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A REVIEW ON THE APPROPRIATENESS OF SURGICAL PROPHYLAXIS IN OBSTETRICS AND GYNAECOLOGY

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ABSTRACT: AIM: This review aims to analyze the appropriateness of surgical antimicrobial prophylaxis in obstetrics and gynecology from 2015 to June 2022. **Methodology:** The review includes interventional, prospective and retrospective observational studies and surveys based on compliance with surgical antibiotic prophylaxis use concerning standard surgical antimicrobial prophylaxis (SAP) guidelines for gynecological and obstetrics surgeries from a web search of PubMed and Google Scholar from the year of 2015 to June 2022. **Results:** The review describes 33 studies focused on the appropriate usage of surgical prophylactic antibiotics. The majority of the studies revealed excessive and inappropriate use, and the compliance is far below the recommended guidelines, especially in terms of duration which is followed by the selection and time of administration of antibiotics. **Conclusion:** The majority of the studies analyzed in this review indicated a remarkable rate of inappropriateness, which may contribute to antimicrobial resistance (AMR), which raises the risk of SSI exacerbated by resistant bacteria followed by prolonged hospitalization and increased mortality. There is evidence that pharmacist intervention promotes the optimal use of SAP. Hence Antimicrobial stewardship (AMS) interventions such as periodic audits and educational interventions should be implemented to improve the appropriate use of SAP and to prevent the emergence of AMR.

INTRODUCTION: Surgical site infections are one of the most commonly diagnosed infections associated with health care in economically developing low and middle-income countries, leading to longer hospital stays, readmissions, increased mortality and morbidity rates, and also increasing financial burden^{1,2}.

According to recent research conducted by the World Health Organisation (WHO), surgical site infection (SSI) is more prevalent in low and middle-income countries (LMICs) than in high-income countries. Still, it appears to be the second most common type of healthcare-associated infection (HAI) in European countries and the United States of America (USA)³.

As the most common complication in obstetrics and gynecology, preventing surgical site infections in women undergoing obstetric and gynecological procedures has always been a primary long-term goal to enhance clinical outcomes^{4,5}. Numerous research conducted over the past four decades

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suggested that surgical site infections can be prevented and the rate of occurrence after high-risk obstetric and gynecological surgical procedures can be reduced through the effective use of preoperative antimicrobial prophylaxis. However, they are the most common type of infection that is reported to cause serious morbidity and mortality^{2, 6}.

There is significant evidence that surgical antibiotic prophylaxis use is more prevalent in obstetric and gynecology units worldwide⁷. Despite being one of the most important measures for preventing postoperative surgical site infections in obstetric and gynecological procedures, antibiotic prophylaxis is nevertheless associated with a significant rate of inappropriateness⁸.

Surgical antimicrobial prophylaxis (SAP), which aims to prevent surgical site infections (SSI), frequently appears to be overused⁹. Inappropriateness, especially in terms of prolonged duration and excessive use of prophylactic antibiotics, may contribute to the emergence of antimicrobial resistance (AMR), and inappropriateness in timing reduces the efficacy of prophylactic antibiotics^{2,9}.

Results of a WHO global survey conducted in 2014 revealed that, on average, 43.5% of procedures used antibiotics for longer than recommended by international standards, and the frequency of prolongation of SAP administration was higher than 60% in African, Eastern Mediterranean, and Western Pacific countries¹⁰.

According to the World Health Organization (WHO), AMR is a global concern and has been ranked as one of the top ten global public health threats facing humanity¹¹. A 2019 UN Ad hoc Interagency Coordinating Group report stated that at least 700,000 people die each year from drug-resistant diseases and AMR has the potential to push up to 24 million people into extreme poverty by 2030, resulting in up to 10 million deaths annually by 2050, and damage the economy as catastrophically as the 2008-2009 global financial crisis¹². The growing prevalence of AMR raises the risk of SSI becoming complicated with resistant bacteria, resulting in worse surgical outcomes with extended antibiotic therapy, prolonged

hospitalization, and higher surgical revision rates and mortality rates¹³. One of the key interventions required to stop the further emergence and spread of AMR and to optimize SAP is to improve the use of antibiotics through antibiotic stewardship (AMS)¹⁴.

For this reason, the WHO Expert Committee on Selection and Use of Essential Medicines developed AWaRe (Access, Watch and Reserve) as a tool to support the efforts of AMS at local, national, and global levels and to reduce the spread of AMR, antibiotic-related adverse events, and drug costs¹⁴⁻¹⁶.

