A STUDY TO FORMULATE A STRATEGY FOR PREVENTION OF VENTRICULO-PERITONEAL SHUNT INFECTIONS

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CERTIFICATE

This is to certify that this dissertation entitled **"A STUDY TO FORMULATE A STRATEGY FOR PREVENTION OF VENTRICULO - PERITONEAL SHUNT INFECTIONS "**submitted by **Dr. T.P. Jeya Selva Senthil Kumar** appearing for **M.Ch.** Degree examination in **August 2010** is a bonafide record of work done by him under my direct guidance and supervision in partial fulfillment of regulations of the Tamil Nadu Dr. M.G.R. Medical University, Chennai. I forward this to the Tamil Nadu Dr.M.G.R. Medical University, Chennai, Tamil Nadu, India.

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DECLARATION

I, **Dr. T.P. Jeya Selva Senthil Kumar** solemnly declare that this dissertation "**A STUDY TO FORMULATE A STRATEGY FOR PREVENTION OF VENTRICULO-PERITONEAL SHUNT INFECTIONS"** was prepared by me in the Institute of Neurology, Madras Medical College and Government General Hospital, Chennai under the guidance and supervision of Prof.V.Sundar M.Ch, Professor of Neurosurgery, Institute of Neurology, Madras Medical College and Government General Hospital, Chennai between 2006 and 2010.

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CONTENTS

INTRODUCTION

Hydrocephalus is an accumulation of excess CSF in the ventricular system of brain due to an increased secretion, defective absorption or disturbances in CSF circulation. The most significant contribution to the treatment of hydrocephalus was made by Nulsen and Spitz[1], who in 1952, first performed the valve- regulated shunt system to prevent the reflux of venous blood. In 1908, Cushing[3] first performed the Ventriculo-peritoneal(VP) shunt, but that did not gained popularity until after the publications of Scarff's[2] work in 1963. Ventriculo – peritoneal shunt placement is a relatively common neurosurgical procedure performed for the treatment of hydrocephalus**.** One of the principal complications associated with the use of these devices is infection, with infection rates ranging from 1.5 to 38%. Age seems to be an important risk factor, with neonates and young children frequently affected. Shunt infection leads to severe morbidity for the patient. Of even greater concern is the infection related mortality, with rates up to 20% reported in the literature.

Though several authors have adopted several protocol and reduced the incidence of shunt infection. Considering the morbidity, mortality and the financial burden in treating shunt infections there is a need to evolve a strategy to prevent shunt infection completely and to bring the incidence to 0% .

AIM OF STUDY

To formulate a strategy for prevention of Ventriculo-peritoneal shunt infections.

REVIEW OF LITERTURE

The literature is reviewed under the following headings:

1. Pathophysiology of Hydrocephalus.
2. Treatment of Hydrocephalus.
3. Shunt infection.
4. Various studies on prevention of shunt infection.

1. PATHOPHYSIOLOGY OF HYDROCEPHALUS:

The Cerebrospinal fluid(CSF) is produced at the rate of 0.33ml/ mt by two distinct processes. First, by an energy- requiring process performed by the choroid plexuses in the lateral, third and fourth ventricles. This process depends on the enzyme Carbonic anhydrase and can be blocked by Acetazolamide. The remainder of the CSF is produced as a by- product of cerebral and white matter metabolism. After its production CSF flows from lateral ventricle to third ventricle via foramen of monro, from there it reaches the fourth ventricle through the aqueduct of sylvius. From the fourth ventricle the CSF exits through the foramen of Lushka and Megendie to reach the cistern magna to get mixed with the CSF from spinal subarachnoid space. Finally the CSF flows through the cortical subarachnoid space to be absorbed through the arachnoid villi in to the sagittal sinus. The energy for circulation of CSF is generated by the

pumping of arterial blood in to the choroid plexus. A pressure differential can be measured between the cranial subarachnoid space and the sagittal sinus[4-5], which ranges from 5 and 7mmHg. This is defined as the opening pressure below which no absorption occurs.

Engelhard et al postulated three forms of hydrocephalus[14]:

1. Disorders of CSF production: This is the rarest form of hydrocephalus. Choroid plexus papillomas and choroid plexus carcinomas can secrete CSF in excess of its absorption.

2. Disorders of CSF circulation: This form of hydrocephalus results from obstruction of the pathways of CSF circulation. This can occur at the ventricles due to CSF flow obstruction by tumors, hemorrhages and congenital malformations (such as aqueductal stenosis).

3. Disorders of CSF absorption: Conditions, such as the superior vena cava syndrome and sinus thrombosis, can interfere with CSF absorption. Some forms of hydrocephalus cannot be classified clearly. This group includes normal pressure hydrocephalus and pseudotumor cerebri.

Clinical Features:

The various types of hydrocephalus can present differently in different age groups[15]. Acute hydrocephalus typically presents with headache, gait disturbance, vomiting, and visual changes. In infants, irritability or poor head control can be early signs of hydrocephalus. When the third ventricle dilates, the patient can present with Parinaud syndrome (upgaze palsy with a normal vertical Doll's eye response) or the setting sun sign (Parinaud syndrome with lid retraction and increased tonic downgaze). Occasionally, a focal deficit, such as sixth nerve palsy, can be the presenting sign. Papilledema is often present, although it may lag behind symptomatology. Infants present with bulging fontanelles, dilated scalp veins, and an increasing head circumference. When advanced, hydrocephalus presents with brainstem signs, coma, and hemodynamic instability. Normal pressure hydrocephalus has a very distinct symptomatology. The patient is older and presents with progressive gait apraxia, incontinence, and dementia. This triad of symptoms defines normal pressure hydrocephalus.

TREATMENT OF HYDROCEPHALUS:

Cerebrospinal fluid shunting is the well-accepted standard treatment for childhood hydrocephalus. There is a vast array of shunting devices with different components, all having similar features. The currently used shunt systems have valve systems incorporated in the shunt with an opening and closing pressure so that currently used shunts are, for the most part, pressure regulated. Given the fact that shunt systems all drain CSF relatively quickly once the child assumes an upright posture due to the effect of siphoning, most flow characteristics in currently used shunts are relatively unimportant. There are other technical aspects of shunt insertion which are far more important to maintain adequate shunt function then the specific details of the shunt valve characteristics. An ideal shunt still needs to be the goal in the future of treating hydrocephalus. The ideal shunt would allow for a flow regulated control to drain a specific amount of fluid, which could be tailored to an individual child's needs. In addition, there would be the ability to monitor externally shunt function and potential shunt malfunction. This ideal valve would allow the drainage of only the amount of fluid that is really excess for a given child, and may avoid the problems of shunt dependency. The currently used valves, however, as mentioned above, are still pressure regulated. Shunt valve systems can be located proximal,

as well as distal. Distal slit valves are now to be avoided because of the high frequency of distal shunt malfunction, as well as unpredictable flow characteristics. Valve mechanisms include slit valves, spring-ball valves or diaphragm valves[16]. The slit valve is somewhat unpredictable, and flow can vary markedly given the amount of previous irrigation or the stickiness of the valve. Spring-ball and diaphragm valves maintain a more constant flow rate. Siphoning is a factor which comes into play when a child assumes an upright position and a negative pressure is exerted, which is related to the vertical distance between the inlet and the outlet of the shunt. In rare cases in which siphoning appears to be detrimental to a child, an antisiphon device[17] can be inserted to negate this negative effect only in the vertical position. The characteristics to be aware of is that shunt valves are described by the pressure above which CSF will flow, as well as resistance to flow. A valve can be low pressure but have a high resistance so that the rate at which fluid flows down to the closing pressure of the shunt will be a gradual drop off . A low resistance valve will drop quickly and then stop abruptly when the fluid pressure reaches the closing pressure of the valve. These are rarely used in the placement of childhood shunts. Occasionally, however, there is a situation where a child is having low pressure symptoms or recurring proximal shunt occlusions due to collapse of the ventricles around the ventricular

catheter, and an antisiphon device may be useful to help control this form of slit ventricle syndrome. One needs to be careful about the use of antisiphon devices, since it may slow down the function of the shunt too much and cause symptoms that are due to inadequate shunt function[18]. This is particularly important in infants, if the antisiphon device is used with a medium pressure shunt. An antisiphon device works only when there is a negative pressure exerted due to the vertical position of a child, and the resultant siphoning. It consists of a diaphragm that covers the inlet to the device, and when there is a negative pressure exerted from below the diaphragm moves downward occluding the inlet so that the shunt is essentially closed. In this way, this closes the shunt only when there is negative pressure present in the distal part of the system. Hydrocephalus must be treated to prevent brain mass damage by ventriculomegaly. Therefore the goal of treating ventriculomegaly is to prevent the microscopic damage that results if left untreated. This is achieved by CSF diversion. The various CSF diversion procedures are

1. Ventriculo-peritoneal shunt
2. Ventriculo-atrial shunt
3. Ventriculo-pleural shunt
4. Ventriculo-subgaleal shunt.

Other distal sites occasionally used are gall bladder, ureter, bladder, sagittal sinus. As the Ventriculo-peritoneal shunt is the most common CSF diversion procedure done, it is described below.

Ventriculo-peritoneal shunt:

The patient is positioned supine with head turned towards opposite shoulder and the neck is hyperextended. Ratios of head circumference and catheter length are 5:1 for patients younger than 1month, 4.5:1 for patients between 1month to 5years and 4:1 for patients older than 5years[6]. Ventricular catheter can be placed through any of these commonly used burrholes.

1. Kocher's point: 11cm from nasion, 2.5cm from midline and 1cm anterior to coronal suture.
2. Keen's point: 2.5cm posterior and superior to highest point of helix.
3. Dandy's point: 4cm superior to inion and 3.5cm lateral to midline.

Ideally the ventricular catheter tip should lie 1cm anterior to the foramen of Monro in the frontal horn of lateral ventricle[7]. The abdominal incision can be in the mid or upper abdomen on the side of ventricular

catheter. Anterior rectus sheath is opened parallel to the fibres. The rectus abdominis muscle is divided bluntly in vertical orientation. Posterior rectus sheath is next incised followed by the peritoneum. The shunt passer should be passed from the retro-auricular region to the abdominal incision. Once the shunt passer is passed in, the trocar is removed and the peritoneal catheter is fed in. The proximal system is then connected and the valve should be purged to ascertain good distal flow. Both the wounds are then closed in layers.

Ventriculoatrial shunting:

This procedure is usually the first choice for patients who are unable to have distal abdominal catheters (eg, multiple operations, recent abdominal sepsis, known malabsorptive peritoneal cavity, abdominal pseudocyst). The insertion of the distal catheter in to the cardiac atrium is performed by a skin incision made 3cm below the mandibular angle. The platysma is divided and the deep cervical fascia opened and the common facial identified and dissected for atleast 1cm from its entry in to the internal jugular vein. The cranial part is ligated and a suture is placed around the cardiac part of facial vein. The wall of the vein is incised and the catheter inserted inside it in the direction of the jugular. The tip is

placed in the right cardiac atrium at the level of the 8th rib confirmed by either X-ray or fluoroscopy.

The procedure carries more risk[8]. Long-term complications are more serious (eg, renal failure, great vein thrombosis). Fluoroscopic guidance is necessary to prevent catheter thrombosis (short distal catheter) or cardiac arrhythmias (long distal catheter).

Ventriculopleural shunting:

This procedure is usually performed for patients with failed peritoneal and atrial shunts. The distal catheter is placed using a skin incision placed just below the breast in the midclavicular line. The incision is deepened and the rib muscles are divided at the superior aspect of the lowest of the two selected ribs and a self-retaining retractor is placed between them. A small hole is placed in the pleura and the distal catheter is inserted in to it. The pleura is closed with a purse string suture around the tubing. A control chest X-ray is usually taken post-operatively.

Shunt system valves:

1. Differential pressure valves:

   →Slit valves

   → Mitter valves

   →Diaphragm valves

   →Ball in cone valves.

