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Concise Communication

Sustainment of perioperative antimicrobial prophylaxis guidelines in children following discontinuation of an educational intervention to support stewardship

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Abstract

Adherence to perioperative antimicrobial guidelines among Greek children was markedly decreased years after the discontinuation of an antimicrobial stewardship (AS) intervention. An educational intervention is effective to improve the perioperative antimicrobial use, but the continuous implementation of AS is important for its long-term sustainability.

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Introduction

Antimicrobial stewardship (AS) are designed coordinated interventions in effort to evaluate and improve the use of perioperative antimicrobial prophylaxis (PAP), minimizing the emergence of resistant microorganisms and surgical site infections (SSIs).[1,2]

To increase the low compliance rate with PAP international guidelines in Greek children, an effective educational intervention was implemented in a pediatric hospital in Greece almost 10 years ago.[3] Basic components of this intervention were meetings with medical staff, presentation of pre-intervention performance data, review of PAP guidelines, and further stewardship by a supervising physician.[3] Unfortunately, this routine AS program was discontinued after 3 years.

The objective of the present study was to assess the adherence to current PAP guidelines among pediatric surgical patients in Greece years after the discontinuation of AS program to emphasize the need of AS and identify opportunities for further improvement.

Methods

Study design, setting, and population: A prospective surveillance study of general surgical procedures was undertaken between July 2021 and May 2022 in the Department of Pediatric Surgery of the Aghia Sophia Children's Hospital, in Athens, Greece, approximately 4 years after the discontinuation of an AS program. All patients subjected to one or more surgical procedures, as defined by the CDC,[4] were eligible to be included in our study.

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Data collection

To capture data on all procedures, we modified the CDC's Denominator for Procedure form to collect pre-operative, perioperative, and procedure data similarly to our previously published study.[3]

Data analysis

We measured the compliance rate to PAP guidelines, defined as the adherence to appropriate dose of agent, drug choice, and duration of administration of PAP according to current guidelines, as well as the SSI rate, similarly to our previously published study.[3,5] The results were compared with those of our previously published study, when AS intervention was being implemented.[3] Moreover, appropriate PAP timing and intraoperative re-dosing were assessed according to published guidelines and the results were also compared to those of our other previous study focuses on these two PAP principles.[5,6]

Statistical analysis

Categorical variables were presented as absolute and relative (%) frequencies, while continuous variables as median and interquartile range, since they were skewed (normality was tested). Associations between categorical variables (ie appropriate PAP and intervention) were tested using the χ^2 test. The association between skewed variables and categorical variables was assessed using the Kruskal–Wallis test. Due to multiple comparisons, Bonferroni correction was applied.

Multivariate logistic regression analysis was applied to assess the impact of discontinuation of intervention to appropriate PAP overall, even after controlling for potential confounders, as detected by univariate analyses. Patient and procedural characteristics, such as

Table 1. Patient and procedure characteristics in pre-intervention and post-intervention period with and without antimicrobial stewardship (AS)

Patients' characteristics	Pre-intervention N = 219* (2013)	Post-intervention N = 670* (2014)	2nd post-intervention (without AS) N = 202 (2021–2022)	*p*-Value
Gender				
Male	169 (77.2%)	516 (77%)	147 (72.8%)	0.434
Female	50 (22.83%)	154 (23%)	55 (27.3%)	
Age (years)**	6 (3–10)	5 (2–10)	10 (6-13)	0.161
Weight (kg)**	24 (14–36)	20 (13–35)	41 (22-57.5)	**<0.001**
Height (cm)**	118 (93–140)	110 (88–140)	151 (130–165)	**<0.001**
Type of procedure				
Appendectomy non-complicated	61 (27.9%)	135 (20.2%)	75 (37.1%)	**<0.001**
Gastrointestinal/Liver-Biliary tract	14 (6.4%)	40 (6.0%)	15 (7.4%)	
Oncologic	12 (5.5%)	18 (2.7%)	0 (0.0%)	
Urologic	23 (10.5%)	71 (10.6%)	15 (7.4%)	
Umbilical hernia/Abdominal wall hernia	6 (2.7%)	29 (4.3%)	2 (1.0%)	
Inguinal/Scrotum	95 (43.4%)	319 (47.8%)	73 (36.1%)	
Pediatric Gynecology	2 (0.9%)	13 (2.0%)	5 (2.5%)	
Skin/Soft tissue	6 (2.7%)	34 (5.1%)	14 (6.9%)	
Other	0 (0.0%)	9 (1.4%)	3 (1.5%)	
Total	219 (100%)	668 (100%)	202 (100%)	
Wound class				
Clean (C)	51 (23.29%)	201 (30.0%)	55 (27.2%)	**0.043**
Clean-contaminated (CC)	161 (73.52%)	463 (69.10%)	145 (71.8%)	
Contaminated (CO)	7 (3.20%)	6 (0.90%)	2 (1.0%)	
Laparoscopic procedure (Yes)	0 (0%)	2 (0.30%)	26 (12.87%)	**<0.001**
Duration of procedure**	30 (30–45)	40 (30–55)	52 (40–70)	**<0.001**
Emergent procedure (Yes)	68 (31.1%)	164 (24.5%)	118 (58.4%)	**<0.001**
Duration of hospital stay**	2 (1–5)	2 (1–4)	2 (1-3)	0.126
Hemoglobin (g/dl)**	12.6 (11.7–13.3)	12.4 (11.6–13.1)	12.8 (12.1-13.4)	**<0.001**
Diabetes mellitus (Yes)	2 (0.91%)	2 (0.30%)	0 (0.0%)	0.27
Oncology patient (Yes)	12 (5.48%)	24 (3.59%)	1 (0.5%)	**0.017**

*Cases of our previously published study[3]
** Data are presented with median (IQR)

type of procedure (procedures of the scrotum/inguinal region, urinary tract, skin/soft tissue, gastrointestinal tract and liver/biliary, appendectomies uncomplicated, oncologic procedures, umbilical and abdominal wall hernia repair, and pediatric gynecology procedures), wound classification (clean, clean contaminated, and contaminated), elective versus urgent procedure, and duration of procedure found to differ significantly between the two periods were used as potential confounders. The results are presented as odds ratios (ORs) and 95% confidence interval (CI). All reported *p*-values were based on two-sided hypotheses and compared to a significant level of 5%.