Despite these increasing challenges, more evidence is required about the approaches of SAP in the era of antibiotic resistance (AMR) to optimize SAP¹³. As a part of AMS, the use of surgical antimicrobial prophylaxis (SAP) in the maternity unit is reviewed to support antibiotic monitoring, make the best use of antibiotics, and stop the further spread of antimicrobial resistance (AMR). The main objective of this review is to describe the appropriateness of surgical antimicrobial prophylaxis (SAP) in terms of five basic parameters: indication, selection, dosing, timing, and duration in obstetrics and gynecology from 2015 - June 2022.

MATERIALS AND METHOD: The review includes a web search of PubMed and Google Scholar based on compliance with surgical antibiotic prophylaxis use concerning standard surgical antimicrobial prophylaxis (SAP) guidelines for gynecological and obstetrics surgeries.

The inclusion criteria for this review include interventional, prospective, and retrospective observational studies and surveys that were published from 2015 to June 2022 about the appropriate use of surgical antibiotic prophylaxis in obstetrics and gynecology. The exclusion criteria for this review include review articles; studies that were conducted before 2015; and animal studies. The review included a total of 33 studies; 2 were published in 2022, 8 in 2021, 4 in 2020, 2 in 2019, 9 in 2018, 2 in 2017, 1 in 2016, and 5 studies in 2015.

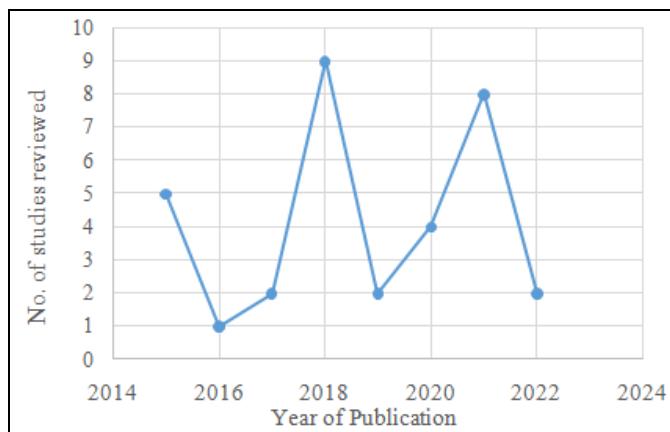


FIG. 1: YEAR OF PUBLICATION OF REVIEWED STUDIES

RESULT AND DISCUSSION

Adherence to Surgical Antimicrobial Prophylaxis: Most of the observational studies included in this review revealed a significant rate of inappropriate use of surgical antimicrobial prophylaxis in obstetrics and gynecological procedures. Santos *et al.* evaluated the appropriateness of physician practice patterns for the use of SAP in gynecological surgeries

concerning evidence-based guidelines from ACOG ASHP and the Brazilian Health Regulatory Agency (ANVISA, 2017); they reported that preoperative antibiotic prophylaxis was appropriate in 52.9% of 306 gynaecological surgeries¹⁷. Mehdi *et al.* assessing the use of SAP in obstetric and gynecologic surgeries based on ACOG and WHO guidelines reported that among 331 surgeries, the use of antimicrobial prophylaxis was highly inappropriate with a rate of 99.3% (329)¹⁸.

Bunduki *et al.* on evaluating adherence to SAP with the evidence-based guidelines, NICE and Stanford Health Care (SHC) reported that the overall rate of non-compliance for SAP use was 87.5% (119) among 136 patients who underwent obstetric and gynecological surgeries¹⁹. Prawai *et al.* in evaluating the level of SAP compliance with guidelines stated that of 391 women who underwent elective hysterectomy surgeries, 63 women (16.1%) received SAP in accordance with guidelines, and concluded that an AMS program has to be implemented to improve the practice²⁰.