2. Programmable valves:

   Externally adjustable differential pressure valves.

3. Flow- regulated valves.
4. Anti-siphon devices.
5. Gravity actuated valves.

Torkildsen shunts or internal shunts:

These are straight tubes that communicate to cerebrospinal fluid spaces without a valve. Their effectiveness and long-term efficacy are not proven.

Endoscopic third Ventriculostomy:

The first open third ventriculostomy was performed by Walter Dandy in the 1910s with moderate success and has recently experienced

resurgence with the introduction of operating endoscopes. The endoscopic equipment has improved, which has resulted in increased use of the procedure. ETV has a success rate of 70% when used in patients with aqueductal stenosis and is regarded by many as the procedure of choice in these patients. Endoscopic cyst fenestration can be used in the presence of arachnoid cysts in various locations (ie, suprasellar, interhemispheric, posterior fossa) with variable success. Third ventriculostomy has been recently performed to treat hydrocephalus in children with myelomeningocele. However, the reported success rates are only approximately 30-40%. One possible explanation for the low success rate of third ventriculostomy is that most patients are infants or neonates when they receive initial treatment and do not have fully developed subarachnoid spaces. A frontal ventricular catheter attached to a blind reservoir or an Ommaya reservoir can be left in place and can be converted to a ventriculoperitoneal shunt if the third ventriculostomy fails. ETV can be used in children who have already received shunting and who present with shunt malfunction at an older age. The reported success rate is approximately 50%. In such patients, an external ventricular drain should be used for the first few days following third ventriculostomy (especially if the shunt has been removed) to allow emergency decompression if the third ventriculostomy does not function

adequately and the patient's condition rapidly deteriorates. ETV may be more effective if it is combined with choroid plexus cauterization. Improved outcomes were reported in a recent study of select patients younger than one year. However, cauterization is not routinely performed and remains a controversial option; further study is needed. ETV is traditionally performed through a frontal burr hole situated just anteriorly to the coronal suture. A rigid or flexible endoscope is preferred. The third ventricle floor is perforated using a purpose-designed monopolar diathermy with retractable tip or another similar purpose-designed dissector. After formation, the stoma is commonly dilated using some kind of purpose-designed balloon dilator. Perforation of the third ventricle floor is the most delicate and important phase because perforation of the adjacent basilar artery is a risk. ETV can be particularly difficult in children with myelomeningocele because the ventricular anatomy is often abnormal, the third ventricle floor is thicker and more difficult to penetrate, the size of the third ventricle is smaller in these children than in those with aqueductal stenosis, or the septum pellucidum is absent, which can lead to disorientation in the inexperienced operator. In general, inexperienced operators should avoid ETV in children with hydrocephalus caused by myelomeningocele. Apart from damage to the basilar artery, another potential source of intraoperative difficulty is

damage to the choroid plexus, which can lead to hemorrhage that clouds the operative field. Most nonarterial bleeding stops with gentle warm irrigation. Failure to perforate the Liliequist membrane may also result in ETV failure. Preoperative MRI is very important because it reveals the bowing of the third ventricle floor and its relationship to the basilar artery. Bowing of the third ventricle floor correlates with a pressure gradient between the ventricular system and the extraventricular CSF spaces. If the third ventricle floor is not bowed, the success rate of ETV is significantly decreased. In cases of shunt revision or shunt removal after successful ventriculostomy, rupture of the choroid plexus during retrieval of the ventricular catheter is common and can lead to life-threatening hemorrhage. Different techniques can be used to avoid this complication; the most common of these techniques involves insertion of a stylet into the catheter lumen, allowing for coagulation with the diathermy before the catheter is retrieved. However, if the ventricular catheter is not easily removed, it should be left in place and an additional catheter should be placed. Image guidance can also be very helpful in ventricular catheter placement, especially in patients with loculated hydrocephalus and cannulating complex cysts.

Contraindication for treatment of hydrocephalus:

Few cases of hydrocephalus should not be treated. Cases in which treatment should not be implemented include the following:

- In ventriculomegaly of senescence, the patient who does not have the symptom triad.
- Ex vacuo hydrocephalus is merely the replacement of lost cerebral tissue with cerebrospinal fluid. Because no imbalance in fluid production and absorption exists, this technically is not hydrocephalus.
- Arrested hydrocephalus is defined as a rare condition in which the neurologic status of the patient is stable in the presence of stable ventriculomegaly. The diagnosis must be made extremely carefully because children can present with very subtle neurological deterioration (eg, slipping school performance) that is difficult to document.
- Benign hydrocephalus of infancy is found in neonates and young infants. The children are asymptomatic, and head growth is normal. CT scan shows mildly enlarged ventricles and subarachnoid spaces.

Complications

The most common complications differ depending on the type of shunt and the underlying pathophysiology.

1. Infection[9] is the most feared complication in the young age group. The overwhelming majority of infections occur within 6 months of the original procedure. Common infections are staphylococcal[10, 11, 12] and propionibacterial. Early infections occur more frequently in neonates and are associated with more virulent bacteria such as *Escherichia coli*. Infected shunts need to be removed, the cerebrospinal fluid (CSF) needs to be sterilized, and a new shunt needs to be placed. Treatment of infected shunts with antibiotics alone[13] is not recommended because bacteria can be suppressed for extended periods and resurface when antibiotics are stopped.
2. Subdural hematomas occur almost exclusively in adults and children with completed head growth. Incidence of subdural hematomas can be reduced by slow postoperative mobilization and perhaps by avoiding rapid intraoperative ventricular decompression. This allows for brain compliance reduction. The treatment is drainage and may require temporary occlusion of the shunt.

3. Shunt failure is mostly due to suboptimal proximal catheter placement. Occasionally, distal catheters fail. Suspect infection if the distal catheter is obstructed with debris.
4. Abdominal pseudocysts are synonymous with low-grade shunt infection.
5. Overdrainage is more common in lumboperitoneal shunts and manifests with headaches in the upright position. In most cases, overdrainage is a self-limiting process. However, revision to a higher-pressure valve or a different shunt system occasionally may be necessary. A positional valve that closes when the patient is upright is also available.
6. Slit ventricle syndrome is an extremely rare condition in which brain compliance is unusually low. It mostly occurs in the setting of prior ventriculitis or shunt infection. The patient may develop high pressures without ventricular dilatation. The slit ventricle syndrome does not imply overdrainage, and the symptoms usually are those of high pressure rather than low pressure. Most experts also agree that slit ventricles predispose the patient to a higher incidence of ventricular catheter failure. Repeated ventricular blockage by the coapted ventricular wall may be helped by performing a subtemporal decompression that creates an artificial pressure reservoir and induces slight reenlargement of the slit ventricle.

Medical Therapy:

Medical therapy is usually a temporizing measure. In transient conditions, such as sinus occlusion, meningitis, or neonatal intraventricular hemorrhage, medical therapy can be effective.

- Acetazolamide (25 mg/kg/d in 3 doses): Careful monitoring of respiratory status and electrolytes is crucial. Treatment beyond 6 months is not recommended.

- Furosemide (1 mg/kg/d in 3 doses): Again, electrolyte balance and fluid balance need to be monitored carefully.

- Theobromine sodiosalicylate appears to have a very definite effect in increasing surface tension and checking oedema of the tissues and the idea suggested itself to Marriott et al that in the communicating type hydrocephalus, absorption of the spinal fluid by the subarachnoid might be favoured by raising the surface tension within the blood vessels by the administration of this theobromine sodiosalicylate. Acting on this hypothesis theobromine sodiosalicylate was administered to infants in whom previously there had been a marked and persistent increase in the circumference of the head notwithstanding repeated rachicenteses.

The dosage given was 0.2gms three times a day continued over a considerable period of time. Gerstenberger et al of Cleveland, and Blackfan et al of Boston, both corroborated these results.

- Lumbar punctures: In neonates recovering from intraventricular hemorrhage, serial lumbar punctures can, in some cases, resolve hydrocephalus. If possible, this is the preferred method of treatment.

- Removal of the underlying cause usually resolves hydrocephalus.

SHUNT INFECTION:

Shunt infection is the most dreaded complication of VP shunt with ranges from as low as 1.5% to 38%. Various researchers have analysed the incidence of shunt infection in various studies[20,21] and are as follows :

Author	No. of patients	Year of study	Infection rate
Walters and colleagues	1500	1960-1979	18%
Ammirati and Raimondi[27]	431	1973-1982	22%
Borgbjerg[9] and associates	884	1958-1989	6.2%
Casey[10] and colleagues	155		9-19%
ISPN		1994	6.5%
Mancao et al	268	1998	10.8%
Lakshmi et al	226	2006	3.98%
Thompson	108	2007	6.48%
Inayatullah et al	151	2009	1.98%

Time to infecton:

Majority of the researchers found that most of the shunt infections occur in the first 3 months following shunt[10-11].

Risk factor for infections:

1. Extremes of age:

A variety of explanations exists for increased infection among very young children, including the presence of age- related changes in the density and identity of bacterial populations on the skin of neonates, as well as increased susceptibility to pathogens due to relative deficiency of the neonatal immune system. In particular children younger than 6 months have immunoglobulin G levels that are approximately half that of the adults. Also there is evidence that highly adherent strains of Staphylococcus occur among children younger than 6 months than among older children.

2. Cause for hydrocephalus:

Post- Haemorrhagic hydrocephalus has higher incidence of infection. Dallacasa and associates reported that half the children in the post-haemorrhagic and post-infectious group had at least one infection by the end of 1year.

3. Type of shunt:

Two larger studies reported that Ventriculo-peritoneal shunts had the highest rates of infection.

4. Presence of spinal dysraphism:

Ammirati and colleagues demonstrated that children with myelomeningocoele who were shunted in the first week of life had a two fold increase in the incidence of infection relative to those shunted at 2weeks or later.

5. Competence of the surgeon.

6. Time period of surgery.

7. Duration of surgery.

8. Use of antibiotics before and after surgery.

Clinical presentation:

The presentation is variable and is age dependent but commonly includes headache, vomiting and lethargy. Infants may present with irritability and in severe cases with apnea and bradycardia. Additional complaints includes fever , gait disturbances, seizures, Visual disturbances, papilledema, abdominal pain, erythema or edema along shunt tube tract. The presentation also depends on the type of infecting organisms. E.coli infections may present acutely with septicemia and severe abdominal pain. Staph epidermidis infection will have an indolent

course and staph aureus infection will present with induration along shunt tube tract[19].

Organisms:

CSF shunt catheter infections occur via three routes: the blood stream, along shunt tube tract from abdominal route and contamination of the shunt material with skin organisms at the time of surgery. The most common organism is Staph epidermidis followed by Staph aureus. Staph epidermidis secretes a mucoid material that enhances its ability to adhere to foreign material. Shunt infections with gram negative organisms like E.coli, Klebsiella. Proteus are also common. Delayed infection with anaerobic organisms like Propianibacterium are difficult to access and treat. Fungal infections are also reported but are very rare. Infection can be defined as the presence of positive CSF culture or alternatively positive culture from shunt tube hardware. But in most instances, only the shunt hardware tests positive for bacterial or other growth and fluid itself remains negative. A hypothesis explains that bacteria and other microorganisms favor adhesion to foreign material than CSF.

Treatment:

Majority of the shunt infections are currently treated by surgical removal of the infected shunt[22,23,24,25]. A new device is then placed either at the time of removal of infected shunt or at a later date. In many instances shunt replacement are delayed until the CSF cultures are negative. The recommended interval between shunt removal and reinsertion ranges fro 10 to 14 days.

An alternative to surgical replacement is the use of antibiotics alone. The method of administration of antibiotics is extremely important, with the addition of intrathecal antibiotics associated with increased rates of cure and survival.

