

Antibiotic use among older adults on an acute care general surgery service

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Background: Antibiotics play an important role in the treatment of many surgical diseases that affect older adults, and the potential for inappropriate use of these drugs is high. Our objective was to describe antibiotic use among older adults admitted to an acute care surgical service at a tertiary care teaching hospital.

Methods: Detailed data regarding diagnosis, comorbidities, surgery and antibiotic use were retrospectively collected for patients 70 years and older admitted to an acute care surgical service. We evaluated antibiotic use (perioperative prophylaxis and treatment) for appropriateness based on published guidelines.

Results: During the study period 453 patients were admitted to the acute care surgery service, and 229 underwent surgery. The most common diagnoses were small bowel obstruction (27.2%) and acute cholecystitis (11.0%). In total 251 nonelective abdominal operations were performed, and perioperative antibiotic prophylaxis was appropriate in 49.5% of cases. The most common prophylaxis errors were incorrect timing (15.5%) and incorrect dose (12.4%). Overall 206 patients received treatment with antibiotics for their underlying disease process, and 44.2% received appropriate first-line drug therapy. The most common therapeutic errors were administration of second- or third-line antibiotics without indication (37.9%) and use of antibiotics when not indicated (12.1%). There was considerable variation in the duration of treatment for patients with the same diagnoses.

Conclusion: Inappropriate antibiotic use was common among older patients admitted to an acute care surgery service. Quality improvement initiatives are needed to ensure patients receive optimal care in this complex hospital environment.

Contexte : Les antibiotiques jouent un rôle important dans de nombreux cas de chirurgie chez les adultes âgés, et le risque d'utilisation inappropriée de ces médicaments est élevé. Notre objectif était de décrire l'utilisation des antibiotiques chez les patients âgés admis au service chirurgical d'urgence d'un centre hospitalier universitaire de soins tertiaires.

Méthodes : Nous avons recueilli de manière rétrospective les données détaillées sur le diagnostic, les comorbidités, la chirurgie et l'utilisation d'antibiotiques chez les patients de 70 ans et plus admis dans un service chirurgical d'urgence. Nous avons évalué le bien-fondé du recours aux antibiotiques (prophylaxie et traitement périopératoire) en fonction des lignes directrices publiées.

Résultats : Durant la période de l'étude, 453 patients ont été admis au service chirurgical d'urgence et 229 ont subi une chirurgie. Les diagnostics les plus fréquents étaient : occlusion de l'intestin grêle (27,2 %) et cholécystite aiguë (11,0 %). En tout, 251 interventions abdominales urgentes ont été effectuées et l'antibioprophylaxie périopératoire était justifiée dans 49,5 % des cas. Les erreurs les plus fréquentes en matière de prophylaxie ont été : moment mal choisi (15,5 %) et dose incorrecte (12,4 %). En tout, 206 patients ont reçu une antibiothérapie pour un processus pathologique sous-jacent et 44,2 % ont reçu un traitement antibiotique de première intention approprié. Les erreurs thérapeutiques les plus fréquentes concernaient l'administration d'antibiotiques de deuxième ou de troisième intention sans indication (37,9 %) et l'utilisation d'antibiotiques lorsque cela n'était pas indiqué (12,1 %). On a noté une variation considérable de la durée des traitements chez des patients porteurs de diagnostics semblables.

Conclusion : L'utilisation inappropriée des antibiotiques a été fréquente chez les patients adultes admis dans un service chirurgical d'urgence. Des initiatives s'imposent sur le plan de l'amélioration de la qualité pour s'assurer ainsi que les patients reçoivent des soins optimaux dans cet environnement hospitalier complexe.

