

Nursing management protocol for mothers of children having ventricular peritoneal shunt

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Introduction

Ventricular peritoneal shunts are considered to be permanent catheters with long-term complications. Management of ventricular peritoneal shunts presents major challenges later in children and their parents' life, requiring multidisciplinary care from nurses.

Aim

This study was undertaken to evaluate the effects of nursing management protocols on mothers with children having ventricular peritoneal shunts.

Research design

A quasi-experimental design was used for the present study.

Setting

The present study was conducted at the Neurology Outpatient Clinic at Benha University Hospital followed by home visits.

Sample

A purposive sample of children visiting the Neurology Outpatient Clinic with ventricular peritoneal shunts during a period of 6 months was included. The study included 39 children. Two tools were used for data collection. A structured interview questionnaire was designed and consisted of four parts: part one included sociodemographic characteristics of the mother and child; part two included past and present medical history of the child; part three included mothers' knowledge regarding ventricular peritoneal shunts, including its meaning, signs of infection, complications, prevention, and treatment; part four included others practices of mothers regarding ventricular peritoneal shunt care such as preventing of infection in the shunt area, preventing other infections, nutrition, treatment, and regular follow-up.

Keywords:

nursing management protocol, ventricular peritoneal shunt, children

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Introduction

Hydrocephalus is considered a long-term condition, normally identified in early childhood, where there is excessive cerebrospinal fluid (CSF) in the ventricular system within the brain. The increased level of CSF causes ventricular enlargement resulting in compression and destruction of adjacent structures that affect brain growth and development. Seventy percent of children with hydrocephalus are managed by the insertion of a ventricular shunt, which diverts excessive fluid from the ventricles to another body compartment, commonly the peritoneum (Smith *et al.*, 2013).

Cerebrospinal shunts are considered to be permanent catheters in which the proximal end of the shunt is in the cerebral ventricle, an intracranial cyst, or the lumbar subarachnoid space; the distal end usually terminates in the peritoneal, pleural, or vascular space.

A ventricular shunt is a small tube that is placed in the child's head, which carries extra fluid from the head to

the abdomen, where it is absorbed. A ventricular peritoneal shunt is a medical device that relieves pressure on the brain caused by CSF accumulation. Normally, the CSF passes through the brain's ventricles to the base of the brain. The fluid then bathes the brain and spinal cord before it is reabsorbed into the blood. When this normal flow is disrupted, the buildup of fluid can create harmful pressure on the brain's tissues, which can damage the brain (Roth, 2016; Margules and Jallo, 2010).

Ventricular peritoneal shunting is the standard therapy for the management of hydrocephalus, 47% of the cases are due to obstruction and infection which constitute the major the cause (Ali *et al.*, 2013). Shunt malfunction is still an existing problem for

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neurosurgeons, which is associated with high incidence of complications (Mostafa, 2010). It was estimated that 50% of ventricular peritoneal shunts in the pediatric population fail within 2 years of placement, and repeated neurological surgeries are often required for the management of shunt obstruction or malfunction (American Academy of Neurological, 2016).

Hydrocephalus can be classified into communicating and noncommunicating types. Communicating (nonobstructive) hydrocephalus occurs when the flow of CSF is blocked after it exits the ventricles. Noncommunicating (obstructive) hydrocephalus occurs when the flow of CSF is blocked along one or more of the narrow pathways connecting the ventricles (Kulkarni, 2008). Children with hydrocephalus could also be classified as technology dependent, because the majority of children require a permanent shunt to manage the condition. However, a shunt is an internal device, and once inserted does not require ongoing maintenance unless it malfunctions (Margules and Jallo, 2010).

