~~SLIDESHOW~~

Surgical antibiotic prophylaxis in Neurosurgery

- Incidence, predictors, and management of postoperative subdural empyema following chronic subdural hematoma evacuation: a population-based cohort study
- Population pharmacokinetics of cefazolin in neurosurgical antibiotic prophylaxis
- Antibiotics consumption in neurosurgery versus appendectomy: a call for antibiotic stewardship initiatives
- Antimicrobial Biomaterials for Cranioplasty: A Systematic Review
- Analysis of intracerebral abscesses in Deep Brain Stimulation and association with hardware-related wound complications
- Incidence and Risk Factors for Surgical Site Infections Following Emergency Laparotomies: A Prospective Observational Study
- Post-craniotomy infections: A point-by-point approach
- Antibiotic prophylaxis for surgical-site infections and adherence to evidence-based guidelines

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The prevention of post-neurosurgical meningitis with antibiotics prior to neurosurgery should be emphasized in clinical practice, and appropriate selection of antibiotics is necessary to prevent the occurrence of infection and inhibit the emergence of antibiotic-resistant bacteria [1].

Choice

The choice of antibiotics depends on the type of surgery, the likely pathogens involved, and local antibiotic resistance patterns. Commonly used antibiotics include cefazolin, cefoxitin, and ceftriaxone. In some cases, a combination of antibiotics may be recommended.

Patient-specific Factors: Consideration should be given to patient-specific factors, such as allergy, renal and hepatic function, and the presence of comorbidities. Adjustments to the choice and dosage of antibiotics may be necessary based on individual patient characteristics.

Timing

Antibiotics should be administered shortly before the surgical incision, typically within 60 minutes before the start of the procedure. This helps ensure adequate antibiotic levels in the body tissues at the time of incision.

This timing ensures that the antibiotic reaches effective concentrations in the tissues when the incision is made and during the early stages of the procedure.

Dosing

Intraoperative Dosing: For prolonged surgeries or those with significant blood loss, additional doses of antibiotics may be required during the operation to maintain effective drug levels.

Prophylactic antibiotics are usually discontinued within 24 hours after surgery. Prolonged postoperative antibiotic use is generally not recommended as it does not reduce infection rates and can increase the risk of antibiotic resistance and other complications.

Redosing: In procedures lasting longer than the half-life of the chosen antibiotic, a redosing strategy may be necessary to maintain therapeutic levels. Redosing may be required for prolonged surgeries or procedures with significant blood loss.

Weight-Based Dosing: The dose of the antibiotic may be adjusted based on the patient's weight, especially in obese patients, to ensure adequate tissue concentrations. Renal Function: Dosage adjustments may also be necessary for patients with impaired renal function to avoid toxicity.

Selection

Duration: The duration of prophylactic antibiotics is typically limited to the perioperative period, usually within 24 hours after surgery. Prolonged use of antibiotics increases the risk of resistance and other adverse effects.

Local Resistance Patterns: Knowledge of local bacterial resistance patterns is essential to guide the selection of appropriate antibiotics. Hospitals may have guidelines or protocols in place to help healthcare providers make informed decisions.

Monitoring and Evaluation: Regular monitoring of patients for signs of infection and adverse reactions to antibiotics is crucial. If a surgical site infection occurs, appropriate diagnostic tests should be performed to identify the causative microorganism and guide targeted therapy.

Multidisciplinary Approach: Collaboration between surgeons, anesthesiologists, pharmacists, and infectious disease specialists can help develop and implement effective antibiotic prophylaxis protocols.

It's important to note that antibiotic prophylaxis is not recommended for all surgical procedures. It is generally reserved for procedures associated with a higher risk of infection, such as clean-contaminated and contaminated surgeries. The decision to use prophylactic antibiotics should be based on a thorough assessment of the specific surgical context and patient characteristics.

