# Prophylactic antibiotherapy in Neurosurgery

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**Abstract**

Prophylactic use of antibiotics in neurosurgery which mean to use an antibiotic before infection start, to reduce the incidence of postoperative wound infections, still is a controversial issue for strong arguments against the use of antimicrobials: promotion of antibiotic-resistant strains of bacteria, superinfection and adverse drug reactions

Prophylaxis has become the standard of care for contaminated, clean-contaminated surgery, insertion of artificial devices. The antibiotic: first/second generation of cephalosporins or vancomicin in allergic patients should recover only the cutaneous posibily contaminating flora (S. aureus, S. epidermidis) and shoud be administrated 30' before the surgical incision, intravenously in a single dose. Most studies pointed that identification of the risk factors for infections, correct asepsia and minimal prophylactic antibiotic regimen adopted to each case, help neurosurgeons to improve patient care and decrease mortality without selecting resistant germens.

In conclusion in neurosurgical operations it's mandatory to assure:

- an optimum protection at operation by a careful evaluation of asepsia
- prophylactic antibiotics should be used for 24 hours, after patient consent, using a minimal schema, adapted to each operation risk factors and the patient status
- prophylactic use of antibiotics is different of antibiotherapy; wide spectrum antibiotics of high dosis and for long term used as standard to cover technical errors should to be avoided.

**Keywords**: prophylactic antibiotics, neurosurgery, risk of infection

Postoperatory infections are a major source of morbidity and letality to surgical patients. A prophilactic use of antibiotics is indicated in surgical operations with risk of infection, where the infection risk cover the risk of using antibiotics, even for those choosed for the contaminated flora. In neurosurgery is generally a low risk of infection comparative with another surgical specialities, only 2-3% (1, 2), liated with surgical strategy, the quality and technological progress.

Postoperatory infections in neurosurgical cases may become dramatic, rapid evolutive from meningitis, epidural abscess, subdural empyema, brain abscess, ventriculitis to sepsis; which demand to start in cranial or spinal surgery prophilactic antibiotics which has proven to be benefic (3-5).

Recent studies has proved that prophylactic use of antibiotics in neurosurgery still are controversial, for

efficacy only on local infections, less on those systemic, selecting resistent germs, difficult to be treated compared to usual cutaneous flora (6-8, 9). In practical use still is a „fight" between progress in aseptic procedures and abusive use as a „standard" of wide spectrum antibiotics of high dosis and for long term to cover technical errors. This study intend to synthetise a clare attitude for each neurosurgeon to prevent and to treat nervous system infections, to perform a prophylactic use of antibiotics adopted to each case, taking care of general and specific conditions.

Different of the antibiotic therapy representing the use of an antibiotic in already proved infected operation, antimicrobian prophylaxy mean to use an antibiotic before infection start, to prevent operatory skin contamination with germs representing skin flora as Staphilococcus. aureus, Staphilococcus epidermidis, Propionibacterium acnes or when a minimal contamination of the surgical wound is anticipated generating a subclinic infection.

Antimicrobian prophylaxy was used in neurosurgery since 1925, before antibiotherapy era, using first hexamine – an antiseptic, than a wide range of antibiotics from Penicilin to Vancomicine; generally considered as benefic with all generated disadvantages. It's mandatory to remember that Harvey Cushing – a pioneer of mondial neurosurgery using only water and soap has an postoperatory infection rate of 1%. Since Cushing era, all neurosurgeons appreciate a meticulous aseptic techniques valuable in all kind of operations (10,11). The main prophylactic used antibiotics are (Table 1):

**Table 1**

**The main prophylactic used antibiotics**

| Antibiotic | standard dose iv | Time for readministration standard dose (h) |
|---|---|---|
| Cefazolin | 1-2 g | 2-5 |
| Cefuroxim | 1,5 g | 3-4 |
| Cephradine | 1 g | 3-4 |
| Clindamicin | 600-900mg | 3-6 |
| Amoxicilin/ clavulanat | 1,2 g | 2-3 |
| Ampicilin/ sulbactam | 1,5 g | 2-3 |
| Metronidazol | 500mg | 6-8 |
| Vancomicin | 1g in pev >1 ora | 6-12 |
| Cotrimoxazol | 960 mg | 12 |

Advantages of prophylactic antimicrobian therapy are: avoid systemic septic complications: meningitis, sepsis or local: celulitis, cerebral or spinal abcesses, osteomielitis.