The most common shunt complications are malfunction and infection. Shunt malfunction is a partial or complete blockage of the shunt that causes it to function intermittently or not at all. When a blockage occurs, CSF accumulates and can result in symptoms of untreated hydrocephalus, which accounts for ~50% of all shunt failures in children. Signs and symptoms of shunt malfunction in infants include enlargement of the infant's head, the fontanelles are full and tense when the infant is upright and quiet, prominent scalp veins, swelling along the shunt tract, vomiting, irritability, sleepiness, downward deviation of the eyes, and seizures. Meanwhile, in toddlers, manifestations include head enlargement, vomiting, headaches, irritability and/or sleepiness, and seizures. In addition, signs such as increased intracranial pressure, vision problems, personality change, seizures, and difficulty in waking up or staying awake in older children are found (Reddy *et al.*, 2014).

Shunt infections are manifested by tiredness, irritability, poor appetite, various aches and pains, and skin rashes. In addition, it can also present with signs of meningitis and ventriculitis. In addition, signs of septicemia or peritonitis can be seen, depending on the type of shunt. The skin may redden over the area of the shunt and tubing, or the wounds may be reddened and/or draining pus. Most commonly, the bacteria responsible are those that reside normally in the skin of the child. Distal shunt malfunctions frequently accompany shunt infections (Gürol *et al.*, 2015).

Parents of children with a long-term condition have identified the need to develop skills to ensure that their child's education and developmental needs are met, as well as to deal with challenging behavior. Parenting responsibilities including illness-specific demands such as maintaining treatment and care regimes, social and financial constraints, and maintaining relationships with siblings and family members (Alnimr, 2012; Khan *et al.*, 2013).

During neurological assessment of the child with hydrocephalus, it is necessary to obtain accurate vital and neurological signs before and after surgery. Measurement of the child's head is essential. If the fontanelles are not closed, carefully observation for any signs of bulging should be performed. Nurses must observe, report, and document all signs of increased intracranial pressure. If the child has returned for revision of an existing shunt, complete history taking before surgery from the family caregivers should be carried out to provide a baseline of the child's behavior (Klossner and Hatfield, 2006).

Nursing responsibilities in the care and management of children with a ventricular shunt are as follows: adhere to strict hand hygiene, provide safe and effective care environment at all times for the child, closely observe for deviations from normal behaviors, monitor body temperature, be alert to any changes in physical status, check skin for redness along shunt site on bony prominences, and check hydration status and fluid consumption (Campbell, 2008). In addition, nurses must use aseptic techniques when handling shunts, minimize shunt manipulation and the length of time the catheter is in place, use bio-occlusive dressing, and change dressings (Smith *et al.*, 2016).

Significance of the study

Hydrocephalus is one of the most frequently seen problems in pediatric neurosurgical practice. The National Institute of Neurological Disorders and Stroke has estimated that one to two in every 1000 children are born with hydrocephalus/year. Approximately 750 000 children suffer from hydrocephalus worldwide, and 160 000 ventricular peritoneal shunts are implanted each year worldwide. There are no robust population-based statistical data worldwide, and it is conceivable that the prevalence of this condition is much higher as ready access to diagnosis and treatment is not available in certain parts of the world (Johnson and Virgo, 2006). The estimated incidence of hydrocephalus is 0.2–0.8/1000 live births in the USA (Jea *et al.*, 2017). Besides, nurses have an important role in teaching home care for children with shunts. For this reason, this study was conducted to

evaluate the nursing management protocol for mothers with children having ventricular peritoneal shunts.

Aim

The present study aimed to evaluate nursing management protocols for mothers with children having ventricular peritoneal shunts by the following:

Assessing mothers' knowledge and practices regarding ventricular peritoneal shunts.

Developing nursing management protocols for mothers about ventricular peritoneal shunts.

Research hypothesis

Mothers' total knowledge and practice scores regarding ventricular peritoneal shunt will be higher after implementing nursing management protocol.

Patients and methods

Research design

A quasi-experimental design was used to carry out the present study.

Setting

The present study was conducted at the Neurology Outpatient Clinic in Benha University Hospital, in which there was a special room for conducting nursing management protocols. This was then followed by home visits.

