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Appropriateness of Surgical Antimicrobial Prophylaxis in the Latium Region of Italy, 2008: A Multicenter Study

Silvia Pittalis,[1] Federica Ferraro,[1] Pierluca Piselli,[1] Luca Enrico Ruscitti,[1] Elisabetta Grilli,[2] Simone Lanini,[1] Giuseppe Ippolito,[3] and Vincenzo Puro[1] on behalf of the Centro di Riferimento per le Infezioni associate alle Pratiche Assistenziali Latium Region Group

Abstract

Background: There is still wide variability in surgical antimicrobial prophylaxis (SAP) practice by different surgical teams and specialties, with potential impact on adverse events and the emergence of antibiotic resistance.
Methods: We assessed SAP appropriateness in a regional prospective multicenter study on the basis of the agreement of the Surgical Care Improvement Project indicators (SCIP-Inf) with Italian guidelines (GL).
Results: Prophylaxis was administered in 2,664 of 2,835 procedures (94%): In 2,346 of 2,468 (95%) as indicated and in 318 of 367 (86.6%) in which they were not indicated. The SCIP-Inf1 (timing), SCIP-Inf2 (antibiotic choice), and SCIP-Inf3 (duration) were in agreement with GL in 1,172 (50%), 1,983 (84.5%), and 1,121 (48%) of 2,346 procedures, respectively.
Conclusions: These results suggest the need for implementation of an antimicrobial stewardship program in this surgical setting.

Surgical antimicrobial prophylaxis (SAP) is one of the main measures recommended to prevent surgical site infections (SSI) and their related adverse events. In Italy, national guidelines (GL) on SAP were drawn up in 2003 and updated in 2008 [1]. In 2006, the Surgical Care Improvement Project (SCIP) was established in the United States to reduce surgical complications by 25% by 2010 [2]. Three of the six SCIP performance indicators related to SSI prevention concern SAP administration: SCIP-Inf1—timing (antibiotics administered within 1 h prior to the surgical incision; 2 h if using vancomycin); SCIP-Inf2—antibiotic selection (antibiotics recommended for the specific surgical procedure); and SCIP-Inf3—duration (antibiotics discontinued within 24 h after surgery end time; 48 h for coronary artery bypass graft or other cardiac surgery) [2]. We present the findings of a regional prospective multicenter study on SAP appropriateness, assessed on the basis of agreement of SCIP indicators with Italian GL.

Patients and Methods

This prospective study was conducted from April to June 2008 in 25 community hospitals in the Latium Region, Central Italy, and coordinated by the Regional Center for Health Care-Associated Infections (Centro di Riferimento Regionale per le Infezioni associate alle Pratiche Assistenziali [CRIPA]). Participation was voluntary, with each center choosing the surgical wards and procedures to be monitored in accordance with a shared protocol based on the Hospitals in Europe Link for Infection Control through Surveillance (HELICS) project, according to the U.S. Centers for Disease Control and Prevention/National Nosocomial Infections Surveillance (NNIS) methodology [3,4]. The referring staff of the participating centers attended a training course organized by the CRIPA before the start of the study.

For each procedure, SAP appropriateness was assessed according to the agreement of SCIP-Inf1, SCIP-Inf2, and SCIP-Inf3 with the Italian 2003 GL (the updated version appeared in September 2008). In caesarean sections, SCIP-Inf1 was considered fulfilled even when SAP was started after umbilical cord clamping. For SCIP-Inf1 and SCIP-Inf3, "best" and "worst" scenarios were created, for which missing data were considered compliant or non-compliant with GL, respectively.

Data were collected using a modified version of the HELICS-Win software [3], and the statistical analysis was

[1]Epidemiology Department and [2]Clinical Department, National Institute for Infectious Diseases "Lazzaro Spallanzani," Rome, Italy.
[3]National Institute for Infectious Diseases "Lazzaro Spallanzani."
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performed using SPSS version 19 (SPSS Inc., Chicago, IL). The χ^2 test (or Fisher exact test when applicable) was used to compare categorical variables for the groups.

The association of inappropriate SAP (i.e., SAP provided when indicated with at least one SCIP indicator not in agreement with GL, or SAP provided when not indicated) with gender, age, NNIS risk index score, or its components (i.e., American Society of Anesthesiologists [ASA] score, duration of the surgical procedure, wound class, and type of admission) was assessed using logistic regression and expressed in terms of the odds ratio (OR) with the respective 95% confidence intervals (CIs). Multivariable analysis was performed after adjustment for those variables found to have a significant association ($p < 0.10$) in the univariable analysis.

