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Treatment outcome and associated factors of infantile hypertrophic pyloric stenosis at eastern Ethiopia public hospitals

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Abstract

Background Infantile hypertrophic pyloric stenosis (IHPS) is a condition whose etiology is not clear, but it is characterized by progressive hypertrophy of the circular muscles of the pylorus with consequent obstruction of the gastric outflow, mostly in neonates and infants under the age of one year.

Objectives To assess the treatment outcome and associated factors of infantile pyloric sphincter stenosis among paediatric patients admitted to HFCSUH and JUSHYRH.

Methodology A retrospective patient record review with 78 participants was studied consecutively using a structured questionnaire. The data was processed and analyzed using Epi Info 7 and SPSS version 24. Descriptive analysis was done, and then associated factors to the outcome were assessed using logistic regression analysis. The association's significance was determined using an odds ratio with a 95% confidence interval and a P-value less than 0.05. The study period was from November 1st to 30th, 2022.

Results The magnitude of unfavorable IHPS was 17.1% with a 95% confidence interval of 16.7–23.9%. Hypokalemia (AOR=2.3, CI=3.015–19.54), severe dehydration (AOR=30.9, CI=2.89–31.75), and delayed presentation (AOR=7.37, CI=2.761–12.08) were independent predictors.

Conclusions The study found a highly unfavorable treatment outcome with delayed presentation; dehydration and electrolyte disturbance were the main predictors of poor outcome. It is recommended to increase community awareness about non-bilious vomiting in infants and ensure high suspicion among healthcare providers. Moreover, following guidelines to correct fluid and electrolyte disturbances and managing these patients in the pediatric ICU postoperatively.

Keywords Infantile hypertrophic pyloric stenosis, Ramstedt, Mortality, Experience, Outcome

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Introduction

Background

Infantile hypertrophic pyloric stenosis (IHPS) is a childhood condition characterized by pylorus smooth muscle fiber hyperplasia, which leads to pyloric canal constriction and gastric outlet obstruction [1]. It is the most frequent infantile gastrointestinal ailment needing surgery in the first months of life [2].

It is believed that the incidence of IHPS varies among different races and ethnicities around the world; according to sex, it is more common among first-born male infants, with a male-to-female sex ratio estimated to be 4–6:1, and geographically, although it is more common in Western countries than in African countries, trends in different European regions are conflicting as to whether the disease is increasing or decreasing [3–5]. IHPS has no established etiology; however, genetic and environmental variables appear to play a role in its pathogenesis, such as race differences, a greater frequency in males, and birth order [6, 7].

The characteristic HPS presentation is non-bilious, projectile vomiting in a full-term baby aged 2 to 8 weeks with each meal; the emesis gets stronger in a short period of time; and when the diagnosis is made early, the neonate appears healthy on physical examination [7–9]. The gold standard for diagnosing IHPS, which is characterized by increased pelvic muscle thickness, length, and diameter, is abdominal ultrasonography [10]. While the gold standard for the surgical treatment of IHPS is still Ramstedt's extra mucosal pyloromyotomy [11].

In the past, pyloric stenosis had a significant death rate, nearing 50%; with advancements in newborn resuscitation, anesthetics, and surgical techniques, mortality is now declining, and morbidity is also much lower than in the past, with an overall complication rate of 1–2% [12]. In most facilities, mortality after pyloromyotomy is less than 1%, and when it occurs, it is mainly due to fluid and electrolyte depletion in infants who have late and inadequately addressed electrolyte issues before surgery [13].

A research conducted in Ethiopia reveals that IHPS is a frequent illness affecting babies, with an incidence rate of 12.9 per 1000 admissions [14]. The proportion of undetected IHPS cases in the community may be higher than predicted, given the majority of these infants die from severe dehydration and sepsis [15, 16]. Studies found that age less than two weeks, delayed presentation, prolonged preoperative hospital stay, surgical site infection, and a high proportion of dehydration and electrolyte imbalance, were the most important predictors of poor outcome [14, 17, 18].

Due to the gap in previous studies of treatment outcome and associated factors, as well as the association between prolonged illness, preoperative hospital stay, and a high proportion of dehydration and electrolyte

disturbance in patients with IHPS, this study delineated more information about outcomes by associating factors, including new IHPS variables. Knowing the important aspects of IHPS is essential for developing suitable, targeted interventions that effectively address the problem caused by delayed diagnosis. As a result, infants with IHPS who are in Ethiopia are the key beneficiaries of this study. Furthermore, the study's findings can be used to develop evidence-based interventions in the study area. It can also help health planners, managers, and future researchers who are interested in conducting research in this field.

