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## INFECTIOUS COMPLICATIONS OF SHUNT SYSTEMS IN CHILDREN FROM THE REGION OF UPPER SILESIA TREATED IN THE YEARS 2000-2010

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### Abstract

**Introduction.** Infections of shunt systems are still a major problem in pediatric neurosurgery. They are the cause of 19% of all revision within 10 years of implantation of the shunt.

**Aim.** The aim of the study was infectious complications in patients of the Pediatric Neurosurgery operated on for hydrocephalus in 2000-2010 in Katowice.

**Material and methods.** In order to implement the above assumptions medical records were reviewed of patients hospitalized in the Pediatric Neurosurgery in Katowice in the years 2000 - 2010.

**Results.** First shunt implantation were performed in children under the 3 months of age. Infectious complications occurred in 5.2% of patients operated on for hydrocephalus in 10 years. **Conclusion.** Shunt system infections occurred most often in children up to the age of 6 months. The most common infectious agent in the test was staphylococcus epidermidis.

**Key words:** infection, shunt system, the etiological agent, shunt implantation, infectious complications.

## Introduction

Most used techniques of internal hydrocephalus treatment are: implementation shunt and endoscopic ventriculocysternostomia. The assumption of shunt allows drainage of excess cerebrospinal fluid from the ventricular system into the peritoneal cavity. Shunt system infections make the important reason for all revisions within 10 years from a shunt implantation and occur in 2-15% of the treated patients. It is agreed that statistically the infection occurrence is significantly more frequent in children operated for hydrocephalus before they are 6 months old. *Staphylococcus epidermidis* is the most frequent cause of the infections taking place. In some cases the etiological agent of the infection remains unknown.

**Objective of the paper.** The objective of this paper was to analyse retrospectively the infectious complications of shunt systems implanted in hydrocephalous children in the material of the Department of Pediatric Neurosurgery in Katowice depending on the age of a patient at the time of a shunt implantation.

**Material and methods.** The source material used was the medical documentation of patients treated at the Department of Pediatric Neurosurgery in Katowice treated in the years 2000-2010. The patients of the above-mentioned department included 711 children undergoing surgery for hydrocephalus. 37 of them had infectious complications. The examined group included patients with congenital, posthemorrhagic, inflammatory hydrocephalus and hydrocephalus related to spina bifida. The youngest patient to develop a shunt system infection was 10 days old. The median of the age of the patients with neurologic infection diagnosed was more than 4 months (4.33). The criterion for recognition of an infection was positive bacteriological culture of cerebrospinal fluid, pleocytosis in the cerebrospinal fluid above 50 in  $\text{mm}^3$  and the time of occurrence of the infection from the time of implantation of the shunt not longer than 6 months. A condition was adopted for completion of treatment and for the possibility of repeated shunt system implantation of obtaining three consecutive negative cultures of cerebrospinal fluid, pleocytosis value below 50 in  $\text{mm}^3$  and protein content in CSF below 500 mg%.

## Results

Infectious complications of shunt systems occurred in 5.2% children treated for hydrocephalus at the Department of Pediatric Neurosurgery in Katowice. The number of boys (49%) against girls (51%) was similar in the analysed group. More than a half of the shunt system infection cases fell on the children aged from 1 day to 6 months (Fig. 1). Among the patients with diagnosed shunt system infection nearly 65% are patients with congenital hydrocephalus, 13.5% are patients with post meningitic hydrocephalus, the remaining group are the patients with posthemorrhagic and inflammatory hydrocephalus (Fig. 2). Among the patients with diagnosed shunt system infection, the implantation of the first shunt was most frequently performed in children up to 3 months old. Nearly 30% were the patients older than 1 year, with their first shunt being implanted (Fig. 3). Infectious complications were revealed at earliest by the 1<sup>st</sup> month of the time of implantation of the shunt system and in the period of 4-6 months from the operation (Fig. 4). The most frequent etiological agent of the infection was *staphylococcus epidermidis* (43%) and *staphylococcus aureus* (25%) (Fig. 5). Other pathogens responsible for occurrence of the shunt system infections were, *inter alia*: *coryne bacterium* (5%), *staphylococcus captis* (5%), *enterococcus faecalis* (3%), *pseudomonas aeruginosa* (3%) (Fig. 5). Each patient with an infection diagnosed had the shunt system removed and external drainage (78%) or Rickham reservoir (22%) was implanted (Fig. 6). During pharmacological treatment Vancomycin (49%) and Amikacin (11%) were the most frequently used antibiotics. Cephalosporin, gentamicin, meticillin were

used less frequently (Fig. 7). The length of treatment was shorter in patients older than 6 months than in younger children (Fig. 8). Average length of infectious complications treatment at the Department was 33 days. The longest an infection was treated was 92 while the shortest time was 9 days. All the 37 patients with the shunt system infection diagnosed had the infection killed.