TABLE 1: REVIEWED STUDIES PUBLISHED BETWEEN 2020 – 2022

Author	Published Year	Type of Study	Duration of study	Name of the Journal
Prawai <i>et al.</i>	2022	Retrospective descriptive study	1 Year	Thai Journal of Obstetrics and Gynaecology
Dohou <i>et al.</i>	2022	Prospective observational study	1 Month	MDPI – Antibiotics
Romero <i>et al.</i>	2021	Retrospective drug utilization study	1 Year	Antimicrobial Resistance and Infection Control
Santos <i>et al.</i>	2021	Retrospective cross-sectional study	1 Year	Research, Society and Development
DwiMahendra <i>et al.</i>	2021	Retrospective study	5 Months	Indonesian Journal of Pharmaceutical and Clinical Research
Magdy <i>et al.</i>	2021	Prospective observational study	6 Months	Pharmacia
Naeimzadeh <i>et al.</i>	2021	Prospective cross-sectional study	6 Months	Journal of Pharmaceutical Care
Tietel <i>et al.</i>	2021	Retrospective study	18 Months	The Journal of Maternal-Fetal& Neonatal Medicine
Karmila <i>et al.</i>	2021	Retrospective study	3 Years	MDPI - Antibiotics 2021
Martin <i>et al.</i>	2021	Online cross-sectional survey	2 Months	The Australian and New Zealand Journal of Obstetrics and Gynaecology (ANZJOG)
Khan <i>et al.</i>	2020	Audit-based prospective study	3 Months	Tropical Journal of Obstetrics and Gynaecology
Mehdi <i>et al.</i>	2020	Retrospective chart review	3 Months	SPHMMC Department of Obstetrics and Gynaecology (OBGYN) Research Papers Repository
Bunduki <i>et al.</i>	2020	Retrospective study	2 Years	Infection Prevention in Practice
Gil-Conesa <i>et al.</i>	2020	Prospective cohort study	4 Years 3 Months	Revistaespanola de quimioterapia: publicacionoficial de la Sociedad Espanola de Quimioterapia

Abubakar *et al.* in evaluating SAP compliance with the standard guidelines, reported that among 248 obstetrics and gynaecological surgeries, one-third of antibiotics used for SAP were found to be inappropriate, and best practice requires AMS intervention²¹. Mousavi *et al.* assessed the use of SAP and compared all the parameters of SAP administration with the recommendation of the American Society of Health-System Pharmacists (ASHP) guideline and reported an overall compliance rate of 28.6% with SAP in 14 obstetric and gynecologic procedures²². Karmila *et al.* evaluating the use of SAP in 3657 patients who underwent delivery for clinician adherence to guidelines, found that the rate of compliance was 68.9% and that the percentage of compliance drastically declined over time, from 77.2 % in 2016 to 71.2% in 2017 and 60.1 % in 2018, they also found that patients with three indications had the highest degree of adherence (93.2%), followed by those with no indications (89.6%) and those with two indications (77.3%). The lowest rate of compliance (59.3%) was seen in patients with one indication²³.

Farret *et al.* evaluated the impact of antibiotic prophylaxis on patients who had a cesarean section with surgical site infection (SSI) within 30 days of the procedure based on criteria established by the Centers for Disease Control and Prevention's National Healthcare Safety Network (CDC/NHSN) and stated that of 106 emergency cesarean deliveries,²⁴ (22.6%) received appropriate SAP. Of these, 11/24 (45.8%) women had an SSI and of the remaining 82 women who did not receive appropriate SAP, 46 (56.1%) had an SSI and out of the 52 elective cesarean sections, 19 (36.5%) received appropriate SAP. Of these, 5/19 (26.3%) women had an SSI, and of the remaining 33 women who did not receive adequate SAP, 10/33 (30.3%) had an SSI²⁴.

Since the rate of the inappropriateness of surgical antimicrobial prophylaxis is significant in obstetrics and gynecological surgeries, it is essential to identify the primary causes of inappropriateness. The discussion that follows includes analyzing the compliance and non-compliance rates of surgical antimicrobial prophylaxis in terms of five basic parameters: indication, selection, dosing, timing and duration.

The Parameters of Surgical Antimicrobial Prophylaxis:

Indication: The first significant parameter in surgical antimicrobial prophylaxis is the indication. Romero *et al.* on evaluating the compliance of SAP in cesarean deliveries with local recommendations (directives stated in the CPG—Ecuador) and international (ASHP) guidelines, state that out of 814 women, 100% of women received postoperative antibiotics when they were not indicated²⁵. Santos *et al.* reported that the adherence to guidelines regarding indication was 66.3%, which led them to conclude that the use of SAP when it was not indicated was the primary factor determining the poor rate of overall adequacy¹⁷. Khan *et al.*, investigating SAP compliance with standard guidelines in common gynecological surgeries (cesarean surgery and hysterectomy), stated that 91.3% of patients received antimicrobial prophylaxis among all 264 women who underwent gynecological surgeries indicated for SAP²⁶.