Methods and materials

Study area and period

This study was conducted at Hiwot Fana Comprehensive Specialized Hospital. It is located in Harar, the capital city of the Harari regional government, which is one of the oldest cities in Ethiopia. Harar is 526 km from Addis Abeba in eastern Ethiopia. The total number of kebeles in the city is 19, with a total population of 183,415, of which 50% are male. In the Harari region, there are four public hospitals and two private hospitals. Additionally, there are eight health centers, of which four are found in Harar town and the rest in the rural part of the city [19]. The research was also carried out at Jigjiga University's Sheik Hassen Yebare specialized comprehensive hospital. Jigjiga is located 626 km east of Addis Ababa, Ethiopia's capital city, and has a total population of 426,122 people. The city is divided into 30 kebeles (the smallest administrative units), 20 of which are urban and 10 of which are rural. Jigjiga has three public hospitals, two private hospitals, and three health centers with eight health posts [20]. The data was collected from November 1st, to November 30th, 2022.

Study design

A retrospective chart review was employed to assess the treatment outcome and associated factors of IHPS.

Source and study populations

All the pediatric patients who were admitted to the pediatric surgical wards of HFSUH and JUSHYRH with the diagnosis of IHPS were the source population, while all selected infants with the diagnosis of IHPS and subsequently underwent surgical procedures were the study population.

Sample size determination

To determine the sample size for this study, the outcome variable and various factors significantly associated with it were considered. Accordingly, a proportion with a larger sample is taken as the sample size. The sample size for the first objective was determined by using a single

population proportion formula with the assumption of a confidence level of 95% ($\alpha=0.05$), $z=1.96$, n =sample size, and a margin of error (the desired level of absolute precision) of $d=5\%$. Non-response rate: 10%; 4.9% of treatment outcome of IHPS in children, which was taken from a previous study conducted in Tanzania (P value=4.9%) [21]. The calculated sample size was 71, then adding 10% of the non-response rate makes a final sample size of 78.

Data collection instruments

A data collection checklist was prepared after reviewing different literature and experts' advice. An extraction format that contains study variables of interest was prepared in English to extract relevant information by two BSC nurses and one resident in each hospital.

Study variables

Dependent variable

Treatment outcome of IHPS.

Independent variables

Socio-demographic characteristics: age, sex, birth date, birth weight, gestational age, birth order, mode of delivery, feeding patterns, maternal age.

Clinical characteristics: duration of the disease, Non-bilious vomiting, Weight loss, dehydration, visible gastric peristalsis, surgical site infection, pyloric muscle thickness, pyloric length, and pyloric diameter.

Electrolyte status: serum sodium, serum potassium, serum chloride.

Operational definitions

Dehydration

Is a medical condition characterized by sunken eyes, restlessness or irritability, a dry mouth, and no tears when crying [22].

Surgical site infection

(SSIs) are infections that occur at or near surgical incision within 30 day of operation [23].

Treatment outcome

In this study the treatment outcome could be Unfavorable or Favorable treatment outcome [24].

Unfavorable treatment outcome

The condition of the patient after the procedure has been done that develops any postoperative complications or died until the patient discharged from hospital [24].

Favorable treatment outcome

The condition of the patient after the procedure has been done and a patient does not develop postoperative complications until the patient discharged from hospital [24].

Data quality control

The data collectors were trained on the data collection process, and a 5% pretest was done before the actual data collection was started. The data collection process was closely monitored by the principal investigator to ensure the completeness, accuracy, and consistency of the data.

Data analysis and interpretations

After data collection is complete, the data is edited and coded for processing and analysis. Data processing and analysis were done using Epi Info 7 and SPSS statistical software version 26. Bivariate analysis was performed to assess the treatment outcome and associated factors of IHPS variables while controlling for the effects of other characteristics; multiple logistic regressions were used to assess a possible relationship between treatment outcome and independent variables. The degree of association between dependent and independent variables was assessed using an odds ratio with a 95% confidence interval and a P -value <0.05 . The results were presented in the form of tables, figures, and text using summary statistics like mean, median, and standard deviation to describe the study population.