## Discussion

Shunt system infections are one of the major causes of complications in hydrocephalus treatment by implantation of shunt systems, they are the reasons of 19% of all the revisions within ten years (1). Literature asserts that on average 5-15% shunt systems get infected (2)(3). In the analysed documentation of our department, during the time span of 10 years of observations, shunt system infections occurred in 5.2% children. It is estimated that occurrence of an infection after the first implantation of a shunt amounts to 6.3%, while after a revision surgery it increases to 13.4% (4).

Most often infections of shunt systems occur within the first 6 months of the operation (90%), and in 70% patients they take place as early as the first month from implantation of a shunt (5). Analysing the determinants of the frequency of complications in shunt treatment it has been found that the shunt system infections correlate with the child's age. The younger the child at the time of implanting the shunt, the higher the risk of occurrence of the infection (5). In the analysed material 30% of the shunt infections occurred within one month from the implantation. Eymann et al. claim that the frequency of occurrence of infections is higher than in children operated for the first time in the first year of their life, compared to older children (6). It also results from our analyses that the highest percentage of shunt system infections concerns children younger than 6 months (more than 50%). Polis L. confirmed the statistically significant more frequent occurrence of infections in children less than 6 months old, relating this phenomenon to the not fully developed immunological system in newborns and infants (1). Moreover, the data of other authors indicate that the risk of shunt system infection occurrence is higher in case of low body weight of newborns and infants (7). The above information can be the explanation for infectious complications among the examined patients mainly in babies with congenital and posthemorrhagic hydrocephalus – occurring most often in prematurely born babies and thus with low birth weight.

It has been proven in the literature that mortality of patients who have not gone through a shunt system infection amounted to ca. 18%, while the mortality doubled among the persons who experienced at least one infection of the above-mentioned system (8)(9).

On the grounds of retrospective study basing on the analysis of the medical documentation of our patients it has been noted that in the patients older than 6 months the length of treatment was shorter than in younger children.

It is not an insignificant fact, as observed by People and others, that on the skin of newborns and infants more malicious strains of coagulase-negative staphylococcus are present, which adds to the occurrence of infections (10).

It is worth noting that the shunt system infections are most often caused by two bacteria belonging to the *Staphylococcus* group. Those are *Staphylococcus epidermidis* 50-75%, and *Staphylococcus aureus*. It is important that in 1/5 of cases the etiological agent of the infection is the mixed flora. The bacteria being the source of the shunt system infections include, among others: *Corynebacterium*, *Haemophilus influenzae*, *Pseudomonas*, *Micrococcus*, *Escherichia coli*, *Klebsiella* (11). Like in most information from the literature(12) the tests performed at the Neurosurgery Department in Katowice confirm

presence of *Staphylococcus epidermidis*, as the main etiological agent causing infections of shunt systems in children treated for hydrocephalus.

For maximum possible reduction of occurrence of complications, the following action principles have been adopted at the Department of Pediatric Neurosurgery in Katowice;

- During an operation disposable draping is always used and the surgical field is covered with bactericidal foil
- The tools are cleansed with a disinfectant before every use during surgery
- During implantation we make efforts not to touch the implants/shunts with gloves, but only with tools or through a gauze
- Cerebrospinal fluid is always sampled mid-operation in a sterile way for bacteriological testing

In spite of application of procedures and available technologies complete elimination of shunt system infections is not possible.

### Conclusions

During the 10 years of observations, infections of shunt systems occurred in 5.2% children treated at the Department of Children's Neurosurgery in Katowice. Shunt system infections most often occurred in infants up to 6<sup>th</sup> month of life. Infectious complications were most often found in the first month and between 4-6 months after the shunt system implantation. The most frequent etiological agent of the infection was *staphylococcus epidermidis*.