Outcomes:

In a series of 108 infants presenting with hydrocephalus at birth and operated from 1971-1981, Renier et al reported a 10-year survival rate of 71% in non-infected, versus 51% in infected children. Similarly Walter and colleagues reported mortality rate of 34% in infected, versus 18% in non-infected patients. Mc Lone et al found that shunted children with infections had a significantly lower IQ(76+/-26) than did shunted children without infection(95+/-19).

SHORT REVIEW OF VARIOUS STUDIES ON PREVENTION OF SHUNT INFECTION:

1. Randolph[31] et al (1979), published a retrospective analysis of 840 cerebrospinal fluid shunting procedures over a 25-year period to determine the relationships between infection rates and several possible influences on infection. Two-thirds of all shunt infections occurred within 1 month of surgery. The very young and very old had higher infection rates. Infections became less prevalent over the period of the study, and mortality from infection decreased from 35% to 6%. Successive shunts (revisions) were found to have progressively higher infection rates. Ventriculoatrial and ventriculoperitoneal silicone plastic shunts had similar infection rates (11.4% and 12.0%). The uncontrolled use of prophylactic antibiotics had no effect on shunt infections. *Staphylococcus epidermidis* became gradually more prevalent over the period of the study, and eventually caused one-half of all infections. Where infection occurred in the presence of prophylaxis, the infectious organism was usually sensitive to the antibiotic being used. The surgeon was found to be the largest single factor in the incidence of shunt infections. A 25-fold variance in infection rates among surgeons could be related to individual experience and technique.

2. Kevin[32] et al (1983) a review on the clinical manifestations and therapy of hydrocephalus shunt infections in 32 patients with a total of 35 shunt infections. These 35 infections accounted for 43 hospital admissions. First infections usually developed within 2 months following surgery. At the time of diagnosis, 89% of patients were febrile. Fever and cough as a symptom complex characterized the initial clinical presentation in six of 19 episodes of infection complicating ventriculoatrial (VA) shunts, as compared with none of 21 episodes in which infection complicated ventriculoperitoneal (VP) shunts. Seven of 21 infectious episodes occurring in patients with VP shunts *in situ* were associated with significant abdominal pain and tenderness. These patients usually had no other clinical features to suggest shunt infection. Both of these symptom complexes often led to delays in diagnosis and treatment. Causative organisms included *Staphylococcus epidermidis* in 21, *Staphylococcus aureus* in seven, Gram-negative aerobic bacilli in seven, diphtheroids in five, *Streptococcus* species in four, and anaerobes in three. Five infections were polymicrobial in nature. Positive blood cultures were seen in 13 of 17 infectious episodes complicating VA shunts, as compared with only three of 13 other infections. When the shunt was completely removed, with

or without replacement, all 13 patients were cured. When intravenous antibiotics were administered in conjunction with incomplete shunt removal, only eight of 15 courses resulted in cure. Intraventricular antibiotics were administered in four patients and all were cured. Therapy of shunt infections with parenteral antibiotics and incomplete shunt removal is associated with an unacceptably high failure rate.

3. Choux[26] et al (1992) published a series of 600 cases with 1197 VP shunts done following a protocol and reduced the infection rate to 0.33%. The protocol he followed has many factors observed during pre-operative, per-operative and post-operative period. During the preoperative period, the patient was assessed for localized skin problem, general medical condition, no pre-op shaving of scalp and no pre-op antibiotic medications was used. All the shunts were posted early in the morning, before other operations and neonates & infants were operated before older children in the list. Not more than four shunt procedures were done per day. All shunts were done within 20 to 40 mts period. Only four people were allowed in the operating room (surgeon, assistant, anesthesiologist, circulating nurse) no scrub nurse. All the shunts were done by an experienced neurosurgeon. The sterile shunt tube packaging was opened at the

last moment just before its insertion and no valve testing done. During surgery, meticulous hemostasis was achieved and great care taken for careful siting of valve/reservoir. Perfect skin closure was done for all cases. Prophylactic intravenous antibiotic was used 30 mins before skin incision. In the postoperative period, head is positioned to avoid pressure on the valve. No antibiotic medications were used. The approximate length of stay in hospital was 4 days for first time shunt and 2 days for shunt revision patients.

4. Kulkarni[28] et al(1999), prospectively analyzed perioperative risk factors for CSF shunt infection in a cohort of children between 1996 and 1999. 299 eligible patients underwent CSF shunt operations (insertions and revisions) that were observed by a research nurse at a tertiary care pediatric hospital. Several perioperative variables were recorded. All cases were followed postoperatively for 6 months to note any development of CSF shunt infection. Various perioperative variables were recorded in the study. The patient's age, sex , weight (kg), cause of hydrocephalus (intraventricular hemorrhage, myelomeningocele, tumor, aqueductal stenosis, meningitis, trauma, others, unknown), length of pre-op hospital stay, presence of previous shunt system

and priority level of operation were recorded. Intraoperatively the timing of surgery, use of prophylactic antibiotic agents w/in 30 mins of 1st incision, duration of operation from 1st incision until final wound closure, total number of persons present in operating room at any time during operation, presence of holes in surgical gloves, number of times shunt system was inadvertently exposed to breached surgical gloves, number of times shunt system was manipulated by a surgical instrument, lowest recorded intraoperative core body temperature (°C), use of surgical ultrasound or endoscope during operation were recorded. Operating room score was calculated as sum of the following factors like number of holes present in sterile drapes, number of persons wearing stained operating scrub suits or stained shoes, number of persons wearing reused operating head covers, number of persons wearing operating mask with nose left uncovered, number of persons incorrectly gowned, number of persons with cuff of gown exposed over gloves, number of times sterile drapes were applied incorrectly or moved, number of times a person not appropriately scrubbed & gowned leaned over operative field or was within 1 ft of operative field, number of times light handles were contaminated. Postoperatively, presence of CSF leak from

operative wound was recorded. At the end of the study, three risk factors for the development of CSF shunt infection have been identified, and changes in clinical practice should address them as follows.

1) Great care should be taken intraoperatively to avoid a postoperative CSF leak.

2) Alternatives to CSF shunt placement in premature infants should be studied and such patients should be considered high risk.

3) Surgeons should minimize manual contact with the shunt system and consider the use of double gloves. These findings may have implications for other clean surgeries involving implantation of prosthetic devices and biomaterials.

5. Scuibba[35] et al (2005) published a study in which he retrospectively reviewed all pediatric patients who had undergone cerebrospinal fluid (CSF) shunt insertion at their institution over a 3-year period between April 2001 and March 2004. During the 18 months prior to October 2002, all CSF shunts included standard, nonimpregnated catheters. During the 18 months after October 2002, all CSF shunts included antibiotic-impregnated catheters. All

patients were followed up for 6 months after shunt surgery, and all shunt-related complications, including shunt infection, were evaluated. The independent association of AIS[34] catheter use with subsequent shunt infection was assessed via multivariate proportional hazards regression analysis. A total of 211 pediatric patients underwent 353 shunt placement procedures. In the 18 months prior to October 2002, 208 (59%) shunts were placed with nonimpregnated catheters; 145 (41%) shunts were placed with AIS catheters in the 18 months after October 2002. Of patients with nonimpregnated catheters, 25 (12%) experienced shunt infection, whereas only two patients (1.4%) with antibiotic-impregnated catheters experienced shunt infection within the 6-month follow-up period ($p < 0.01$). Adjusting for intercohort differences via multivariate analysis, AIS catheters were independently associated with a 2.4-fold decreased likelihood of shunt infection. From which he concluded that the AIS catheter significantly reduced incidence of CSF shunt infection in children with hydrocephalus during the early postoperative period (< 6 months). The AIS system used is an effective instrument to prevent perioperative colonization of CSF shunt components.

6. Thompson[8] et al conducted a prospective study of pediatric patients undergoing primary shunt insertion in 2007. He collected three swab samples from the surgical wounds during each procedure. These samples were incubated and subcultured, and the isolates were identified and stored. In patients who subsequently presented with clinical evidence of shunt infection, cerebrospinal fluid (CSF) was analyzed using microscopy, tissue cultures, and sensitivity testing. The organisms isolated at the time of shunt insertion and those responsible for subsequent shunt infection were then compared. The study population consisted of 107 pediatric patients. Because one patient underwent placement of an additional contralateral shunt system, there were 108 total shunt insertions yielding 325 swab samples. Organisms were identified in cultures of 50 swab samples (15%) obtained in 40 patients (37%). In seven of these 40 patients (17.5%) a CSF infection subsequently developed. In only one patient was the infectious organism the same as that isolated from the swab specimens. In an additional six patients (8.8%) a CSF infection occurred despite the lack of growth in the cultures from intraoperative swab samples. From the study he concluded that the organisms responsible for shunt infection were rarely detected in the operative wound at the time of shunt

insertion, leading the authors to conclude that the vulnerable period for bacterial colonization of shunts may not be restricted to the operative procedure as is commonly believed, but may extend throughout the postoperative period of wound healing. These findings have implications not only for a better understanding of the cause of shunt infections but also for the development of strategies to prevent them.

7. Khan et al (2009), conducted a retrospective case study with nonrandomized convenience sampling. He studied 121 patients who underwent neurosurgical shunt operations during year 1994 to 1999. These patients received pre, per and post operative antibiotics to combat shunt infection. Study design was retrospective case study with non randomized convenience sampling. He found that out of 121 patients, 65 patients were females and 56 males. The total number of shunts procedures performed in these patients was 151. Ninety-seven patients operated once for shunt procedure. Eightythree patients underwent ventriculo-peritoneal shunt, 10 patients underwent lumboperitoneal shunt, 3 had ventriculo-pleural shunt and 1 had ventriculo-atrial shunting done. Three patients developed shunt infection, only one had true primary infection. All were

adults with male to female ratio of 2 to 1 and in all of them shunt was inserted first time. He concludd that strict aseptic technique and prophylactic use of antibiotics have critical role in the prevention of shunt infections.

MATERIALS AND METHODS

This study was done prospectively in 486 cases admitted in Institute of Neurology, Government General Hospital, Chennai during the period from 2006 – 2010.

Inclusion criteria:

All patients with Congenital hydrocephalus, Tumour associated hydrocephalus, Hydrocephalus associated with spinal dysraphism, Normal pressure hydrocephalus, Post-meningitic Hydrocephalus without active meningitis were included.

Exclusion criteria:

Immunocompromised patients with Hydrocephalus, Hydrocephalus associated with active meningitis, Patients having skin diseases, Patients with focal sepsis.

The Patients were divided in to two groups,

Group 1: Ventriculo-peritoneal shunt was done based on protocol to reduce shunt infection

Group 2 : No protocol was followed while doing the shunt.

Group 1 patient's Ventriculo-peritoneal shunt was done based on the protocol. The details of the protocol modified from the one suggested by Choux et al, are as follows:

1. It is done as a first case in the operative list.
2. It is done by an experienced surgeon.
3. Surgeon, Anaesthetist and Staff nurse alone in the operating room.
4. Skin must be thoroughly prepared and drapped and should not be touched during the surgical procedure.
5. Avoiding autoclaved gloves.
6. Shunt tube pack must be opened just before its insertion.
7. Shunt tube should not be immersed in saline for checking the valve.
8. Minimising the duration of surgery.
9. Peri-operative Antibiotics given for all cases.
10. Avoiding intermediate skin incisions along shunt tube tract.
11. Patient advised not to lie over the operated side to avoid pressure over the shunt pump.

FOLLOW-UP:

All these patients were followed up by phone interviews and out-patient reviews for signs and symptoms of shunt infection.

DIAGNOSIS OF SHUNT INFECTION:

1. Redness and tenderness along shunt tube tract.
2. Wound gaping and pus discharge of either the cranial or abdominal wound.
3. Exposed shunt tube anywhere along the tract.
4. Signs of meningeal irritation.
5. Unexplained fever.