Abdel *et al.* assessed compliance with the use of SAP based on ASHP guidelines. They stated that out of 1173 women who underwent cesarean deliveries, a higher rate of adherence to guidelines regarding indication was observed, where only 0.5% of the included women did not receive SAP when indicated²⁷. Gil-Conesa *et al.* assessing the effect of compliance with SAP guidelines on the incidence of surgical site infection in patients who had a hysterectomy, found that, out of 1025 interventions, 1014 were indicated with antibiotic prophylaxis, which was administered in 1009 (99.5%) of them and concluded that the overall appropriateness of SAP was very high (92.5%)²⁸.

Dohou *et al.* on assessing the SAP use in cesarean section stated that out of 141 women who underwent cesarean section, the compliance towards indication was found to be 99.30%²⁹. Magdy *et al.* on evaluating the utilization and compliance of SAP with ASHP, WHO and ACOG guidelines in 264 obstetric and gynecologic procedures found that only 1% of the 200 (75.75%) women who were indicated for the use of SAP did not receive prophylactic antibiotics, and of the 64 women who were not indicated, 27 (42.18%) of them received prophylactic antibiotics 30. Uppendah *et al.* found that among 1735

gynecological surgeries, 1045 (60.2%) were indicated SAP in which 1031 (98.7%) received an appropriate antibiotic and 394 (57.1%) of the 690 (39.8%) cases received antibiotic without indication while evaluating compliance of SAP with ACOG guidelines³¹.

TABLE 2: REVIEWED STUDIES PUBLISHED BETWEEN 2017 – 2019

Author	Published Year	Type of Study	Duration of study	Name of the Journal
Abubakar et al.	2019	Prospective Interventional study	6 Months	PLOS ONE
Abubakar	2019	Retrospective study	12 Months	Value in Health
Abdel et al.	2018	Prospective interview followed by retrospective chart review	11 Months	American Journal of Infection Control
Uppendah et al.	2018	Retrospective cohort study	1 Year	Mary Ann Liebert, Inc. Publishers
Abubakar et al.	2018	Prospective study	3 Months	International journal of clinical pharmacy
Alemkere et al.	2018	Prospective cross-sectional study	3 Months	PLOS ONE
Panciroli et al.	2018	Multi-center retrospective study	2 Years	European Journal of Hospital Pharmacy
Kremer et al.	2018	Single-centre retrospective study	2 Years	Journal of Obstetrics and Gynaecology
Kawakita et al.	2018	Retrospective cohort study	6 Years	American College of Obstetricians and Gynecologists
Shapiro et al	2018	Retrospective chart review research	4 Years	International Journal of Health Care Quality Assurance
Brunozzi et al.	2018	Retrospective study	1 Year	American College of Obstetricians and Gynecologists
Mousavi et al.	2017	Prospective cross-sectional study	6 Months	Journal of Research in Pharmacy Practice,
Joyce et al.	2017	Retrospective study	2 Years	Baylor University Medical Center Proceedings

Kremer M et al. analyzed the use of prophylactic antibiotics when not indicated by the ACOG guidelines and found that 199 (19%) of 1046 gynecological procedures used antibiotic prophylaxis when not indicated³². Joyce et al. examined the use of SAP in patients undergoing gynecologic surgery when antibiotics were not recommended per the American College of Obstetricians and Gynecologists (ACOG) guidelines and observed that antibiotics were prescribed quite frequently by gynecologic surgeons, with 54% of the 326 patients receiving antibiotics when not indicated and 11 (3%) experiencing adverse events from inappropriate prophylactic antibiotics³³.

Karmila et al. on accessing the use of SAP based on local guidelines, stated that, among 3657 patients who underwent delivery, 2725 (74.5%) cases had an indication for antibiotic prophylaxis, in which 1654 (60.7%) patients received SAP, and when 932 women not indicated for prophylactic

antibiotics, 67 (7.2%) received SAP²³. Govender carried out a three-month retrospective Medicine Use Evaluation (MUE) to assess the compliance of SAP administration with standard treatment guidelines in 120 cesarean sections and observed that the rate of compliance concerning the indication was 100%³⁴. Shapiro et al. examine the use of preoperative antibiotic prophylaxis in gynecological procedures to determine adherence rates with the current ACOG guidelines and found that the physician re-education improved compliance with ACOG guidelines from 52% to 92% and the overall rate of patients receiving SAP when it was not indicated dropped from 23% to 9%³⁵.

