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Outcomes of hydrocephalus ventriculoperitoneal shunt surgery at a rural hospital

Degree Project in Medicine

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Abstract

Introduction

Idiopathic normal pressure hydrocephalus (iNPH) is a disease portrayed by a triad of symptoms, gait disturbance, incontinence, and cognitive impairment. iNPH is common among the elderly population with a 3.7 % prevalence (65 years or older). The main treatment is shunt insertion, to transport cerebrospinal fluid (CSF) from the ventricles to the peritoneal cavity, a ventriculoperitoneal (VP) shunt.

Aim

To evaluate the shunt response, complication and mortality rate among patients who received a VP-shunt at a rural hospital.

Methods

Sixty-seven patients underwent surgery at Östersund's Hospital from 2016 to 2020 after being chosen by a neurologist and a neurosurgeon. In this retrospective study, the medical records of all patients who received a shunt were reviewed, and data were collected using protocols from the Swedish National Hydrocephalus Registry. Patients were tested preoperatively, 3 months and 12 months postoperatively. A modified version of the iNPH score was used to evaluate shunt response. Mortality and cause of death was observed using the death certificate. Complications were found in medical records.

Results

Three months postoperatively, 89 % of the patients improved significantly in their modified iNPH-score, and 79 % significantly improved in the twelve-months postoperative examination. The six months revision rate was 6 %, caused by infection, subdural hematoma, and distal catheter obstruction. All complications amounted to 9 %, with 3 % being subdural hematoma. Mortality was 15%, with a mean time of 24 months since surgery when the patient died (span: 11-49 months).

Conclusion

VP shunt surgery for iNPH at a rural hospital resulted in a shunt response rate of 89 %, and a low complication rate (6 %) compared to the literature.

KEYWORDS: idiopathic normal pressure hydrocephalus, rural hospital, iNPH-score

Background

Idiopathic normal pressure hydrocephalus

Epidemiology

iNPH is mainly found among the elderly population and there is no significant difference in prevalence between men and women (1). In a study performed in Jämtland in 2014 using American-European guidelines for diagnosis, a prevalence of 2.1 % was found in the population 65-80 years old, and 8.9 % among those 80 years or older. The total prevalence in the population 65 years or older was 3.7 % (2).

Etiology

The characteristics of idiopathic normal pressure hydrocephalus (iNPH) is an expansion of the ventricles of the brain, portrayed by radiology, while the intracranial pressure (ICP) remains within normal values (3). The ventricle system is part of the liquid system of cerebrospinal fluid (CSF) which circulates the entire central nervous system (CNS). CSF is produced mainly by the choroid plexus which is located in the lateral, third and fourth ventricle of the brain. CSF is also believed to originate from extracellular fluid from the brain's parenchyma (4). The fluid circulates the CNS with the help of intracranial arterial pulsations and a difference in pressure between the production sites and absorption sites, which are the arachnoid granulations located by the venosus sinuses. In patients with iNPH, the compliance of the brain is reduced due to an overabundance of CSF caused by an imbalance between production and absorption of CSF. The excess CSF causes the ventricles to enlarge. The poor compliance decreases the intracranial stroke volume due to the restriction of arterial expansion, by up to 50 % of that of a non-iNPH affected individual, which reduces the perfusion of the brain (5).

Symptoms

iNPH is manifested by a triad of clinical symptoms: gait disturbance with a broad based, small-stepped gait, incontinence, and cognitive impairment. However, this triad of symptoms rarely debuts simultaneously and therefore it is of great importance to be observant of each symptom individually. Only in half of the diagnosed cases, the full triad is seen. Gait disturbance is usually the first symptom, followed by dementia, and later incontinence (3). Poor balance with retropulsion is also considered a characteristic.

Diagnosis

Because of the complexity of the disease along with the symptomatic similarity to other diseases such as Alzheimer's disease and Parkinson's disease, iNPH is underdiagnosed and often diagnosed late in its lapse. There are several ways to diagnose iNPH, one of which is the "tap-test". About 30-60ml of CSF is removed with lumbar punction and is sent for analysis. Before and after "the tap", neuropsychological tests and gait evaluation is performed. If the patient improves after the tap, it is a positive tap test and indicates that neurosurgical intervention could be beneficial. However, the sensitivity is only about 60 % and therefor a negative outcome does not rule out iNPH and a prolonged lumbar drainage can be the next step. Neuroimaging is a pilar in diagnosing iNPH. CT or MRI is used to measure and detect ventriculomegaly which gives a reliable diagnosis, along with the clinical symptoms. MRI might else way find another explanation for the symptoms. Therefore, the symptomatic triad along with neuroimaging gives a reliable diagnosis, while the tap test indicates if shunt surgery could ease the symptoms (3). The surgery should be performed promptly after diagnosis since there is a progression of symptoms over time (6). The patient's probability to fully restore their functions decreases with the progression of the disease (6, 7).

Treatment, outcome, complications, and revision rate

The aim of treatment is to improve the quality of life in patients (3). The most used treatment for iNPH is to surgically insert a ventriculoperitoneal shunt (VP shunt) which diverts CSF from the lateral ventricle to the peritoneal cavity. The shunt catheter runs subcutaneously from the skull to the abdomen opening into the peritoneal cavity (Fig. 1). There is also a ventriculoatrial shunt where the catheter is placed in the atrium of the heart. The valve of the shunt is either fixed or adjustable, where the ladder one can adjust the resistance postoperatively with the use of a magnet. Less resistance means a higher flow of CSF from the brain which reduces symptoms; however, over-drainage is the constant risk one must take into consideration when setting the resistance. CSF over-drainage causes subdural hematoma which is the most common complication. Other post-operative complications are infection, headache, and mechanical shunt failure (8). The incidence of complications varies between studies but lies around 20-30 % (3, 8). Subdural hematoma occurred among 6.8 % of patients in a review study from 2013 containing 3063 patients (9). An average of 60-80 % of patients improves after VP shunting, however, since 2006 that number has been as high as 82 % (3, 9, 10). The review study containing 3063 patients reported a shunt revision rate of 16 % (9). The mortality rate varies (1-16%) between studies (9, 11). Shunt revision is necessary if the shunt malfunctions or is wrongfully placed.

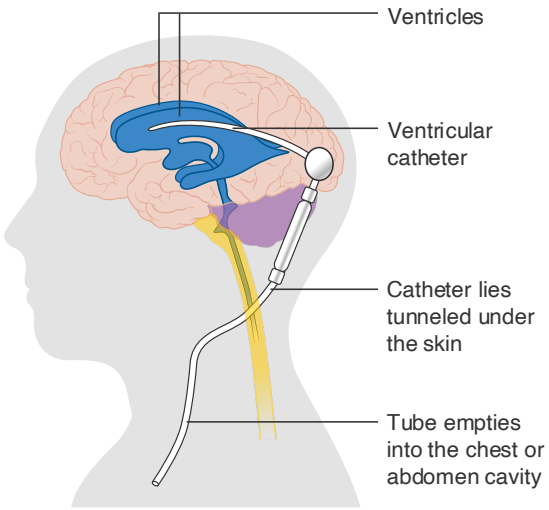

Figure 1. Schematic view of placement of cerebral shunt (12).