Perioperative antibiotic prophylaxis refers to the administration of antibiotics to patients before, during, and sometimes after surgery to prevent surgical site infections (SSIs). These infections are one of the most common complications after surgery and can lead to increased morbidity, extended hospital stays, and additional healthcare costs. The goal of perioperative antibiotic prophylaxis is to reduce the risk of infection by ensuring adequate levels of antibiotics in the tissues at the time of potential contamination.

Key Principles of Perioperative Antibiotic Prophylaxis: Timing of Administration:

Choice of Antibiotic:

Spectrum of Activity: The chosen antibiotic should have activity against the most common pathogens associated with SSIs for the specific type of surgery. For many procedures, cefazolin (a first-generation cephalosporin) is commonly used due to its broad activity against skin flora, including Staphylococcus aureus and Streptococci. Patient Factors: The choice of antibiotic may be adjusted based on patient-specific factors such as allergies (e.g., to penicillin or cephalosporins), local resistance patterns, and the presence of specific risk factors for infection by certain pathogens. Type of Surgery: Different surgical procedures have different risk profiles and common pathogens. For example: Clean surgeries (e.g., orthopedic, cardiac): Cefazolin is commonly used. Clean-contaminated surgeries (e.g., gastrointestinal, gynecological): Additional coverage for gram-negative bacteria and anaerobes might be required, such as with a combination of cefazolin and metronidazole. Contaminated or dirty surgeries: These situations might require broader-spectrum antibiotics or therapeutic doses instead of prophylaxis.

Minimizing Resistance: Appropriate use of perioperative antibiotics is crucial in minimizing the development of antibiotic resistance. This includes avoiding unnecessary use, selecting narrow-spectrum antibiotics when possible, and adhering to guidelines on timing and duration. Local Guidelines: Hospitals and surgical centers often have protocols based on local microbial resistance patterns and infection rates, which guide the selection and administration of antibiotics for specific procedures. Commonly Used Antibiotics:

Cefazolin: Frequently used for a wide range of procedures due to its effectiveness against common skin flora. Vancomycin: Used in patients with a history of MRSA (Methicillin-resistant Staphylococcus aureus) colonization or in settings with a high prevalence of MRSA. Clindamycin: An alternative for patients allergic to beta-lactams (penicillins and cephalosporins). Metronidazole: Often added to cover anaerobes in surgeries involving the gastrointestinal tract. Evaluation of Effectiveness:

Monitoring Outcomes: The effectiveness of perioperative antibiotic prophylaxis is often evaluated by monitoring the rate of SSIs, adherence to prophylaxis protocols, and the incidence of antibiotic-related adverse effects. Quality Improvement: Data on infection rates and antibiotic use can be used for continuous quality improvement in surgical practice, ensuring that guidelines are up-to-date and reflect the best evidence. Summary: Perioperative antibiotic prophylaxis is a critical strategy to prevent surgical site infections. It involves the timely administration of appropriately chosen antibiotics, typically starting within 30 to 60 minutes before surgery, with the goal of achieving effective tissue concentrations during the operation. The choice of antibiotic depends on the type of surgery, the patient’s health status, and local resistance patterns. Proper use of prophylaxis helps minimize the risk of infection while also reducing the likelihood of antibiotic resistance and other complications.

Decolonization in the medical context refers to the process of removing or reducing the presence of potentially harmful bacteria from a person's body, typically from areas like the skin or nasal passages. This is often done to prevent infections or reduce the risk of spreading harmful bacteria.

Purpose

Reduce risk of infection in patients Prevent transmission of bacteria to others Prepare patients for medical procedures

Common target organisms

Methicillin-resistant Staphylococcus aureus (MRSA) Vancomycin-resistant Enterococci (VRE) Carbapenem-resistant Enterobacteriaceae (CRE)

Common sites for decolonization

Nasal passages Skin (especially in high-risk areas like the groin and axilla) Throat Digestive tract

Methods of decolonization

Topical antibiotics (e.g., mupirocin for nasal decolonization) Antiseptic body washes (e.g., chlorhexidine) Oral antibiotics (in some cases) Specialized mouthwashes

Settings where decolonization is often used:

Hospitals, especially intensive care units Long-term care facilities Pre-surgical preparation

Challenges

Bacterial resistance to decolonization agents Recolonization after treatment Compliance with multi-step protocols

Effectiveness

Can significantly reduce infection rates in healthcare settings May need to be repeated periodically in some cases

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A guideline panel reviewed the impact of decolonization, targeted perioperative antibiotic prophylaxis (PAP), and combined interventions (e.g., decolonization and targeted PAP) on the risk of surgical site infections (SSIs) and other outcomes in multidrug-resistant Gram-positive bacteria (MDR-GPB) carriers, according to the type of bacteria and type of surgery.