TREATMENT OF INFECTION:

The treatment options for shunt infection are

1. Conservative
2. Shunt tube removal, treatment of infection, fresh Ventriculo-peritoneal shunt.

The removed shunt tube was subjected to culture and sensitivity. CSF sample was also taken for Biochemical analysis, culture and sensitivity and cytology. Blood culture, urine culture, blood widal, peripheral smear for malarial parasite, chesy X-RAY was done to rule out other causes for fever. Conservative treatment includes treatment with antibiotics covering gram positive, gram negative and anaerobes like Crystalline penicillin, Gentamicin and Metronidazole.

RESULTS

In Group 1, comprising 80 cases, for whom the shunt was done based on the protocol, none of the cases were infected.

In Group 2, comprising 406 cases, where the protocol was not followed while doing the shunt, 22 cases got infected between 13days to 1year. The details about various steps in the protocol and their contribution to the incidence of shunt infection are tabulated below:

Parameter	Total cases	Infected	Percentage
Not as first case	270	14	5.18
Emergency	176	4	2.27
Immersion in saline	368	15	4.07
H/o previous shunt	14	2	14.28
No Pre-op antibiotics	393	22	5.59
Intermediate skin incision	7	1	14.28
Duration of surgery >1hr	5	1	20

In the group II comprising 406 cases, where the protocol was not followed while doing the shunt, 226 were males and 180 were females.

270 cases were not operated as a first case in the operating list, the shunt tube was immersed in saline in 368 cases for checking the valve, the shunt was done as an emergency procedure in 176 patients, previous history of shunt was present in 14 of the patients, Pre-op antibiotics was not used in 393 patients, Intermediate skin incisions were used in 7 patients and the duration of surgery lasted for more than an hour in 5 patients.

In a group of 270 patients were shunt was not done as a first case, 14 patients got infected(5.1%). Of the 368 patients, whose shunt tube was immersed in saline, 15 patients got infected(4.07%). Of the 176 patients operated as emergency, 4 patients got infected (2.2%). With 14 patients already having a shunt done, 2 patients got infected(14.2%). Of the 393 patients for whom pre-op antibiotics were not used, 22 patients got infected(5.5%). One out of seven patients, for whom intermediate skin incisions were used got infected(14.28%). Of the 5 Patients where the shunt procedure was lasted for more than one hour, one patient got infected(20%).

Of the 22 cases which got infected, 36.36% (8 cases) got infected in first 2 months following surgery. Of the 91 infants, for whom shunt was done, 8 patients got infected(8.79%). 0f the 18 neonates for whom

shunt was done, none of them got infected. 6.19% of male shunts and 4.44% of female shunts got infected.

Majority of the shunt infections were seen in aqueductal stenosis, followed by tumour associated hydrocephalus. Post- haemorrhagic and Post- infective hydrocephalus comes next in the list. Two cases of myelomeningocoele associated hydrocephalus got infected.

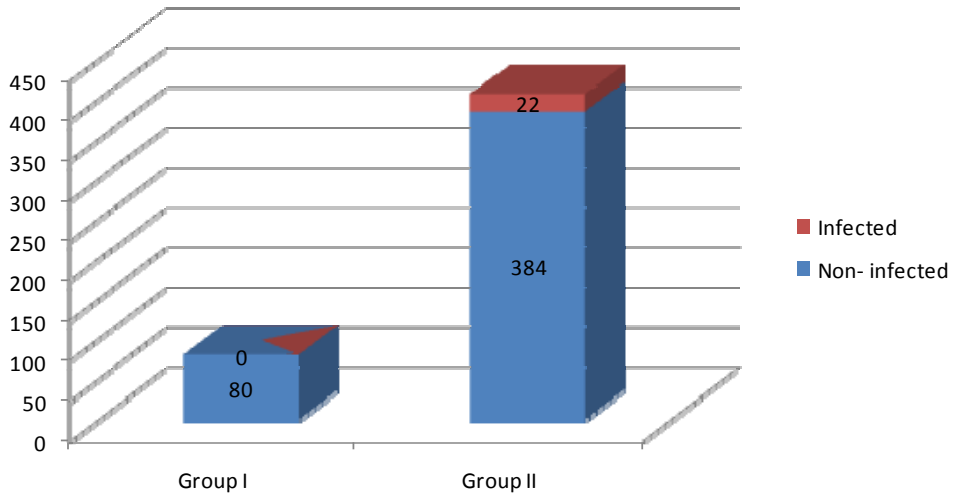
Of all the infected cases, 3 patients were managed conservatively with antibiotics, 3 patients were managed with shunt removal only as they were shunt independent, the remaining 16 patients were managed with fresh shunt after removing the infected shunt and controlling the infection.

On subjecting the removed shunt tube for culture, Staph aureus, Staph epidermidis and E.coli was grown in three cases respectively. Rest of the cultures were negative.

The antibiotics used to treat shunt infection were Crystalline penicillin, Gentamicin, Metronidazole. In some patients Cefaperazone-sulbactum and Piperacillin were also used based on culture and sensitive reports.

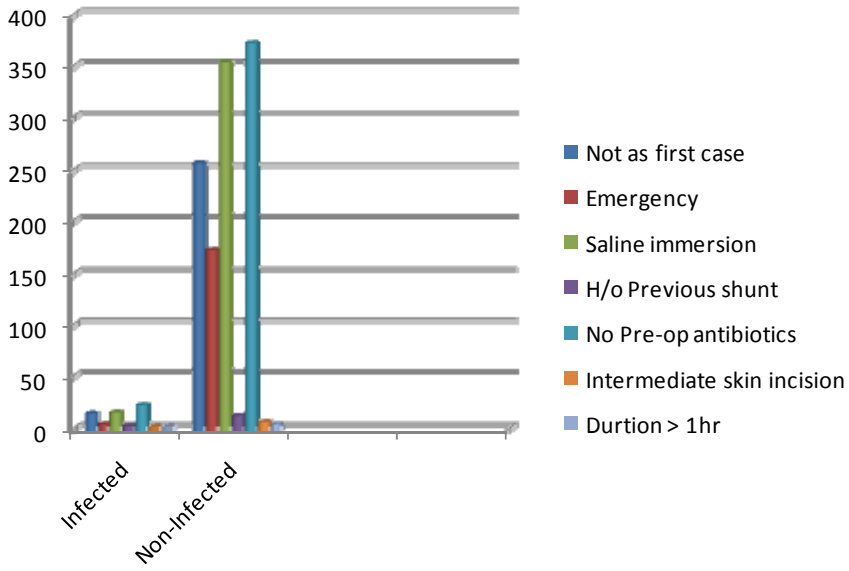
In a group of 80 patients, for whom shunt was done based on the protocol none of the cases got infected.

Infected Vs Non- Infected in Group I and Group II



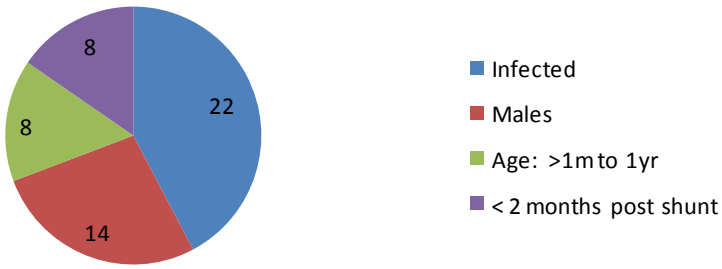
The chart comparing the total number of infected and non-infected cases in the each of the groups.

Various parameters in Infected Vs Non-infected



The chart depicts the contribution of various factors involved in shunt surgery for the development of shunt infection.

Demographic profile of infected cases



The chart showing the demographic profile of the infected cases.

STASTICAL ANALYSIS

Independent Samples Test

		t-test for Equality of Means				
					95% Confidence Interval of the Difference	
		t	df	Sig. (2-tailed)	Lower	Upper
Not as first case	**Equal variances assumed**	-12.860	484.000	.000	-.778	-.572
	Equal variances not assumed	-28.995	405.000	.000	-.721	-.629
Immersed in saline	**Equal variances assumed**	25.602	484.000	.000	.823	.960
	Equal variances not assumed	57.724	405.000	.000	.861	.922
Emergency	**Equal variances assumed**	6.728	484.000	.000	.271	.495
	Equal variances not assumed	10.426	231.807	.000	.311	.456
H/O Previous. Shunt	**Equal variances assumed**	.953	484.000	.341	-.026	.074
	Equal variances not assumed	1.178	145.332	.241	-.016	.065
Antibiotic	**Equal variances assumed**	-49.077	484.000	.000	-1.007	-.929
	Equal variances not assumed	-110.650	405.000	.000	-.985	-.951
Intrmediate incision	**Equal variances assumed**	1.182	484.000	.238	-.011	.046
	Equal variances not assumed	2.666	405.000	.008	.005	.030
duration of surgery	**Equal variances assumed**	.997	484.000	.319	-.012	.037
	Equal variances not assumed	2.247	405.000	.025	.002	.023
Infected	**Equal variances assumed**	-2.136	484.000	.033	-.104	-.004
	Equal variances not assumed	-4.817	405.000	.000	-.076	-.032

For shunts which have not been done as a first case, there is a statistically significant difference between controls and patients groups.

(P-value – 0.000) < (P-value – 0.05).

For the patients where the shunt system was immersed in saline, there is statistically significant difference between controls and patients groups. (P-value – 0.000) < (P-value – 0.05).

For shunts done as an emergency procedure, there is statistically significant difference between controls and patients groups. (P-value – 0.000) < (P-value – 0.05).

For patients who already underwent shunt surgery, there is no statistically significant difference between controls and patients groups. (P-value – 0.341) > (P-value – 0.005).

For the use of peri-operative antibiotics, there is statistically significant difference between controls and patients groups. (P-value – 0.000) < (P-value – 0.005).

For patients where an intermediate skin incision was used, there is no statistically significant difference between controls and patients groups. (P-value – 0.238) > (P-value – 0.005).

For patients where the duration of surgery lasted for more than an hour, there is no statistically significant difference between controls and patients groups. (P-value – 0.319) > (P-value – 0.005).

Crosstabs

AGE * TYPE Crosstabulation

Count

		TYPE		
		Group II	Group I	Total
AGE	<=12	211	37	248
	>12	195	43	238
Total		406	80	486

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.875[b]	1	.350		
Continuity Correction[a]	.661	1	.416		
Likelihood Ratio	.875	1	.349		
Fisher's Exact Test				.392	.208
Linear-by-Linear Association	.873	1	.350		
N of Valid Cases	486				

a. Computed only for a 2x2 table

b. 0 cells (.0%) have expected count less than 5. The minimum expected count is 3

Inference: Age with Infected and not infected patients between groups there is no statistically significant difference, (P-value – 0.350) > (P-value – 0.05) i.e Infected and not infected patients between age groups are equal.

DISCUSSION

Thus from the above study it has become clear that by following meticulous surgical technique, the shunt infection rate has been reduced to 0%. The majority of shunt infections are observed within 2 months of its insertion and are a result of probable direct contamination at the time of its insertion. In accordance with data in other reports in which the infection rate ranged from 3.8 to 27%, the infection rate was 5.4% in our Institute. After introduction of this new strategy the infection rate was reduced from 5.4% to 0%. In agreement with other studies, more than one- third of the infections occurred in children less than 1year of age and on the contrary none of the neonates got infected. For patients undergoing multiple shunts the infection rate increased from 5.4% to 14.28%. This is supported by other studies by George et al and Meirovitch et al. In accord with the report of George et al, the experience of the surgeon is the most important factor in the reduction of shunt infection rates, we also believe that shunt procedure should be carried out only by an experienced surgeon. In various literatures, 70 to 75% of shunt infections were caused by Staph. epidermidis and 20 to 25% of infections were due to Staph. aureus but in our study most of the cultures were negative. Regarding the use of prophylactic antibiotics, there is zero infection in the group where peri-operative antibiotics were used. On the contrary 5.4% infection

occurred in the group where no peri-operative antibiotics were used. Haines and Taylor despite demonstrating the reduction in infection with the use of prophylactic antibiotics, were unable to show a statistically significant reduction. We routinely use the prophylactic antibiotic at the time of induction. On the contrary to various studies, most of the shunt infections are seen in aqueductal stenosis patients than those having associated myelomeningocoele. Of all the steps described in our protocol, prolonged duration of surgery, using intermediate skin incisions and patients who already underwent a shunt poses an increased risk of developing shunt infection in the range of 20%, 14.28% and 14.28% respectively. Use of pre-operative antibiotics and doing shunt as a first case in the operative list significantly reduces the incidence of shunt infection.