Swedish National Hydrocephalus Registry

The Swedish National Hydrocephalus Registry (NHR) is the result of a joint effort from all neurological and neurosurgical centers in Sweden. It is a database intended to aid practitioners in their daily work and to be a guideline for quality control. The registry also contains data of outcome and the occurrence of complications after shunt surgery (Fig. 2). The aim of NHR is to advance the hydrocephalus care nationwide (13).

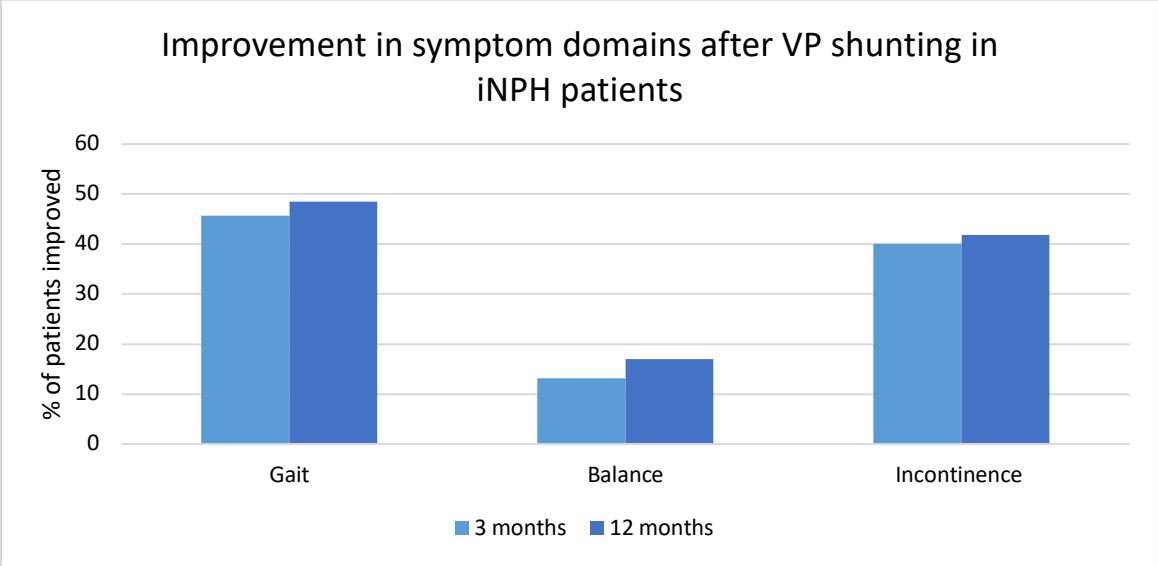

Figure 2. Statistics from the Swedish National Hydrocephalus Registry, 2004-2020 (13). Mean improvement rate in patients 3- and 12-months post ventriculoperitoneal shunting.

VP shunting at a rural hospital

In Sweden, a VP shunt surgery is only performed in neurosurgical centers and rural hospitals send their iNPH-patients by plane or car to a center to have the procedure. There are only six neurosurgical centers in Sweden. This imposes several challenges, not only logistically for the patient and family members, but also administratively for both hospitals. Since 2016, one neurosurgeon from Sahlgrenska University Hospital (a neurosurgical center) has been travelling to Östersund's Hospital (ÖH) (a rural hospital) to perform primary VP shunting with a Strata valve (a type of shunt with an adjustable valve) on iNPH patients.

Research questions /Aim

The aim is to evaluate shunt response rate, complication rate and mortality rate among patients who have had a primary shunt insertion at a rural hospital.

What is the shunt response rate and mortality rate for iNPH patients after VP shunt treatment at Östersund's Hospital?

What was the 6 months shunt revision rate and complication rate for patients who underwent primary VP shunting at Östersund's Hospital 2016-2020?

Methods

Study population

The study population consisted of every patient who underwent a primary VP shunt surgery at Östersund's Hospital between January 2016 and December 2020, performed by the same neurosurgeon from Sahlgrenska University Hospital. The patients were selected for surgery

by an experienced neurologist at Östersund's Hospital, along with the neurosurgeon for consult. For the retrospective study, the patients were found in the medical records system Cosmic using the diagnostic code for shunt insertion, and a list of all patients was composed.

Data collection procedures

This was a retrospective observational cohort study where the data was collected from medical records using protocols from the Swedish National Hydrocephalus Registry (see Appendix). Patients were assessed, preoperatively, three months postoperative examination and 12 months postoperative examination. The variables included were gait, balance, continence, TUG time in seconds and number of steps, 10m walk time in seconds and number of steps, and MMT (Mini Mental Test). The occurrence of complications was noted, as well as the measure taken to handle the complication, and included subdural hematoma, intracerebral hematoma, peritoneal infection, stroke/TIA within one month and faulty distal shunt placement. Shunt revision within six months postoperatively was considered in the assessment of the shunt revision rate. No revisions occurred after the six months mark; therefore, all shunt revisions are included in this study. Cause of death was found in the patient's death certificate. Death within 12 months will be looked at.

Quantifying symptoms

The iNPH score scale was used to accurately assess the symptoms in the three different examinations. The values of gait scale, 10-meter walk time in seconds and number of steps, continence scale and balance scale were converted using the iNPH score scale, established by Hellström et al, and later calculated accordingly. The modified equation used to find the iNPH score is $Gait: mean \times 2 + Continence + Balance$[4]. Neuropsychology was not accounted for in this equation since the examinators used MMT to assess this domain, while

Hellström et al uses three other neuropsychological tests. MMT and TUG was assessed separately (14).

iNPH score scale and iNPH score

The iNPH score scale was developed by Hellström et al "To present a new, continuous, calibrated and norm-based scale for the grading of severity and assessment of treatment outcome in idiopathic normal pressure hydrocephalus". The scale focuses on the four domains that characterizes iNPH: Gait, balance, continence, and neuropsychology. Each domain is evaluated in a clinical examination performed by a neurologist or a physical therapist and graded on a scale with specific requirements. This scale can later be converted to a value between 0 and 100, where 100 represents no symptoms and 0 represents severe symptoms. By using the converted values and the equation $Gait: mean \times 2 + Continence + Balance + Neuropsychology$□5□, the iNPH score is calculated. "Gait:mean" in this equation is determined by calculating the mean of the combined converted values of gait scale, 10m walk time in seconds and 10m walk number of steps. The calculated iNPH score is a number

between 1 and 100 and the patient has to increase their score ≥5 points to be considered improved after shunt surgery (14).

Gait

This domain is evaluated on an ordinal scale (Table 1) as well as the number of steps and time in seconds needed to walk 10 meters. These measurements are then converted into iNPH score values (Table 2) (14).

Table 1. Gait scale ordinal rating requirements.

1	Normal
2	Slight disturbance of tandem walk and turning
3	Wide-based gait with sway, without foot corrections
4	Tendency to fall, with foot corrections
5	Walking with cane
6	Bi-manual support needed
7	Aided
8	Wheelchair bound

Table 2. Conversion of gait tests to iNPH score values (Taken from Hellström et al.).