Sample

A purposive sample of mothers of children with hydrocephalus who presented for treatment and follow-up at the previously mentioned setting after shunt surgery during a period of 6 months was included. The present study included 39 children and their mothers.

Tools for data collection: two tools were used for data collection:

Tool I

A Structured Interviewing Questionnaire Sheet: this tool was designed and utilized by the researchers in simple Arabic language based on the scientific literature, textbooks, articles, websites, and magazines. It is divided into four parts and entailed the following items:

Part 1

(1) Personal characteristics of mothers such as age, education, occupation, family income, and residence.

(2) Personal characteristics of children such as age, sex, and ranking.

Part 2

Past and present medical histories of the child were obtained, including onset of shunt insertion, recurrence of infection, recurrence of hospitalization, and causes of hospitalization.

Part 3

Information on mothers' knowledge regarding ventricular peritoneal shunts, such as sources of information, meaning of ventricular peritoneal shunt, reasons for ventricular peritoneal shunt, signs of infection, care of shunt, warning signs, complications, prevention of complications, and treatment, was obtained.

Scoring system

For knowledge items, a correct complete answer was scored two points, whereas a correct incomplete answer was scored one point, and the wrong answer or 'do not know' was scored zero. According to the mothers' answers, the total knowledge scores were categorized into the following:

- (1) Good knowledge at least 75%,
- (2) Average knowledge at least 50% to more than 75%, and
- (3) Poor knowledge less than 50%.

Part 4

Mothers' practices regarding ventricular peritoneal shunts included protection of shunt area, prevention of infection, activity, providing good nutrition with increase in vitamins, treatment and regular follow-up, and providing medications on time.

Scoring system for mothers' practices

Mothers' practices with regard to ventricular peritoneal shunt were scored as follows: 'regularly performed' was scored 2 points, 'irregularly performed' was scored 1 point, and not done was scored 0.

Mothers' practices were scored as follows:

- (1) Good, if the score was at least 75%,
- (2) Average, if the score was at least 50% to more than 75%, and
- (3) Poor, if the score was less than 50%.

Tool II

The observational checklist for home environment included ventilation, lighting, sanitation, arrangement

of house furniture, and suitable bathroom. This tool was utilized during home visits (follow-up).

Content validity

Tools were revised by seven experts from the Faculty Members of Community Health Nursing Department, Pediatric Nursing Department, and Neurology Department from Benha University Hospital.

Reliability

Reliability coefficients were calculated for questionnaire items. The coefficient α was 0.81.

Ethical considerations

All ethical considerations were taken into account such as oral consent from each mother. The general and specific objectives of the study were clarified, and mothers were informed that the data collected will be used for research purposes only with confidentiality. They were also informed about the right to withdraw at any time point from the study without giving any reasons.

Pilot study

A pilot study was carried out on 10% of mothers having children with ventricular peritoneal shunts (four mothers and their children) to identify the clarity of the tools' items and the estimated time needed for applicability of the tools; they were excluded from the main study sample.

Data collection procedures

- (1) Preparation of data collection tools was carried out from the beginning of May 2015 to the end of August 2015, and data collection was carried out from the beginning of September 2015 to the end of February 2016.
- (2) An official letter was issued from the Dean of the Faculty of Nursing to the Directors of Benha University Hospital including the aim of the study and expected outcomes of the study to obtain approval to carry out the study.
- (3) Approval was obtained from the Directors, and oral consent was also obtained from each mother for participation.
- (4) The researchers conducted the program twice/week (Saturdays and Thursdays) from 10:00 a.m. to 1:00 p.m. in the Neurology Outpatient Clinic at Benha University Hospital.
- (5) The mothers were interviewed individually by the researchers to implement the program in the Neurology Outpatient Clinic.

- (6) Handouts were provided for mothers having children with ventricular peritoneal shunts regarding care of these shunts.

