Int Clin Neurosci J. 2026;13:e53638 Original Article

doi: 10.22037/icnj.v13iContinuous.53638

Clinical Outcomes of Ventriculoperitoneal Shunt Placement for Hydrocephalus at a Tertiary Care Hospital in Bangladesh: A Prospective Observational Study

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Abstract

Background: Hydrocephalus is a major cause of raised intracranial pressure (ICP), leading to ventriculomegaly and neurological impairment due to disturbed cerebrospinal fluid (CSF) dynamics across all age groups. Ventriculoperitoneal (VP) shunt placement remains the gold-standard surgical treatment, diverting excess CSF to restore intracranial homeostasis. Despite its effectiveness, VP shunting is associated with complications such as obstruction, disconnection, and infection, which affect long-term outcomes. This study aimed to evaluate clinical outcomes and complications of VP shunt placement in patients with hydrocephalus at a tertiary hospital in Bangladesh.

Methods: A prospective observational study was conducted from July 2024 to July 2025 at Rajshahi Medical College Hospital, enrolling patients of all ages diagnosed with communicating, non-communicating, or normal pressure hydrocephalus. Data were collected using a standardized pro forma, and surgical procedures followed accepted international protocols. Patients underwent postoperative CT imaging and shunt function assessment, with follow-up of up to 12 months (no patient censored before 12 months) to evaluate outcomes and complications. Data were analyzed in SPSS v30 using descriptive statistics, chi-square/Fisher's exact tests, and Kaplan–Meier analysis of complication-free survival (event = death or shunt infection), with significance set at $P < 0.05$.

Results: A total of 37 patients were included (51.4% male, 48.6% female). Postoperative complications occurred in 10 patients (27%), including mortality in 7 patients (18.9%) and shunt infection in 3 patients (8.1%). Good outcomes were observed in 27 patients (73%), while 10 patients (27%) had poor outcomes. No significant associations were found between age group, etiology, or shunt pressure and clinical outcome, complications, or revision (all $P > 0.05$; revision analyses were limited by a single event). Kaplan–Meier complication-free survival (event = death or shunt infection; 10 events) declined from 94.6% at 1 month to 73.0% at 12 months. Only one patient (2.7%) required shunt revision.

Conclusion: In this small, uncontrolled single-centre series, 73% of patients had a good outcome, but mortality was substantial (18.9%), and complications were common. Larger controlled studies with complete, standardized follow-up are needed.

Keywords: Hydrocephalus; Ventriculoperitoneal shunt; Clinical outcomes; CSF diversion; Shunt infection; Shunt survival.

Received: October 1, 2026, **Accepted:** November 14, 2026, **Published online:** November 18, 2026

Citation: Parveen SA, Haque M, Kadir L, Islam R, Huda S, Siddika M. Clinical Outcomes of Ventriculoperitoneal Shunt Placement for Hydrocephalus at a Tertiary Care Hospital in Bangladesh: A Prospective Observational Study. Int Clin Neurosci J. 2026;13:e53638.

Introduction

Hydrocephalus represents a quintessential neurosurgical condition characterized by pathological ventriculomegaly secondary to cerebrospinal fluid (CSF) hypersecretion, impaired resorption, or obstructed circulation, culminating in intracranial hypertension. The condition was first described by Hippocrates as having wide ramifications in medicine and surgery[1]. For subnormal CSF reabsorption, HCP is classified into obstructive (non-communicating) and non-obstructive (communicating) types. Despite seemingly straightforward diagnostic classifications such as "communicating" versus "non-communicating" types, the reality is that there remains a burden of clinical heterogeneity among patients with hydrocephalus[1]. Another special form of hydrocephalus includes normal pressure hydrocephalus (NPH), also known as Hakim-Adam Syndrome, which is diagnosed with a triad of dementia, gait

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disturbance, and urinary incontinence. NPH is commonly observed in males over 60 years of age. Ventriculo-peritoneal (VP) shunt placement is the mainstay of treatment for hydrocephalus in both adult and pediatric patients[2]. Traditionally, placement of the distal portion of the VP shunt was performed exclusively by a neurosurgeon via an open mini-laparotomy. In 1993, Basauri et al. introduced laparoscopy-assisted visualization and placement of the distal end as a collaborative approach involving neurosurgery and general surgery[3]. The survival rates and quality of life of patients with hydrocephalus have improved dramatically since the introduction of shunts almost 50 years ago[4]. There are several etiological factors of hydrocephalus, which can be congenital anomalies, genetic diseases, or medically acquired conditions, including brain tumors, infections, or hemorrhages[5].