Ordinal rating of gait	Walk 10 m, free pace, number of steps	Walk 10 m, free pace, seconds
1 = 100	<15.50 = 100	<8.75 = 100
2 = 86	15.50–16.50 = 90	8.75–9.25 = 90
3 = 71	16.75–17.25 = 80	9.50–9.75 = 80
4 = 57	17.50–18.00 = 70	10.00–10.25 = 70
5 = 43	18.25–19.25 = 60	10.50–10.75 = 60
6 = 29	19.50–20.25 = 50	11.00–11.50 = 50
7 = 14	20.50–21.25 = 40	11.75–13.00 = 40
8 = 0	21.50–23.75 = 30	13.25–16.00 = 30
	24.00–27.25 = 20	16.25–19.25 = 20
	27.50–40.00 = 10	19.50–27.00 = 10
	>40 or fail = 0	>27 or fail = 0

Balance

The balance domain is evaluated on an ordinal scale based on how well the patient manages to stand up straight, on both legs and on one (Table 3). The ordinal scale is later converted into iNPH score values (Table 3) (14).

Table 3. Balance scale ordinal rating requirements and iNPH score values.

Scale	Requirements	iNPH score value
1	Able to stand independently for more than 30 s on either lower extremity alone.	100
2	Able to stand independently for <30 s on either lower extremity alone.	83
3	Able to stand independently with the feet together (at the heels) for more than 30 s.	67
4	Able to stand independently with the feet together for <30 s.	50
5	Able to stand independently with the feet apart (one foot length) for more than 30 s.	33
6	Able to stand independently with the feet apart for <30 s.	17
7	Unable to stand without assistance.	0

Continence

This domain is based on the patient's own statement and is evaluated on an ordinal scale which is later converted into iNPH score values (Table 4) (14).

Table 4. Continence scale ordinal rating requirements and iNPH score values.

Scale	Requirements	iNPH score value
1	Normal.	100
2	Urgency without incontinence.	80
3	Infrequent incontinence without napkin.	60
4	Frequent incontinence with napkin.	40
5	Bladder incontinence.	20
6	Bladder and bowel incontinence.	0

Other measurements

Timed Up and Go

Timed Up and Go test (TUG) is a test evaluating movement and coordination that has been useful in evaluating iNPH patients. The patient is sitting in an armchair and is timed getting up and walking three meters and back, until the patient sits back down. Number of steps is also counted. This test is used to assess mobility and ability to be alone, safely, at home and outside. Improvement is considered to be fewer number of steps and a faster time (15). Approximately 60-80 % of patients with iNPH who receive a shunt improve one second/step or more in the 3- and 12-months postoperative examination (Figure 3 and 4) (13).

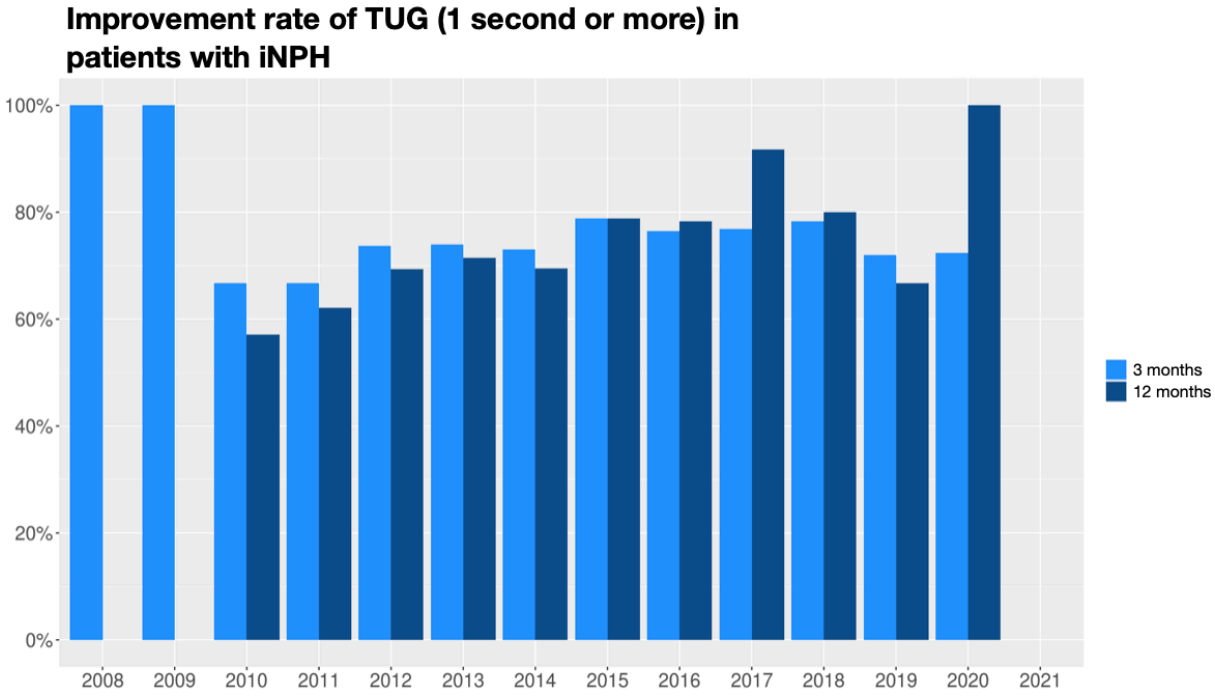

Figure 3. Improvement rate of TUG (1s or more) in patients with iNPH 3 and 12 months after shunt surgery. Extracted from the Swedish National Hydocephalus registry 21-04-18 (13).

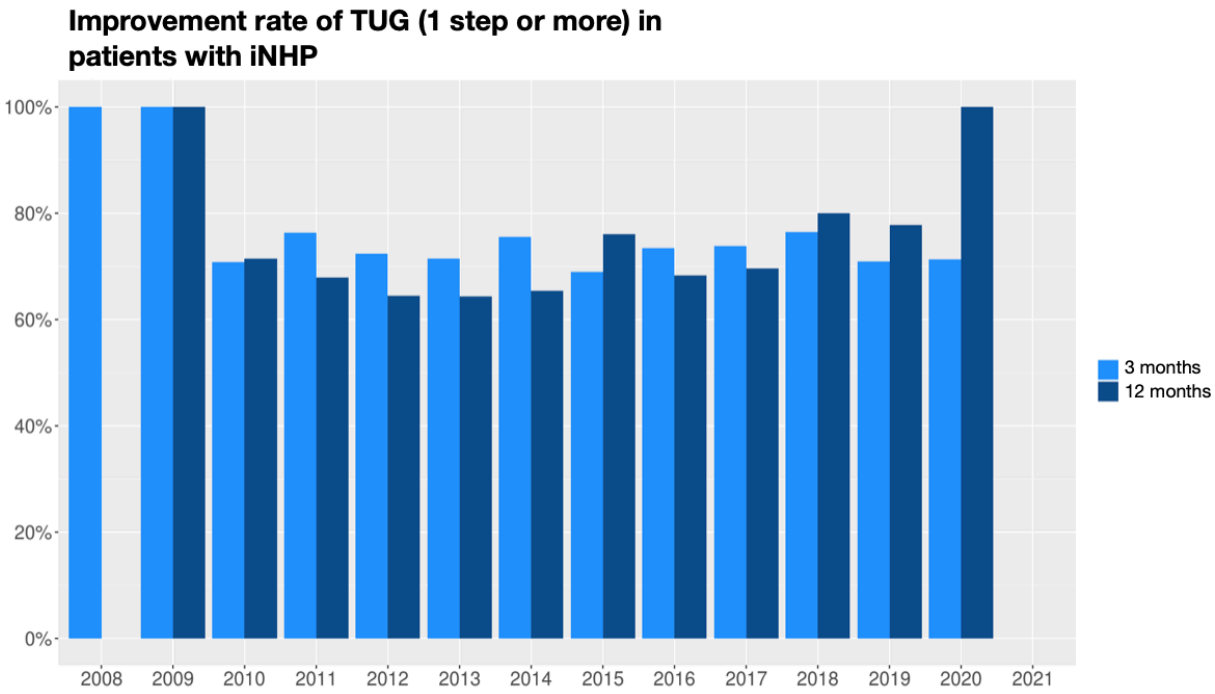

Figure 4. Improvement of TUG (1 step or more) in patients with iNPH 3 and 12 months after shunt surgery. Extracted from the Swedish National Hydocephalus registry 21-04-18 (13).

