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Major article

Antimicrobial stewardship to optimize the use of antimicrobials for surgical prophylaxis in Egypt: A multicenter pilot intervention study

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Objective: To measure the impact of an antimicrobial stewardship (AMS) program on the use of antibiotics for surgical prophylaxis at acute care hospitals in Egypt.

Methods: This was a before-and-after intervention study conducted in 5 tertiary, acute-care surgical hospitals. The baseline, intervention, and follow-up periods were 3, 6, and 3 months, respectively. The impact of the intervention was measured by preintervention and postintervention surveys for surgical patients with clean and clean-contaminated wounds. Information was collected on demographic characteristics and antibiotic use. The intervention focused mainly on educating surgical staff on the optimal timing and duration of antibiotics used for surgical prophylaxis. Only 3 hospitals identified a surgeon to audit antibiotic surgical prescriptions. The primary outcome measures were the percentages of surgical patients receiving optimal timing and duration of surgical prophylaxis.

Results: Data were collected for 745 patients before the intervention and for 558 patients after the intervention. The optimal timing of the first dose improved significantly in 3 hospitals, increasing from 6.7% to 38.7% ($P < .01$), from 2.6% to 15.2% ($P < .01$), and from 0% to 11% ($P < .01$). All hospitals showed a significant rise in the optimal duration of surgical prophylaxis, with an overall increase of 3%-28% ($P < .01$). Days of therapy per 1000 patient-days were decreased significantly in hospitals A, B, C, and D, with no change in hospital E.

Conclusions: An AMS program focusing on education supported by auditing and feedback can have a significant impact on optimizing antibiotic use in surgical prophylaxis practices.

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The excessive and inappropriate use of antibiotics in acute care hospitals is common in developing and developed countries,[1,2] and is associated with emergence of antimicrobial resistance, prolonged hospital stays, and high costs of health care.[3] Several studies have shown that approximately 30% of antimicrobial use is inappropriate or suboptimal.[4,5] In the developing countries of the eastern Mediterranean region, limited studies have documented the inappropriate use of antibiotics in hospitals.[6,7] In Egypt, a point prevalence survey of antibiotic use was conducted in 18 Egyptian hospitals in March 2011 using the European Surveillance of Antimicrobial Consumption Network methodology.[8] Among 3194 antibiotic prescriptions, surgical prophylaxis accounted for 38.4% of overall antibiotics prescribed in the hospitals, and 66.5% of the antibiotics prescribed in the surgical departments. Two percent of the antibiotics prescribed for surgical prophylaxis were given within 1 hour before incision and discontinued within 24 hours after the surgery.[9]

Consequently, we aimed to pilot an antimicrobial stewardship (AMS) program to optimize antimicrobial use for surgical prophylaxis, focusing on the education of surgeons to promote optimal timing and duration of surgical prophylaxis. The impact of the intervention was measured through repeated surveys measuring antibiotic prescribing practices related to surgical prophylaxis.

METHODS

Setting

This intervention study was performed at 5 tertiary acute care surgical hospitals performing a variety of surgical procedures, including general surgeries (eg, herniorrhaphy, colectomy), orthopedic surgeries (eg, joint replacements, spinal fusion), and obstetric and gynecologic surgeries. All 5 hospitals have functioning infection control programs with full time infection control teams (Table 1). None of the hospitals had any previous activity related to AMS.

Study design

Preintervention and postintervention surveys were conducted to measure the antibiotic prescribing practices of surgical prophylaxis for clean and clean-contaminated elective surgeries before and after implementation of the AMS program. The preintervention surveys were conducted between January and March 2013, the interventions were performed between April and September 2013, and the postintervention surveys were done between October and December 2013.