Congenital anomalies responsible for hydrocephalus in infants include primary stenosis of the Aqueduct of Sylvius, Chiari Malformations, and Dandy-Walker malformations, among others. Globally, an estimated 80 to 125 infants per 100,000 births are diagnosed with congenital and acquired HCP[6].

VP shunt insertion and endoscopic third ventriculostomy (ETV) are common surgical procedures used to treat hydrocephalus[7]. Alternative procedures include ventriculo-atrial (VA) shunts and ventriculo-peritoneal (VP) shunts. The VP shunt procedure has been in practice for decades but still has a very high first-year complication rate of 11% to 25%[8]. Two main valve types exist: programmable (adjustable differential pressure valve) and non-programmable (fixed differential pressure valve). A programmable shunt uses an adjustable pressure-setting valve that regulates CSF flow from outside the body without another surgical procedure. In contrast, a non-programmable shunt has a fixed pressure setting[9]. A study published in 2017 found that although programmable shunts are more expensive, they have a lower chance of complications. Therefore, the price difference is greatly reduced when the cost of complication surgeries is considered[10]. There are two types of VP shunts based on valve pressure: medium (for communicating and non-communicating HCP) and low (for NPH). Despite being a well-established procedure in modern medical practice, shunt malfunction and failure occur at a rate of about 40% to 50% in the pediatric population and about 30% in adults[11]. In the first year after shunt installation, however, the incidence of VP shunt failure has been reported to be 11% to 25%[12]. Shunt failure may result from several complications, which include obstruction (either complete or partial), shunt infection (most commonly caused by Staphylococcus epidermidis), over-drainage leading to subdural hematoma, under-drainage, shunt migration, peritoneal pseudocysts, bowel perforation, and hernia development[9, 13].

ETV refers to a surgical approach that creates an alternate pathway for CSF circulation, bypassing the aqueduct of Sylvius by perforating the Liliequist membrane[14]. ETV may be used in patients with obstructive HCP and may also be employed in cases of shunt infection, subdural hematoma, or slit ventricle syndrome. Initially, ETV morbidity and mortality were very high due to limited visualization, as high as 75%. ETV has experienced a resurgence in popularity since the early 2000s, driven by the work of Dr. Benjamin Warf with patients in sub-Saharan Africa with limited access to shunt hardware[15].

A VA shunt, or vascular shunt, transports CSF from the ventricle through the jugular vein to the superior vena cava. Reported primary revision rates ranged from 5.4% to 48% and 9.1% to 58% for VA and VP shunting, respectively. A higher shunt revision rate was reported among patients undergoing VP shunting compared with VA shunting[16].

The study aimed to assess the overall outcome of VP shunt placement at a tertiary care hospital, focusing on improvement in hydrocephalus and the detection of post-operative complications. This study was conducted to highlight the importance of further research and developing surgical skills in improving the outcome of this life-saving procedure.

Materials and Methods

Data Acquisition

A one-year (from July 2024 to July 2025) prospective observational study was conducted in the Department of Neurosurgery at Rajshahi Medical College Hospital, Bangladesh.

Sampling

Sampling was done through purposive sampling. A total of 37 patients were operated on for VP shunt.

Inclusion and Exclusion Criteria

Patients of both genders with communicating hydrocephalus, non-communicating hydrocephalus, and NPH were included. Both congenital and acquired HCP patients were included. Patients with a previous history of VP shunt surgery were excluded.

Data collection and Variables

Demographics, clinical presentations, and imaging findings were recorded on a standardized pro forma. Outcomes were classified as follows: a good outcome was survival with clinical improvement and no postoperative complication; a bad outcome was postoperative death or shunt infection (i.e., 10 patients had a bad outcome). Shunt revision (any further operation on the shunt system) was recorded separately as the measure of mechanical shunt survival. Complications were recorded prospectively[17]. Variables included age, sex, type and etiology of HCP, shunt pressure, radiological findings, revision operation, post-operative complications, follow-up, outcome, status.