Antibiotics are one of the most highly used drug classes in hospitals, and it is estimated that more than half of all patients admitted to acute care services receive antibiotics.^{1,2} They are used to treat both community- and hospital-acquired infections and as prophylaxis before invasive procedures, including surgery. However, research suggests that in up to 50% of cases antibiotics are unnecessary or inappropriately selected for treatment.²⁻⁴ This may contribute to the development of antibiotic-resistant bacteria, increased health care expenditures, longer hospital stays and unnecessary adverse events.⁵ Similarly, inappropriate perioperative antibiotic prophylaxis is associated with increased risk of wound infections. Despite interventions and the use of surgical checklists, full adherence to antibiotic guidelines in the operating room continues to be suboptimal.⁶⁻⁸

As the population ages, older adults make up an increasing proportion of patients admitted to hospitals, and antibiotics play an important role in the management of many diseases. This is especially true of older patients who are admitted to acute care general surgery services, where antibiotics are routinely used for both treatment and prophylactic purposes. However, very little research has specifically examined antibiotic use in this patient population. This is important to study, given that older patients are among those who are most susceptible to the consequences of inappropriate antibiotic use.⁹⁻¹² Additionally, patients on acute care surgery services may be at increased risk for antibiotic errors, given the high volume of heterogeneous patients, frequent handovers, rotating surgeon coverage and the prominent role of trainees in treatment decisions. Therefore, the purpose of this research was to describe antibiotic use among older adults admitted to an acute care surgical service at a tertiary care teaching hospital.

METHODS

All patients aged 70 years and older who were admitted to an acute care general surgery service with intra-abdominal or abdominal wall conditions between July 1, 2011, and Sept. 30, 2012, were included in this study. Patients were identified prospectively at the time of admission to hospital, and we obtained their consent for participation. We retrospectively collected detailed data regarding demographic characteristics, admission diagnosis, allergies, comorbidities, treatments, surgery and antibiotic therapies from medical records after the patients were discharged. Detailed data were collected for antibiotics given in the emergency department (ED), the general surgery ward, the intermediate care unit (IMCU), the intensive care unit (ICU) and in the operating room (OR). We recorded information regarding antibiotic type, dose, frequency and route of administration (oral v. intravenous). Procedure start times in the OR and antibiotic administration times were collected to evaluate prophylactic antibiotic use.

Appropriate prophylactic antibiotic use was also examined according to the time of day when the procedure occurred: daytime (7:30 am to 4:59 pm), evening (5:00 pm to 11:59 pm) or nighttime (midnight to 7:29 am).

Antibiotic use was categorized as appropriate or inappropriate based on centre-specific antibiotic guidelines for surgical prophylaxis and treatment of common infectious diseases, including those associated with general surgery. These were available online and in handbook format during the study period.¹³ They were consistent with other published guidelines taking into account local resistance patterns.¹⁴⁻¹⁶ No specific educational initiatives were undertaken to influence prescriber adherence to local guidelines. We assessed each antibiotic prescription independently and then used them to categorize the antibiotic treatment of each patient as appropriate or inappropriate overall; if inappropriate, the reason was recorded. In cases where there was uncertainty regarding the appropriateness of antibiotic use, the case was discussed and clarified with an infectious disease physician at our institution.

We considered antibiotic prophylaxis (perioperative antibiotics to prevent infection associated with surgery) to be appropriate if the correct antibiotics and dose were administered within the 60 minutes before the incision time recorded in the operative record,¹⁶ or if antibiotics given for therapeutic purposes before surgery provided adequate prophylactic coverage. Therapeutic antibiotic decisions (for treatment of surgical diseases or intra-abdominal septic complications) were deemed appropriate if the condition required antibiotic treatment and the patient received the recommended agent and dose, or if the condition did not require antibiotics and none were given. We took documented patient allergies into account when determining appropriate antibiotic prescriptions, and the alternative guideline-recommended antibiotic was considered to be the correct one. Otherwise we categorized antibiotic use as inappropriate, and the reasons were described. Instances of antibiotic use for indications other than prophylaxis or treatment of surgical diseases, such as urinary tract or respiratory infections, were not evaluated for appropriateness. Our institutional research ethics board approved our study protocol.

RESULTS

During the study period 453 patients aged 70 years or older were admitted to the acute care general surgery service. The most common admission diagnoses were small bowel obstruction and acute cholecystitis, and the median length of stay in hospital was 6 days (Table 1). Overall 224 (49%) patients were managed nonoperatively, and 229 (51%) underwent surgery. One hundred patients spent time in the IMCU, and 62 were admitted to the ICU during their stay in hospital. During their admission, 339 (74.8%) patients received antibiotics for any reason

(perioperative prophylaxis or therapeutic). Most patients ($n = 361$) did not have antibiotic allergies or intolerances recorded. Among the remaining patients, penicillins ($n = 33$), sulfonamides ($n = 42$) and macrolides ($n = 8$) were the most common antibiotic classes with documented sensitivities. Twenty patients had intolerances documented to multiple antibiotic agents. There were no instances of patients receiving antibiotics that were contraindicated owing to allergies.