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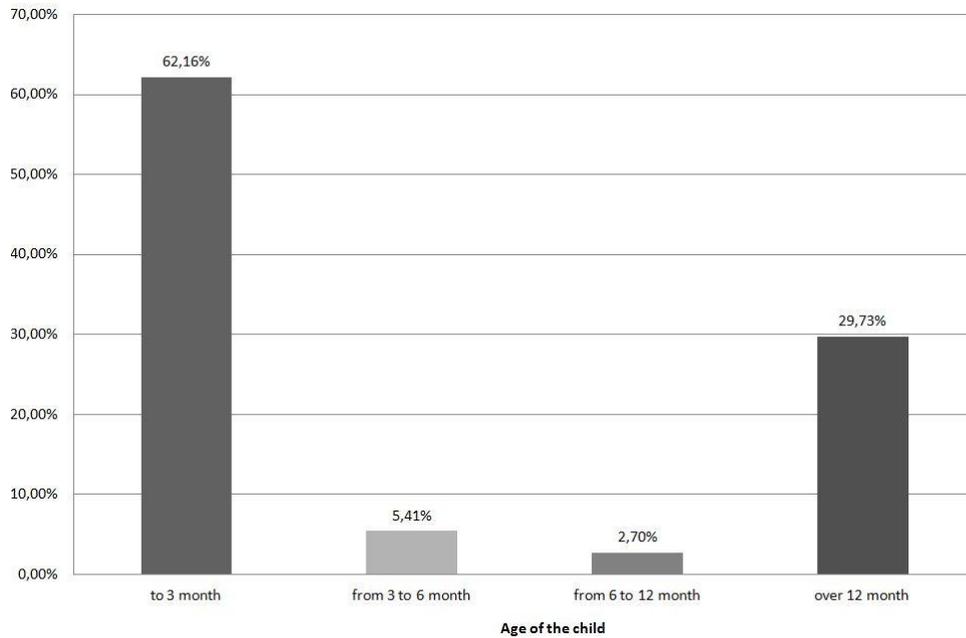


Fig. 1 Occurrence of shunt system infections against the patient age (Source: own work).

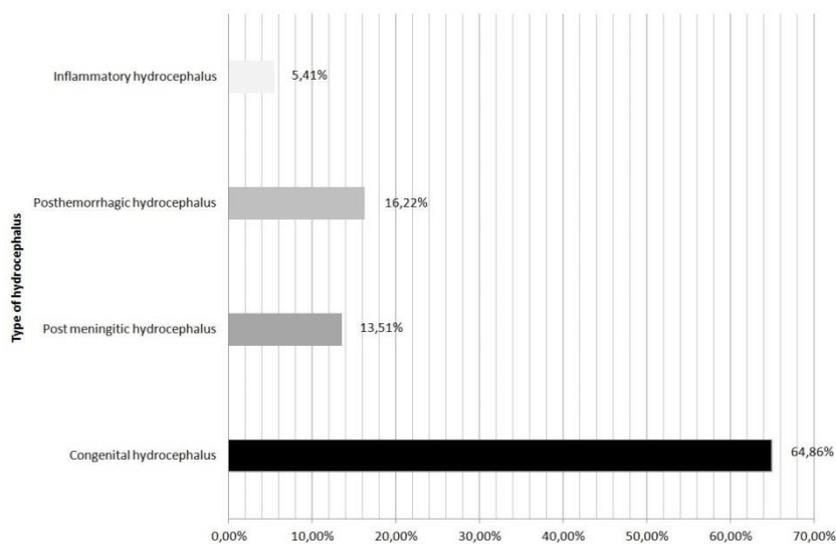


Fig. 2 Hydrocephalus etiology among the examined patients (Source: own work).