Statistical analysis

The dataset was analyzed using SPSS version 30, with descriptive and inferential statistics. Outcomes were categorized as good or bad as defined above. Associations between categorical variables (age group, etiology, shunt pressure) and outcome, complications, or revision were tested with the chi-square test or, when expected cell counts were <5, Fisher's exact test (Fisher–Freeman–Halton test for tables larger than 2×2); t-tests were not used for categorical variables. Complication-free survival was estimated by the Kaplan–Meier method; the event was death

or shunt infection (time from surgery to first event), and patients without an event were censored at their last follow-up. Shunt revision was analysed descriptively because only one revision occurred. A two-sided p-value <0.05 was considered significant.

Surgical procedure

VP shunt procedures were performed under general anesthesia by experienced neurosurgeons[18]. A burr hole was created at right Keen's point. A ventricular catheter was inserted into the lateral ventricle. A shunt passer was then employed to tunnel the distal catheter subcutaneously into the peritoneal cavity[19]. Unobstructed CSF flow through the shunt system was carefully verified, and the distal catheter was then successfully placed within the peritoneal cavity. All incisions were meticulously closed in layers under strict aseptic precautions.

Postoperative management and Follow-up

Patients were monitored for evidence of shunt dysfunction, infection, or over-drainage. Routine non-contrast CT scan was carried out to check shunt placement and ventricular decompression. The sutures were removed on the 10th day after surgery (20). Follow-up continued for 12 months after surgery to evaluate outcomes and complications; follow-up of the last enrolled patient (operated on 12 July 2025) was completed in July 2026. The time from surgery to death or shunt infection was recorded for each patient; patients without an event were followed to 12 months, and none were lost to follow-up.

Results

A total of 37 patients were included in the study who underwent VP shunt; 51.4% were male, and 48.6% were female (Figure 1).

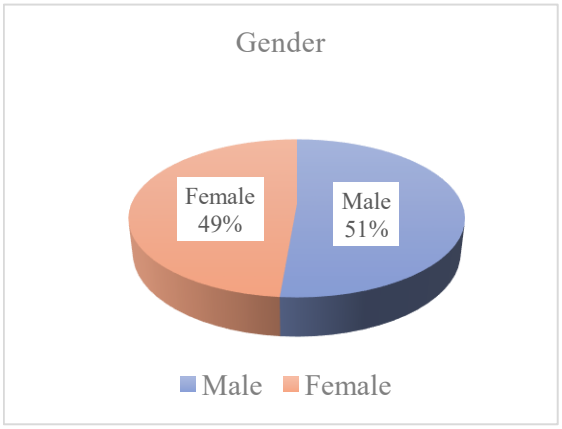

Figure 1. Participant gender pie.

Patients were categorized into four groups based on chronological age. Patients aged 13 to 60 years were the most common group (40.5%); patients aged 1 month to 12 years were 37.8%; patients aged more than 60 years were 16.2%; and patients less than 28 days were 5.4%. Among the patients studied, 67.6% were diagnosed with obstructive or non-communicative HCP, 18.9% had NPH, and 13.5% were found to have communicative HCP. The causes showed a varied distribution among the patients studied. Congenital causes accounted for 29.7% of patients and formed a major group; an equal number of patients were idiopathic 29.7%, where no definite cause could be identified despite proper evaluation. Tumors were another significant cause in 18.9% of patients. Similarly, trauma contributed notably (18.9%). Infection 2.7% was rare. A medium-pressure shunt was inserted in 81.1% of patients, whereas a low-pressure shunt was inserted in 18.9% of patients. Radiological evaluation showed good ventricular size reduction in 78.4% of patients. Ventricular noncompliance was observed in 18.9% of patients due to death, while progressive HCP was noted in 2.7% of patients. No case of slit ventricle syndrome was identified, and no patients showed radiological evidence of unchanged ventricular size. Only one patient (2.7%) required shunt revision (for infection, at month 4), giving a revision-free shunt rate of 97.3% (36/37); no mechanical malfunction was recorded. Post-operative complications were observed in 10 of 37 patients (27%). Death was the predominant adverse event in 18.9% of patients, followed by shunt infection in 8.1% of patients. Shunt migration and displacement were not encountered.