Results

Socio-demographic characteristics of the study participants

A total of 78 IHPS patients were admitted and operated on during the study period. Among these, eight were excluded from the study due to incomplete data. Out of 70 patients, 56 (80%) were male, with a male-to-female ratio of 4:1. The youngest child operated on was one week old, and the oldest was 12 weeks old, with a median age of five weeks (IQR=four to six weeks). More than 83% were present between two and six weeks, while only seven (10%) patients were present after seven weeks. Thirty-four (48.6%) cases occur in first-born children. No associated congenital anomalies were identified. Sixty-six (80%) infants were breastfed, nine (12.9%) were bottle-fed, and five (7.1%) were mixed-feeding. The majority of the children were between weeks four and six at admission, 39 (55.7%), and the majority were between 37 and 42 weeks pregnant (92.9%). Mostly, 37 (52.9%) of their weight at birth was not documented (Table 1).

Clinical characteristics of the study participants

Ultrasound was performed on all patients, and the majority of patients had a pyloric muscle thickness of 4 mm+2 and a pyloric length of 19 mm+4 mm. The most common signs and symptoms reported were non-bilious vomiting. 70(100%) and poor weight gains 43 (61.4%) blood-stained vomiting was observed in three (4.3%) patients; a palpable olive' was noted in 30 (42.9%) patients. The duration of symptoms before admission ranged from

Table 1 Socio-demographic characteristics of infants with IHPS

Variable	Category	Number	Frequency
Age	< 2 weeks	2	2.9
	2–4 weeks	16	22.9
	5–6 weeks	43	61.4
	> 6 weeks	9	12.8
Gender	Male	56	80
	Female	14	20
Mode of delivery	Spontaneous delivery	54	77.1
	Cesarean section	16	22.9
Feeding patterns	Breast feeding	56	80
	Bottle feeding	9	12.9
	Mixed feeding	5	7.1
Gestational age	< 37 weeks	3	4.3
	37–42 weeks	65	92.9
	> 42 weeks	2	2.8
Birth weight	< 2.5 kg	1	1.4
	2.5–4 kg	30	42.9
	> 4 kg	2	2.9
	Not documented	37	52.9

Table 2 Clinical characteristics of the study participants

Variables	Categories	Number	Percentages
Patients clinical signs and symptoms			
Non-bilious vomiting	Yes	70	100
	No	-	-
Blood stained vomiting	Yes	3	4.3
	No	67	95.7
Sever acute malnutrition	Yes	40	57.1
	No	30	42.9
Palpable mass	Yes	30	42.9
	No	40	57.1
Dehydration	Yes	40	57.2
	No	30	42.9
Visible gastric peristalsis	Yes	34	48.6
	No	36	51.4
Poor weight gain	Yes	43	61.4
	No	27	38.6
Length of hospital stay	1–7 days	26	37.14
	> 7days	44	62.86
Postoperative complications	Wound infection	7	10
	Postoperative vomiting	3	4.3
	Pneumonia	3	4.3
	Wound dehiscence	2	2.8
	Sepsis	1	1.4
Treatment outcome	Favorable	58	82.9
	Unfavorable	12	17.1

two to 50 days (median 21 days). The length of hospital stay before surgery was in the range of one to seven days for 26 (37.1%) patients, while the remaining 44 (62.9%) patients stayed in the hospital for more than seven days. Moreover, according to the postoperative complications of the patients who have been operated on, seven (10%)

Table 3 Electrolyte status of the study participants

Variable	Number	Percent
Hypokalemia	5	7.4
Hypochloremia	41	58.5
Hypokalemia and hypochloremia	19	27.1
Hypokalemic, hypochloremia and hyponatremic	2	2.8
Normal range	3	4.2

developed wound infections, and three (4.3%) had post-operative vomiting and pneumonia. Wound dehiscence was developed by two (2.8%) of the operated patients. Furthermore, for the treatment outcome of the study participants, the magnitude of unfavorable IHPS was 17.1% with a 95% confidence interval of 16.7–23.9% (Table 2).

Electrolyte status of the study participants

The majority of patients (78.6%) had electrolyte imbalances. During the data collection, each electrolyte was classified as low, normal, or high. Of those with electrolyte imbalances, 70% exhibited abnormalities in multiple electrolytes. Potassium imbalance was the most common among the patients seen (Table 3).