Nursing management protocol construction

The program was conducted in four phases:

- (1) Preparatory phase: a review of recent, current, national, and international literature on various aspects of the problem was carried out. The tools questionnaire was designed to assess mothers' knowledge and practices regarding the ventricular peritoneal shunt before and after implementing the program.
- (2) Assessment phase: the pretest questionnaire was implemented to identify mothers' knowledge about ventricular peritoneal shunts and their practices of care giving.
- (3) Planning and implementation phase: The program was designed with the general objective to evaluate the effect of nursing management protocol for mothers with children having ventricular peritoneal shunts.

The nursing management protocol contents included the following:

- (a) Mothers' knowledge regarding the meaning of ventricular peritoneal shunt, signs and symptoms of infection, nutrition, complications, prevention of complications, treatment, high-risk persons, prognosis, and diagnosis.
 - (b) Mothers' practices regarding care giving included regular drug administration, regular follow-up, providing a healthy diet, and avoiding overcrowded places, using special equipment, preventing droplet infection, providing nutrition with increased vitamins, decreasing tea and coffee consumption, and thoroughness in regular follow-up and administration of medicines.
- The program included six sessions – two for theory and four for practices. Each session took 20–30 min for theory and practice.
- (i) At the end of the program, a booklet of the program was given to each mother for reference.
 - (ii) A post-test was performed to evaluate the effect of the nursing management protocol on increasing mothers' knowledge and improving their practices.
 - (iii) The teaching methods used were discussions, brainstorming, demonstration, and re-demonstration. Booklets were distributed for teaching.

(4) Evaluating phase: to evaluate the effect of the nursing management protocol of mothers' knowledge and practices regarding ventricular peritoneal shunts, post-tests similar to pretests were applied.

Statistical design

The collected data were analyzed and tabulated using χ^2 -test for number and percentage distribution as well as correlation coefficients (*r*); *t*-test for comparison of means was used with the statistical package for the social sciences, version 20 (IBM 2015, Chicago), to determine whether there are statistically significance differences. Statistical significance was considered at *P* 0.05 or less, and a highly statistically significant difference was considered at *P* 0.001 or less.

Results

Table 1 shows that 59% of the studied mothers were aged 25–35 years, with a mean age of 32.97±6.6 years. Regarding educational level, 64.1% of them had secondary education. Regarding marital status, 89.7% of them were married: about 79.5% were housewives and 79.5% did not have enough income.

Table 2 shows that 51.3% of the studied children were aged less than 5 years. Regarding sex, 76.9% of them were females and 30.8% of them were ranked as the first child.

Table 1 Frequency distribution of the studied mothers regarding their personal characteristics (n=39)

Items	N (%)
Age (years)	
20 to <25	3 (7.7)
25 to <30	11 (28.2)
30 to <35	12 (30.8)
≥35	13 (33.3)
Mean±SD	32.97±6.6
Marital status	
Married	35 (89.7)
Not married (divorced-winded)	4 (10.3)
Mothers' education	
Read and write	9 (23.1)
Intermediate education	25 (64.1)
Higher education	5 (12.8)
Mothers' occupation	
Employee	8 (20.5)
Housewife	31 (79.5)
Income	
Enough	8 (20.5)
Not enough	31 (79.5)
Home place	
Rural	20 (51.3)
Urban	19 (48.7)

Table 3 shows that 94.9% of the studied children had no family history of hydrocephalus, and 56.4% had previous ventricular peritoneal shunts.

Table 4 elaborates that the studied mothers' knowledge regarding ventricular peritoneal shunt (meaning, causes, signs of increased intracranial pressure, care of the child, and complications) improved after implementing the nursing management protocol with a statistically significant difference between before and after the test (*P*<0.001).

Figure 1 illustrates that all the studied mothers reported that the main source of information regarding hydrocephalus was the health team, whereas 28.8% of them reported family and friends, and 18.4% of them reported mass media as the source of information.