The majority of patients (73%) experienced an uneventful recovery. Of the 37 patients, 73.0% achieved good clinical outcomes, while 27% experienced bad outcomes (death or shunt infection, as defined in Methods). The clinical outcome based on etiology, age group, and gender is summarized in Tables 1 and 2, and Figure 2, respectively

Table 1. Etiology vs. clinical outcome tabulatio.

Etiology	Outcome				P value (Fisher's exact)
	Good		Bad		
	N	%	N	%	
Congenital	8	21.6	3	8.1	0.83
Tumour	4	10.8	3	8.1	
Trauma	5	13.5	2	5.4	
Infection	1	2.7	0	0	
Idiopathic	9	24.3	2	5.4	

Table 2. Clinical outcome vs. age group.

Age Group	Outcome	Counts	% of Total	P value (Fisher exact)
Group A (1-28 days)	Good	1	2.7	0.75
	Bad	1	2.7	
Group B (1month - 12years)	Good	11	29.7	
	Bad	3	8.1	
Group C (13-60 years)	Good	11	29.7	
	Bad	4	10.8	
Group D (60+ years)	Good	4	10.8	
	Bad	2	5.4	

Postoperative mortality occurred in 7 patients (18.9%); their characteristics and timing are given in **Table 3**. Deaths occurred between 0.4 and 9.0 months after surgery (median 4.4 months), with three within the first three months; the

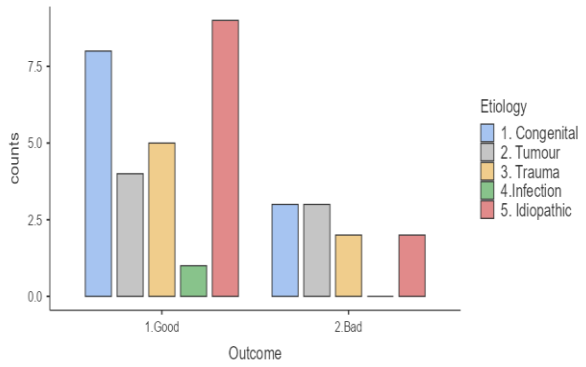

Figure 2. Bar chart of clinical outcome stratified by HCP etiology.

three shunt infections occurred at 1.0, 2.5, and 4.0 months. Etiological breakdown revealed 5.4% deaths attributed to congenital hydrocephalus, 5.4% associated with tumor-related pathology, 2.7% linked to traumatic etiology, and

Table 3. Frequency of post-operative complications.

Etiology	Postoperative Complications	Count (N)	% of Total
Congenital	Shunt Infection	1	2.7
	Death	2	5.4
	None	8	21.6
Tumour	Shunt Infection	1	2.7
	Death	2	5.4
	None	4	10.8
Trauma	Shunt Infection	1	2.7
	Death	1	2.7
	None	5	13.5
Infection	Shunt Infection	0	0
	Death	0	0
	None	1	2.7
Idiopathic	Shunt Infection	0	0
	Death	2	5.4
	None	9	24.3

5.4% occurring in idiopathic cases (Table 4). This series is too small, and the available data too limited, to determine whether these deaths were related to the underlying disease, comorbidity, or the procedure; no such attribution is therefore made. Shunt infections affected 8.1% of patients, with 2.7% of patients each from congenital, tumour, and trauma causes. Among these, two patients were managed with antibiotics and follow-up, while one required shunt revision at 4 months. This shows that management varied by severity. The study also demonstrated that 73% of patients had good outcomes, with etiologies including 45.9% obstructive HCP, 10.8% communicating HCP, and 16.2% NPH. Bad outcomes hit 27% of patients due to 21.6% obstructive HCP, 2.7% communicating HCP, and 2.7% NPH. Obstructive HCP patients drove most successes and failures, while communicating HCP or NPH fared better overall.