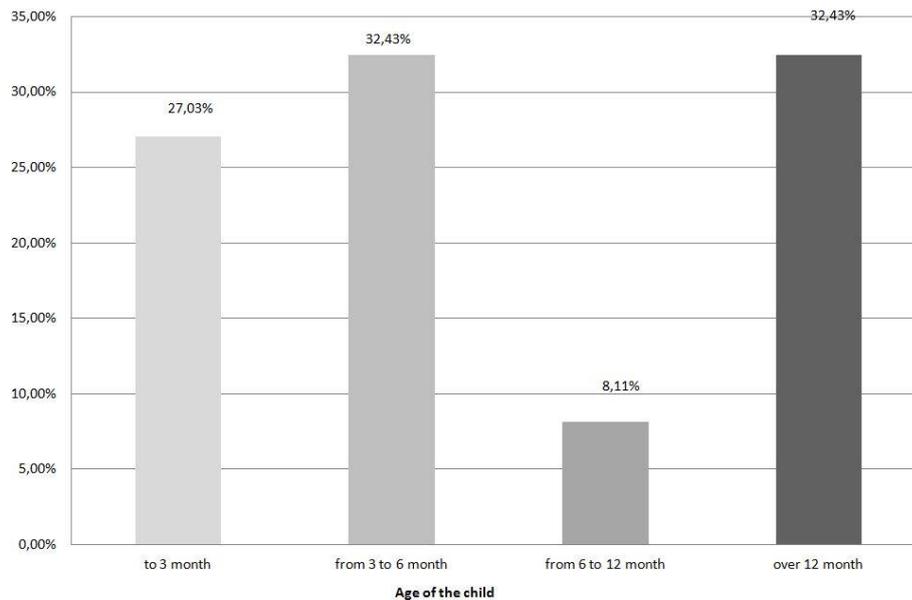


Fig. 3 Age of the child at the time of implantation of the first shunt (Source: own work).

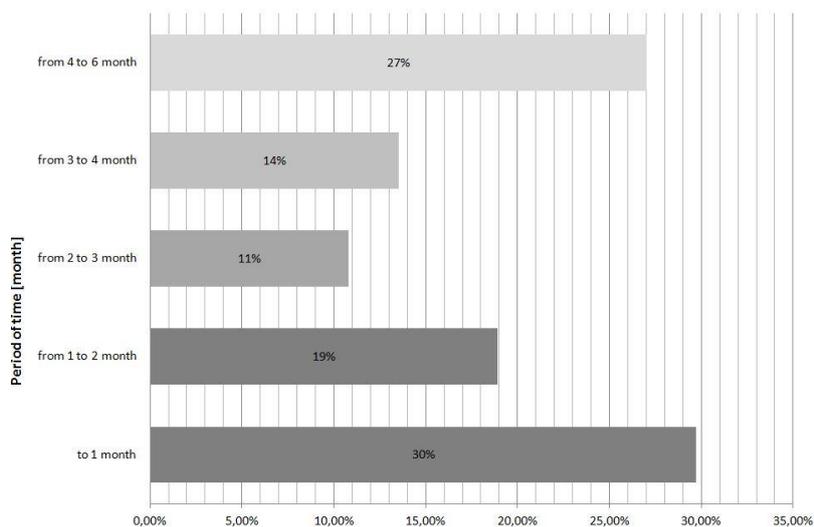


Fig. 4 Occurrence of shunt system infections from the time of the shunt implantation (Source: own work).

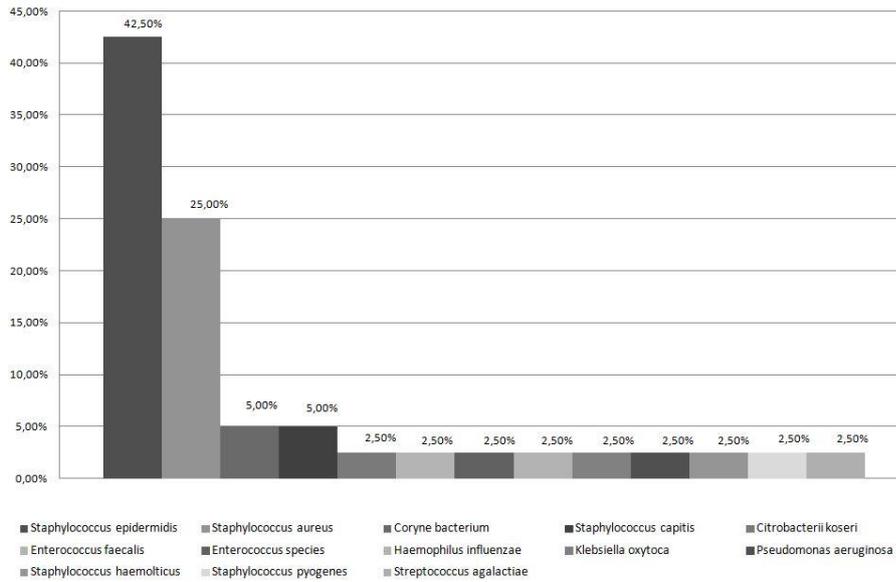


Fig. 5 Etiological agent of infectious complications in the examined patients (Source: own work).