Perioperative antibiotic prophylaxis

A total of 251 nonelective abdominal operations were performed on 229 patients. The most common procedures were large bowel resection (20.3%), laparoscopic cholecystectomy (19.5%), small bowel resection (13.5%) and lysis of adhesions (13.1%). Most surgeries were classified as clean-contaminated (54.2%), followed by clean (20.7%), dirty (19.9%) and contaminated (5.2%).

Prophylactic antibiotics were indicated for all surgeries performed and were given in 223 of 251 cases (89%). In 188 cases prophylactic antibiotics were given in the OR, and in 35 cases antibiotics used preoperatively for therapeutic indications provided adequate prophylaxis. Overall, perioperative prophylactic antibiotic coverage was appropriate in 49.5% of cases. The most common error was timing of antibiotic administration (Table 2). In 78% of these cases the antibiotics were given after surgical incision, and in 22% of cases they were given too early (> 60 min before the procedure). More than 1 error occurred in 25 cases.

Operations that were performed at nighttime had lower rates of appropriate prophylactic antibiotic use (35.5%) than those performed during the daytime and evening (52.9% and 48.8%, respectively); however, this finding was not statistically significant.

Therapeutic antibiotic use

Therapeutic antibiotic treatment decisions were appropriate (antibiotics indicated and appropriate antibiotics given, or antibiotics not indicated and not given) in 336 of 453 (74.2%) admitted patients. Of the 117 categorized as inappropriate, 78 involved administration of non-first line antibiotics when a first-line antibiotic would have been appropriate, 25 involved the use of antibiotics when not indicated, and in 14 cases additional antibiotic therapy was required but not given. We did not observe any antibiotic errors owing to patient factors, such as allergies or drug interactions.

Overall 206 of 453 (45.5%) patients received therapeutic antibiotics for treatment of their surgical disease or intra-abdominal complication. A total of 576 antibiotic prescriptions were ordered for these patients. The most common indications for therapeutic antibiotics were intra-abdominal septic complications (15.5%), acute cholecyst-

itis (15.5%), diverticulitis (12.6%), ischemic colitis (10.7%) and cholangitis (8.3%). The median total duration of therapeutic antibiotic treatment was 8 (interquartile range [IQR] 3–15) days, and 68 (15.0%) admitted patients were discharged with an antibiotic prescription. There was considerable variation in the nature and duration of antibiotic therapy for many common surgical problems (Table 3).

Analysis of individual prescriptions showed that 449 of all 576 (78.0%) therapeutic antibiotic prescriptions were appropriate for the treatment of underlying surgical disease ($n = 463$) or intra-abdominal complications ($n = 113$). For antibiotic treatment associated with the admission diagnosis, an alternate antibiotic was available for 98 of 463 prescriptions. Cefazolin was the antibiotic most frequently identified as an alternative (11.2% of prescriptions), followed by amoxicillin-clavulanate (5.4%). In 25 cases of ciprofloxacin use and 24 cases of ceftriaxone use, cefazolin was the guideline-recommended first-line antibiotic. For 9 ciprofloxacin and 18 metronidazole

Table 1. Demographic and clinical characteristics of 453 patients aged 70 years or older admitted to an acute care general surgery service

Characteristic	Median [IQR] or %
Age, yr	78 [74–83]
Female sex	53.2
BMI	28.6 [23.1–28.7]
LOS, d	6 [3–11]
Admission diagnoses	
Small bowel obstruction	27.2
Acute cholecystitis	11.0
Lower gastrointestinal bleeding	7.9
Diverticulitis	5.7
Incarcerated hernia, no obstruction	5.3
Ischemic colitis	4.9
Gallstone pancreatitis	4.6
Colorectal cancer	4.4
Cholangitis	4.3
Intra-abdominal abscess	2.9
Choledocholithiasis	2.2
Others	19.6

BMI = body mass index; IQR = interquartile range; LOS = length of stay.