Results

A total of 2,835 surgical interventions (73% in males; 25% emergency) were monitored. Surgical antibiotic prophylaxis was administered in 2,664 procedures (94%). Procedure-related SAP rates for the various hospitals ranged from 48.1% (range 0–100%) for hernia repair without prosthetic implant to 98.6% (95.7%–100%) and 99.1% (89.3%–100%) for colon surgery and caesarean section, respectively, to 100% for hip and knee prosthetic implants. The greatest variation in SAP rates was observed for hernia repair and breast surgery (data not shown).

Surgical antibiotic prophylaxis was provided in 2,346 of 2,468 procedures (95%) for which it was indicated. It was not provided in 52% of hernia repairs with prosthetic implant and in 7.4% of breast operations. Among the 367 procedures for which SAP was not indicated, it properly was not provided in 49 (13.4%). Thus, an overall rate of adherence to GL of 84.5% was observed (Table 1).

Considering only the 2,346 procedures for which SAP was indicated and provided, SCIP-Inf1 (timing) was in agreement with GL in 1,172 (50%); data were missing in 15.4%. The SCIP-Inf2 (antibiotic choice) was in agreement in 1,983 procedures (84.5%), whereas in the remaining 363 (15.5%), antimicrobials that were not recommended were given, also in combination (third-generation cephalosporin in 66.4%, penicillin + anti-beta-lactamase in 32.2%, and carbapenems in 5.4%). The SCIP-Inf3 (duration) was in agreement with GL in 1,121 cases (48%) and not documented in 7%.

In the "best" scenario, where we conceived all missing data as being in compliance with GL, all SCIP-Inf would have been in agreement with GL in 36.8% of the procedures, two of the three would have been in agreement in 38.1%, only one in 17.7%, and none in 7.4%. In the "worst" scenario, these proportions would have been 22.7%, 45.5%, 23.2%, and 8.6%, respectively (Table 1).

For 1,919 of 2,346 cases (81.8%) for whom data on all the three SCIP-Inf were available, we found a statistically significant association of inappropriate SAP with contaminated/dirty wound class and urgent surgery, whereas an ASA score >2 was associated with appropriate SAP (Table 2). In particular, a strong association was found between contaminated/dirty procedures and erroneous antibiotic choice (29% vs. 15% in clean/clean-contaminated wounds; $p < 0.001$) and prolonged operation (65% vs. 53%; $p = 0.002$). Moreover, SAP inappropriateness in urgent procedures was associated mainly with incorrect timing. However, these associations disappear if we consider the NNIS risk index: An index score >2 was associated with a lower proportion of inappropriate SAP administration (OR 0.63; $p < 0.01$; data not shown).

On the other hand, of 318 cases in which SAP was administered even if not indicated, in 58% antibiotic was

Table 1. Appropriateness of Surgical Antimicrobial Prophylaxis (SAP), as Judged by Surgical Care Improvement Project (SCIP) Indicators and Italian Guidelines, Latium Region, Italy, April–June 2008

	N (%)	*SAP N (%)*[a]	*SCIP-Inf1 (timing) %*[b]	*SCIP-Inf2 (antibiotic selection) %*[b]	*SCIP-Inf3 (duration) %*[b]
SAP indicated by Italian guidelines					
APPY	61 (2.5)	59 (96.7)	16.9–20.3	86.4	79.7–89.8
CABG	109 (4.4)	108 (99.1)	56.5	100	58.3
CHOL (laparotomy)	106 (4.3)	104 (98.1)	16.3–46.2	59.6	11.5–41.3
COLO	329 (13.3)	326 (99.1)	41.1–51.5	68.7	24.5–36.5
CSEC	1051 (42.6)	1036 (98.6)	52.1–77.9	93.3	54.3–58.1
HER (with prosthetic implant)	135 (5.5)	65 (48.1)	35.4–52.3	75.4	64.6–84.6
HPRO	106 (4.3)	106 (100)	88.7–95.3	84.0	64.2–65.1
KPRO	77 (3.1)	77 (100)	64.9–67.5	36.4	16.9–18.2
LAM	104 (4.2)	104 (100)	61.5–62.5	94.2	20.2–22.1
MAST	390 (15.8)	361 (92.6)	49.6–51.2	85.0	58.7–65.7
Total	2468 (100)	2346 (95.1)	50.0–65.3	84.5	47.8–54.5
SAP not indicated					
CHOL (laparoscopic)	320 (87.2)	281 (87.8)		Not applicable	
HER (without prosthetic implant)	47 (12.8)	37 (78.7)			
Total	367 (100)	318 (86.6)			

[a]Percentage of total numbers of specific procedure.