Brunozzi et al. investigated the use of antibiotics in 1338 women undergoing gynaecologic surgery. They found that 161 (96.4%) of 167 gynecological surgeries for which an antibiotic was indicated received appropriate SAP, whereas 210 (17.9%) of 1,171 patients received inappropriate SAP when

antibiotics were not indicated. They implemented an intervention aimed at improving adherence to ACOG recommendations³⁶. Joyce *et al.* in investigating the use of prophylactic antibiotics in gynecologic surgeries where ACOG guidelines do

not recommend antibiotics stated that of 326 gynecologic surgeries in which SAP was not indicated, 53.7% received preoperative antibiotics³⁷.

TABLE 3: REVIEWED STUDIES PUBLISHED BETWEEN 2015 – 2016

Author	Published Year	Type of Study	Duration of study	Name of the Journal
<i>Govender</i>	2016	Retrospective medicine use evaluation (MUE)	3 Months	Research Space
<i>Farret et al.</i>	2015	Retrospective case-control observational study	4 Years	The Brazilian Journal of Infectious Diseases
<i>Wang et al.</i>	2015	Single center prospective interventional study	6 Months	Int. Journal of Clinical Pharmacology and Therapeutics
<i>Saied et al.</i>	2015	Multi-center pilot interventional study	6 Months	American Journal of Infection Control
<i>Joyce et al</i>	2015	Retrospective study	2 Years	Journal of Minimally Invasive Gynecology
<i>Muller et al.</i>	2015	Retrospective monocentric study	4 Months	Anaesthesia Critical Care & Pain Medicine

Selection and Dosing: The selection and dosage of the antibiotic are two additional fundamental parameters of surgical antimicrobial prophylaxis aside from the indication. Romero *et al.* stated that of the 814 patients who underwent cesarean deliveries, 69.90% received preoperative antibiotic prophylaxis, of which the selection of SAP was appropriate in 558 (98.07%) women and 526 (92.44%) received an appropriate dose of SAP as per ASHP guidelines²⁵. Santos *et al.* stated that the rate of compliance with the guidelines regarding the choice and dose of SAP was 100% in all 306 gynecological surgeries¹⁷. Mehdi *et al.* reported that non-compliance with the selection of SAP was 17.5% among 331 patients who underwent gynecology and obstetrics surgeries¹⁸.

Abdel *et al.* stated that out of 1173 women who underwent cesarean deliveries, 37.50% received an insufficient dose of SAP²⁷. Dwi Mahendra *et al.* on accessing the adherence to standard guidelines for selection of SAP (ASOG, ASHP) in hysterectomy and cesarean section found that only 6.1% of 33(34.74%) patients who underwent hysterectomy and 1.75% of 62 (65.26%) patient underwent cesarean section adhered to the guidelines concerning the proper selection of SAP³⁸. Gil-Conesa *et al.* in assessing compliance with SAP guidelines found that out of 1025 interventions, 35.2% received an inappropriate choice of SAP²⁸. Dohou *et al.* stated that out of 141 women who

underwent cesarean section, the rate of inappropriateness towards the dose of the SAP was found to be 49.30%²⁹. Naeimzadeh *et al.* evaluating the SAP regimen in gynaecological surgeries stated that the rate of compliance with the selection of prophylactic antibiotics based on ASHP guidelines was 71.4% (n = 150) among 198 gynaecological procedures³⁹. Abubakar *et al.* assessed the impact of AMS on the appropriate use of SAP and found that among 226 pre-and 238 post-interventional studies, prescribing with third-generation cephalosporin was reduced from 29.2% to 20.6% and the overall rate of unnecessary SAP use decreased by 19.1% following an AMS intervention⁴⁰.

Abubakar *et al.* reported that inappropriate SAP combinations were used in 71.4% of procedures and a greater rate of unnecessary antibiotic prophylaxis usage (83.6%) in cesarean sections compared to other surgical procedures²¹. Panciroli *et al.* evaluating the appropriate use of SAP after implementing local guidelines, found that compliance with appropriate antibiotic selection improved after guideline implementation from 7.2% (pre-guideline) to 56.9% (post-guideline)⁴¹. Tietal *et al.* evaluating the appropriate use of SAP after implementing local guidelines, found that compliance with appropriate antibiotic selection improved after guideline implementation from 7.2% (pre-guideline) to 56.9% (post-guideline)⁴².