Table 2. Errors in perioperative prophylactic antibiotic administration among patients aged 70 years or older who underwent nonelective abdominal surgery

Error	No. (%) [*]
Incorrect timing (not within 60 min before incision)	15.5 (39)
Incorrect dose	12.4 (31)
Antibiotics indicated, not given	11.2 (28)
Additional antibiotics given, not required	8.0 (20)
Additional antibiotics required	6.0 (15)
Wrong antibiotic, not first-line	5.2 (13)
Incorrect or missed re-dose	1.6 (4)

^{*}Multiple errors occurred in some cases.

prescriptions, amoxicillin-clavulanate was the preferred alternative. In 5.6% of prescriptions associated with the surgical disease, the antibiotic was unnecessary either because there was sufficient coverage by other antibiotics, or because there was no indication.

DISCUSSION

In the present study, therapeutic and prophylactic antibiotic use was examined to give a comprehensive view of use and errors on an acute care general surgery service. Although acute care surgery services are designed to reduce morbidity and mortality,¹⁷ they are prone to errors owing to complex system factors.^{18,19} Care may be compromised by frequent suboptimal transfers of care and a high turnover of busy nursing staff, surgeons and trainees.²⁰ Older adults cared for on these services commonly have evolving medical needs and multiple comorbidities. If undergoing urgent surgery, their health status often cannot feasibly be optimized preoperatively as would be done for patients undergoing elective operations. The presence of these factors in acute care services renders patients vulnerable to medical errors, including inappropriate prophylactic and therapeutic antibiotic use.¹⁸

Although surgeons commonly must make antibiotic therapy decisions in the absence of definitive evidence for infection, optimizing antibiotic use in hospitals is important for 2 key reasons. First, inappropriate antibiotic therapy is associated with several adverse outcomes, such as increased postoperative complications, resulting in longer hospital stays and higher care costs.²¹⁻²⁵ Second, adherence to empiric antibiotic prescribing guidelines and stewardship programs helps to reduce the prevalence and avoid emergence of antibiotic-resistant bacteria.²⁶⁻²⁹

Research investigating antibiotic use is extensive, and recent studies continue to show disappointing rates of prophylactic antibiotic use across various patient populations.^{8,30-34} We found that prophylactic antibiotic errors

were common in the acute care general surgery setting. This is disappointing, given that surgical “time outs” before incision were in use at the time of this study. The most frequent error was inappropriate timing, particularly the delayed administration of antibiotics after incision, which has been a common trend in prior studies.³⁰⁻³² Circumstances surrounding acute surgical care, including communication between surgical staff and anesthesiologists, compliance with checklists, competing care priorities and quick transitions from the ED to the OR may be factors involved in such errors. Barriers to provision of appropriate prophylaxis identified in the literature include a perceived low importance and inconvenience, impaired workflow, and organizational communication.³⁵ Besides timing, administration of incorrect doses and omission of antibiotics were common errors, both potentially attributable to lack of awareness or availability of prescribing guidelines in the OR.

Strategies evaluated to optimize antibiotic prescribing in surgical settings have largely targeted prophylactic antibiotic use in elective operations. Effective interventions are often multifaceted and have included interdisciplinary guideline development, prescriber feedback, educational initiatives, posters, checklists, and forced functions.³⁶⁻⁴¹ In the acute surgical setting, Weiser and colleagues⁴² showed that the use of a surgical checklist is feasible, effectively improves adherence to antibiotic prophylaxis guidelines and reduces surgery-associated complications and mortality. A 3-phase surgical safety checklist (surgical briefing, surgical time out and surgical debriefing) has recently been implemented at our institution and may address some of these issues. A review by Gagliardi and colleagues⁴¹ found improved antibiotic prophylaxis adherence with the implementation of institutional guidelines, individualized performance feedback and multidisciplinary strategies involving education and reminders.

Compared with prophylactic antibiotic use, therapeutic antibiotic use was more often in accordance with guidelines.