[b]Percentage of total number of specific procedure for which SAP was provided. For SCIP-Inf1 and SCIP-Inf3, "worst scenario" and "best scenario" percentages are reported: see text for method of calculation.

APPY = appendicectomy; CABG = coronary artery bypass grafting; CHOL = cholecystectomy; COLO = colon surgery; CSEC = caesarean section; HER = hernia repair without or with prosthetic implant; HPRO = hip prosthesis; KPRO: knee prosthesis; LAM = laminectomy; MAST = breast surgery.

Table 2. Variables Associated with Inappropriate Surgical Antimicrobial Prophylaxis (SAP) in Procedures for which It Was indicated,[a] Latium Region, Italy, April–June 2008

	N°	*SAP inappropriate*[b]	*Odds ratio*[c]	*MLR-OR*[a]
Gender				
M	459	324 (70.6)	1	1
F	1,460	1,063 (72.8)	1.12 (0.89–1.41)	0.91 (0.70–1.19)
Age				
10-yr increase			0.95 (0.91–1.01)	1.06 (0.99–1.13)
ASA score				
1–2	1,386	1,040 (75.0)	1	1
3–5	411	262 (63.7)	0.59 (0.46–0.74)	0.54 (0.42–0.71)
Missing	122	85 (69.7)	0.76 (0.51–1.15)	0.77 (0.51–0.16)
Duration of surgery >75th percentile				
No	1519	1,116 (73.6)	1	1
Yes	403	271 (67.2)	0.74 (0.58–0.93)	0.82 (0.63–1.08)
Wound contamination class				
Clean/clean-contaminated	1729	1,236 (71.5)	1	1
Contaminated/dirty	190	151 (79.5)	1.54 (1.07–2.23)	1.65 (1.12–2.42)
Type of admission				
Elective	1401	966 (69.0)	1	1
Urgent	518	421 (81.3)	1.95 (1.53–2.51)	2.11 (1.60–2.78)
	1,919*	1,387 (72.3)		

[a]Procedures in which SAP was indicated and provided and data on all the three Surgical Care Improvement Project (SCIP) indicators were available.
[b]At least one SCIP indicator disagrees with Italian Guidelines.
[c]Underlined: $p < 0.10$; underlined boldface: $p < 0.05$.
ASA = American Society of Anesthesiologists score (1 = healthy; 2 = mild systemic disease; 3 = severe systemic disease ; 4 = severe systemic disease that is a constant threat to life; 5 = moribund patient); MLR-OR = multiple logistic regression–odds ratio.

administered the day before the surgical procedure, in 49% it was continued >48 h after the procedure (average 3.9 days; range 2–16 days), and in 38%, a not recommended antimicrobial agent was administered. By univariable analysis, we found an association of SAP administration when not indicated with urgent surgery (OR 5.62; $p = 0.057$) and a very strong and significant association with an ASA score >2 (OR 13.0; $p < 0.001$).

Discussion

Despite a plethora of evidence on SAP effectiveness and the availability of several GL designed to optimize perioperative antimicrobial use, there is still wide variability in SAP practice among surgical teams and specialties, with a potential impact on adverse events and the emergence of antibiotic resistance.

We choose the SCIP performance measures for our evaluation because they are supported by good quality evidence, although we agree that prevention of SSI requires an ensemble of prevention tactics, not all of which are included in SCIP, and whether reduced numbers of SSI actually are achieved remains obscure [5–9]. Whereas many factors deserve clarification, for others there should not be any doubt. It was reassuring to see that in almost all the surgical procedures for which SAP is recommended strongly, it was administered. Instead, although it is concerning to find that in 5% of the procedures, SAP was withheld when indicated, these procedures were mainly hernia repairs with prosthetic implant and breast surgery. In the former situation, SAP is no longer indicated according to 2008 national GL, and no SAP benefits were evident at the time of the study. For breast surgery, the 2003 GL recommended SAP on the basis of the local epidemiology pattern. If these procedures are removed from the total count, indicated SAP would have been withheld in only 1% of the cases.

A propensity to provide prophylactic antibiotics when not indicated is evident from the high proportion of patients receiving SAP for laparoscopic cholecystectomy and hernia repair without prosthetic implant, drugs being given for more than 48 h in some cases. However, it is possible that the long-term antibiotic use was for purposes other than prophylaxis.