Factors associated with the treatment outcome of the study participants

Binary logistic regression analysis was used to identify the factors associated with the treatment outcome of IHPS. Electrolyte imbalance, severe acute malnutrition, dehydration, length of hospital stay before surgery, duration of the illness, and duration of the procedure were the factors associated with unfavorable outcome at $p < 0.25$. In multivariate logistic regression analysis, hypokalemia (AOR=2.3, CI=3.015–19.54), severe dehydration (AOR=30.9, CI=2.89–31.75), and delayed presentation (AOR=7.37, CI=2.76–12.08) were independent predictors of unfavorable IHPS (Table 4).

Discussion

Infantile Hypertrophic pyloric Stenosis has been linked to preterm births [25]. In this setting, only two of the children diagnosed with IHPS were born preterm. This could be due to the mother’s lack of diagnosis and knowledge of the gestational age. The mean duration of illness in this study of 3 weeks was longer than most published series [26]. However, it is comparable to studies in Tanzania and Ethiopia (27 days) [14]. This could be due to low awareness among families, who may dismiss vomiting as a minor symptom and neglect it, or to a disease misdiagnosis. This delayed presentation is frequent in developing nations and might cause a delay in diagnosis.

Diagnosis delays might result in electrolyte imbalance, weight loss, and failure to thrive. The most prevalent cause of gastric outlet obstruction, infantile hypertrophic pyloric stenosis, usually manifests as non-bilious

Table 4 Factors associated with the treatment outcome of the study participants

Variables	Category	Treatment outcome		COR(95%CI)	AOR(95%CI)	P-value
		Favorable (%)	Unfavorable (%)			
Hypokalemia	Yes	34(58.6)	9(75)	2.12(1.484–4.687)	2.3(3.015–19.54)	0.014
	No	24(41.4)	3(25)	1	1	
Severe Dehydration	Yes	10(6.8)	54(83.4)	2.7(4.478–14.56)	30.9(2.89–31.75)	0.005
	No	2(93.2)	4(16.6)	1	1	
Length of hospital stay before surgery	1-7days	40(69)	4(33.4)	1	1	0.050
	> 7days	18(31)	8(66.6)	4.44(1.04-25.234)	8.1(0.998–15.72)	
Delayed presentation	< 2wks	31(53.4)	3(25)	1	1	0.009
	> 2wks	27(46.6)	9(75)	3.44(0.997–18.47)	7.37(2.76–12.08)	

vomiting [27]. This was the most common symptom reported by all individuals. This is comparable to a previous series documented elsewhere in Africa, in which all of the subjects reported vomiting [14, 25, 28, 29]. Thirty (42.9%) of the cases had the characteristic presentation of an olive mass in the epigastric area on probing. This suggests that the olive is tactile in around 25% of IHPS instances. Similarly, a 2018 research in Cameroon discovered 33.3% [25]. However, in Ethiopia and Tanzania, the palpable olive-shaped mass in the epigastrium was 23–26%, respectively, which is relatively lower than this study [14, 28].

Preoperatively, IHPS is usually complicated by dehydration, weight loss, and a characteristic hypochloremic hypokalaemia metabolic alkalosis [13, 30]. In this study, the most common electrolyte abnormalities were hypokalaemia (7.4%), hypochloremia (58.5%), and their combination (27.1%). All of these problems occurred in the series with the most prevalent electrolyte abnormalities, hypochloremia and hypokalaemia. In a 2015 study in Tanzania, similar electrolyte abnormalities were detected in hypokalaemia (66.7%), hyponatraemia (40.7%), and hypochloremia (33.3%) [18].

Individuals with hypokalaemia or simultaneous hypochloremia at admission were more than twice as likely as others to have postoperative difficulties in a univariate and multivariate study [25]. This was comparable with a study in Tanzania [18]. Dehydration, poor weight growth, malnutrition, metabolic changes, and lethargy might result from a prolonged delay in diagnosis. There was also a longer preoperative hospital stay (average of 8 days), which could be attributed to the time required to rectify hydration and electrolyte problems, late admissions, bed shortages, and busy surgical services.

Atropine has also shown some long-term results and may be a feasible option for poor surgical candidates [31]. Because laparoscopic pyloromyotomy was not available at this centre, all patients in this study had open Ramstedt's pyloromyotomy. Mucosal perforation is an uncommon intraoperative complication of Ramstedt's pyloromyotomy that occurs when the myotomy is prolonged beyond the pyloric-duodenal junction. The

presence of bilious fluid is a sign. When this happens, interrupted fine monofilament long-term absorbable sutures placed transversely and covered with omentum are utilized to treat the wound [32].