Study patients

All surgical patients undergoing clean or clean-contaminated operations at select surgical wards were enrolled in the surveys. Patients of all ages were eligible to participate. A standardized data collection form was completed for each enrolled patient, on which information was collected on patient demographics, surgery type and date, indication for antibiotic use, and dose and duration of antimicrobial therapy. Hospital infection control teams extracted the data from the patient files and drug prescription sheets. A sample size of 473 surgeries was required for both the preintervention and postintervention surveys to detect an improvement in the timing and duration of surgical prophylaxis ranging from 24% to 48% ($\alpha = 0.05$ and 80% power).

Intervention

The 6-month AMS intervention aimed to launch appropriate strategies for improving the timing of the first dose before surgery and the duration of antimicrobial therapy for clean and clean-contaminated surgeries. The intervention targeted hospital staff responsible for surgical prophylaxis, who were either surgeons or anesthesiologists.

Leadership

Leadership of the AMS program was established within the scope of the hospital's infection control team. The elements of the AMS were developed by the hospital infection control teams through advocacy workshops with senior surgeons and pharmacists, and hospital administration approved the plan. They all agreed that education of surgeons on the international guidelines for surgical prophylaxis would form the basis of the AMS activities.

Education

Education targeted personnel responsible for surgical prophylaxis procedures, who were either surgeons or anesthesiologists. A 2-day training curriculum was developed focusing on the principles of antibiotic use for surgical prophylaxis, such as the type of operations eligible for surgical prophylaxis, optimal timing of the first dose, and duration of postoperative antibiotic use.[10] In addition, on-the-job training on the optimal use of antibiotics was provided to junior surgeons and residents during morning rounds. A wall-mounted poster was developed to remind prescribers of the optimal timing and duration of antibiotic administration for surgical prophylaxis.

Auditing and feedback

Three of the 5 participating hospitals (hospitals B, D, and E) nominated a senior surgeon as a champion to audit antibiotic prescriptions for surgical prophylaxis and provide feedback to the prescribers. The senior surgeon visited the surgical departments at least twice weekly and reviewed the documented prescribed antibiotics in the patient records. In the event that the patient file specified suboptimal timing of the first dose, noted suboptimal duration of surgical prophylaxis, or lacked sufficient information on the antibiotics prescribed, the senior surgeon discussed the antibiotic prescription plan with the prescriber and provide feedback.

Outcome measures

The outcome measure was the change in the proportion of surgical patients who received optimally timed prophylaxis, defined as the proportion of patients who received at least one prophylactic dose administered within 60 minutes before the incision (120 minutes for the administration of fluoroquinolones or vancomycin). When more than 1 antibiotic was administered, timing was based on the antibiotic given closest to the time of the incision. The second primary outcome was the change in the proportion of surgical patients in whom duration of the antibiotic prophylaxis was no longer than 24 hours after the completion of surgery.

Secondary outcome measure was the changes in days of therapy (DOT; the number of days on which a patient receives at least 1 dose of an antibiotic for surgical prophylaxis, summed for each antibiotic/1000 patient-days). Patient-days were calculated as the sum of lengths of hospital stay for each individual patient.

Statistical analysis

Statistical analyses were performed using Stata version 12 (StataCorp, College Station, TX). Proportions were compared using the Z-test, and rates of antimicrobial use (measured by DOT/1000 patient-days) were compared using incidence rate ratios (IRRs). All statistical tests were 2-tailed; a P value $\leq .05$ was considered significant.

Table 1
Characteristics of the 5 acute care tertiary hospitals in this study

Characteristic	Hospital A	Hospital B	Hospital C	Hospital D	Hospital E
Number of beds	300	180	280	320	180
Type of surgery assessed	General surgery	General surgery, ob/gyn	Orthopedics	Ob/gyn	Ob/gyn
Full-time IC team	Yes	Yes	Yes	Yes	Yes
No. of IC team members	3	3	2	3	2
Ratio of IC personnel to hospital beds	1:100	1:60	1:160	1:100	1:90
Intervention activities					
Education	Yes	Yes	Yes	Yes	Yes
Audit and feedback	No	Yes	No	Yes	Yes

IC, infection control; *ob/gyn*, obstetrics and gynecology.