With regard to the SCIP–Inf agreement with the GL, there is a wide variability in timing of SAP administration—with some even advocating delivery on the previous day or on the day after the procedure—and in its duration. Many surgeons continue to use as prophylactic antibiotics third- and fourth-generation cephalosporins, penicillins + anti-beta-lactamase, carbapenems, which, together with monobactams, are not recommended, as these agents should be reserved for the therapy of multi-resistant microbial infections [1]. Finally, our data show that contaminated/dirty wound class and urgent surgery were significantly associated with inappropriate SAP for procedures in which it was indicated. In the first case, given the higher proportion of SCIP-Inf2 and SCIP-Inf3 inappropriateness, we cannot exclude the possibility that the antibiotic was for therapy rather than prophylaxis. Conversely, the association of the higher ASA score with an almost totally appropriate SAP when indicated and with inappropriate SAP when not indicated suggests physicians' high confidence in antibiotic use in case of established comorbidities. A similar watchful approach in the presence of some known risk factors for SSI has been described recently by Prospero et al. in another Italian surgical setting [10].

Our results should be interpreted with caution, because of the possibility of a selection bias because of the voluntary participation in the study and the possibility of choosing the procedures to be monitored. Moreover, we analyzed a number of surgical interventions corresponding to 10% of all the same procedures performed in the Latium Region in the same period [11]. However, in the context of inter-hospital variability, we found extensive use of antimicrobial agents, which can lead to pressure for the selection of resistant microorganisms. Moreover, considering both the "best" and "worst" scenarios, our data, as is true for those from similar studies that evaluated adherence to GL in other Italian surgical units [10,12,13], underline the need for implementation of broader antimicrobial stewardship in a surgical setting.

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References

1. Istituto Superiore di Sanità, Centro Nazionale Epidemiologia, Sorveglianza e Promozione della Salute. Sistema Nazionale per le Linee Guida. Antibioticoprofilassi perioperatoria nell'adulto. Settembre 2003. Updated September 2008.
2. Bratzler DW. The Surgical Infection Prevention and Surgical Care Improvement Projects: Promises and pitfalls. Am Surg 2006;72:1010–1016.
3. Europe Link for Infection Control through Surveillance, Surveillance of Surgical Site Infections. Protocol. Version 9.1, September 2004.
4. Horan TC, Andrus M, Dudeck MA. CDC/NHSN surveillance definition of health care-associated infection and criteria for specific types of infections in the acute care setting. Am J Infect Control 2008;36:309–332.
5. Barie PS. SCIP to the loo? Surg Infect 2011;12:161–162.
6. Awad SS. Adherence to surgical care improvement project measures and post-operative surgical site infections. Surg Infect 2012;13:234–237.
7. Davis JM, Kuo YH, Ahmed N, Kuo YL. Report cord on Surgical Cite Improvement Project (SCIP): Nationwide inpatient sample infection data 2001–2006. Surg Infect 2011;12:429–434.
8. Rosenberger LH, Politano AD, Sawyer RG. The surgical care improvement project and prevention of postoperative infection, including surgical site infection. Surg Infect 2011;12:163–168.
9. Edmiston CE, Spencer M, Lewis BD, et al. Reducing the risk of surgical site infection. Did we really think SCIP was going to lead us to the promised land? Surg Infect 2011;12:169–177.
10. Prospero E, Barbadoro P, Marigliano A, et al. Perioperative antibiotic prophylaxis: Improved compliance and impact on infection rates. Epidemiol Infect 2011;139:1326–1331.
11. Laziosanità. Agenzia di Sanità Pubblica. Sistema Informativo Ospedaliero 2008. Available at http://151.1.149.50/sio-sistema-informativo-ospedaliero/dati/sio-sistema-informativo-ospedaliero-dati-2006-2010/SIO_2008.zip/at_download/file. Accessed June 25, 2012.
12. De Chiara S, Chiumello D, Nicolini R, et al. Prolongation of antibiotic prophylaxis after clean and clean-contaminated surgery and surgical site infection. Minerva Anestesiol 2010; 76:413–419.
13. Barchitta M, Matranga D, Quattrocchi A, et al. Prevalence of surgical site infections before and after the implementation of a multimodal infection control programme. J Antimicrob Chemother 2012;67:749–755.

Address correspondence to:
Dr. Silvia Pittalis
Epidemiology Department
National Institute for Infectious Diseases "Lazzaro Spallanzani"
via Portuense, 292
00149, Rome, Italy

E-mail: silvia.pittalis@inmi.it