The following chart compares the incidence of shunt infection in various studies:

Author	Year of study	No. of cases	Infection rate
George et al	1979	388	12.97%
Mc cullough et al	1980	223	2.62%
Duret et al	1983	56	3.54%
Fitzgerald et al	1984	82	2.43
Mancao et al	1998	268	10.8%
Lakshmi et al	2006	226	3.98%
Thompson et al	2007	108	6.48%
Inayatullah et al	2009	151	1.98%
Present study	2010	80	0%

Thus from the above study, it is clear that attention to detail and meticulous surgical technique are important if a high rate of shunt infection has to be avoided. This has important implications for the obvious and hidden costs for treating repeated shunt infections in our patients.

CONCLUSION

The following conclusions were derived from this study,

The shunt infection can be brought to 0% , by observing a simple, practicable protocol. (modified from the one suggested by Choux et al , 1992).

In the group, where the protocol was not followed, it is observed that prolonged surgery, use of intermediate skin incision and previous shunt surgery contribute to increased risk of shunt infection(ranging from 14 to 20%). Immersion of shunt tube in saline prior to its insertion, non-usage of peri-operative antibiotics also contributed to increased risk of shunt infection, though to a lesser degree.

APPENDIX - 3
GROUP - II
INFECTED CASES

S.No.	Age	Sex	I.P. No	Diagnosis	First case	Immersed in Saline	Emergency	H/o Previous H1 Shunt	Time Since Shunt	Persons in O.T	Treatment	Organisms Grown	Peri-op Antibiotics	Intrmediate Incision	Duration of Surgery
1	33	F	6870	Post- trauma hydrocephalus	No	yes	No	No	8m	More than 3	Shunt removec	No Growth	No	no	less than hr
2	21	F	61123	Lt. CP Angle SOL with Hydrocephalus	No	Yes	No	No	1yr	More than 3	Cons		No	no	less than hr
3	3m	M	6116	Aqueductal Stenosis	Yes	Yes	No	No	1m	More than 3	Shunt removed with opp. Shunt	Staph	No	no	less than hr
4	3m	M	6428	Aqueductal Stenosis	No	yes	No	No	1m	More than 3	Shunt removed with opp. Shunt	No Growth	No	no	less than hr
5	17	M	20023	Aqueductal Stenosis	No	No	No	Yes	13m	More than 3	Shunt removed with opp. Shunt	No Growth	No	no	less than hr
6	2	M	54326	Post - IVH Hydrocephalus	Yes	yes	No	Yes	9m	More than 3	Shunt removed with opp. Shunt	No Growth	No	no	less than hr
7	5m	M	87945	Post - IVH Hydrocephalus	No	No	No	No	2m	More than 3	Shunt removed with opp. Shunt	commensals	No	no	less than hr
8	1	M	71797	Dandy walker mal with hydrocephalu	Yes	yes	No	No	5m	More than 3	Shunt removed with opp. Shunt	No Growth	No	no	less than hr
9	3m	M	41234	MMC with Hydrocephalus	Yes	yes	No	No	1.5m	More than 3	Shunt removed with opp. Shunt	No Growth	No	no	less than hr
10	1.5m	M	7034	Post- meningitic Hydrocephalu	No	No	Yes	No	15days	More than 3	Shunt removed with opp. Shunt	E.coli	No	no	less than hr
11	1	F	37395	Aqueductal Stenosis	Yes	yes	No	No	45days	More than 3	Shunt removed with opp. Shunt	No Growth	No	no	less than hr
12	5	M	52491	post-meningitic hydrocephalu	No	No	Yes	No	7m	More than 3	Shunt removed with opp. Shunt	No Growth	No	no	less than hr
13	3	F	23509	Aqueductal Stenosis	No	yes	No	No	1yr	More than 3	Shunt removed with opp. Shunt	Staph aureus	No	no	less than hr
14	28	F	101918	Cerebellar SOL with Hydrocephalus	No	No	Yes	No	9m	More than 3	Cons		No	no	less than hr
15	22	M	100838	Post - IVH Hydrocephalus	No	No	Yes	No	21days	More than 3	Shunt removed with opp. Shunt	No Growth	No	no	more than hr
16	19	M	91948	Sellar SOL with Hydrocephalus	Yes	yes	No	No	16m	More than 3	Shunt removed with opp. Shunt	No Growth	No	no	less than hr
17	38	F	89055	Cerebellar SOL with Hydrocephalus	Yes	yes	No	No	10m	More than 3	Shunt removed	commensals	No	Yes	less than hr
18	5	F	47467	MMC with Hydrocephalus	No	No	No	No	1yr	More than 3	Shunt removed with opp. Shunt	No Growth	No	no	less than hr
19	14	M	52722	post-meningitic hydrocephalu	No	yes	No	No	7m	More than 3	Shunt removed with opp. Shunt	No Growth	No	no	less than hr
20	19	M	52759	Cerebellar SOL with Hydrocephalus	No	yes	No	No	6m	More than 3	Cons		No	no	less than hr
21	11m	M	62950	Aqueductal Stenosis	Yes	yes	No	No	13days	More than 3	Shunt removed with opp. Shunt	No Growth	No	no	less than hr
22	19	F	62967	Cerebellar SOL with Hydrocephalus	No	yes	No	No	2m	More than 3	Shunt removec	No Growth	No	no	less than hr

NON INFECTED CASES

23	1	F	79276	Cerebellar SOL with Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
24	1	M	81480	Cerebellar SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
25	8/ 365	M	81584	Dandy Walker mal with Hydrocephalus	yes	yes	No	No		More than 3			No	Yes	less than hr
26	40	F	85625	Sellar SOL with Hydrocephalus	No	No	Yes	No		More than 3			No	no	less than hr
27	2	F	84724	Communicating Hydrocephalu	No	yes	No	No		More than 3			Yes	no	less than hr
28	1.5m	M	93660	Aqueductal stenosis	yes	yes	No	No		More than 3			Yes	no	less than hr
29	15/ 365	F	93676	Aqueductal stenosis	No	yes	No	No		More than 3			No	no	less than hr
30	3m	F	93307	Aqueductal stenosis	yes	yes	No	No		More than 3			No	no	less than hr
31	43	F	90101	Rt. CP Angle SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
32	6m	M	84669	MMC with Hydrocephalus	No	No	No	No		More than 3			Yes	no	less than hr
33	8	M	85434	Cerebellar SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
34	45	F	85329	SAH with Hydrocephalus	No	No	Yes	No		More than 3			No	no	less than hr
35	12	M	91485	Cerebellar SOL with Hydrocephalus	No	No	Yes	No		More than 3			No	no	less than hr
36	4	F	80795	Cerebellar SOL with Hydrocephalus	No	No	Yes	No		More than 3			No	no	less than hr
37	30	F	71758	Sellar SOL with Hydrocephalus	No	yes	No	No		More than 3			No	Yes	less than hr
38	32	F	71750	Cerebellar SOL with Hydrocephalus	No	No	Yes	No		More than 3			No	no	less than hr
39	15	F	1191	Cerebellar SOL with Hydrocephalus	No	No	Yes	No		More than 3			No	no	less than hr
40	5	F	80108	Cerebellar SOL with Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
41	45	F	80126	Rt. CP Angle SOL with Hydrocephalus	No	No	Yes	No		More than 3			No	no	less than hr
42	60	M	80824	Cerebellar SOL with Hydrocephalus	No	No	Yes	No		More than 3			No	no	less than hr
43	30	M	82620	Communicating Hydrocephalu	yes	yes	No	No		More than 3			No	no	less than hr
44	6	M	80123	Pineal SOL with Hydrocephalus	No	No	No	No		More than 3			No	no	less than hr
45	2	M	80103	Post- meningitic Hydrocephalu	yes	yes	No	No		More than 3			No	no	less than hr
46	1m	F	80094	MMC with Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
47	3m	F	80034	Aqueductal stenosis	yes	yes	No	No		More than 3			No	no	less than hr
48	1	M	80009	MMC with Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
49	8	M	79984	Tuberculoma braim with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
50	4	M	79973	Post- meningitic Hydrocephalu	yes	yes	No	No		More than 3			No	no	less than hr
51	30	f	79864	Lt.CP Angle SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
52	56	M	79851	Cerebellar SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
53	29	F	79840	Cerebellar SOL with Hydrocephalus	No	No	No	No		More than 3			No	no	less than hr
54	10m	M	101238	Cerebellar SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
55	10m	M	101027	Cerebellar SOL with Hydrocephalus	yes	yes	No	No		More than 3			Yes	no	less than hr