Abubakar reported that unnecessary antibiotic combinations were found in 50% of the cases⁴³. Mousavi *et al.* stated that on assessing the use of SAP according to the ASHP recommended guidelines, the appropriate selection of SAP among 14 obstetric and gynaecologic procedures was found to be 21.4%²². Kawakita *et al.*, assessing the compliance of the choice of prophylactic antibiotic with ACOG guidelines, observed that among 6,584 cases included in the analysis, 6,163 (93.6%) women received cefazolin and 421 (6.4%) women were administered non-cephalosporin (alternate) antibiotics, of which 274 (65.1%) were based on guidelines and 147 (34.9%) were not, and they also found that the non-compliance rate regarding the selection of antibiotics was 2.2% and concluded that both standard alternative and inappropriate alternatives were associated with increased odds of surgical site infections compared with cefazolin⁴⁴. Govender on assessing the compliance of SAP administration in cesarean sections found that the rate of compliance concerning the recommended dosage was 100%³⁴. Wang *et al.* on assessing the impact of pharmacist interventions on rational use of prophylactic antibiotics and economic outcomes in elective caesarean section, they found that the appropriateness of SAP in terms of dosage and choice was 3.55% of 197 surgeries prior to intervention and 93.91% of 197 surgeries after intervention⁴⁵.

Timing: Romero *et al.* stated that of the 569 patients who received antibiotics, the rate of appropriateness to ASHP guidelines with respect to the time of administration was 100%²⁵. Santos *et al.* stated that of 306 gynecological surgeries, the compliance with the timing of prophylactic antibiotics was 97.4%¹⁷. Khan *et al.* stated that the adherence rate to surgical prophylaxis guidelines for timing was 56.4% of the 264 patients who underwent cesarean and hysterectomy procedures²⁶. Mehdi *et al.* stated that the inappropriateness in timing regarding SAP use was 30.2%¹⁸. Bundukiet *al.* stated that 18.0% of gynecology and obstetrics procedures did not adhere to the timing for SAP use¹⁹. Abdel *et al.* stated that out of 1173 women, 51.5% received SAP within the specified dosing interval, indicating compliance with the time of SAP administration; of the remaining, 41.9% received SAP earlier than recommended, and 6.6% received SAP later²⁷. Dohou *et al.* stated that out

of 141 women who underwent cesarean section, the rate of non-adherence towards the time of administration of SAP was found to be 31.15%²⁹. Abubakar *et al.* stated that overall adherence to guidelines regarding timing for SAP improved from 14.2% to 43.3% after AMS intervention and elective surgeries showed an improved compliance rate of 10.6% to 58.9%, but no difference was seen in the case of emergency surgeries⁴⁰. Abubakar *et al.* reported 16.5% Compliance with antibiotic prophylaxis timing²¹. Alemkerestudied the compliance of SAP with the ACOG and national Standard Treatment Guidelines of the country and stated that among 38 gynecology and obstetrics procedures, the rate of non-compliance with SAP timing is 21.1%⁴⁶. Tietal *et al.* stated that compliance with antibiotic prophylaxis timing in cesarean section is 94.6%⁴². Abubakar stated that adherence to the timing for SAP is found to be 36.5%⁴³. Mousavi *et al.* stated that of 14 obstetric and gynaecologic procedures, the compliance with the timing of antibiotic prophylaxis was 35.7%²². Martin *et al.* evaluated the self-reported adherence to a range of perioperative strategies and surgical techniques in preventing SSI following caesarean sections through online cross-sectional survey of Australian obstetricians and obstetric diplomates and found that out of 828 respondents, 472 (57.4%) were implementing infection prevention bundle with respect to time of administering SAP (within 15 - 60 minutes before skin incision)⁴⁷.

Wang *et al.* stated that after the intervention, there was an increase in the appropriateness of the timing of SAP administration in cesarean sections from 2.54% to 92.39%⁴⁵. Saied *et al.* measured the impact of an AMS program focused on educating surgical staff on the optimal use of SAP concerning time and duration in 5 tertiary acute-care hospitals and found that compliance with the timing of SAP administration in obstetric and gynecological surgeries before intervention was 5% of 343 surgeries and 26.4% of 341 surgeries after the intervention⁴⁸. Muller *et al.* on evaluating the surgical antibiotic prophylaxis (SAP) for the practice of non-compliance concerning the 2010 version of the French national recommendations reported that of 158 women who had undergone obstetrics and gynecological surgeries, 58 cesarean sections and 100 gynecological procedures had a

non-compliance rate of 96.6% and 57%, respectively, with SAP timing⁴⁹.