Table 5 shows that the studied mothers' knowledge regarding shunt (meaning of shunt, efficient tube working, complications of the shunt, signs of shunt

Table 2 Frequency distribution of the studied children regarding their personal characteristics (n=39)

Items	N (%)
Child age (years)	
1	8 (20.5)
1 to <5	20 (51.3)
5 to <10	8 (20.5)
≥10 years	3 (7.7)
Mean±SD	5.92±4.8
Sex	
Male	9 (23.1)
Female	30 (76.9)
Child ranking	
The first	12 (30.8)
The second	11 (28.2)
The third	10 (25.6)
Fourth and more	6 (15.4)

Table 3 Frequency distribution of the studied children regarding medical history (n=39)

Medical history	N (%)
Family history of hydrocephalus	
Yes	2 (5.1)
No	37 (94.9)
Previous shunt	
Yes	22 (56.4)
No	17 (43.6)
Prognosis	
Good	35 (89.7)
Poor	4 (10.3)
Complication	
Yes	35 (89.7)
No	4 (10.3)

Table 4 Frequency distribution of the studied mothers' knowledge regarding hydrocephalus before and after the program (n=39)

Items	Pre [N (%)]	Post [N (%)]	χ^2	P-value
Definition of hydrocephalus				
Poor	17 (43.6)	4 (10.3)	23.1	0.000
Average	17 (43.6)	10 (25.6)		
Good	5 (12.8)	25 (64.1)		
Causes of hydrocephalus				
Poor	25 (64.1)	5 (12.8)	32.04	0.000
Average	11 (28.2)	8 (20.5)		
Good	3 (7.7)	26 (66.7)		
Signs of increased intracranial pressure				
Poor	13 (33.3)	6 (15.4)	29.3	0.000
Average	23 (59.0)	7 (17.9)		
Good	3 (7.7)	26 (66.7)		
Early signs of hydrocephalus				
Poor	23 (59.0)	3 (7.7)	32.8	0.000
Average	12 (30.8)	9 (23.1)		
Good	4 (10.2)	27 (69.2)		
Late signs of hydrocephalus				
Poor	6 (15.4)	6 (15.4)	22.2	0.000
Average	28 (71.8)	9 (23.1)		
Good	5 (12.8)	24 (61.5)		
Treatment of hydrocephalus				
Poor	18 (46.2)	7 (17.9)	23.22	0.000
Average	18 (46.2)	9 (23.1)		
Good	3 (7.6)	23 (59.0)		
Complications of hydrocephalus				
Poor	6 (15.4)	5 (12.8)	26.42	0.000
Average	30 (76.9)	10 (25.6)		
Good	3 (7.7)	24 (61.6)		

Table 5 Frequency distribution of the studied mothers' knowledge regarding ventricular peritoneal shunt before and after the program (n=39)

Items	Pre [N (%)]	Post [N (%)]	χ^2	P-value
Definition of the hydrocephalus shunt				
Poor	20 (51.3)	6 (15.4)	20.3	0.000
Average	13 (33.3)	8 (20.5)		
Good	6 (15.4)	25 (64.1)		
Efficiency in tube working				
Poor	20 (51.3)	4 (10.2)	26.6	0.000
Average	16 (41.0)	12 (30.8)		
Good	3 (7.7)	23 (59.0)		
Complication of shunt				
Poor	7 (17.9)	3 (7.7)	33.6	0.000
Average	29 (74.4)	8 (20.5)		
Good	3 (7.7)	28 (71.8)		
Signs of shunt infection				
Poor	11 (28.2)	3 (7.7)	16.85	0.000
Average	22 (56.4)	13 (33.3)		
Good	6 (15.4)	23 (59.0)		
Signs of shunt blockage or not working properly				
Poor	8 (20.5)	6 (15.4)	25.88	0.000
Average	27 (69.2)	8 (20.5)		
Good	4 (10.3)	25 (64.1)		
Dangerous signs that require hospitalization				
Poor	17 (43.6)	4 (10.3)	23.55	0.000
Average	15 (38.5)	7 (17.9)		
Good	7 (17.9)	28 (71.8)		