Disadvantages of prophylactic antimicrobian therapy are multiple: hepato-renal failure, fever, arterial hypotension, alergic reactions even letal; microbian resistence inducing „superinfections" after wide range antibiotics used for resistent germs or fungus, hospital nosocomial infections, increase hospital treatment costs.

Antimicrobian prophylaxy in neurosurgery, similar as the anesthesia techniques, should be accepted by the patient, mentioned in the informed consent of the surgical tehnical procedure, less for the emmergency cases, applied after following rules:

1. prophylactic utility of an antibiotic should be limited only to operation! (12,13)

2. use an antibiotic with high concentration in the surgical field during intervention with a restrained spectrum on the skin flora; intravenous admininstration, 30' prior to skin incision, during anesthesia

induction and discontinued within 24 hours from the end of surgery. For important blood loss > 1500 ml or if operation time surpass, antibiotic half time dosis should be repeted.

3. used dosis is generally the therapeutic one, adapted to corporeal weight

The utility of an antibiotic used prophylactic should be corelated to the tissulary bactericide levels during intervention and for the first 3-4 hours in postoperatory suite. Another way to use an antibiotic as several days before and after operation it's not justified and represent the real modality to spread resistance in the hospital environement. If operation time extend for some antibiotics a new dose should be given (table 1).

Using antibiotics for prophylactic activity there are "general" specifications: liated to the patient, infection risc, surgical technique; also "specific" concerning the type of surgical intervention.

**A. General specifications**

- risc factors for postoperatory infections: extreme ages, nutritional status, smoking, another infection at distance, immunodepression induced by corticotherapy, citostatics, neoplasia, diabetus, HIV infection, prior transplanted organs; several foreign materials used: shunts, intrathecal catethers, cerebral and spinal electrodes for stimulation or neuromodulation procedures, materials for osteosinthesis, hemostasis and s.o.

- sources for postoperatory infections (14,15):

1. microbian flora colonising skin is represented in 90% of cases by Staphiloccocus aureus, coagulase-negative Staphiloccocus speciaes, Difteroides, some Gram + bacilli as Propionibacterium acnes generating shunt infections or Gram – bacilli Acinetobacter, coliforms. It's important to be mentionated the coagulase-negative Staphilococcus capacity to generate glicocalix, transforming into a biofilm in the host tissue, protecting the patogeneus agent for fagocitosis, blocking the antibiotic action.

2. microbian flora of paranasal sinuses may generate infections for transsphenoidal and cranial base operations: Streptococcus pneumoniae, Staphiloccocus aureus resistent to meticiline, Enterococcus resistent to Vancomicine, Gram negative bacilli, fungus - frequent Candida albicans.

3. defectous operating room and postoperatory asepsia, the number of staff or visiting persons in the operation room, ventilation and clima used, the quality of sterilisation for all instruments, surgical materials and gloves used.

- the type of neurosurgical technique, operations time over 4 hours, reinterventions less than 30 days

- CSF fistula exceed infection risc for 13 times, another infection outside meningeal space may generate an infection risc up to 6 time.

- skull base surgery, paranasal sinuses, otic cavities, debridement for cerebral lacerations may generate infections outside any statiostics

To prevent postoperatory infections several mesures are mandatory: correct hand washing, using the sterile gloves, fixing the mask over the nose, skin shaving on the incision direction, etc