Table 2
Characteristics of surgical patients and procedures in the pre and post intervention periods

Characteristic	Preintervention (n = 745)	Postintervention (n = 558)
Age, y, mean ± SD (range)	29.9.± 14.1 (1-80)	31.5 ± 12.6 (1-80)
Length of hospital stay, d, mean ± SD (range)	4.3 ± 5.0 (1-38)	5.1 ± 5.6 (1-31)
Sex, n (%)		
Male	215 (28.9)	83 (14.9)
Female	530 (71.1)	475 (85.1)
Hospital, n (%)		
Hospital A	139 (18.7)	95 (17.0)
Hospital B	150 (20.1)	150 (26.9)
Hospital C	198 (26.6)	105 (18.8)
Hospital D	154 (20.7)	99 (17.7)
Hospital E	104 (14.0)	109 (19.5)
Surgeries done, n (%)		
Obstetrics and gynecology	343 (46.0)	341 (61.1)
General surgery	204 (27.4)	112 (20.1)
Orthopedics	198 (26.6)	105 (19.9)
Wound type*		
Clean	417 (56.0)	301 (53.9)
Clean-contaminated	319 (44.0)	256 (45.9)

*Data on wound type are unavailable for 9 surgical patients in the preintervention period and 1 surgical patient in the postintervention period.

RESULTS

Among the 5 participating hospitals, the number of beds varied from 180 to 320. All of the hospitals had a functioning infection control program with a full-time hospital infection control teams. None of the hospitals had previous experience in promoting antibiotic use or consumption (Table 1).

Data were collected for 745 surgical patients before the intervention and for 558 surgical patients after the intervention. The characteristics of the patient population, including age, sex, length of hospital stay, and type of surgery, were recorded. The 1303 patients included 1005 females (77.1%), and the mean patient age was 30.1 years. Descriptive data for patients in the preintervention and postintervention surveys are compared in Table 2.

The overall proportion of patients who received optimal antimicrobial prophylaxis initiated within 1 hour before the surgical incision was 37.6% in the preintervention period and 41.6% in the postintervention period, a statistically nonsignificant change (Table 3). The impact of surgical AMS varied across the 5 hospitals, however. There was a significant rise in the proportion of optimal timing of the first dose in hospitals B, D, and E. In hospital B, the proportion of patients receiving a prophylactic dose of antibiotics within 60 minutes of the incision increased from 6.7% to 38.7% ($P < .0001$). In hospitals D and E, where the baseline rate of optimal timing of the first dose was generally low (2.6% in hospital D and 0% in hospital E), there was a significant increase in optimal timing, from 2.6% to 15.2% in hospital D and from 0% to 11% in hospital E. Hospital C had a high baseline rate of 88.4% for optimal timing of the first dose of surgical prophylaxis, but showed no significant change after the intervention. Hospital A was the only hospital exhibiting a significant reduction in the rate of optimal timing of surgical prophylaxis, from 67.6% to 52.6% ($P = .021$).

Regarding the optimal duration of surgical prophylaxis, the overall preintervention proportion was very low (3%), ranging from 0% in hospital A to 7.6% in hospital C. A significant rise was observed after the intervention, from 3% to 28.7% ($P < .01$). Hospitals B, C, D, and E demonstrated significant increases in the proportion of optimal duration of surgical prophylaxis.