They recommend screening for Staphylococcus aureus (SA) before high-risk operations, such as cardiothoracic and orthopedic surgery. Decolonization with intranasal mupirocin with or without chlorhexidine bathing is recommended in patients colonized with SA before cardiothoracic and orthopedic surgery and suggested in other surgeries. Addition of vancomycin to standard prophylaxis is suggested for MRSA carriers in cardiothoracic surgery, orthopedic surgery, and neurosurgery. Combined interventions (e.g., decolonization and targeted prophylaxis) are suggested in MRSA carriers undergoing cardiothoracic and orthopedic surgery. No recommendation could be made regarding screening, decolonization, and targeted prophylaxis for vancomycin-resistant enterococci (VRE), due to the lack of data.

No evidence was retrieved for methicillin-resistant coagulase-negative staphylococci (MR-CoNS) and pan-drug-resistant (PDR)-GPB. Careful consideration of the laboratory workload and involvement of antimicrobial stewardship as well as infection control teams are warranted before implementing screening procedures or performing changes in PAP policy. Future research should focus on novel decolonizing techniques, on the monitoring of resistance to decolonizing agents and PAP regimens, and on standardized combined interventions in high-quality studies [2)]

Surgical antibiotic prophylaxis in neurosurgery is an important practice aimed at preventing surgical site infections (SSIs) and minimizing the risk of postoperative complications. Neurosurgical procedures involve the manipulation of the central nervous system, and infections in this area can lead to serious consequences.

Considerations

Duration of Prophylaxis: Prophylactic antibiotics are generally administered as a single preoperative dose. Prolonged use of antibiotics is generally not recommended to reduce the risk of antibiotic resistance unless there are specific considerations such as prolonged surgery or a high risk of infection.

Consideration of Blood-Brain Barrier: The choice of antibiotics in neurosurgery should take into account the blood-brain barrier. Not all antibiotics effectively penetrate the central nervous system, so selecting antibiotics with good penetration is essential.

Patient-Specific Factors: Patient-specific factors, such as allergies, renal and hepatic function, and comorbidities, should be considered when choosing and dosing antibiotics.

Collaboration with Infectious Disease Specialists: Collaboration with infectious disease specialists can be beneficial in developing and implementing effective antibiotic prophylaxis protocols. They can guide local resistance patterns and help optimize antibiotic choices.

Preventing Hypothermia: Maintaining normothermia during neurosurgery is important, as hypothermia can increase the risk of surgical site infections. Using appropriate warming devices can help prevent hypothermia.

Aseptic Techniques: Strict adherence to aseptic techniques during surgery, including proper sterilization of instruments and maintaining a sterile field, is crucial in preventing infections.

It's important to note that neurosurgical prophylaxis may differ from prophylactic regimens used in other surgical specialties. Neurosurgeons, in collaboration with infectious disease specialists and other relevant healthcare professionals, should establish and follow institution-specific protocols based on the latest evidence and guidelines. The goal is to balance the prevention of SSIs with the judicious use of antibiotics to minimize the risk of antibiotic resistance.

Principles of Antibiotic Prophylaxis Policy

Timing of antibiotic(s):

Optimum timing is intravenous dose given or infusion completed 60 minutes before skin incision

Sub-optimal if >1 hour before skin incision or post-skin incision

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Recording of antibiotic prescription in the ‘once only’ section of the medicine chart to avoid multiple dosing

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The frequency of administration should be a single dose only unless:

1.5 liters intra-operative blood loss re-dose following fluid replacement

operation prolonged

Choice of Antibiotics

Antibiotics for surgical site infection prevention

Risk

Because of a low risk of infections in neurosurgery (around 2-3%), antibiotic prophylaxis is a controversial issue.

Some neurosurgeons consider that there are strong arguments against the use of antimicrobials (promotion of antibiotic-resistant strains of bacteria, superinfection, and adverse drug reactions) and meticulous aseptic techniques could be more useful than prophylactic antibiotics. On the other hand, despite being rare, the consequences of a neurosurgical infection can be dramatic and may result in a rapid death, caused by meningitis, cerebritis, abscess formation, or sepsis. Clinical studies emphasized that the most important factors influencing the choice of antibiotic prophylaxis in neurosurgery are the patient's immune status, the virulence of the pathogens, and the type of surgery (“clean-contaminated”–a procedure that crosses the cranial sinuses, “clean non-implant”–a procedure that does not cross the cranial sinuses, CSF shunt surgery, skull fracture). Prophylaxis has become the standard of care for contaminated and clean-contaminated surgery, as well as for surgery involving the insertion of artificial devices. The antibiotic (first/second generation of cephalosporins or vancomycin in allergic patients) should recover only the cutaneous possibly contaminating flora (S. aureus, S. epidermidis) and should be administrated 30' before the surgical incision, intravenously in a single dose. Most studies pointed out that identification of the risk factors for infections, correct asepsis, and minimal prophylactic antibiotic regimen, help neurosurgeons improve patient care and decrease mortality without selecting resistant bacteria [3].

Neurosurgery began with the use of the antiseptic hexamine in 1925 and has continued till the present with the introduction of new drugs from penicillin to vancomycin [4]. Although clean neurosurgical procedures without implantation of foreign devices carry a low risk of postoperative infection, yet the application of prophylactic antibiotics is now routine in neurosurgery. This fact was supported by the results of multiple published studies [5] [6].

Cost-effectiveness

Very little data about the cost-effectiveness of the appropriate duration of antibiotic prophylaxis in low- and middle-income countries is available.

A cost-analysis study demonstrates that prolonged antibiotic prophylaxis correlates with an increased burden of cost, but it is not preventive for SSI [7].

Administration of parenteral antibiotics before surgery reduces the incidence of postoperative infections after neurosurgical procedures, especially in cases with increased risk factors for SSI, such as ACA score of ≥ 2/3, the duration of the surgical intervention ≥ 4 hours, contaminated wound, and comorbidities. Perioperative antibiotic prophylaxis should be directed to better coverage of the S.aureus arrays. [8].

Since the pioneering study of Mallis [9] who reported the beneficial effects of local and preoperative antibiotic prophylaxis in clean neurosurgical wound infection, many randomized and meta-analysis studies confirmed the benefit of antibiotic prophylaxis in reducing the incidence of surgical site infection [10] [11] [12] [13] [14].

Protocols

The protocol of antibiotic prophylaxis is different among centers and the majority of previous publications came from The United States or Europe and rarely from developing countries.

The available evidence to assess the effect of wearing additional gloves, intraoperative glove change, or type of gloves on SSI rates is very limited and of low quality. The findings indicate the need for

RCTs on this topic [15].

Double gloving is the practice of wearing two layers of medical gloves to reduce the danger of infection from glove failure or penetration of the gloves by sharp objects during medical procedures. A systematic review of the literature has shown double gloving to offer significantly more protection against inner glove perforation in surgical procedures compared to the use of a single glove layer [16] [17].

The local application of powdered vancomycin was not associated with a significant difference in the rate of deep SSI after spinal deformity surgery, and other treatment modalities are necessary to limit infection for this high-risk group. This study is in contrary to prior studies, which have reported a decrease in SSI with vancomycin powder.Level of Evidence: 2 [18].

Drain tip culture had a high positivity rate in the SSI group and the coincidence rate for the causative pathogen was relatively high [19].

GADSA gamified decision support app

The GADSA gamified decision support app uses WHO and Sanford prescribing guidelines to deliver real-time persuasive technology feedback to surgeons through an interactive mentor. The app can advise on whether clinician's decisions align with SAP recommendations and provides the opportunity for clinicians to make adjustments. Twenty surgeons actively participated in a 6-month pilot study in three hospitals in Nigeria. The surgeons determined the risk of infection of a surgical procedure, and the need, type and duration of SAP. The study used a longitudinal approach to test whether the GADSA app significantly changed prescribing behaviour of participating surgeons by analysing the reported prescription decisions within the app.

Results: 321 SAP prescriptions were recorded. Concerning the surgical risk decision, 12% of surgeons changed their decision to be in line with guidelines after app feedback ($p < 0.001$) and 10% of surgeons changed their decision about the need for SAP ($p = 0.0035$) to align with guidelines. The change in decision making for SAP use in terms of “type” and “duration” to align with guidelines was similar with 6% and 5% respectively (both p-values < 0.001).

Conclusion: This study suggests that the GADSA app, with its game based and feedback feature, could significantly change prescribing behaviour at the point of care in an African setting, which could help tackle the global challenge of antibiotic resistance [20].

Pediatric antibiotic prophylaxis

see Pediatric antibiotic prophylaxis.

Intraventricular antibiotic

Intraventricular antibiotic.

Prolonged Antibiotic Use

see Ventriculostomy related infection prevention.

Prolonged antibiotic prophylaxis, while the EVD is in place, does not decrease the risk of infection and may select for resistant organisms. However, one dose pre-procedure antimicrobial may be administered.

Prophylactic systemic antibiotics, while drains are in place, are frequently used to reduce surgical site infection rate (SSIR), though the practice remains controversial. Pivazyan et al. demonstrated a two-fold reduction of SSI with the implementation of the PPSA regimen. This benefit was demonstrated separately for both cervical and lumbar regions. Randomized trials and increase sample size are warranted to elucidate the significance of PPSA in posterior spinal surgery. Level of evidence: 3 [21).

For Abola et al. there was no difference in the rate of surgical site infections between patients who received 24 hours of postoperative antibiotics and those who did not. Additionally, they found no observable risks, such as more antibiotic-resistant infections and C. difficile infections, with prolonged antibiotic use [22)].

Prolonged antibiotics in neonates with negative blood culture were associated with significantly longer hospital length of stay and increased total cost of hospitalization [23)].

Antibiotic-impregnated catheter

Antibiotic-impregnated catheter.

Antibiotics for Brain Abscess

see Antibiotics for Brain Abscess.

Case series

A cohort analysis was performed using the clinical database in Beijing Tiantan Hospital and Capital Medical University. Data were collected on patients with the diagnosis of post-neurosurgical meningitis (n = 3931) during 2012.01 to 2022.04. The microbial distribution, types of antibiotic prophylaxis, and 42 and 90 days survival analysis of AP patients were evaluated using probable statistical methods. Independent risk factors for mortality were established by constructing a logistic regression analysis.

A total of 1,190 patients were included in this study, Klebsiella pneumoniae, Acinetobacter baumannii, and Staphylococcus aureus occupied the highest proportion. Of them, 929 cases received AP, cefuroxime and ceftriaxone are the most frequent used antibiotics. In addition, We found that PNM patients without AP significantly increased the 42 days and 90 days all-cause mortality rates. The use of different levels of AP did not improve patient outcomes, and ICU admission and assisted mechanical ventilation (AMV) were identified as independent mortality risk factors for PNM patient received AP.

AP plays an important role in the prognosis of PNM patients and has a significant function in improving prognosis. The prevention of PNM with antibiotics prior to neurosurgery should be emphasized in clinical practice, and appropriate selection of antibiotics is necessary to prevent the occurrence of infection and inhibit the emergence of antibiotic-resistant bacteria [24].

Survey

Antibiotic prophylaxis practices in neurosurgery: A Society for Healthcare Epidemiology of America (SHEA) survey [25].

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