56	4m	M	101052	Aqueductal stenosis	yes	yes	No	No		More than 3			Yes	no	less than hr
57	40	M	101040	Lt.CP Angle SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
58	28	M	101046	Trapped lateral ventricle	No	No	Yes	No		More than 3			No	no	less than hr
59	28	M	101024	Rt. CP Angle SOL with Hydrocephalus	No	No	Yes	No		More than 3			No	no	less than hr
60	2	F	101030	Post- meningitic Hydrocephalu	No	No	No	Yes		More than 3			No	no	less than hr
61	1m	M	101140	Aqueductal stenosis	yes	yes	No	No		More than 3			No	no	less than hr
62	50	F	101156	Cerebellar SOL with Hydrocephalus	yes	No	Yes	No		More than 3			No	no	less than hr
63	5	F	79545	Lt. cerebellar SOL with Hydrocephalus	No	yes	No	No		More than 3			No	Yes	less than hr
64	1.5m	M	79701	Aqueductal stenosis	yes	yes	No	No		More than 3			No	no	less than hr
65	2.5	F	79721	Cerebellar SOL with Hydrocephalus	No	No	No	No		More than 3			No	no	less than hr
66	20	F	80247	colloid cystwith hydrocephalu	No	yes	No	No		More than 3			No	no	less than hr
67	4m	M	82586	Aqueductal stenosis	No	yes	No	No		More than 3			No	no	more than hr
68	11m	F	88066	Aqueductal stenosis	No	yes	No	No		More than 3			No	no	less than hr
69	65	F	81646	Lt.CP Angle SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
70	5	M	82798	Aqueductal stenosis	No	No	No	Yes		More than 3			No	no	less than hr
71	7	M	85196	Cerebellar SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
72	2.5	M	85214	Cerebellar SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
73	11m	M	83066	LOCULATED Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
74	6m	M	84147	Cerebellar SOL with Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
75	25	M	84831	Post- meningitic Hydrocephalu	No	yes	No	No		More than 3			No	Yes	less than hr
76	38	M	54133	Rt. CP Angle SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
77	21	F	54156	Rec. Meduloblastoma with Hydrocephalu	No	yes	No	No		More than 3			No	no	less than hr
78	2.5	F	77362	Aqueductal stenosis	yes	yes	No	No		More than 3			No	no	less than hr
79	1.5	F	67385	Aqueductal stenosis	No	yes	No	No		More than 3			No	no	less than hr
80	3m	M	73021	Aqueductal stenosis	yes	yes	No	No		More than 3			No	no	less than hr
81	29	M	72945	Pineal SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
82	17/365	f	72421	Aqueductal stenosis	yes	yes	No	No		More than 3			No	no	less than hr
83	30	F	72346	Rt. CP Angle SOL with Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
84	27	F	74632	Post- meningitic Hydrocephalu	yes	yes	No	No		More than 3			Yes	no	less than hr
85	15	F	75643	Post- meningitic Hydrocephalu	No	yes	No	No		More than 3			No	no	less than hr
86	11	F	77067	Pineal SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
87	29	M	626	Cerebellar SOL with Hydrocephalus	yes	yes	No	Yes		More than 3			No	no	less than hr
88	50	F	958	Rt. CP Angle SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
89	1m	M	1253	Communicating Hydrocephalu	yes	yes	No	No		More than 3			No	no	less than hr
90	8m	F	2577	Aqueductal stenosis	yes	No	No	No		More than 3			No	no	less than hr
91	45	F	3813	Lt.CP Angle SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
92	4m	F	3069	Dandy Walker mal with Hydrocephalu	yes	No	No	No		More than 3			No	no	less than hr
93	25	F	1601	Lt.CP Angle SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
94	1	M	1970	Post- meningitic Hydrocephalu	No	yes	No	No		More than 3			No	no	less than hr
95	32	M	3517	Post- meningitic Hydrocephalu	No	yes	No	No		More than 3			No	no	less than hr
96	20	F	5814	Aqueductal stenosis	yes	yes	No	No		More than 3			Yes	no	less than hr
97	7	F	4357	Post- meningitic Hydrocephalu	No	yes	No	No		More than 3			No	no	less than hr
98	1	M	5864	Aqueductal stenosis	No	yes	No	No		More than 3			No	no	less than hr
99	2.5	F	7179	Dandy Walker mal with Hydrocephalu	No	yes	No	No		More than 3			No	no	less than hr
100	27	M	8554	Post-traumatic hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
101	18	M	802	Post-traumatic hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
102	7	M	6818	Cerebellar SOL with Hydrocephalus	No	yes	No	No		More than 3			No	Yes	more than hr
103	9	F	9801	Sellar SOL with Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
104	1m	M	15768	Aqueductal stenosis	yes	yes	No	No		More than 3			No	no	less than hr
105	2M	f	45611	MMC with Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
106	6m	F	45670	Aqueductal stenosis	No	yes	No	Yes		More than 3			No	no	less than hr
107	18	M	46307	colloid cystwith hydrocephalu	No	yes	No	No		More than 3			No	no	less than hr
108	31	M	46347	Rt. CP Angle SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
109	31	F	47996	Post-meningitic Hydrocephalu	No	yes	No	No		More than 3			No	no	less than hr
110	25	M	49120	Adult aqueductal stenosis	No	yes	No	No		More than 3			No	no	less than hr
111	8	F	30069	MMC with Hydrocephalus	yes	yes	No	Yes		More than 3			No	no	less than hr
112	23	M	47246	Sellar SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
113	85	M	47562	NPH	No	yes	No	No		More than 3			No	no	less than hr
114	3	F	51646	Sellar SOL with Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
115	70	M	51982	Cerebellar SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
116	17	F	52446	Communicating Hydrocephalu	yes	yes	No	No		More than 3			No	no	less than hr
117	50	M	51116	Rt. CP Angle SOL with Hydrocephalus	No	yes	No	No		More than 3			Yes	no	less than hr
118	10days	F	52987	MMC with Hydrocephalus	yes	No	No	No		More than 3			Yes	no	less than hr
119	18days	F	53016	MMC with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
120	45	M	51224	Communicating Hydrocephalu	No	yes	No	No		More than 3			No	no	less than hr
121	7m	M	50615	LOCULATED Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr

122	1m	F	54870	Aqueductal stenosis	yes	No	No	No		More than 3			No	Yes	less than hr
123	8m	M	50528	Communicating Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
124	30	F	52540	Rec. PITUITARY ADENOMA	No	yes	No	No		More than 3			No	no	less than hr
125	35	F	54334	Rt. CP Angle SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
126	13	M	57766	Lt.CP Angle SOL with Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
127	28	M	58780	Cerebellar SOL with Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
128	47	M	58788	Post- fossa SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
129	66	m	59048	Pineal SOL with Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
130	6m	M	57779	MMC with Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
131	3m	F	59397	Aqueductal stenosis	No	yes	No	No		More than 3			No	no	less than hr
132	40	F	54228	Communicating Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
133	35	F	60923	Cerebellar SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
134	1	F	57811	MMC with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
135	5m	F	51244	Aqueductal stenosis	yes	yes	No	No		More than 3			No	no	less than hr
136	4m	M	63639	Aqueductal stenosis	No	yes	No	No		More than 3			No	no	less than hr
137	35	F	59580	Post-meningitic Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
138	34	M	61092	Post-meningitic Hydrocephalus	No	yes	No	No		More than 3			No	no	more than hr
139	10	F	59066	Post-meningitic Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
140	11m	F	62273	MMC with Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
141	27	M	65934	Post-meningitic Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
142	2.5	F	53020	LOCULATED Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
143	1	m	66453	Aqueductal stenosis	yes	yes	No	Yes		More than 3			No	no	less than hr
144	16	F	66852	Rt. CP Angle SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
145	1m	M	68232	MMC with Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
146	22	M	70273	Cerebellar SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
147	2.5	F	70579	Cerebellar SOL with Hydrocephalus	yes	No	No	No		More than 3			No	no	less than hr
148	8m	F	70951	Aqueductal stenosis	No	yes	No	No		More than 3			No	no	less than hr
149	7	M	67107	Aqueductal stenosis	No	yes	No	No		More than 3			No	no	less than hr
150	25days	M	73260	Aqueductal stenosis	yes	yes	No	No		More than 3			Yes	no	less than hr
151	1.5m	M	76077	Communicating Hydrocephalus	yes	No	No	No		More than 3			Yes	no	less than hr
152	13	M	76132	Brainstem SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
153	30	F	76103	FM SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
154	2m	M	74811	Aqueductal stenosis	yes	yes	No	No		More than 3			No	no	less than hr
155	55	F	76782	Post- fossa SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
156	4m	M	72560	Aqueductal stenosis	yes	yes	No	No		More than 3			No	no	less than hr
157	45	M	78984	Communicating Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
158	1m	F	76802	MMC with Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
159	3m	F	80280	Communicating Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
160	1.5m	M	84572	Communicating Hydrocephalus	yes	No	No	No		More than 3			No	no	less than hr
161	5m	F	84908	Aqueductal stenosis	yes	yes	No	No		More than 3			No	no	less than hr
162	2	F	83323	Aqueductal stenosis	yes	yes	No	No		More than 3			No	no	less than hr
163	5m	F	84169	MMC with Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
164	2m	M	84118	Dandy Walker mal with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
165	6	F	90867	Sellar SOL with Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
166	28	M	91381	Post-meningitic Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
167	1m	M	89987	Aqueductal stenosis	yes	yes	No	No		More than 3			No	no	less than hr
168	67	M	88931	NPH	No	yes	No	No		More than 3			No	no	less than hr
169	6	F	96394	Post-fossa SOL with Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
170	5	F	97116	Pineal SOL with Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
171	2	M	96506	Post-meningitic Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
172	1m	M	100484	Post-meningitic Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
173	1m	F	1989	Post-meningitic Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
174	48	M	1858	Lt.CP Angle SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
175	6m	M	1835	Dandy Walker mal with Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
176	25	M	2169	Rt. CP Angle SOL with Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
177	2m	M	341	MMC with Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
178	40	F	2985	Post-fossa SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
179	10days	F	3490	Occipital encephalocoele with Hydrocephalu	yes	yes	No	No		More than 3			No	no	less than hr
180	2	M	7391	Aqueductal stenosis	No	yes	Yes	No		More than 3			No	no	less than hr
181	3m	M	4382	Aqueductal stenosis	yes	yes	No	No		More than 3			No	no	less than hr
182	9	F	6451	Pineal SOL with Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
183	4m	F	5155	MMC with Hydrocephalus	yes	No	No	No		More than 3			No	no	less than hr
184	7	M	7852	Post-fossa SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
185	1.5	M	2125	Dandy Walker mal with Hydrocephalus	yes	No	No	No		More than 3			No	no	less than hr
186	5m	M	9711	MMC with Hydrocephalus	No	No	No	No		More than 3			No	no	less than hr
187	22	M	9769	Post-traumatic hydrocephalus	yes	No	No	No		More than 3			No	no	less than hr

188	35	M	9772	Post-traumatic hydrocephalus	No	No	No	No		More than 3			No	no	less than hr
189	7m	M	6547	Aqueductal stenosis	yes	yes	No	No		More than 3			No	no	less than hr
190	6m	M	8484	Aqueductal stenosis	No	yes	No	No		More than 3			No	no	less than hr
191	55	F	11719	Cerebellar SOL with Hydrocephalus	yes	No	No	No		More than 3			No	no	less than hr
192	7	M	12765	Pineal SOL with Hydrocephalus	No	yes	No	Yes		More than 3			No	no	less than hr
193	37	M	13456	Cerebellar SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
194	4m	M	11775	Aqueductal stenosis	No	yes	No	No		More than 3			No	no	less than hr
195	43	F	14926	Tentorial meningioma with Hydrocephalu	yes	No	No	No		More than 3			No	no	less than hr
196	33	M	15460	Trapped lateral ventricle	No	yes	No	Yes		More than 3			No	no	less than hr
197	1m	F	15768	Aqueductal stenosis	yes	No	No	No		More than 3			No	no	less than hr
198	7m	F	16686	Aqueductal stenosis	No	yes	No	No		More than 3			No	no	less than hr
199	1	F	15206	Aqueductal stenosis	No	yes	No	No		More than 3			No	no	less than hr
200	47	M	7271	Lt.CP Angle SOL with Hydrocephalus	yes	No	No	No		More than 3			No	no	less than hr
201	3m	M	17845	Aqueductal stenosis	yes	yes	No	No		More than 3			No	no	less than hr
202	36	F	19676	Post-fossa SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
203	3	M	15221	Aqueductal stenosis	No	yes	No	No		More than 3			No	no	less than hr
204	2m	M	15199	Occipital encephalocoele with Hydrocephalu	yes	yes	No	No		More than 3			No	no	less than hr
205	1	F	18832	Sellar SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
206	30	F	82620	Communicating Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
207	60	M	80824	Cerebellar SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
208	45	F	80126	Rt. CP Angle SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
209	5	F	80108	Post-fossa SOL with Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
210	15	F	3340	Post-fossa SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
211	1	F	79276	Cerebellar SOL with Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
212	1	M	81480	Post-fossa SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
213	8days	M	81365	Dandy Walker mal with Hydrocephalus	yes	No	No	No		More than 3			No	no	less than hr
214	40	F	85615	Sellar SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
215	1.5	F	50593	Post-meningitic Hydrocephalus	yes	yes	Yes	No		More than 3			No	no	less than hr
216	39	F	46717	Rt. CP Angle SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
217	6	M	45123	Aqueductal stenosis	yes	yes	No	No		More than 3			No	no	less than hr
218	1	F	45132	Aqueductal stenosis	No	yes	No	No		More than 3			No	no	less than hr
219	13	F	47541	Aqueductal stenosis	yes	yes	No	No		More than 3			No	no	less than hr
220	2	M	48441	Tuberculoma braim with Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
221	28	M	52665	Post-fossa SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
222	17	M	54491	Post-fossa SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
223	45	F	51015	colloid cystwith hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
224	4	M	51060	Sellar SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
225	40	F	51173	Lt.CP Angle SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
226	16	M	54336	Post-meningitic Hydrocephalus	yes	No	No	No		More than 3			No	no	less than hr
227	1m	F	54487	Aqueductal stenosis	yes	No	No	No		More than 3			No	no	less than hr
228	50	F	52740	Cerebellar SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
229	3m	F	53306	Aqueductal stenosis	yes	yes	No	No		More than 3			Yes	no	less than hr
230	37	F	52361	Aqueductal stenosis	No	yes	No	No		More than 3			No	no	less than hr
231	1.5	M	55729	Post-meningitic Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
232	3m	F	53016	MMC with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
233	2m	M	55060	Aqueductal stenosis	yes	yes	No	No		More than 3			No	no	less than hr
234	5	M	55063	Aqueductal stenosis	No	yes	No	No		More than 3			No	no	less than hr
235	55	F	54050	Rt. CP Angle SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
236	5	M	52491	Cerebellar SOL with Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
237	3m	F	52504	Post-meningitic Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
238	20	M	54697	Cerebellar SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
239	33	M	58176	Post- traumatic Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
240	20	M	57101	Rt. CP Angle SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
241	32	M	61153	Cerebellar SOL with Hydrocephalus	yes	No	No	No		More than 3			No	no	less than hr
242	27	F	58915	Rt. CP Angle SOL with Hydrocephalus	No	yes	No	No		More than 3			No	no	less than hr
243	30	M	63643	Post-fossa SOL with Hydrocephalus	yes	yes	No	No		More than 3			No	no	less than hr
244	3m	F	23763	Aqueductal stenosis	No	yes	Yes	No		More than 3			No	no	less than hr
245	3m	M	27871	MMC with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
246	30	M	28177	Rt. CP Angle SOL with Hydrocephalus	yes	yes	Yes	No		More than 3			No	no	less than hr
247	7	G	28095	Suprasellar SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
248	24	F	29173	Lt.CP Angle SOL with Hydrocephalus	yes	yes	Yes	No		More than 3			No	no	less than hr
249	40	F	29390	Rt. CP Angle SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
250	11	F	30083	Aqueductal stenosis	No	yes	Yes	No		More than 3			No	no	less than hr
251	28	M	27641	Cerebellar SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
252	47	F	30720	Post-fossa SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
253	10m	F	31010	Aqueductal stenosis	yes	yes	Yes	No		More than 3			No	no	less than hr