Mini Mental Test/Mini Mental State Exam

There are several methods to evaluate symptoms of cognitive impairment in patients with iNPH, and the Mini Mental Test (MMT) or Mini Mental State Exam (MMSE) is a commonly used one (16). The MMT consists of questions and tasks designed to test orientation, attention, short- and long-term memory, language, and ability to copy a figure. Scores range between 0 points (severe cognitive impairment) and 30 points (no measurable cognitive impairment). MMT is the least likely symptom to improve after shunt surgery and between 0-80 % of patients improve (17). The estimated average pre-shunt score is 23.1 points with an average improvement of 2.2 points 3-12 months postoperatively (16).

Statistical methods

IBM® SPSS® Statistics version 27 was used for all analyzes. Wilcoxon signed-rank test with paired samples was used to analyze the data. This method was most suitable since the sample was relatively small and of a nonparametric nature with related samples. There was also one extreme value (patient 27) that would have influenced a paired T-test but would not affect the Wilcoxon test because of the use of ranks. (To assure this, the test was performed with and without that patient's values. The mean was lower without patient 27's values but the median remained the same, which shows that a non-parametric test is not affected by extreme values). Descriptive statistics were used for complications and revisions. The p-value was set to <0.05 to be considered statistically significant.

Ethics

Formal approval to study charts and collect data was attained from the operations manager of the neurology department at Östersunds Hospital. Personal information was de-identified, and each patient received a reference number to protect their integrity. There was no risk to the patient's health in this study since the examinations were already performed and only medical records were studied.

Conflict of interest

There was no conflict of interest in this study.

Results

Cohort

In total, 67 patients were included in the study, all of whom were adults. 95.5 % of the study population had iNPH, the other 4.5 % had NPH secondary to: trauma (1), tumor (1) and

congenital NPH with decompensation as an adult (1). The mean age upon surgery was 75.4 years. The gender distribution was 37 % female and 63 % male.

Diagnosis	N = 67	Percent
iNPH	64	95,5
NPH secondary to trauma	1	1,5
NPH secondary to tumor	1	1,5
Congenital NPH with decompensation as an adult	1	1,5
Mean age upon surgery (y)	75.4	
Gender distribution:		
_Men	63%	
_Women	37%	

iNPH score

The iNPH score increased significantly 3 months after surgery ($p<0.001$) and 12 months after surgery ($p<0.001$). 89 % (55 out of 62) improved their score after 3 months and 79 % (34 out of 43) after 12 months. The mean increment after 3 months was 13.4p and 13.0p after 12 months (Fig. 5, Table 5). Not all patients have completed both follow up examinations.

Table 5. Mean and median values of the modified iNPH score scale score for all three examinations.

iNPH score	Mean	Median	Improved score (n)	Worse score (n)	Same score (n)
Preop (n=67)	49.8	50.5			
3 months postop (n=62)	63.2	67.7	55	6	1
12 months postop (n=43)	62.8	66.1	34	9	0

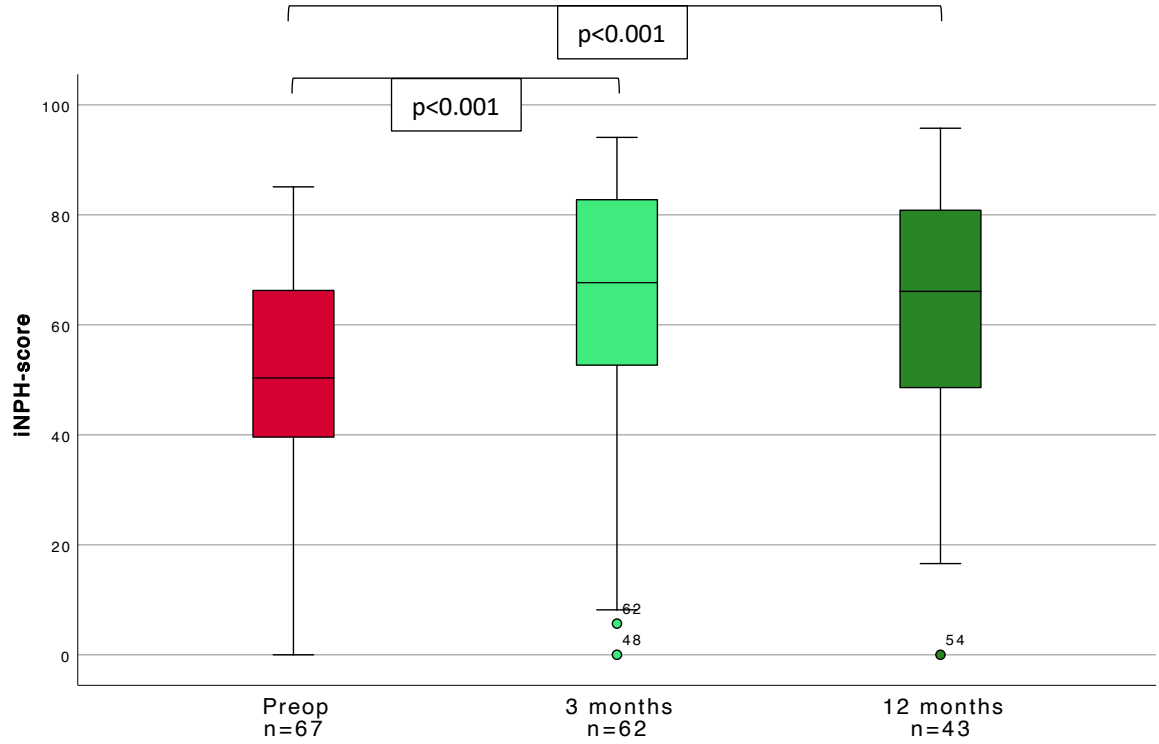

Figure 5. iNPH-score before surgery, 3 months after and 12 months after.

MMT

In the 3 months postoperative examination, 62 % (37 out of 60) improved in the MMT (p=0.001) (Fig. 6, Table 6).

In the 12 months postoperative examination, 51 % (22 out of 43 patients) improved (p=0.076) (Fig. 6, Table 6).

Table 6. Mean and median values of the mini mental test for all three examinations.