Table 3. Therapeutic antibiotic use for common surgical diseases among patients aged 70 years or older admitted to an acute care general surgery service

Primary admission diagnosis	Antibiotics indicated, %	Antibiotics received, %	Appropriate treatment, %	Discharged with antibiotic, %	Median [IQR] duration, d*
Acute cholecystitis (n = 50)	64.0	64.0	54.0	10.0	3 [1-69]
Ischemic colitis (n = 22)	100	100	63.6	54.5	13 [1-21]
Pancreatitis, gallstone (n = 21)	28.6	28.6	90.5	0.0	5 [4-15]
Cholangitis (n = 19)	100	89.5	42.1	36.8	5 [1-20]
Intra-abdominal abscess (n = 13)	100	100	53.8	69.2	18 [4-47]
Perforated ulcer (n = 10)	100	100	50.0	10.0	8 [1-44]
Diverticulitis, simple (n = 9)	100	100	11.1	66.7	11 [3-17]
Diverticulitis, abscess (n = 9)	100	100	33.3	66.7	17 [1-77]
Diverticulitis, perforation (n = 8)	100	100	62.5	12.5	9 [1-22]
Acute appendicitis (n = 8)	50.0	50.0	75.0	12.5	7 [3-22]

IQR = interquartile range.
 *Treatment duration includes in-hospital and outpatient prescriptions.

This is comparable across other studies, where therapeutic antibiotic use has been reported to be correct in 49%–87% of patients across various surgical settings.^{21,22,43–45} Our study showed that older patients received therapeutic antibiotics when indicated, although there was significant variability in how patients with the same diagnosis were treated in the acute care setting, specifically with respect to the choice of antibiotic and the duration of treatment prescribed. Although some of the variability in duration of treatment certainly reflects differences in disease severity, other factors, such as lack of evidence or guidelines on the duration of treatment, or individual surgeon preference, are likely important. The extended duration of antibiotic therapy in some patients may present substantial overtreatment without added benefit. A recent large trial showed no significant difference in infectious outcomes when duration of antibiotic use was shortened to 4 days.⁴⁶ The use of second- or third-line antibiotics instead of first-line empiric antibiotics, as recommended by hospital guidelines, was common. A lack of awareness of prescribing guidelines, limited accessibility to guidelines on the surgical ward and managing a heterogeneous population with different antibiotic needs may contribute to this finding.⁴⁷

Research has been done to evaluate persuasive, restrictive and structural interventions aimed at mitigating the consequences of antibiotic misuse and overcoming barriers to improved prescribing in patients admitted to hospital.⁴⁵ Both persuasive (e.g., education, prescribing feedback) and restrictive interventions (e.g., limiting access to certain antibiotics, policy changes) can improve antibiotic use. However, it is unclear which interventions are best at improving use long-term, as direct comparisons of interventions have not been done and study methods and settings are heterogeneous.⁴⁵ In general surgery specifically, studies of education and guideline-based antibiotic stewardship programs have shown improved prescribing and reduced antibiotic use.^{48,49} Moving forward, surgeons will need to be engaged in antibiotic stewardship initiatives and should be involved in the development of local guidelines.^{50,51}

Limitations

Our research adds to the literature in an area that has been largely unstudied and requires intervention. Our audit of antibiotic use identifies important gaps in use and can serve to inform and benchmark quality-improvement initiatives in acute care surgical settings, especially in the care of older adults. However, there are several limitations with this research that should be considered. The descriptive aim of this study limits the inferences that can be made regarding associations between antibiotic treatment and patient outcomes. We did not examine factors associated with inappropriate antibiotic use. Although we examined older adults who were likely typical of those managed

on an acute care surgical service, the study population was heterogeneous, having various diagnoses and procedures. The retrospective nature of this study made it difficult to determine the need for therapeutic antibiotics for some conditions, such as acute cholecystitis. Our institutional guidelines provided direction in the majority of cases, yet we acknowledge that antibiotic treatment decisions are not always clear-cut. Finally, our study was performed in a tertiary care academic teaching hospital and may not be applicable to other settings.

CONCLUSION

Seventy-five percent of older adults who were admitted to an acute care general surgery service received antibiotics. Perioperative antibiotic prophylaxis errors were common despite established evidence to support their benefit and the use surgical “time outs.” There was considerable variation in the therapeutic antibiotic treatment among patients with the same diagnoses. Alongside hospital guidelines and education, quality-improvement and quality-assurance initiatives are required to ensure patients receive optimal care in this complex treatment environment. It is unclear which strategies will lead to sustainable improvements in antibiotic use in the acute care setting.

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