Categorical associations were tested with Fisher's exact test (Fisher–Freeman–Halton test for tables larger than 2×2) because expected cell counts were small. No significant association was found between clinical outcome (good vs bad) and etiology (P = 0.83) or age group (P = 0.75), or between postoperative complications and etiology (P = 0.92). Shunt revision was not significantly associated with age group (P = 1.00), etiology (P = 0.40), or shunt pressure (P = 1.00); however, only one patient required revision, so these analyses had almost no power and should be interpreted with caution.

Kaplan-Meier analysis showed a progressive decline in complication-free survival (event = death or shunt infection), from 94.6% (95% CI: 87.6–100.0%) at month 1 to 73.0% (95% CI: 60.0–88.8%) at month 12, with 10 total events. The number of patients at risk fell from 37 to 27 over this period entirely due to the 10 events (no patient was censored before month 12), with confidence intervals broadening progressively to reflect heightened uncertainty from the diminishing sample size. Consistent with the provided survival curve, this pattern reveals pronounced early event incidence followed by a tapering hazard rate, with median complication-free survival not reached within the observation window. This composite endpoint should not be equated with mechanical shunt survival: only one shunt revision (2.7%) occurred. (Figure 3).

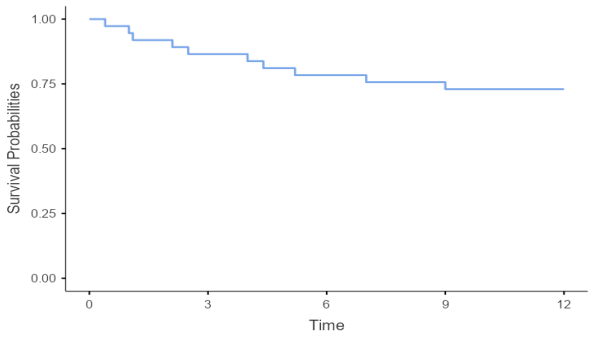

Figure 3. Kaplan – Meier curve of complication-free survival (event = death or shunt infection).

Postoperative complications and follow-up outcomes

Postoperative complications were observed in 10 of 37 patients (27%). Mortality was the most common adverse

Table 4. Characteristics of the seven postoperative deaths (ordered by time after surgery).

Serial	Age group	Sex	HCP type	Etiology	Shunt pressure	Months after surgery
1	>60 years	Female	NPH	Idiopathic	Low	0.4
2	>60 years	Male	Obstruct.	Trauma	Medium	1.1
3	1–28 days	Male	Obstruct.	Congenital	Medium	2.1
4	1 month–12 years	Female	Commun.	Congenital	Medium	4.4
5	13–60 years	Female	Obstruct.	Idiopathic	Medium	5.2
6	1 month–12 years	Male	Obstruct.	Tumour	Medium	7.0
7	13–60 years	Female	Obstruct.	Tumour	Medium	9.0

outcome, occurring in 7 patients (18.9%) (causes and timing in Table 4). Shunt infection occurred in 3 patients (8.1%); two were managed conservatively with antibiotics, while one required shunt removal and revision. No mechanical complications such as shunt blockage, displacement, or over-drainage were observed.

Clinical follow-up showed good outcomes in 27 patients (73%), with symptomatic improvement in gait, cognition, and urinary continence, compared with poor outcomes in 10 patients (27%), including 7 deaths and 3 shunt infections. Median complication-free survival was not reached within follow-up; only a single shunt revision was required.

Discussion

VP shunt insertion has remained the most popular method for treatment of hydrocephalus in adults, with other available treatment options, the most noteworthy being ETV[21]. In this study, there is a male predominance in hydrocephalus, with a ratio of 1.06:1. This is similar to a few other studies[8, 22]. The cause of this male predominance is not yet clear. Patients aged 13 to 60 years were the most common group, at 40.5%. The majority of patients (67.6% were diagnosed with obstructive HCP. Children below eight years were reported to have congenital hydrocephalus, where the most common cause was Aqueductal stenosis.