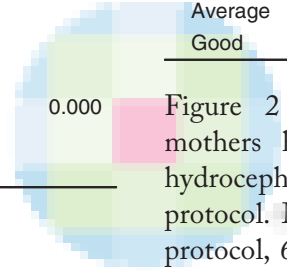
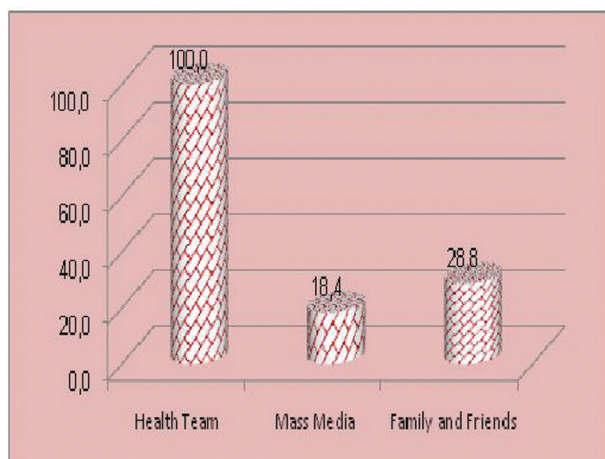


Figure 2 illustrates that 64.1% of the studied mothers had poor total knowledge scores about hydrocephalus before the nursing management protocol. Meanwhile, after the nursing management protocol, 66.7% of them had a good total knowledge scores and there was a highly statistically significant difference ($P < 0.001$).

Figure 1



Frequency distribution of the studied mothers regarding their sources of information.

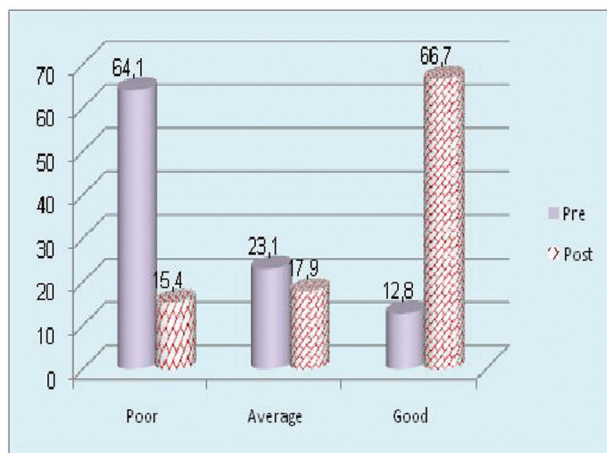
infection, signs of shunt blockage, or dangerous signs that require hospitalization) improved after implementing the nursing management protocol with statistically significant difference before and after the test ($P < 0.001$).

Table 6 clarifies that the studied mothers' practices regarding care of shunt area such as protection, avoiding infection, activity, nutrition, treatment, follow-up, and prevention of constipation improved after implementing the nursing management protocol with a statistically significant difference before and after the test ($P < 0.001$).

Figure 3 illustrates that the total practice scores of the studied mothers improved after implementing the nursing management protocol to 46.2% compared with 7.7% before implementing the nursing management protocol.

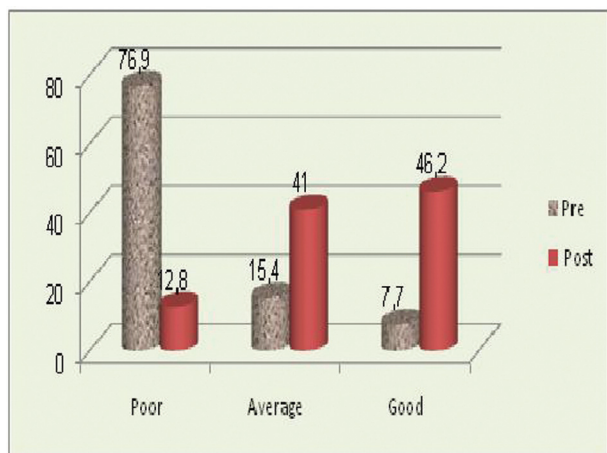
Table 7 clarifies that 89.7% of the studied homes had a good sanitary environment, and 79.5% of them lived in a good, ventilated place, but only 59.0% of them had proper arrangement of furniture.