In this study, five (7.1%) cases had intraoperative problems, four (5.7%) had mucosal perforations, and 1.4% had bleeding, which is greater than the figure described in the literature [11, 32, 33], south Africa [17], and in Tanzania [18]. In Cameroon, a study reported 9.5% of intraoperative mucosal perforation. This discovery necessitates extreme caution when performing Ramstedt's pyloromyotomy to avoid mucosal perforation, particularly at the lower end of the incision (pyloric-duodenal junction).

In this study, the overall postoperative complication rate was 17.1%, this number is high compared to what is reported in other studies [34] and in Tanzania (11.8%) [21], but comparable to a study in Ethiopia (16.4%) [14]. In this study, all postoperative problems were handled conservatively, except for wound dehiscence in two patients, which required surgical correction. The average postoperative hospital stay was 2–3 days for uncomplicated cases and 7–15 days for complex cases. In most major cases, mortality after pyloromyotomy is less than 0.4%, and when it occurs, it is mainly due to fluid and electrolyte depletion in new-borns who present late and inadequately addressed electrolyte abnormalities before surgery [13, 30]. This study's total mortality rate was reported to be 4.2%, which is higher than the 3.6%, 3.3%, and 2.3% found in Ghanaian, Ethiopian, and Iranian investigations [14, 35, 36], respectively. A high mortality rate of 6.7% was reported in Dares Salaam, Tanzania [33], 9.5% in Cameroon [25] and 9% and in Uganda [21]. The high mortality rate in this study was attributed to delayed presentation, severe dehydration on admission, hypokalaemia on admission, length of hospital stays before surgery, pneumonia, and surgical site infection.

Limitations

Some limitations of this study include a relatively small sample size of 70 participants and a short time period of 3 years. Solely hospital-based, as most patients with IHPS die in communities of dehydration and electrolyte

imbalance. The fact that information about some patients was incomplete in view of the retrospective nature of the study might have introduced some bias in our findings. Poor documentation of data, leading to the exclusion of many patients, was also a major limitation of this study.

Conclusions

This study aimed to assess the treatment outcome and associated factors of IHPS and found that a high unfavourable treatment outcome with delayed presentation, a high proportion of dehydration and electrolyte disturbance were the main predictors of poor outcome.

It is recommended to disseminate health information regarding IHPS, increase community awareness about non-bilious vomiting in infants and the health-seeking behaviour of the community. Furthermore, health care providers should have a high index of suspicion in infants with non-bilious vomiting to avoid delay in diagnosis and treatment. The guideline should be followed strictly to correct the fluid and electrolyte disturbances after diagnosis to shorten the preoperative hospital stay. Postoperatively, these patients have to be managed carefully in the paediatric ICU, at least for the immediate postoperative period and the hospitals should investigate that duration.

Abbreviations

CI	Confidence Interval
HFCSUH	Hiwot Fana Specialized Comprehensive University Hospital
HMIS	Health Management Information System
IHPS	Infantile Hypertrophic pyloric Stenosis
IHRERC	Institutional Health Research Ethics Review Committee
JJUSHYCSH	Jigjiga University Sheik Hassen Yabare Comprehensive Specialized Hospital
MOE	Ministry Of Education
NPV	Negative Predictive Value
OR	Odds Ratio
SAM	Severe Acute Malnutrition

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Author contributions

AI and BO were involved in conceptualization, acquired the data and methodology, and validated the original draft. BM and MO contributed to supervision, writing review, and editing. ZB and MA contributed to the formal analysis. All authors read and approved the final manuscript.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

Before starting the data collection process, the study protocol was approved by Haramaya University, the College of Health and Medical Sciences, the Institutional Health Research Ethics Review Committee (ref. HUIHRERC/54/2022). Official letters of cooperation were submitted to HFCSUH

and JJUSHYRH to secure their cooperation and permission for the data access. Participants' confidentiality of information was assured by excluding all identifiers from the questionnaire. Since all of the participants were not able to give consent because of their age, written permission to participate was obtained from all the infants' caregivers or parents.

Consent for publication

This is not applicable.

Clinical trial number

Is not applicable.

Competing interests

The authors declare no competing interests.

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