Mini mental test	Mean	Median	Improved (n)	Worsened (n)	Same score (n)
Preop (n=66)	24.4	25.0			
3 months postop (n=60)	25.6	27.0	37	13	10
12 months postop (n=43)	25.5	28.0	22	10	11

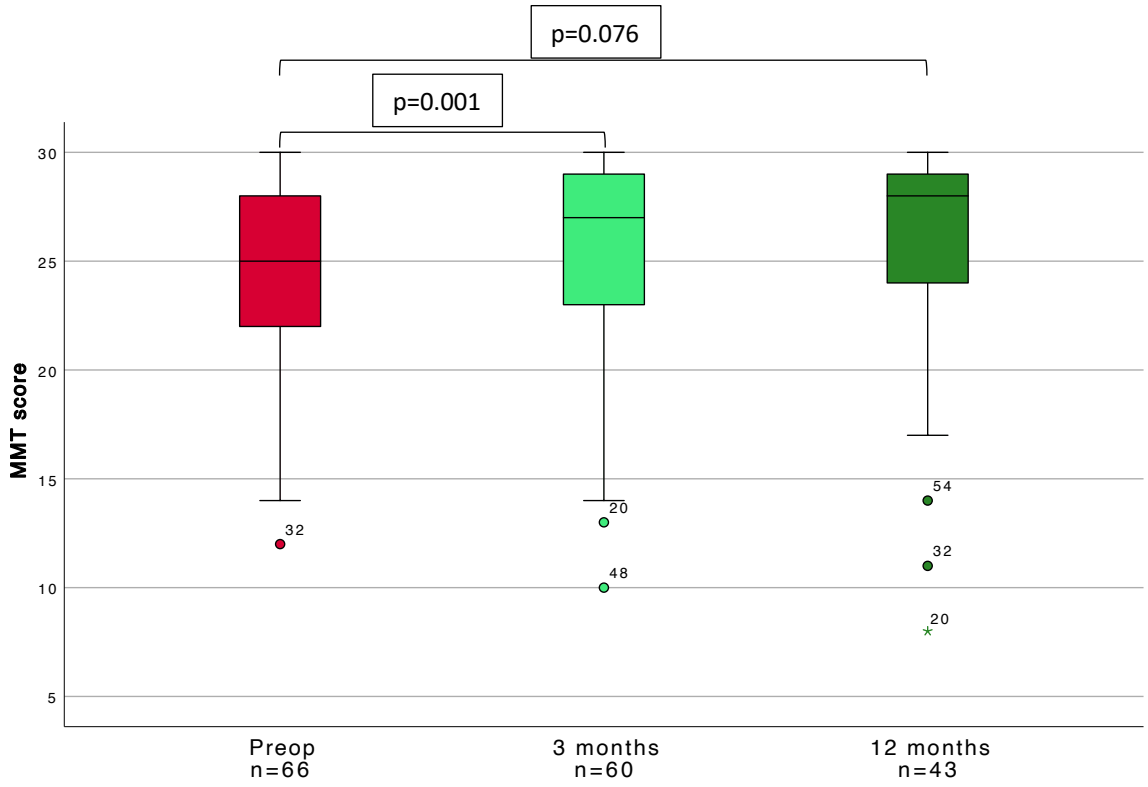

Figure 6. Mini mental test (MMT) scores before surgery, 3 months after and 12 months after surgery.

TUG

There was an outlier in the TUG test. The pre-surgery values for patient 27 were 176 seconds and 179 steps. Mean and median time with his values included were 25.9s and 18.1s, and without them they were 23.5s and 18.0s. Mean and median number of steps with his values were 26.9 and 23.0, and without them they were 24.3 and 22.5. All calculations were performed with patient 27's values included.

Mean time 3 months after surgery significantly decreased (p=0.001), 74 % (42 out of 57) were faster than before surgery. The mean time decreased 12 months after surgery, non-significantly (p=0.054), 65 % (26 out of 40) were faster than before surgery (Fig. 7, Table 7).

Mean number of steps 3 months after surgery significantly decreased ($p<0.001$), 65 % (35 out of 54) had fewer number of steps than before surgery. The mean number of steps decreased significantly 12 months after surgery ($p=0.046$), 65 % (26 out of 40) decreased their number of steps (Fig. 7, Table 7).

Table 7. Mean and median values of the timed up and go (TUG) test (number of steps and time in seconds) for all three examinations.

Timed up and go	Mean	Median	Improved (n)	Worsened (n)	Same value (n)
Time (s):					
Preop (n=62)	25.9	18.1			
3 months postop (n=57)	20.1	15.0	42	14	1
12 months postop (n=40)	17.7	14.5	26	14	0
Number of steps:					
Preop (n=59)	26.9	23.0			
3 months postop (n=54)	23.0	19.0	35	14	5
12 months postop (n=40)	22.0	20.0	26	12	2

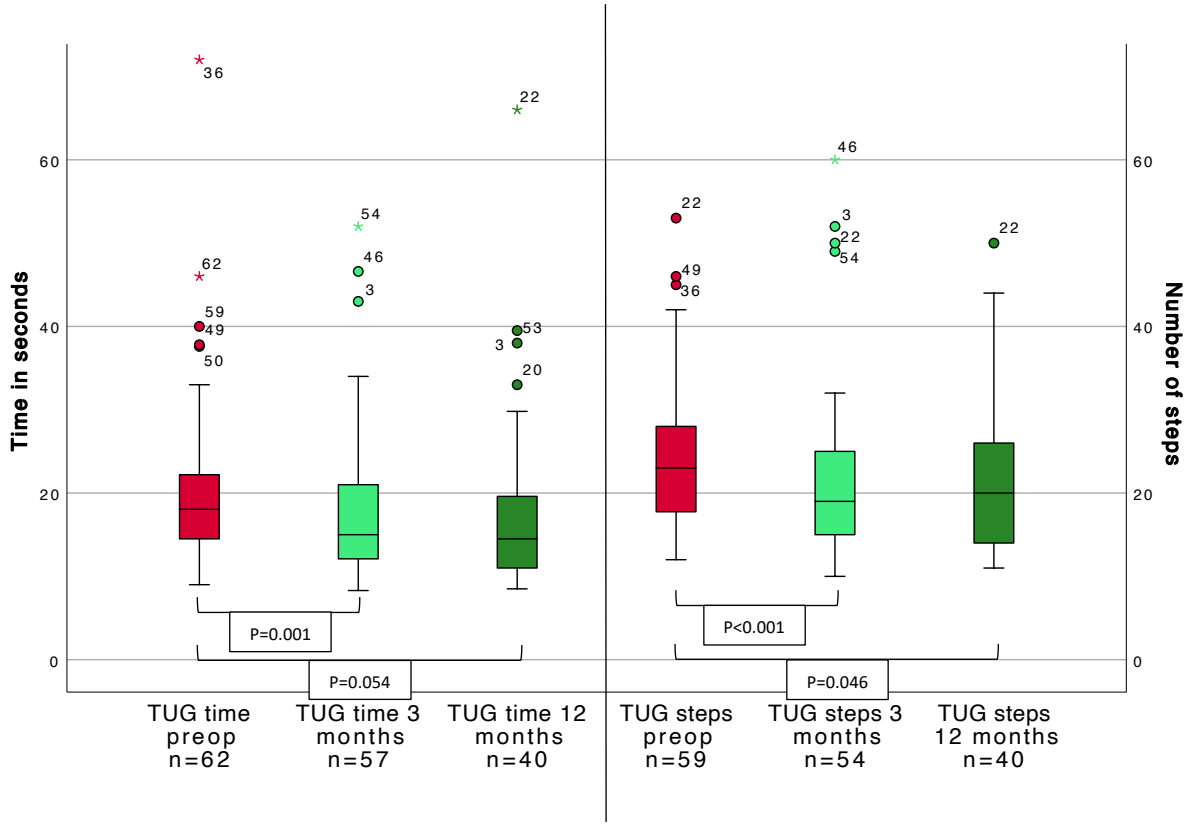

Figure 7. Timed up and go (TUG) time and number of steps before, 3 months after and 12 months after surgery. The preop-values for patient 27 are not shown on this chart because of their extreme value. Time = 176s, Number of steps = 179.

Complications

There were 61 out of 67 patients (91 %) who did not suffer any complications. Two patients (3 %) suffered a subdural hematoma, one had an intracerebral hematoma, one had a peritoneal infection, one had a misplaced distal shunt catheter and one had a cerebrovascular event within one month of the procedure. Nine patients had asymptomatic subdural effusions discovered on routine CT-scans.

Revisions

Six percent (n=4) underwent a shunt revision within 6 months of the primary surgery; two subdural hematoma, one infection, one distal catheter obstruction.

Deceased

Two patients died within 12 months after surgery. Both these patients died 11 months after surgery and the cause of death was not directly related to the surgery. (Table 8).

Table 8. Table of cause of death, age upon surgery and time since surgery when they died among all those who died in this study.

Patient ID	Age upon surgery	Sex	Cause of death	Time in months from surgery when patient died
38	80	F	Dementia and hypertension	11
46	74	F	Cervix cancer, urosepsis	11
Mean:	77			11

Discussion

The shunt response rate (89 %) found in the present study is comparable to results from previous studies where the improvement rates were 60-82 % (3, 9). This implies that performing VP shunting at a rural hospital has the same success rate as performing the surgery in a conventional setting. The mean iNPH-score was similar 3 months postoperative (63.2) than it was 12 months postoperative (62.8). Although, there were 19 fewer patients in the 12 months examination than in the 3 months examination (62 compared to 43). To assure that there is a significant difference between the two post op examinations, the groups need to be comparable. Hence, this comparison would be of interest when the 12 months examination has been performed on the remaining patients. One could then also speculate if the shunt effect after 12 months, may be related to other diseases common in this age group. For example, Israelsson et al showed that iNPH patients have more vascular risk factors than non-iNPH individuals in the same sex- and age-group (18). It is not uncommon however to see a better result in the 3 months postoperative examination than in the 12 months postoperative examination, which can be seen in the statistics from Swedish National Hydrocephalus Registry (13). One factor that made this comparison difficult is that this study used the iNPH-

scale to quantify and measure symptoms. However, the NHR does not use this method yet, seeing that it is rather new (2012), but instead uses the iNPH values for gait and balance etc. separately. Therefore, this study uses the percentage of improved patients as a standard for comparison.

The MMT score improved significantly in the 3 months postoperative examination. However, the improvement was not significant in the 12 months postoperative examination, possibly because data collection for all the 12 months examination is not completed. MMT has previously been shown to be the least likely variable to improve after shunt surgery (17). The TUG test showed a significant improvement in both time and number of steps in the both the 3 months postoperative examination and the 12 months postoperative examination. However, the median number of steps increased between the 3- and 12-months examinations. This implies that a higher number of patients had a higher number of steps in the 12 months examination than in the 3 months examination, but that some patients had a much lower number. The percentages of improved patients are comparable to statistics from NHR.

In this study, the 6-months shunt revision rate was 6 % which is lower than previously published studies (19, 20) and also compared to a big review study on 3063 patients where 16 % had a revision within 6 months (9). The reason for this low revision rate could be coincidental, or there is some other factor involved. One can speculate that the Hawthorne effect (21) comes into play here, where someone performs better when being part of a new approach (shunt surgery at a rural institution). It is possible that the surgeon performed better since this was a new setting with him being in charge. More studies need to be performed in rural hospitals, with different surgeons, to get a more accurate revision rate for shunts inserted in a non-neurosurgical center. Furthermore, the mortality rate was 3 % in this study. In a study

with a 5-year follow up, the mortality rate was 16 %, which is higher than our result. The cause of deaths in that study were unrelated to the surgery or iNPH (11). Since the causes of death in this study were also unrelated to surgery or iNPH, one might speculate that a longer follow-up time would result in a higher mortality rate. The incidence of complications was lower than the range of what is expected. A study showed 6.8 % of patients are expected to suffer subdural hematoma (9), whereas this study showed that 3 % did so. Also, the incidence of other complications was lower, which is why the total amount of complications is lower than that of other studies (3, 8, 9).

A limitation of this study was the use of the modified iNPH score scale, with neuropsychology removed (because the test used to assess cognition was the MMT, which is not functional with the iNPH score scale). This might have shifted the scores to a higher improvement. However, this study has focused of the percentage of improved patients, not the score per se, to be able to compare results to other studies and statistics from NHR. Another limitation was the patient lapse that occurred. Due to the Covid-19 pandemic, many non-essential visits to the hospital were postponed, including the follow-up examinations. This was the main reason for the lapse. However, a minority of the lapse occurred because of missing values in medical records, or tests not being performed. This could be prevented in a prospective study.

The aim of this study was to evaluate the shunt response rate and occurrence of complications after VP shunting at a rural hospital. The used method of reading medical records and retrieving data using protocols from NHR was an effective way to approach the research questions. In being a retrospective study, a weakness is the patient and data lapse that did occur. All tests during the examinations were not performed or not documented correctly

which made data collection difficult and inadequate. For future studies, the protocols could be filled out straightaway after the examination and stored for future use in eventual retrospective studies. This would also ensure all tests are performed and documented correctly and reduce the risk of a misunderstanding to a minimum. Moreover, in most retrospective studies, there is the risk of selection bias through including/excluding patients in hindsight to get more beneficial results. However, the risk of that happening in this study is minimal since it was a consecutive study and included all patients who underwent surgery at the hospital. Also, a list of patients was created beforehand using the diagnostic code for shunt insertion. It would be of great value to perform a prospective study with a higher number of participants, and having the procedure performed by different surgeons, as it is at a neurosurgical center. Having the same surgeon perform the procedure on all patients does not resemble the conventional context. The surgeons' skill and technique differ depending on experience. Also, in a prospective study, the iNPH score scale could be used in its full since which tests that will be performed will be decided beforehand.

Conclusion

Patients who underwent shunt insertion for idiopathic normal pressure hydrocephalus at a rural hospital showed good shunt response rate (89 %), and a low shunt revision rate (6 %) compared to the literature. This implies that the procedure can be performed outside a neurosurgical center, using a neurosurgical setup. This may imply better access to shunt surgery for patients with iNPH in rural areas.

Acknowledgement

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Populärvetenskaplig sammanfattning

Utfall av ventrikuloperitoneala shuntoperationer på patienter med normaltryckshydrocefalus utförda på ett mindre sjukhus

Idiopatisk normaltryckshydrocefalus (iNPH) är en sjukdom som drabbar hjärnan och orsakar gång- och balansrubbningar, demens och inkontinens. Det blir en obalans mellan produktionen och absorptionen av ryggmärgsvätska vilket leder till att vätskan ansamlas i hjärnans vätskefyllda hålrum, ventriklarna. Ventriklarna förstoras vilket man kan se på en skiktröntgen av hjärnan. Detta är en relativt vanlig sjukdom och förekommer hos ca 3,7 % av befolkningen som är 65 år eller äldre. Trots detta är det många som inte får rätt diagnos då symtomen kan misstolkas som andra sjukdomar eller ”vanligt åldrande”.