A significant reduction in the amount of antimicrobials used for surgical prophylaxis was observed in 4 hospitals (Table 4). The use of drugs for surgical prophylaxis decreased from 843 DOT/1000 patient-days in the preintervention period to 335 DOT/1000 patient-days in the postintervention period (IRR, 0.40; 95% confidence interval [CI], 0.34-0.47; $P < .001$) in hospital A, from 1321 DOT/1000 patient-days in the preintervention period to 1090 DOT/1000 patient-days in the postintervention period (IRR, 0.82; 95% CI, 0.71-0.95; $P = .011$) in hospital B, from 465 DOT/1000 patient-days in the preintervention period to 264 DOT/1000 patient-days in the postintervention period (IRR, 0.57; 95% CI, 0.5-0.65; $P < .001$) in hospital C, and from 669 DOT/1000 patient-days in the preintervention period to 336 DOT/1000 patient-days in the postintervention period in hospital D (IRR, 0.50; 95% CI, 0.41-0.60; $P < .001$). Hospital E showed no significant change in the amount of antimicrobial use from the preintervention period to the postintervention period (IRR, 0.89; 95% CI, 0.89-1.09; $P = .296$).

DISCUSSION

This AMS pilot study found that inappropriate surgical prophylaxis, including suboptimal timing of the first dose and duration of antibiotic use, was common in the 5 participating hospitals. It also demonstrated that an AMS with focused intervention by educating surgeons can have an impact on optimizing antimicrobial use for surgical prophylaxis of varying degrees for different hospitals.

To the best of our knowledge, this study piloting AMS for antimicrobial use in surgical prophylaxis is the first in Egypt. None of the 5 participating hospitals, even with a full-time hospital infection control team, has ever promoted general antibiotic use or antibiotic use for surgical prophylaxis. The extremely high baseline rates of suboptimal timing (62%; range, 11.6 - 100%) and duration of surgical prophylaxis (97%; range, 92.4%-100%) were expected despite the available evidence from several studies that the optimal timing and duration of surgical prophylaxis reduce the resistance of microorganisms and increase the efficacy of antibiotics in reducing bacterial counts at surgical sites.[10-13]

Several interacting factors account for the inappropriate surgical prophylaxis in Egyptian hospitals; for example, only a limited number of hospitals have policies, regulations, or guidelines on general antimicrobial use, and specifically for surgical prophylaxis,

Table 3
Surgical antimicrobial prophylaxis before and after the intervention (timing and duration of surgical prophylaxis)

	No. of surgeries		Optimal timing of the first dose*			Optimal postoperative duration†		
	Baseline	Intervention	Baseline, n (%)	Intervention, n (%)	*P* value	Baseline, n (%)	Intervention, n (%)	*P* value
Hospital								
A	139	95	94 (67.6)	50 (52.6)	<.05	0	0	—
B	150	150	10 (6.7)	58 (38.7)	<.001	2 (1.3)	43 (28.7)	<.001
C	198	105	175 (88.4)	97 (92.4)	.28	15 (7.6)	32 (30.5)	<.001
D	154	99	4 (2.6)	15 (15.2)	<.001	1 (0.7)	40 (40.4)	<.001
E	104	109	0	12 (11)	<.001	4 (3.9)	45 (41.3)	<.001
Total	745	558	283 (37.6)	232 (41.6)	.49	22 (3)	160 (28.7)	<.001
Operation type								
Ob/gyn	343	341	17 (5.0)	90 (26.4)	<.001	5 (1.5)	128 (37.5)	<.001
General surgery	204	112	91 (44.6)	45 (40.2)	.45	2 (1.0)	0	.38
Orthopedic	198	105	175 (88.4)	97 (92.4)	.28	15 (7.6)	32 (30.5)	<.001
Wound type								
Clean	417	301	251 (60.2)	164 (54.5)	.127	21 (5.0)	103 (34.2)	<.001
Clean-contaminated	319	256	26 (8.2)	68 (26.6)	<.001	1 (0.3)	56 (21.9)	<.001
Surgery type								
Open	664	508	221 (33.3)	201 (39.6)	<.05	19 (2.9)	134 (26.4)	<.001
Scopes	56	40	46 (82.1)	29 (72.5)	.26	3 (5.4)	17 (42.5)	<.001

*Optimal timing of the first dose: At least one prophylactic dose administered within 60 minutes before incision (120 minutes for the administration of fluoroquinolones or vancomycin).
†Optimal postoperative duration: Duration of the antibiotic prophylaxis no longer than 24 hours after completion of surgery.