**B. Specific specifications**

1. For operations not demanding cranial sinuses opening and in absence of all implants "clean nonimplant procedures", local flora is represented by: Staphylococcus

aureus -50%, coagulase negative Staphylococcus - 15%, Gram negative aerobe bacilli - 15%, Streptococcus spp. - 10%, another species < 10%. Prophilactic antibiotics should cover all mentioned spectrum, which could be realised by a cephalosporine first or second generation, efficace on Gram positive cocci, especially Staphylococcus aureus and Gram negative bacilli (16). Last 20 years studies revealed the efficacy of prophylactic use of antibiotics in "clean" neurosurgical interventions using as narrow an antibiotic spectrum, one dosis, considered to have an antimicrobian activity against specific patogenes agents to neurosurgical department or hospital, as: Cephradine 1g i.v., Cefuroxime 1,5 g i.v., Cefazolin 1 g iv to patients < 80 kg and 2 g to those > 80 kg. If alergia to betalactamines exist, Vancomicine 1 g in perfusion should be administrated, lent, at least 1 h before incision (Vancomicine has a 1/2 time of 3-9 hours). Despite several combinations used: Cefazolin and Gentamicine versus monotherapie with Cefazolin or another antibiotics: Piperacillin, Cloxacillin, no medication has proved to be superior.

Another antibiotics used represent a suboptimal chose:

-İzoxazolilpeniciline (Oxaciline, Flucloxaciline) can not always cover all Staphiloccus species and are inefficace on Gram negative bacilli

-Metronidazol: anaerobe germs are very rare in such interventions

-Vancomicine with or without Gentamicine: there are few multiresitant germs to justify such a prophylaxy

-Clindamicine (Tobramicine) could be an alternative to cutaneous germs, but doesn't cover Gram negative flora.

2. Operations demanding aeric cranial sinuses, complex approaches of cranial base, transsphenoidal approaches, transoral approaches - "clean contaminated procedures". In such operations which means crossing naso and oropharynx the local flora is variated, including anaerobes. Prophilactic antibiotics should be done using ß lactamines/ß lactamases inhibitors (clavulanat or sulbactam) or Metronidazol associations:

-Amoxiciline/clavulanat 1,2 g iv. in anesthesia induction

-Cephradine 1 g iv + Metronidazol 500 mg iv. in anesthesia induction

-Cefuroxime 1,5 g iv + Metronidazol 500 mg iv. in anesthesia induction

For rare selected cases: Cefotaxime 1 g iv. to patients < 80 kg and 2g la those > 80 kg.

To peniciline alergic patients it is recomanded: Gentamicine and Metronidazol.

3. Different prosthetics devices, inclusive CSF shunt - „surgery involving insertion of artificial devices"

Shunt surgery has an infection rate > 3% and all authors recomanded prophilactic antibiotics. There is not a consensus for such a prohilaxy for the antibiotic administration method. Postoperatory infections are generated by coagulase negative Staphylococcus -90%, Staphylococcus aureus - 13-27%, Gram negative aerobe bacilli - 10-20%. Prophilactic antibiotics in shunt operations means to use Rifampicine + Clindamicină impregnated shunts to prevent microbian colonisation also one dosis of Cefradine 1 g iv or Cefuroxime 1g iv.

For ventriculitis Vancomicine + Gentamicine administrated

intraventriculary are useful for the largest spectrum (17,18).

For external shunts, monitoring intracranial pressure, the accuracy of neurosurgical technique are essential, prophilactic antibiotherapy is not nedded.

4. Skull fracture, CSF shunt surgery

For such neurosurgical operations it's recommended: Cefotaxime 1 g iv. to patients < 80 kg and 2g to those > 80 kg or Cotrimoxazol 960 mg. Meningitis is a severe complication of skull fracture with CSF fistula, in 11%-25% of cases, the microbian speciae most frequent encountred are Streptococcus pneumoniae. To patients with CSF fistula prophilactic antibiotics are not indicated, there is a risk for adverse effects of antibiotherapy for long term use, also for antibiotic resistence (19).

5. In spinal surgery infection rate is low. Insertion of artificial devices in spinal operations: osteosynthesis material, catethers and electrodes for pain therapy, it's recommended: Cefazolin 1 g iv to patients < 80 kg and 2 g to those over 80 kg or Vancomicine, in case of alergia to betalactamines (20) .

In conclusion in neurosurgical operation it's mandatory to assure (21):

- an optimum protection at operation by a careful evaluation of asepsia
- prophylactic antibiotics should be used after patient consent, using a minimal schema, adapted to each operation risk factors and the patient status, for 24 hours
- prophylactic use of antibiotics is different of antibiotherapy; wide spectrum antibiotics of high dosis and for long term used as standard to cover technical errors should to be avoided.

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