi.org/10.1136/bmjquality.u206996.w3769>
 19. Popovski Z, Mercuri M, Main C, Sne N, Walsh K, Sung M, Rice T, Mertz D (2015) Multifaceted intervention to optimize antibiotic use for intra-abdominal infections. *J Antimicrob Chemother* 70(4):1226–1229. <https://doi.org/10.1093/jac/dku498>
 20. Tonkin-Crine S, Walker AS, Butler CC (2015) Contribution of behavioural science to antibiotic stewardship. *BMJ* 350:h3413. <https://doi.org/10.1136/bmj.h3413>