Det finns idag ingen medicinsk behandling för iNPH. För att behandla en patient med iNPH krävs en operation där man sätter in en så kallad shunt, som förflyttar ryggmärgsvätskan från ventriklarna via en slang som går under huden till bukhålan. Denna operation utförs bara på neurokirurgiska center som finns på sex platser i Sverige. Om man bor långt ifrån dessa center skickar hemsjukhuset patienten till ett neurokirurgiskt center för att sätta in shunten. Detta är påfrestande, inte bara för både patienten och anhöriga som behöver resa, utan också för administrativ personal på sjukhusen som koordinerar resan. Patienten går sedan på uppföljning hos neurologen på sitt hemsjukhus med en tremånaderskontroll och en tolvmånaderskontroll.

I ca fem år har en neurokirurg från Sahlgrenska Universitetssjukhuset åkt till Östersunds sjukhus med jämna mellanrum och opererat in shuntar på plats. I denna studie har vi tittat på resultaten av de uppföljande kontrollerna för att se om man får lika bra effekt av operationen som man brukar. Det vi har kunnat se är att en lika stor andel patienter förbättras efter sin

shuntoperation, som det gör i många andra studier och i Sverige i stort. Det har inte varit en större andel komplikationer än vanligt heller. Detta tyder på att det går lika bra att utföra shuntoperationer på små sjukhus som det gör på stora sjukhus med neurokirurgiska center. Om fler sjukhus börjar med detta hade det ökat tillgängligheten för patienterna och sparat sjukhusen och patienterna både tid och pengar. Vidare forskning behövs för att om de får samma resultat på andra sjukhus, innan man helt säkert kan säga att det går precis lika bra att operera in shuntar på små sjukhus.

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Appendix

FORMULÄR FÖR UPPGIFTER TILL NATIONELLT KVALITETSREGISTRET FÖR HYDROCEPHALUS

Patientnamn och personnummer:		År för symtomdebut:	
		Hemortssjukhus:	
		Datum när remiss ankom:	
Datum för preoperativ undersökning:		Beslutsdatum för operation:	

DIAGNOSTYP	DIAGNOS KOMMUNICERANDE
☐ Kommunicerande ☐ Icke kommunicerande ☐ Vet ej	☐ Idiopatisk NPH ☐ Sekundär till SAH ☐ Sekundär till trauma ☐ Sekundär till infektion ☐ Sekundär till tumörsjukdom ☐ Annat
DIAGNOS ICKE KOMMUNICERANDE	**ORSAK TILL ICKE KOMMUNICERANDE**
☐ Akveduktocklusion ☐ Ocklusion foramina Luschkae/Magendi ☐ Ocklusion foramen Monroi ☐ Annat	☐ Idiopatisk ☐ Sekundär
ORSAK TILL SEKUNDÄR ICKE KOMMUNICERANDE	
☐ SAH ☐ Trauma ☐ Infektion ☐ Tumör ☐ Annat	

SYMTOM VID DEBUT			
Gång	☐ Nej	☐ Ja	☐ Vet ej
Balansstörning	☐ Nej	☐ Ja	☐ Vet ej
Inkontinens	☐ Nej	☐ Ja	☐ Vet ej
Kognitiv störning	☐ Nej	☐ Ja	☐ Vet ej
Huvudvärk	☐ Nej	☐ Ja	☐ Vet ej

SYMTOM/FYND/FUNKTION FÖRE FÖRSTA OPERATION

MEDVETANDEPÅVERKAN: RLS (1-8):

GÅNGRUBBNING	BALANS
☐ Normal ☐ Viss störning vid tandemgång och vändningar ☐ Bredspårig och vajande gång utan stegkorrektion ☐ Falltendens vid försök till stegkorrektion ☐ Går med en krycka ☐ Bimanuellt gångstöd (rullator m.m.) ☐ Gång med levande stöd ☐ Rullstolsburen ☐ Vet ej	☐ Kan stå utan stöd 30 sek eller mer på ett ben ☐ Kan stå utan stöd 5-29 sek på ett ben ☐ Kan stå utan stöd 30 sek eller mer med fötterna ihop ☐ Kan stå utan stöd 5-29 sek med fötterna ihop ☐ Kan stå utan stöd 30 sek eller mer med fötterna isär (30 cm) ☐ Kan stå utan stöd 5-29 sek med fötterna isär (30 cm) ☐ Kan ej stå utan stöd (står < 5 sek) ☐ Vet ej
INKONTINENS	**RANKINSKALA**
☐ Normal ☐ Trängningar utan inkontinens ☐ Sällan inkontinent utan blöja ☐ Ofta inkontinent med blöja ☐ Urininkontinent alltid ☐ Urin- och faecesinkontinens ☐ KAD ☐ Vet ej	☐ Inga symtom ☐ Smärre besvär som inte begränsar livsstilen ☐ Mindre handikapp. Viss restriktion av livsstilen har dock förmågan att klara sig själv. ☐ Moderat handikapp som tydligt begränsar livsstilen. I behov av hjälp i vardagen. ☐ Svårt handikapp. Beroende, dock utan att vara helt hjälpberoende. ☐ Mycket svårt handikapp. Helt beroende med konstant tillsyn dag och natt. ☐ Vet ej

VAR GOD VÄND

FORMULÄR FÖR UPPGIFTER TILL NATIONELLT KVALITETSREGISTRET FÖR HYDROCEPHALUS

SYMTOM/FYND/FUNKTION FÖRE FÖRSTA OPERATION			
GÅNG 10 meter valfri hastighet (hämtas från SG-bedömning)	Tid:		Steg:
TIMED UP AND GO (TUG): (hämtas från SG-bedömning)	Tid:		Steg:
MINI MENTAL TEST (MMT):			

BAKGRUNDSDATA			
Claudicatio intermittens	☐ Nej	☐ Ja	☐ Vet ej
Diabetes	☐ Nej	☐ Ja	☐ Vet ej
Hypertoni	☐ Nej	☐ Ja	☐ Vet ej
Hjärtsjukdom	☐ Nej	☐ Ja	☐ Vet ej
Stroke	☐ Nej	☐ Ja	☐ Vet ej
Radiologi	☐ CT	☐ MRT	☐ CT och MRT ☐ Vet ej
Infusionstest	☐ Nej	☐ Ja	☐ Vet ej
Tapptest	☐ Nej	☐ Ja; antal ml_____	☐ Vet ej
Tapptest, långtids	☐ Nej	☐ Ja	☐ Vet ej
Tapptest, långtidstyp	☐ Intermittent	☐ Kontinuerlig	☐ Vet ej

VAR GOD VÄND

Nationellt hydrocefalusregister
Nyinläggning av shunt

Operationsdatum: _____

Operatör: _____

Patient-id

Akut operation: ❑ Ja (<24 tim) ❑ Nej **Tidigare shunt**: ❑ Ja ❑ Nej **ASA**:_____ **RLS:** _____

Diagnos kommunicerande	Diagnos icke kommunicerande	Orsak icke kommunicerande
❑ Idiopatisk NPH ❑ Sekundär till SAH ❑ Sekundär till trauma ❑ Sekundär till infektion ❑ Sekundär till tumörsjukdom ❑ Annat_____	❑ Akveduktocklusion ❑ Ocklusion foramina Luschkae/Magendi ❑ Ocklusion foramen Monroi ❑ Annat_____	❑ Idiopatisk ❑ Sekundär till intraventrikulär cysta ❑ Sekundär till infektion ❑ Sekundär till tumör ❑ Annat_____