Duration: Romero *et al.* stated that of the 814 patients who underwent cesarean deliveries, (569) 69.90% received preoperative antibiotic prophylaxis and there was poor compliance with the CPG-Ecuador and ASHP surgical antibiotic prophylaxis guidelines in cesarean deliveries, especially in terms of duration of antibiotic prophylaxis, in which the compliance rate was 0%²⁵. Santos *et al.* stated that of 306 gynecological surgeries, adherence to guidelines regarding the duration of SAP administration was 99%¹⁷. Mehdi *et al.* stated that the rate of inappropriateness regarding the duration of antibiotic prophylaxis was 99.4%¹⁸. Bunduki *et al.* stated that the non-adherence with the duration of SAP use was 51.4% in gynecology and obstetrics¹⁹.

Abdel *et al.* stated that out of 1173 women who underwent cesarean deliveries, 88.20% received SAP longer than recommended²⁷. Dohou *et al.* stated that out of 141 women who underwent cesarean section, the rate of inappropriateness towards the duration of SAP administration was found to be 32.10%²⁹. Magdy *et al.* stated the duration of SAP administration was not in accordance with ASHP, WHO, and ACOG guidelines³⁰. Abubakar *et al.* stated that after AMS intervention, compliance with duration for SAP improved from 0% to 21.8% in both gynecology and obstetrics elective surgeries but not in emergency surgeries⁴⁰. U. Abubakare valued the adherence to the timing and duration of SAP among patients who underwent obstetric and gynecologic procedures and found that in all 52 procedures, SAP was prolonged beyond 24 hours²¹. Alemkere stated that inappropriate SAP duration was 28.9% among 38 procedures⁴⁶. Panciroli *et al.* stated that SAP duration improved from 57.6% to 81.5% after the implementation of guidelines⁴¹. Tietel *et al.* found that there was 100% compliance with SAP duration in patients who underwent cesarean section⁴².

Abubakar stated that there is 100% non-compliance regarding the duration of SAP use⁴³. Mousavi *et al.* in assessing the use of SAP according to the ASHP recommended guidelines, reported that of 14 obstetric and gynecologic procedures, compliance

with the duration of SAP was 7.1%²². Govenderreported that out of 120 women who underwent cesarean sections, none received appropriate SAP as recommended in the standard treatment guidelines. There was a 0% compliance rate with the duration of SAP³⁴. Wang *et al.* reported that the excessive non-compliance of SAP administration in cesarean sections was due to a high rate of inappropriateness in the duration of SAP administration, and after the intervention, there was an increase in the appropriateness of the duration of SAP administration from 0% to only 19.29%⁴⁵. Saied *et al.* observed that after AMS intervention, compliance with the duration of SAP in obstetric and gynecological surgeries improved from 1.5% of 343 surgeries to 37.5% of 341 surgeries⁴⁸.

CONCLUSION: Most of the studies included in this review indicated a remarkable rate of inappropriateness, especially in terms of duration, followed by the selection and time of administration of antibiotics. The inappropriate use of SAP may also be driven by various other factors, including inappropriate physician practices such as over-prescribing antibiotics without the proper indication, failing to follow up with patients, ignorance of the optimal SAP, *etc.*, as well as patient-related factors such as self-medication, non-compliance with prescribed treatment, *etc.*, and many other practices in hospitals. All these contribute to AMR, raising the risk of SSI exacerbated by resistant bacteria, prolonged hospitalization, and increased mortality rate. Interventional studies in this review found that pharmacist interventions had promoted the rationale use of prophylactic antibiotics. This shows that appropriate measures, such as the utilization of AWaRe, a tool developed by WHO to monitor antibiotic consumption, define targets, and monitor the effects of stewardship policies, periodic audits, awareness, seminars, E-learning modules on adherence to SAP guidelines, as well as the development of local guidelines should be implemented to improve appropriate surgical prophylactic antibiotic usage and to prevent the emergence of antimicrobial resistance (AMR).

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