Table 4
Rates of antimicrobial use, based on DOT per 1000 patient-days

DOT/1000 patient-days	Hospital A	Hospital B	Hospital C	Hospital D	Hospital E
Baseline	843	1321	465	669	606
Postintervention	335	1090	264	336	541
IRR	0.40	0.82	0.57	0.50	0.89
95% CI	0.34-0.47	0.71-0.95	0.5-0.65	0.41-0.60	0.89-1.09
P value	<.001	<.05	<.001	<.001	.29

and there are no national or coordinated legislative or regulatory mandates available in Egypt to optimize the use of antimicrobial therapy through AMS. The lack of national guidelines on surgical prophylaxis, the general perception of clinicians and surgeons regarding the protective role of antibiotics in preventing infections, the belief that longer duration of surgical prophylaxis will reduce surgical site infections, and the perception of an extremely unclean environment and its association with acquiring surgical site infections are all factors contributing to the inappropriate use of antibiotics.

The AMS resulted in significant improvements in the timing of the first dose of surgical prophylaxis in hospitals in which the baseline rates of optimal timing of the first dose were extremely low (hospitals B, D, and E), ranging from 0 to 6.7%. Even though the change in rates was statistically significant, the rates of optimal timing in the postintervention period ranged from only 11% to 38.7%. The low rates of compliance after the intervention may be explained by logistical issues regarding the provision of antibiotics to surgical patients. In the majority of hospitals, patients received surgical prophylaxis in the surgical ward before being transferred to the operating theater (OT), and the time interval before the incision usually exceeded 1 hour, owing to either delays in the transportation of the patient to the OT or prolonged preoperative preparation. Despite recommendations by the hospital infection control teams to administer the surgical prophylaxis in the OT, many hospitals failed to change their practices. In hospital A, the rate of optimal timing of surgical prophylaxis decreased significantly after the intervention (from 67.6% to 52.6%). This could be attributed to the high turnover rate of surgeons in the wards, many of whom missed the education sessions. Hospital C did not show any significant change in the proportion of surgical patients provided with optimal timing of the first dose, but its preintervention rate was high (88.4%) compared with that of the other hospitals.

The results of this study show significant improvements in all 5 hospitals in terms of the duration of surgical prophylaxis. However, the rate of optimal duration in the postintervention period ranged from 28.7% to 41.3%. This change is considered favorable, because the baseline rates of optimal duration of surgical prophylaxis were extremely low (ranging from 0 to 7.6%). Lower compliance was noted from surgeons regarding the duration of surgical prophylaxis compared with the start time. Restricting the duration to only 24 hours after the completion of surgery was not acceptable from the perspective of the surgeons, who did not want to apply the international standards in that regard. Even though the intervention was based on evidence-based international guidelines for surgical prophylaxis [10], barriers to successful changes in prescribing practices, particularly to shortening the duration of surgical prophylaxis, have included poor awareness of antimicrobial resistance, surgeons' resistance to changing routine practices, and the strong belief that hospitals in Egypt are different in terms of increased contamination.

The benefits of AMS for surgical prophylaxis have been demonstrated in various studies. Van Kasteren et al[14] reported that the rate of appropriate prophylactic antibiotic administration rose from 0.4% to 25% after education. In a study conducted by Prado et al,[15] the rate of appropriate surgical prophylaxis increased from 54% to 100% after an educational intervention. Nonetheless, other international guidelines consider the effect of interventions that depend on education as only marginally effective in changing antimicrobial prescription practices.[1]

This pilot study proved effective in showing that an AMS (targeting surgeons and anesthesiologists) that focused on education and was supported by auditing and feedback of prescribed antibiotics had a significant impact on improving surgical prophylaxis practices, even though there remains considerable room for improvement. Further studies to demonstrate the important economic benefits and long-term financial impact of stewardship is needed to make the AMS programs an integral part of all health care facilities.

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