Operation:
- ❑ Ventrikuloperitoneal shunt
- ❑ Ventrikuloatrial shunt
- ❑ Ventrikulocisternostomi
- ❑ Endoskopisk fenestration
- ❑ Annat

Ventrikelkateter:
- ❑ Standard
- ❑ Bactiseal Codman
- ❑ ARES Medtronic
- ❑ Annat _____

Ventrikelkateter inlagd:
- ❑ Occipitalt
- ❑ Frontalt
- ❑ Bilateralt
- ❑ Hö ❑ Vä

Ventil
Fabrikat: _____

Tryckinställning cm H_20: _____

Rickhamreservoar: ❑ Ja ❑ Nej

Antisifon: ❑ Ja ❑ Nej

Anteckningar: _____

_____

_____

NATIONELLT KVALITETSREGISTRET FÖR HYDROCEFALUS

- UPPFÖLJNINGSSTATUS -

☐ 3 MÅNADER

☐ 12 MÅNADER

PATIENTNAMN OCH PERSONNUMMER	UPPFÖLJNINGSDATUM:	
	DATUM FÖR POSTOPERATIV RÖNTGENUNDERSÖKNING:	

GÅNGRUBBNING	BALANS
☐ Normal ☐ Viss störning vid tandemgång och vändningar ☐ Bredspårig och vajande gång utan stegkorrektion ☐ Falltendens vid försök till stegkorrektion ☐ Går med en krycka ☐ Bimanuellt gångstöd (rullator m.m.) ☐ Gång med levande stöd ☐ Rullstolsburen ☐ Vet ej	☐ Kan stå utan stöd 30 sek eller mer på ett ben ☐ Kan stå utan stöd 5-29 sek på ett ben ☐ Kan stå utan stöd 30 sek eller mer med fötterna ihop ☐ Kan stå utan stöd 5-29 sek med fötterna ihop ☐ Kan stå utan stöd 30 sek eller mer med fötterna isär (30 cm) ☐ Kan stå utan stöd 5-29 sek med fötterna isär (30 cm) ☐ Kan ej stå utan stöd (står <5 sek) ☐ Vet ej

INKONTINENS	RANKINSKALA
☐ Normal ☐ Trängningar utan inkontinens ☐ Sällan inkontinent utan blöja ☐ Ofta inkontinent med blöja ☐ Urininkontinent alltid ☐ Urin- och faecesinkontinens ☐ KAD ☐ Vet ej	☐Inga symtom ☐Smärre besvär som inte begränsar livsstilen ☐Mindre handikapp. Viss restriktion av livsstilen har dock förmågan att klara sig själv. ☐Moderat handikapp som tydligt begränsar livsstilen. I behov av hjälp i vardagen. ☐ Svårt handikapp. Beroende, dock utan att vara helt hjälpberoende. ☐ Mycket svårt handikapp. Helt beroende med konstant tillsyn dag och natt. ☐Vet ej

GÅNG 10 meter valfri hastighet (hämtas från SG-bedömning)	Tid:	Steg:
TIMED UP AND GO (TUG): (hämtas från SG-bedömning)	Tid:	Steg:

MINI MENTAL TEST:	

NYTILLKOMNA KRAMPER
☐ Nej ☐ Ja

ANTAL VENTILOMSTÄLLNINGAR:	
DATUM FÖR EVENTUELLT AVSLUT:	

ANLEDNING TILL AVSLUT
☐ Vill inte fortsätta ☐ Avliden ☐ Annat

NATIONELLA KVALITETSREGISTRET FÖR HYDROCEPHALUS

- KOMPLIKATION –

PATIENTNAMN	PERSONNUMMER

DATUM FÖR KOMPLIKATION:	

KOMPLIKATIONSTYP

☐ Subduralhematom/hygrom	☐ Felaktig shuntplacering proximalt
☐ Epiduralhematom	☐ Felaktig shuntplacering distalt
☐ Intracerebralt hematom	☐ Felaktig shuntplacering - annat
☐ Shuntstopp proximalt	☐ Sårruptur
☐ Shuntstopp distalt	☐ Hjärtinfarkt (inom 1 mån)
☐ Shuntstopp - ventilfel	☐ Tromboembolism (inom 1 mån)
☐ Shuntstopp ospecificierat	☐ Ockluderad ventrikulocisternostomi
☐ Hudinfektion	☐ Annat
☐ CNS-infektion	
☐ Bukinfektion	
☐ Annan infektion	

BEHANDLING

☐ Reoperation	☐ Annat
☐ Shuntomställning	☐ Ingen

- SHUNTOMSTÄLLNING –

DATUM FÖR SHUNTOMSTÄLLNING:	
ORSAK TILL SHUNTOMSTÄLLNING	

☐ Underdränage/otillräcklig effekt
☐ Överdränage
☐ Annat

TYP AV SHUNTVENTIL	

☐ Codman	☐ Certas
☐ Codman med antisifon	☐ Vet ej
☐ Strata	☐ Annat

VENTILINSTÄLLNING

Ny ventilinställning Codman:……(30 - 200) Tidigare:…….…… ☐ Vet ej

Ny ventilinställning Strata:……..(0,5 - 2,5) Tidigare:…… ☐ Vet ej

Ny ventilinställning Certas:……..(0 – 8) Tidigare:…… ☐ Vet ej

Nationellt hydrocefalusregister
Revision av shunt

Operationsdatum: _____

Operatör:_____

Patient-id

Shunttyp som pat har:
- ❑ Ventrikuloperitoneal
- ❑ Ventrikuloatrial
- ❑ Annat

Akut operation: ❑ Ja (<24 tim) ❑ Nej

Operationsindikation

- ❑ Shuntstopp: ❑ v-kateter ❑ bukdel
- ❑ Felläge: ❑ v-kateter ❑ bukdel
- ❑ Avbrott: ❑ v-kateter ❑ bukdel
- ❑ Ventilfel
- ❑ Överdränering
- ❑ CNS-infektion
- ❑ Hudinfektion
- ❑ Bukinfektion (abscess/cysta)
- ❑ Subduralhematom
- ❑ ICH
- ❑ Annat _____

Ingrepp – revision

- ❑ Ventrikelkateter: ❑ oml ❑ byte
- ❑ Bukdel: ❑ oml ❑ byte
- ❑ Ventilbyte: fel eller obstr
- ❑ Ligatur
- ❑ Totalbyte
- ❑ Utrymning hematom
- ❑ Borttagning av shunt
- ❑ Inläggning av ventrikeldrän
- ❑ Endoskopisk fenestration/VCS
- ❑ Externalisering av bukslang
- ❑ Annat _____

Ventrikelkateter:
- ❑ Standard
- ❑ Bactiseal Codman
- ❑ ARES Medtronic
- ❑ Annat

Ventrikelkateter inlagd:
- ❑ Occipitalt
- ❑ Frontalt
- ❑ Bilateralt
- ❑ Hö ❑ Vä

Ventil
Fabrikat: _____ _____

Tryckinställning cm H_20: _____

Rickhamreservoar: ❑ Ja ❑ Nej

Antisifon: ❑ Ja ❑ Nej

Anteckningar: _____

_____

_____