Figure 2



Frequency distribution of the studied mothers regarding total knowledge score before and after the program.

Figure 3



Frequency distribution of the studied mothers regarding total practice scores before and after the program.

Table 8 reveals that there was a highly statistically significant positive correlation between the studied mothers' total knowledge scores and total practice scores regarding shunt infection ($P < 0.001$).

Discussion

Hydrocephalus can cause permanent brain damage, and thus it is important to recognize symptoms of this condition and seek medical attention. The condition is more common in children, but it can occur at any age. The main treatment for hydrocephalus is shunts. When shunts malfunction, the consequences are serious and can be life-threatening. Parents need to recognize and respond appropriately to the symptoms of shunt malfunction in their child (Bouras and Sgouros, 2012). Therefore, the aim of this study was to evaluate the effect of nursing

Table 6 Frequency distribution of the studied mothers' practices regarding care of their children with ventricular peritoneal shunts before and after the program (n=39)

Items	Pre [N (%)]	Post [N (%)]	χ^2	P-value
Protection of the shunt area				
Poor	11 (28.2)	6 (15.4)	13.42	0.000
Average	18 (46.2)	7 (17.9)		
Good	10 (25.6)	26 (66.7)		
Avoid infection				
Poor	10 (25.6)	6 (15.4)	17.52	0.000
Average	21 (53.8)	7 (17.9)		
Good	8 (20.5)	26 (66.7)		
Activity				
Poor	16 (41.0)	4 (10.3)	39.3	0.000
Average	23 (59.0)	9 (23.1)		
Good	0 (0.0)	26 (66.7)		
Nutrition				
Poor	12 (30.8)	4 (10.3)	38.1	0.000
Average	22 (56.4)	3 (7.7)		
Good	5 (12.8)	32 (82.1)		
Therapy				
Poor	6 (15.4)	2 (5.1)	41.3	0.000
Average	33 (84.6)	10 (25.6)		
Good	0 (0.0)	27 (69.2)		
Follow-up				
Poor	8 (20.5)	4 (10.3)	39.2	0.000
Average	27 (69.2)	4 (10.3)		
Good	4 (10.3)	31 (79.5)		
Constipation				
Poor	6 (15.4)	4 (10.3)	28.87	0.000
Average	27 (69.2)	6 (15.4)		
Good	6 (15.4)	29 (74.4)		

Table 7 Frequency distribution of the study sample regarding home environment (n=39)

Home environment	Good [N (%)]	Poor [N (%)]
Ventilation	31 (79.5)	8 (20.5)
Enough lighting	28 (72.8)	11 (28.2)
Sanitation	35 (89.7)	4 (10.3)
Arrangement of furniture	23 (59.0)	16 (41.0)
Suitable bathroom	29 (74.4)	10 (25.6)

Table 8 Correlation between studied mothers' total knowledge score and total practices score (n=39)

	Total knowledge score			
	Pre		Post	
	r	P-value	r	P-value
Total practices score	0.50	0.001	0.6	0.000

management protocols in mothers with children having ventricular peritoneal shunts.

Regarding personal data of the studied mothers, the results of the present study revealed that slightly less than three-fifths of the studied mothers were aged 25–35 years with a mean age of 32.97 ± 6.6 years

(Table 1). This is similar to the results obtained by Smith and Firth (2011), who found that the mothers' ages ranged from 25 to 35 years. This finding is in disagreement with Gurol *et al.* (2015) who reported that the mean age of the studied mothers was 42.8±9.4 years according to the study carried out in Turkey. Regarding residence, half of the studied mothers lived in rural areas. This result was similar to the results obtained by Smith and Firth (2011), who found that half of the mothers lived in rural areas.