Among 37 hydrocephalus patients undergoing shunting, outcomes were stratified as good in 73% of patients, encompassing 63% of successes in obstructive HCP, 15% in communicating HCP, and 22% in NPH etiologies. Conversely, suboptimal results afflicted 27% of patients, predominantly 21.6% of failures in obstructive HCP, with solitary communicating and NPH patients at 2.7% each. This etiological dichotomy showed obstructive HCP predominance in both success (17/27) and failure (8/10). Post-operative mortality was 18.9% (5.4% due to congenital, 5.4% tumor-related, 2.7% traumatic, 5.4% idiopathic etiologies.

Shunt failure and infection are common and frequently necessitate subsequent surgeries. For shunt infection, treatment typically involves two surgeries and a prolonged hospitalization while receiving intravenous (IV) antibiotics[23]. In this study, Shunt infections affected 8.1% of patients (3 patients); 2 patients were treated with antibiotics and followed up, and 1 patient needed revision at 4 months.

Kaplan–Meier analysis showed a decline in complication-free survival (death or shunt infection) from 94.6% at 1 month to 73.0% at 12 months, with median survival not reached. This composite endpoint is not equivalent to mechanical shunt survival, for which only one revision (2.7%) was required.

In the study, among 37 patients, 7 were diagnosed with NPH, of whom 6 had good outcomes, and 1 had a bad outcome. The gait and balance domain showed the highest mean improvement. In contrast with previous studies (24–26), Gait and balance improvement was highest. Among the 7 NPH cases, urinary incontinence and cognitive domains showed better improvement. However, cognitive decline continued during follow-up, particularly with coexisting neurodegenerative disease. Debate persists on cognitive reversibility, with most literature emphasizing gait's dominant role in overall scores.

This single-centre study with a small sample size limits generalizability, while heterogeneous etiologies, variable follow-up, high mortality, and lack of a control group restrict long-term and comparative outcome assessment. These descriptive findings cannot establish VP shunting as first-line therapy; they highlight the need for larger, multicentre studies with longer follow-up to identify predictors of shunt success.

Limitations

a) Small Sample Size (n=37):
b) Single-Centre Experience:
c) Variable Follow-up Duration: Follow-up was limited to 12 months, so late shunt failures may have been missed.
d) No Control Group:
e) High Mortality Rate (18.9%): Seven deaths occurred; autopsy data were not available, timing is summarized in Table 4, and a relationship to the procedure cannot be excluded.
f) Etiological Heterogeneity.

Conclusion

Ventriculoperitoneal shunting offers life-sustaining potential for hydrocephalus patients yet carries inherent risks of complications akin to all neurosurgical interventions. This study of 37 patients showed good clinical outcomes in 73% and a single shunt revision (2.7%), with Kaplan–Meier complication-free survival (death or shunt infection) of 73% at 12 months, despite a 27% complication rate driven primarily by mortality (18.9%).

Exact categorical tests across age group, etiology, and shunt pressure found no significant predictors of poor outcomes or complications; revision analysis was uninformative because only one revision occurred (all $P > 0.05$).

Only one shunt revision occurred among 37 patients, but this small, uncontrolled, single-centre series cannot validate standardized implantation protocols or establish the reliability of shunt systems. Postoperative mortality was the predominant complication; its causes and relationship to the procedure could not be determined from the available data (Table 4), underscoring the need for careful patient selection and perioperative optimization.

These observations support continued evaluation of ventriculoperitoneal shunting while emphasizing prospective, multicenter investigations with more patients, longer follow-up intervals (>5 years), and advanced imaging modalities to elucidate subtle predictors of shunt success. Larger controlled studies with complete, standardized follow-up are needed before firm conclusions can be drawn.

Acknowledgments

None.

Ethical consideration

The study was conducted in accordance with the Declaration of Helsinki. This study was not reviewed by an institutional review board or ethics committee. All patients underwent

ventriculoperitoneal shunt placement as part of routine clinical care, and no intervention or procedure beyond standard management was performed for research purposes. Data were collected prospectively from routine clinical care and anonymized for analysis. Written informed consent for surgery and for the use of anonymized data was obtained from patients or their parents or legal guardians.

Competing Interests

The authors declare no conflict of interest.

Funding

No funds were received for this research.

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