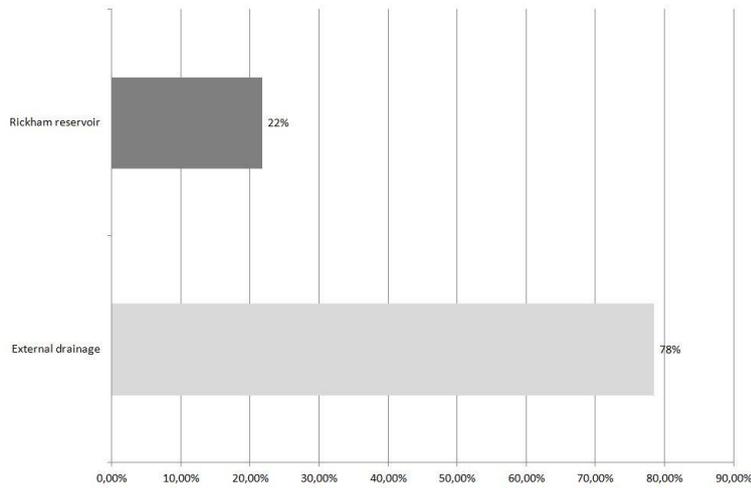


Fig. 6 Type of surgery treatment applied in the examined patients (Source: own work).

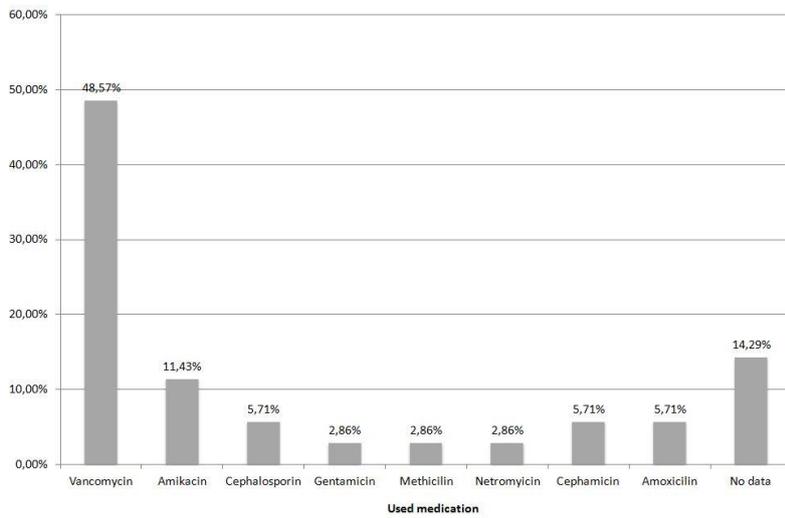


Fig.7 Type of pharmacological treatment applied in the patients with neurologic infection diagnosed (Source: own work).

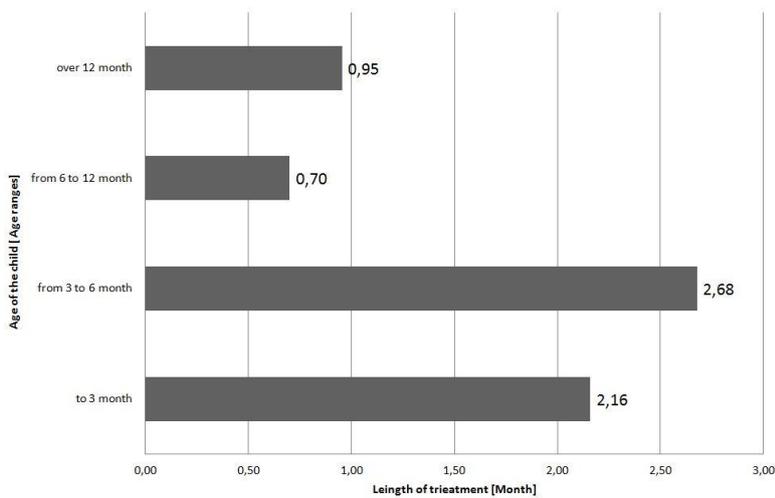


Fig. 8 Length of treatment of shunt system infections against the patient age (Source: own work).