Concerning mothers' occupation, the present study revealed that more than three-quarters of them were housewives and did not have enough income (Table 1); this finding is supported by the study by Smith *et al.* (2008), who found that three-quarters of the mothers were housewives. This may be due to the economic condition of country, where there is no work for many women and also the mothers were usually from lower socioeconomic conditions.

Regarding age of the studied children, the present study revealed that the prevalence of ventricular peritoneal shunt was found to be the highest in the age group of 1 year (Table 2). This finding was supported by a study by Smith (2009), which found that the highest prevalence of ventricular peritoneal shunts is during the first year of life. The present study showed that more than three-quarters of the study children were females; this finding was similar to results obtained by Garne *et al.* (2010) who found that more two-thirds of the studied children were females. These results are also supported by a study carried out in Egypt by Abd El-Azim (2012). This study found that more than one-third of children were aged 1 day to 1 month (37.5%) and from 1 month to 1 year (47.5%). In addition, more than half of them were males (62.5%). This due to the higher incidence of the hydrocephalous in first year of life as well as increased birth of females than males in the country.

Regarding knowledge of hydrocephalus, the present study found that more than half of the studied mothers had poor levels of knowledge regarding causes and early signs of hydrocephalus (Table 4). This finding was supported by Hummelink and Pollock (2006) in a study about knowledge of hydrocephalus, who found that more than half of the parents living with a child with shunted hydrocephalus showed knowledge deficits with regard to causes and early signs of hydrocephalus. However, after implementing the

nursing management protocol, there were statistically significant differences before and after the test ($P<0.001$). This indicated the positive effect of nursing management.

A significant statical difference was found between mother's awareness before and after implementation of the program (Table 5). However, after implementing the nursing management protocol, there was a statistically significant difference ($P<0.001$). This may be due the fact that mothers had no awareness about the disease, but nursing management increased mothers' awareness.

Regarding mothers' practices in caring for children with ventricular peritoneal shunts, the present study found that more than three-quarters of mothers had poor practices before the program compared with less than half after the nursing management protocols (Table 6). These results are supported by Smith and Firth (2011). They found that parents having poor practice require educational programs to better deal with their children. Moreover, this finding is supported by Gurol *et al.* (2015), who found that the responsibility of nurses is very important in helping mothers receive social support. Nurses should be aware of the concerns of mothers and solve this problem with their educative, counseling, and supportive roles.

Moreover, the findings of the present study indicated that there was a highly statistically significant positive correlation between the studied mothers' total knowledge score and total practices score regarding shunt infection ($P<0.001$). This may be because of the increasing knowledge of mothers, leading to improved care and practices for their children. These results are supported by Khalafallah *et al.* (2017) in a study carried out in Egypt about 'the impact of protocol of care for mothers of children with ventriculoperitoneal shunt on occurrence of post-operative complications'. They found that there was a statistically significant positive correlation between total mean scores in the study group of mothers' knowledge and practices.

Conclusion

Mothers' level of knowledge increased after implementing nursing management protocols, and their practices improved. There were positive statistically significant correlations between the total knowledge score and the total practice score regarding ventricular peritoneal shunts.

Recommendations

In the light of the findings of the present study, the following recommendations are suggested:

- (1) Provide continuous education and training sessions for mothers having children with hydrocephalus to prevent and decrease recurrence of infection and to ensure enough knowledge and practices.
- (2) Emphasize on the availability of printed and illustrative booklets regarding care of children suffering from hydrocephalus, which are presented simply in posters and colored pictures to guide practice among mothers.
- (3) Further studies can be replicated in other hospitals using a larger sample size to generalize the findings.

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Conflicts of interest

There are no conflicts of interest.

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