Results

Totally, 202 children underwent surgical procedure during the study period. Table 1 presents the baseline patient and procedural characteristics for patients enrolled in the pre- and post-intervention period in our published study[3] and in the current study 4 years after the discontinuation of AS program.

The selection of the antimicrobial agent was correct in the 67.8% of the cases, while the duration of PAP was appropriate in 59.4% of patients. Comparing these results with those of our previous study after the implementation of the educational intervention,[3] we found a marked decrease (67.85 and 59.4% vs 94.7% and 80.2%, $P < 0.001$). Additionally, the overall percentage of patients receiving the correct antimicrobial agent for the appropriate duration was significantly decreased (47.5% and 77.1%, respectively, $P < 0.001$). Of note, the compliance rate, even after years without AS, did not fell to the extremely low rate of 6.2% observed before the intervention (Table 2).

In contrast to our published results (88.6%), the timing of PAP was appropriate only in 60.9% of procedures ($P < 0.001$).[6] Also, re-dosing was required in 11 out of 202 procedures and a second dose was administered in 0% of these procedures, whereas in our

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Table 2. Comparison of perioperative antimicrobial prophylaxis (PAP) administration pre-intervention and post-intervention period with and without antimicrobial stewardship (AS)

	Pre-intervention N = 219*	Post-intervention N = 670*	2nd post-intervention (without AS) N = 202	*p*-Value
Need for PAP prophylaxis	213 (97.3%)	655 (97.9%)	199 (98.5%)	0.669
Received PAP	215 (98.2%)	650 (97.0%)	202 (100.0%)	**0.037**
Indication for PAP among those received PAP	209 (97.2%)	645 (99.4%)	199 (98.5%)	**0.039**
Correct PAP (both agent and duration)	13 (6.2%)	498 (77.1%)	96 (47.5%)	**<0.001**
Correct antimicrobial agent	61 (29.2%)	612 (94.7%)	137 (67.8%)	**<0.001**
Discontinued within 24 h	64 (30.6%)	518 (80.2%)	120 (59.4%)	**<0.001**

*Cases of our previously published study[3]

previous study re-dosing was indicated in 22 procedures and was performed in 40.9% of them ($P = 0{,}015$).[6]

Finally, no significant increase in the SSI rate was detected in the present study compared to pre- and post-intervention periods of our previous published study (2.48% vs 0.93% and 0.92%, $P = 0.177$, respectively).[3]

Due to significant differences in the wound class, emergent status, types, and duration of procedure, logistic regression was applied to assess the impact of the intervention on correct PAP. It was found that even after controlling for the mentioned factors, the odds of receiving the correct PAP following intervention and 4 years after discontinuation of AS intervention were nearly 50 and 14 times higher than the pre-intervention period, respectively (adjusted OR: 50.8 95% CI: 28.2 – 92.69 and 13.9, 95%: 7.3–26.6).

Discussion

The cornerstone of our educational intervention and its long-term effectiveness was the continuous reinforcement of the recommendations, full evaluation, and ongoing audit of the changes in practice by AS physisians.[3]

Investigating the sustainability of success of this intervention, we observed that under half of the patients received the appropriate agent for the appropriate duration, a significant decrease compared to the high compliance rate of 77.1% recorded during the post-intervention period.[3] Beyond the lack of AS due to the break of the stewardship team and the supervising physician quit, the decrease in the rates of compliance could be potentially attributed to the medical staff turnover through the years and the inadequate training of the new surgical staff about the appropriate PAP use. Nevertheless, the effectiveness of our intervention was long term, as the compliance rate did not fell dramatically, but the absence of AS did not allow its maintenance at such high levels.

Numerous studies demonstrate the efficacy and the need of development of AS programs, especially in the field of PAP, as its appropriate use remains an unsolved issue.[7,8] On the contrary, too limited data exist about the impact of the AS intervention discontinuation on the appropriate use of antibiotics in general and no data about PAP specifically.[9,10] Similarly to our results, these studies revealed that the discontinuation of AS programs is a barrier to correct antimicrobial use, as the administration of antimicrobials returned rapidly to inappropriate patterns before their implementation. Finally, this study demonstrates the importance of extending AS for the appropriate PAP use, as keys of the long-term effectiveness of an educational intervention are the prospective audit and feedback strategies.

A limitation of our study was the fact that it was conducted at a single, tertiary-care center, which may limit the generalizability of our findings. Moreover, the surgical staff turnover of our department and the lack of appropriate education of newly hired surgeons about the correct use of PAP could be another limitation of our study.

In conclusion, an educational intervention is effective to improve the PAP use, but the continuous implementation of AS and ongoing evaluation and feedback process are required for its long-term sustainability.

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Competing interests. All authors report no conflicts of interest relevant to this article.

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