254	11	F	31332	Aqueductal stenosis	No	yes	Yes	No		More than 3				No	no	more than hr
255	16	F	32980	Post-meningitic Hydrocephalus	No	yes	Yes	No		More than 3				No	no	less than hr
256	55	F	33844	Post-meningitic Hydrocephalus	No	yes	Yes	No		More than 3				No	no	less than hr
257	6	M	35440	Cerebellar SOL with Hydrocephalus	yes	yes	Yes	No		More than 3				No	no	less than hr
258	2	F	37035	Aqueductal stenosis	No	yes	Yes	Yes		More than 3				No	no	less than hr
259	30	M	38008	Post-traumatic hydrocephalus	No	yes	Yes	No		More than 3				No	no	less than hr
260	9	M	34952	Aqueductal stenosis	No	yes	Yes	Yes		More than 3				No	no	less than hr
261	55	M	36123	Rt. CP Angle SOL with Hydrocephalus	No	yes	Yes	No		More than 3				No	no	less than hr
262	30	M	35710	Intraventricular SOL with Hydrocephalus	No	yes	Yes	No		More than 3				No	no	less than hr
263	13	M	42543	Cerebellar SOL with Hydrocephalus	yes	yes	Yes	No		More than 3				No	no	less than hr
264	2m	F	1899	Aqueductal stenosis	No	yes	Yes	No		More than 3				No	no	less than hr
265	7m	f	30612	Aqueductal stenosis	yes	yes	Yes	No		More than 3				No	no	less than hr
266	25	M	43503	Post-meningitic Hydrocephalus	No	yes	Yes	No		More than 3				No	no	less than hr
267	25	F	42865	Post-meningitic Hydrocephalus	No	yes	Yes	No		More than 3				No	no	less than hr
268	3m	M	44836	Aqueductal stenosis	yes	yes	Yes	No		More than 3				No	no	less than hr
269	71	M	45037	NPH	No	yes	Yes	No		More than 3				No	no	less than hr
270	5	M	43870	Cerebellar SOL with Hydrocephalus	yes	yes	Yes	No		More than 3				No	no	less than hr
271	29	M	45173	Rt. CP Angle SOL with Hydrocephalus	No	yes	Yes	No		More than 3				No	no	less than hr
272	10	M	40240	Cerebellar SOL with Hydrocephalus	yes	yes	Yes	No		More than 3				No	no	less than hr
273	44	M	5088	Rt. CP Angle SOL with Hydrocephalus	No	yes	Yes	Yes		More than 3				No	no	less than hr
274	36	M	52445	Obstructive Hydrocephalus	No	yes	Yes	No		More than 3				No	no	less than hr
275	21	F	50265	Rt. CP Angle SOL with Hydrocephalus	No	yes	Yes	No		More than 3				No	no	less than hr
276	65	M	53441	NPH	No	yes	Yes	No		More than 3				No	no	less than hr
277	14	M	55671	Post-fossa SOL with Hydrocephalus	yes	yes	Yes	No		More than 3				No	no	less than hr
278	6	M	56476	Cerebellar SOL with Hydrocephalus	No	yes	Yes	No		More than 3				No	no	less than hr
279	13	F	54710	Post-meningitic Hydrocephalus	No	yes	Yes	No		More than 3				No	no	less than hr
280	4.5	F	55601	Post-fossa SOL with Hydrocephalus	yes	yes	Yes	No		More than 3				No	no	less than hr
281	11	M	57249	Post-meningitic Hydrocephalus	No	yes	Yes	No		More than 3				No	no	less than hr
282	2.5m	M	57220	Aqueductal stenosis	yes	yes	Yes	No		More than 3				No	no	less than hr
283	35	F	57831	Rt. CP Angle SOL with Hydrocephalus	No	yes	Yes	No		More than 3				No	no	less than hr
284	73	M	55740	NPH	No	yes	Yes	No		More than 3				No	no	less than hr
285	4	F	60129	Suprasellar SOL with Hydrocephalus	yes	yes	Yes	No		More than 3				No	no	less than hr
286	38	M	60181	Lt.CP Angle SOL with Hydrocephalus	No	yes	Yes	No		More than 3				No	no	less than hr
287	2.5m	M	62387	Aqueductal stenosis	yes	yes	Yes	No		More than 3				No	no	less than hr
288	3	F	51644	Suprasellar SOL with Hydrocephalus	No	yes	Yes	No		More than 3				No	no	less than hr
289	50	F	62046	Post-meningitic Hydrocephalus	No	yes	Yes	No		More than 3				No	no	less than hr
290	11m	M	62950	Aqueductal stenosis	No	yes	Yes	No		More than 3				No	no	less than hr
291	8m	F	63700	Aqueductal stenosis	No	yes	Yes	No		More than 3				No	no	less than hr
292	14	F	92160	Post-meningitic Hydrocephalus	No	yes	Yes	No		More than 3				No	no	less than hr
293	6m	F	61244	Aqueductal stenosis	No	yes	Yes	Yes		More than 3				No	no	less than hr
294	35	M	57831	Rt. CP Angle SOL with Hydrocephalus	No	yes	Yes	Yes		More than 3				No	no	less than hr
295	5m	F	64948	Aqueductal stenosis	yes	yes	Yes	No		More than 3				No	no	less than hr
296	14	F	66505	Post-meningitic Hydrocephalus	No	yes	Yes	No		More than 3				No	no	less than hr
297	13	M	65070	Post-fossa SOL with Hydrocephalus	No	yes	Yes	No		More than 3				No	no	less than hr
298	63	M	66299	Rt. CP Angle SOL with Hydrocephalus	No	yes	Yes	No		More than 3				No	no	less than hr
299	11	M	67335	Post-meningitic Hydrocephalus	yes	yes	Yes	No		More than 3				No	no	less than hr
300	4m	F	68180	Aqueductal stenosis	No	yes	Yes	No		More than 3				No	no	less than hr
301	8m	M	68477	Post-meningitic Hydrocephalus	No	yes	Yes	No		More than 3				No	no	less than hr
302	2m	M	68605	Aqueductal stenosis	No	yes	Yes	No		More than 3				No	no	less than hr
303	2	F	68580	Cerebellar SOL with Hydrocephalus	No	yes	Yes	No		More than 3				No	no	less than hr
304	23	F	68897	Post-meningitic Hydrocephalus	No	yes	Yes	No		More than 3				No	no	less than hr
305	24	F	68264	Obstructive Hydrocephalus	No	yes	Yes	No		More than 3				No	no	less than hr
306	9	m	69702	Cerebellar SOL with Hydrocephalus	yes	yes	Yes	No		More than 3				No	no	less than hr
307	31	M	69501	Communicating Hydrocephalus	No	yes	Yes	No		More than 3				No	no	less than hr
308	5	F	71001	Obstructive Hydrocephalus	yes	yes	Yes	No		More than 3				No	no	less than hr
309	32	F	55601	Lt.CP Angle SOL with Hydrocephalus	No	yes	Yes	No		More than 3				Yes	no	less than hr
310	8	M	71051	Obstructive Hydrocephalus	yes	yes	Yes	No		More than 3				No	no	less than hr
311	33	M	71786	Post-meningitic Hydrocephalus	No	yes	Yes	No		More than 3				No	no	less than hr
312	19	M	84164	Obstructive Hydrocephalus	No	yes	Yes	No		More than 3				No	no	less than hr
313	5	F	72445	Post-fossa SOL with Hydrocephalus	yes	yes	Yes	No		More than 3				No	no	less than hr
314	43	M	72286	Suprasellar SOL with Hydrocephalus	No	yes	Yes	No		More than 3				No	no	less than hr
315	50	M	70280	Obstructive Hydrocephalus	No	yes	Yes	No		More than 3				No	no	less than hr
316	45	M	73779	Rt. CP Angle SOL with Hydrocephalus	No	yes	Yes	No		More than 3				No	no	less than hr
317	33	M	71786	Lt.CP Angle SOL with Hydrocephalus	No	yes	Yes	Yes		More than 3				No	no	less than hr
318	3m	F	74573	Aqueductal stenosis	yes	yes	Yes	No		More than 3				No	no	less than hr
319	12	M	74813	Post-meningitic Hydrocephalus	No	yes	Yes	No		More than 3				No	no	less than hr

320	9m	M	73151	Aqueductal stenosis	No	yes	Yes	Yes		More than 3			No	no	less than hr
321	3	M	75131	Cerebellar SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
322	9	M	74376	Obstructive Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
323	30	M	74894	Rt. CP Angle SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
324	2	M	77340	Post-fossa SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
325	7	M	77355	Post-meningitic Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
326	6	F	76203	Obstructive Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
327	4	M	78920	Post-fossa SOL with Hydrocephalus	yes	yes	Yes	No		More than 3			No	no	less than hr
328	68	M	79487	Obstructive Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
329	1.5m	M	76277	MMC with Hydrocephalus	yes	yes	Yes	No		More than 3			No	no	less than hr
330	5	M	80106	Obstructive Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
331	50	M	80502	Post-meningitic Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
332	27	M	80134	Post-meningitic Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
333	16	M	81367	Post-meningitic Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
334	57	F	81998	Obstructive Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
335	45	F	78803	Cerebellar SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
336	4	F	82938	Post-fossa SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
337	32	F	83041	Obstructive Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
338	23	M	82750	Rt. CP Angle SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
339	50	M	83428	Cerebellar SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
340	48	M	83644	Obstructive Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
341	24	F	79269	Rt. CP Angle SOL with Hydrocephalus	yes	yes	Yes	No		More than 3			No	no	less than hr
342	52	M	81730	NPH	No	yes	Yes	No		More than 3			No	no	less than hr
343	22	M	84780	Aqueductal stenosis	No	yes	Yes	Yes		More than 3			No	no	less than hr
344	25	M	85621	Post-meningitic Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
345	19	F	87563	Communicating Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
346	33	M	87883	Cerebellar SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
347	38	F	89055	Rt. CP Angle SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
348	1.1	M	89859	Aqueductal stenosis	No	yes	Yes	Yes		More than 3			No	no	less than hr
349	35	F	89778	Post-meningitic Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
350	7	M	88784	Obstructive Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
351	18	M	90007	Obstructive Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
352	27	M	91945	Rt. CP Angle SOL with Hydrocephalus	No	yes	Yes	Yes		More than 3			No	no	less than hr
353	6m	F	95131	Aqueductal stenosis	yes	yes	Yes	No		More than 3			No	no	less than hr
354	55	F	95391	Communicating Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
355	3	M	96072	Cerebellar SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
356	1	M	97017	Obstructive Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
357	5	M	96382	Cerebellar SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
358	7m	M	99636	Aqueductal stenosis	No	yes	Yes	No		More than 3			No	no	less than hr
359	4	M	99509	Obstructive Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
360	20	M	100203	Rt. CP Angle SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
361	35	F	91762	SAH with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
362	15	M	2177	Post-meningitic Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
363	44	M	1905	Cerebellar SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
364	55	F	2495	Rt. CP Angle SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
365	19	M	3458	Cerebellar SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
366	22	M	1714	Rt. CP Angle SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
367	3	M	5844	Aqueductal stenosis	No	yes	Yes	No		More than 3			No	no	less than hr
368	20	M	5085	Obstructive Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
369	9	F	6910	Obstructive Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
370	49	M	7405	Post-meningitic Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
371	6	M	7810	Post-meningitic Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
372	22	M	7402	Cerebellar SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
373	56	F	8522	Rt. CP Angle SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
374	19	F	9443	Suprasellar SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
375	8m	M	8416	Cerebellar SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
376	35	F	9176	Rt. CP Angle SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
377	40	M	10080	Obstructive Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
378	4	M	12827	Post-fossa SOL with Hydrocephalus	yes	yes	Yes	No		More than 3			No	no	less than hr
379	3m	M	8528	MMC with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
380	18	M	15309	Aqueductal stenosis	No	yes	Yes	No		More than 3			No	no	less than hr
381	2	M	16582	Post-meningitic Hydrocephalus	yes	yes	Yes	No		More than 3			No	no	less than hr
382	39	F	16851	Suprasellar SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
383	80	M	18001	Cerebellar ICH	No	yes	Yes	No		More than 3			No	no	less than hr
384	4m	M	19055	Aqueductal stenosis	yes	yes	Yes	No		More than 3			No	no	less than hr
385	2	F	6743	Post-fossa SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr

386	1.5m	F	19451	MMC with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
387	45	F	21050	Rt. CP Angle SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
388	2	M	42632	Communicating Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
389	23	F	43207	Sellar SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
390	63	M	39799	Post-traumatic hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
391	46	F	46544	Rt. CP Angle SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
392	1	m	41276	Post-fossa SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
393	1	F	40850	Aqueductal stenosis	yes	yes	Yes	No		More than 3			No	no	less than hr
394	42	M	38588	Post-fossa SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
395	3m	F	40256	MMC with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
396	15	M	3766	Suprasellar SOL with Hydrocephalus	yes	yes	Yes	No		More than 3			No	no	less than hr
397	9	M	34333	Post-meningitic Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
398	16days	F	37411	Aqueductal stenosis	No	yes	Yes	No		More than 3			No	no	less than hr
399	44	F	36454	Lt.CP Angle SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
400	6	F	35200	Post-fossa SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
401	9	F	31226	Communicating Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
402	18	F	31457	Post-meningitic Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
403	36	M	31420	Rt. CP Angle SOL with Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr
404	18	M	31500	Post-fossa SOL with Hydrocephalus	yes	yes	Yes	No		More than 3			No	no	less than hr
405	70	m	31517	NPH	No	yes	Yes	No		More than 3			No	no	less than hr
406	14	F	31510	Post-meningitic Hydrocephalus	No	yes	Yes	No		More than 3			No	no	less than hr

APPENDIX - 3
GROUP - 1

S.No.	Age	Sex	IP. N o	Diagnosis	First case	Immersed In saline	Emergency	2nd time shunt	Persons in OT	Peri-operative antibiotics	Intermediate skin incision
1	17	F	19237	Post- meningitic Hydrocephalus	Yes	No	No	No	3	Yes	No
2	28	M	58780	Cerebellar SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No
3	28	M	58794	Sellar SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No
4	33	M	72773	Trapped lateral ventricle	Yes	No	No	No	3	Yes	No
5	8m	M	71507	Aqueductal Stenosis	Yes	No	No	No	3	Yes	No
6	14	F	66505	Post- fossa SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No
7	26	M	69104	Colloid cyst with Hydrocephalus	Yes	No	Yes	No	3	Yes	No
8	2.5	F	78599	Aqueductal Stenosis	Yes	No	No	No	3	Yes	No
9	3m	F	97055	Aqueductal Stenosis	Yes	No	No	No	3	Yes	No
10	30	M	34862	Tuberculoma with Hydrocephalus	Yes	No	No	No	3	Yes	No
11	8	F	1664	Sellar SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No
12	35	M	94446	Obstructive Hydrocephalus	Yes	No	Yes	No	3	Yes	No
13	1	F	418	Aqueductal Stenosis	Yes	No	No	No	3	Yes	No
14	40	F	44695	Lt. CP Angle SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No
15	48	F	45558	Lt. CP Angle SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No
16	30	M	41261	Post-Traumatic Hydrocephalus	Yes	No	No	No	3	Yes	No
17	59	M	21439	Cerebellar SOL with Hydrocephalus	Yes	No	Yes	No	3	Yes	No
18	27	F	27283	Post- fossa SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No
19	21	F	61123	Lt. CP Angle SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No
20	5	M	52491	Post- fossa SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No
21	36	F	60491	Obstructive Hydrocephalus	Yes	No	No	No	3	Yes	No
22	45	F	84421	Lt. CP Angle SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No
23	14	F	89133	Cerebellar SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No
24	29	M	90829	Rt.CP Angle SOL WITH hydrocephalus	Yes	No	Yes	No	3	Yes	No
25	47	F	88006	Lt. CP Angle SOL with Hydrocephalus	Yes	No	Yes	No	3	Yes	No
26	23	F	43207	Sellar SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No
27	1	F	85193	Aqueductal Stenosis	Yes	No	No	No	3	Yes	No

28	1	F	86120	Pineal SOL with HYDROCEPHALUS	Yes	No	No	No	3	Yes	No
29	21	M	17875	Cerebellar SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No
30	2.5	M	17904	Tuberculoma with Hydrocephalus	Yes	No	No	No	3	Yes	No
31	1.5	F	16350	Communicating Hydrocephalus	Yes	No	No	No	3	Yes	No
32	4m	M	23214	Aqueductal Stenosis	Yes	No	No	No	3	Yes	No
33	1.5	M	7815	MMC with HYDROCEPHALUS	Yes	No	No	No	3	Yes	No
34	31	M	6804	Sellar SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No
35	45	M	21185	Cerebellar SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No
36	52	F	25736	Lt. CP Angle SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No
37	8m	F	30069	MMC with HYDROCEPHALUS	Yes	No	No	No	3	Yes	No
38	6	F	30104	POST- FOssa SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No
39	1	m	41276	Post- fossa SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No
40	11	M	96102	Post- fossa SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No
41	8	F	1664	Sellar SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No
42	32	M	6246	Communicating Hydrocephalus	Yes	No	No	No	3	Yes	No
43	55	M	6922	Communicating Hydrocephalus	Yes	No	No	No	3	Yes	No
44	30days	F	30069	MMC with HYDROCEPHALUS	Yes	No	No	No	3	Yes	No
45	45	F	32799	Supraselar SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No
46	5m	M	26737	MMC with HYDROCEPHALUS	Yes	No	No	No	3	Yes	No
47	1	M	31235	Aqueductal Stenosis	Yes	No	No	No	3	Yes	No
48	6m	F	12188	Aqueductal Stenosis	Yes	No	No	No	3	Yes	No
49	40	F	28203	Lt. CP Angle SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No
50	20days	F	21560	Dandy Walker Malformation with Hydrocepha	Yes	No	No	No	3	Yes	No
51	8	F	26448	Intraventricular SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No
52	5	M	27039	Aqueductal Stenosis	Yes	No	No	No	3	Yes	No
53	11m	F	26933	Aqueductal Stenosis	Yes	No	No	No	3	Yes	No
54	3m	M	15142	MMC with HYDROCEPHALUS	Yes	No	No	No	3	Yes	No
55	13days	F	20960	Aqueductal Stenosis	Yes	No	No	No	3	Yes	No
56	28	M	25740	Post- meningitic Hydrocephalus	Yes	No	No	No	3	Yes	No
57	8m	M	13052	Aqueductal Stenosis	Yes	No	No	No	3	Yes	No
58	12	m	23275	Supraselar SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No

59	1	M	23014	Cerebellar SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No
60	4m	M	23123	MMC with HYDROCEPHALUS	Yes	No	No	No	3	Yes	No
61	3	F	23167	MMC with HYDROCEPHALUS	Yes	No	No	No	3	Yes	No
62	1	F	23197	Post- meningitic Hydrocephalus	Yes	No	No	No	3	Yes	No
63	67	M	23267	NPH	Yes	No	No	No	3	Yes	No
64	5	M	23280	Cerebellar SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No
65	18	F	23285	Rt.CP Angle SOL WITH hydrocephalus	Yes	No	No	No	3	Yes	No
66	28	M	23287	Post-Traumatic Hydrocephalus	Yes	No	No	Yes	3	Yes	No
67	45	M	23314	Post- fossa SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No
68	30	M	23326	Rt.CP Angle SOL WITH hydrocephalus	Yes	No	No	No	3	Yes	No
69	18	m	23367	Cerebellar SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No
70	80	M	23389	NPH	Yes	No	No	No	3	Yes	No
71	45	F	24010	Rt.CP Angle SOL WITH hydrocephalus	Yes	No	No	No	3	Yes	No
72	23	F	24015	Cerebellar SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No
73	12days	F	24028	MMC with HYDROCEPHALUS	Yes	No	No	No	3	Yes	No
74	45days	M	24098	Aqueductal Stenosis	Yes	No	No	Yes	3	Yes	No
75	2m	M	25124	Aqueductal Stenosis	Yes	No	No	No	3	Yes	No
76	32	M	25136	Lt. CP Angle SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No
77	30	M	26014	Cerebellar SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No
78	19	M	26074	Supraselar SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No
79	24	M	26090	Sellar SOL with Hydrocephalus	Yes	No	No	No	3	Yes	No
80	35	F	26099	Rt.CP Angle SOL WITH hydrocephalus	Yes	No	No	No	3	Yes	No

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APPENDIX – 1

PROFORMA OF STUDY

Patient's name:

Age: Sex:

I.P.No. MIN.No.

D.O.A D.O.D

Address: Contact no.

Presenting complaints:

Clinical examination:

Radiology:

Treatment:

D/B: A/B:

Whether done as first case?

Whether shunt tube immersed in saline?

Whether done as emergency?

H/o previous shunt:

Whether pre-op antibiotics given?

Whether intermediate skin incision used?

Duration of surgery:

Follow-up:

APPENDIX – 2

PATIENT CONSENT FORM

STUDY TITLE:

Study centre : Department of Neurosurgery, MMC, Chennai – 600003.

Patient's name :

Patient's age :

Identification No:

Patient may check () these boxes

I confirm that I have understood the purpose of this study. I have the opportunity to ask the questions and all my questions and doubts were answered to the best of my satisfaction.

I understand that my participation in the study is voluntary and that I am free to withdraw at anytime without my legal right being affected.

I understand that sponsor of the clinical study. Other's working on the sponsor's behalf, the ethic's committee and the regulatory authorities will not need my permission to look at my health records both in respect of the current study and any further research that may be conducted in relation n to it, even if I withdraw from the study. I agree to this access, however, I understand that my identity would not be revealed. In any

information released to the third parties or published, unless as required under the law. I agree not to restrict the use of any data or results that arise from this study.

I agree to take part in the above study and to comply with the instructions given during the study and to faithfully to cooperate with the study team, and to immediately inform inform the study staff if I suffer from any deterioration in my health or my well being or any expected or unusual symptoms.

I hereby give consent to participate in this study.

Signature/ Thumb impression of the patient:

Place:

Patient’s name and address:

Signature of the investigator:

Name of the investigator: