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NASOGASTRIC TUBE FEEDING IN STROKE CARE: A CROSS-SECTIONAL ASSESSMENT OF CAREGIVER KNOWLEDGE AND TECHNIQUE AT A TERTIARY HOSPITAL IN PESHAWAR, PAKISTAN

Original Research (ID: 1710)

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ABSTRACT

Background: Stroke-related dysphagia often necessitates nasogastric tube feeding to maintain nutrition, hydration, and medication delivery. In resource-constrained hospitals, family caregivers frequently perform this task with limited supervision after discharge. Unsafe positioning, inadequate flushing, poor hygiene, and failure to verify tube placement may expose patients to preventable complications. Evidence regarding caregivers' knowledge and feeding technique in Pakistan remains limited, making assessment of competence and its determinants important for planning practical, targeted education within routine stroke care services.

Objective: To assess caregiver knowledge and technique in nasogastric feeding after stroke and identify factors associated with adequate knowledge and safe practice.

Methods: This cross-sectional study included 280 caregivers of stroke patients receiving nasogastric feeding at Hayatabad Medical Complex, Peshawar. A structured questionnaire and observational checklist assessed five knowledge and five technique items. Scores of at least 4/5 indicated adequate knowledge or safe technique. Chi-square tests and multivariable logistic regression identified associated factors, reported as adjusted odds ratios with 95% confidence intervals.

Results: Caregiver age was 39.0 ± 10.0 years, and 119 (42.5%) had prior training. Mean knowledge and technique scores were 67.0% ± 28.0% and 59.5% ± 30.2%. Adequate knowledge was found in 145 caregivers (51.8%), while 115 (41.1%) demonstrated safe technique. Higher education predicted adequate knowledge (aOR 7.80, 95% CI 3.99–15.26; p<0.001), whereas rural residence reduced the odds (aOR 0.31, 95% CI 0.18–0.56; p<0.001). Prior training predicted adequate knowledge (aOR 2.14, 95% CI 1.23–3.74; p=0.007) and safe technique (aOR 3.82, 95% CI 2.15–6.81; p<0.001). High confidence predicted safe technique (aOR 2.71, 95% CI 1.39–5.29; p=0.003). Feeding difficulties or complications occurred in 130 caregivers (46.4%) and were more frequent with inadequate knowledge (59.3% vs 34.5%; p<0.001).

Conclusion: Caregiver competence remained insufficient, especially among less-educated, rural, and untrained participants. Structured pre-discharge instruction with return-demonstration may strengthen feeding safety.

Keywords: Caregivers; Deglutition Disorders; Enteral Nutrition; Health Knowledge, Attitudes, Practice; Intubation, Gastrointestinal; Patient Safety; Stroke.

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INTRODUCTION

Stroke remains a major global health concern and is among the leading causes of mortality, acquired disability, and long-term dependence in adults. Although advances in acute stroke management have improved survival, many survivors continue to experience neurological impairments that interfere with mobility, communication, cognition, and independent self-care. Dysphagia is particularly important because it affects a substantial proportion of patients during the acute and subacute stages of stroke and can compromise the safe intake of food, fluids, and medicines (1). When swallowing is impaired, patients face an increased risk of aspiration, dehydration, malnutrition, chest infection, prolonged hospitalization, and poor functional recovery. Maintaining adequate and safe nutritional support is therefore an essential component of comprehensive stroke care. When oral feeding is considered unsafe or insufficient, enteral nutrition is commonly initiated through a nasogastric tube. Nasogastric tube feeding is generally preferred as the initial approach because the tube can be inserted promptly at the bedside, is relatively inexpensive, and does not require surgery or sedation (2,3). It enables the administration of nutrition, water, and essential medications while swallowing function is being assessed or rehabilitated. Although nasogastric feeding is often described as a short-term intervention, many patients continue to require it for several weeks, including during the transition from hospital-based care to home care (4,5). Consequently, responsibility for feeding and tube maintenance frequently extends beyond trained healthcare professionals and becomes part of the daily duties performed by family caregivers.

The involvement of family members in direct patient care is particularly common in Pakistan and other South Asian healthcare settings. In many tertiary hospitals, relatives remain at the bedside and assist with feeding, hygiene, positioning, medication administration, and other basic care activities. Limited nursing staff, high patient volumes, financial constraints, and established cultural expectations all contribute to this pattern of caregiving (6-8). A spouse, adult child, sibling, or other relative may therefore become the primary person responsible for administering nasogastric feeds. While such involvement can provide valuable emotional and practical support, it may also expose patients to avoidable harm when caregivers have not received adequate instruction, supervised practice, or assessment of their competence (9,10). Nasogastric tube feeding is not technically complex, but its safe administration requires several precise and consistently performed steps. Before feeding, the caregiver should understand the prescribed type, amount, and timing of the feed and should assess whether the patient is in an appropriate condition to receive it. The patient should be positioned upright, or with the head and upper body elevated, to reduce the likelihood of regurgitation and aspiration. Tube placement should be checked before each feed and after any event that may have displaced the tube, such as coughing, vomiting, retching, or accidental pulling. Recommended methods place particular emphasis on aspirate pH testing, whereas the traditional practice of injecting air and listening over the stomach is considered unreliable and may provide false reassurance (11,12). Caregivers must also avoid excessive pressure or rapid administration, flush the tube appropriately before and after feeding or medication, and maintain basic standards of hand and equipment hygiene (13).

Failure to follow these principles can result in serious complications. Feeding through a displaced or unverified tube may introduce formula or medication into the respiratory tract. Feeding a patient while lying flat can increase the risk of reflux and aspiration, particularly when cough and airway-protective reflexes are already impaired by stroke. Inadequate flushing can cause tube blockage, interrupt nutrition and medication delivery, and lead to unnecessary tube replacement. Poor hand hygiene, reuse of inadequately cleaned feeding equipment, inappropriate storage of prepared feeds, and prolonged exposure of feeds at room temperature may contribute to contamination and infection (14). Other errors, such as administering feeds too rapidly, giving unsuitable volumes, crushing medications incorrectly, or mixing drugs directly with the feeding formula, may cause abdominal discomfort, diarrhoea, altered drug absorption, or interactions between medicines and nutrients. Many of these complications are preventable when caregivers understand not only what actions to perform, but also why each action is necessary. Caregiver competence involves both knowledge and practical performance. A caregiver may be aware that the patient should be elevated during feeding but may not maintain the correct position in routine practice. Similarly, a caregiver may recognize that tube placement should be checked but rely on an unsafe method because it was observed informally or learned from another attendant. Assessment of knowledge alone may therefore overestimate the actual safety of care. Direct assessment of feeding technique is needed to identify whether essential actions are performed in the correct order, at the appropriate time, and with adequate attention to hygiene and patient monitoring. Evaluating both domains can provide a more realistic picture of the risks faced by stroke patients receiving caregiver-administered nasogastric feeding.

Evidence suggests that focused education can improve the quality of enteral feeding care. Structured teaching sessions, demonstrations, return demonstrations, written instructions, and bedside supervision have been associated with improvements in the knowledge and performance of nurses and family caregivers (15,16). However, the effectiveness of any educational programme depends on whether it addresses the actual deficiencies of the target population. Training designed without a baseline assessment may devote attention to procedures caregivers already understand while overlooking common unsafe practices. The need for support may also differ according to educational level, place of residence, relationship to the patient, previous caregiving experience, duration of caregiving, and exposure to formal instruction. The wider management of post-stroke dysphagia adds further importance to this issue. Recommendations regarding the timing and duration of nasogastric feeding, reassessment of swallowing, and transition to gastrostomy are not always applied consistently, and uncertainty remains regarding the most appropriate long-term feeding route for individual patients (17). Nevertheless, nasogastric feeding remains widely used during the early stages of stroke recovery and is frequently administered by relatives in routine clinical practice (18). Safe caregiver performance is therefore an immediate patient-safety priority, irrespective of whether the patient later resumes oral intake or undergoes placement of a more permanent feeding tube.

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Despite the clinical importance of caregiver-administered nasogastric feeding, limited evidence is available regarding the knowledge and practical technique of family caregivers in tertiary hospitals in Pakistan, particularly in Peshawar. It remains unclear which feeding steps are most frequently misunderstood or omitted and whether competence differs according to caregiver or patient characteristics. The present study was therefore conducted to assess the knowledge and observed technique of caregivers responsible for nasogastric tube feeding among stroke patients at a tertiary hospital in Peshawar, Pakistan. It further aimed to determine the caregiver- and patient-related factors associated with adequate knowledge and safe feeding practices. The study addressed the research question of whether caregiver education, residential background, previous caregiving experience, and prior formal training influence competence in nasogastric tube feeding. It was hypothesised that caregivers with higher educational attainment, urban residence, and previous structured training would demonstrate significantly better knowledge and safer practical technique than caregivers without these advantages.

METHODOLOGY

This single-centre, cross-sectional descriptive and analytical study was conducted in the Department of Medicine at Hayatabad Medical Complex, Peshawar, Pakistan. Hayatabad Medical Complex is a tertiary care teaching hospital that receives patients from Peshawar and surrounding urban and rural districts (19). Data were collected over a six-month period following approval of the research synopsis. The study population comprised primary caregivers of adult patients diagnosed with stroke who were receiving nutrition, hydration, or medication through a nasogastric tube in the medical inpatient wards or during follow-up visits. A primary caregiver was defined as the family member or attendant who held the main responsibility for the patient's day-to-day nasogastric tube feeding at the time of data collection. Caregivers were eligible when they were 18 years of age or older, were primarily responsible for feeding a patient with stroke through a nasogastric tube, and were willing and able to provide informed consent. Professional healthcare workers serving in a formal clinical capacity were excluded because their training and experience could have differed substantially from those of family caregivers. Caregivers who declined participation or were unable to complete the interview were also excluded. In addition, caregivers of patients whose nasogastric tubes had been inserted for conditions other than stroke were not included.

The sample size was calculated using OpenEpi for estimation of a single population proportion. Previous studies conducted in comparable low- and middle-income settings indicated that approximately 40% to 50% of caregivers might have adequate knowledge of nasogastric tube feeding (20). A conservative expected proportion of 50%, a 95% confidence level, and an absolute precision of approximately 5.9% were used, producing a required sample of approximately 276 participants. The final target was rounded to 280 caregivers to provide adequate precision and sufficient observations for multivariable analysis. Participants were recruited through consecutive non-probability sampling, whereby every eligible and consenting caregiver encountered during the study period was enrolled until the required sample size was achieved. Data were collected using a structured, interviewer-administered questionnaire supported by a brief observational checklist. The questionnaire consisted of five sections covering caregiver sociodemographic characteristics, patient-related information, knowledge of nasogastric tube feeding, routine feeding practices, and perceptions regarding training and feeding-related difficulties. The knowledge component contained five items assessing understanding of the indication for nasogastric feeding, the recommended tube-replacement interval, appropriate patient positioning, confirmation of tube placement, and recognition of common complications. The practice component assessed hand hygiene, tube flushing, type of feed, volume administered per feeding session, and daily feeding frequency. The observational checklist was used whenever a feeding episode could be directly observed and assessed essential actions, including hand hygiene, patient positioning, verification of tube placement, and flushing of the tube. Where direct observation was available, observed performance was given priority over the corresponding self-reported response when determining technique. The instruments were piloted among a small convenience sample of caregivers who were not included in the final analysis. Minor revisions were made to improve clarity, sequence, and cultural appropriateness before formal data collection.

Nasogastric tube feeding was operationally defined as the administration of liquid nutrition through a tube introduced through the nose and advanced into the stomach. Caregiver knowledge referred to understanding of the purpose, safety requirements, and potential complications of nasogastric feeding. Each of the five knowledge items was awarded one point for a correct answer and zero points for an incorrect or unknown response. The designated correct responses included identification of the clinical purpose of nasogastric feeding; recognition of an approximately four-week replacement interval for the fine-bore tubes used under the unit protocol; maintenance of head-of-bed elevation at approximately 30° to 45° during feeding; confirmation of gastric placement through aspiration and pH testing rather than reliance on air insufflation and auscultation alone; and identification of at least two recognised complications. Caregiver technique was evaluated using five similarly weighted items. One point was awarded for hand hygiene before handling the feeding system, flushing the tube before and after each feed, using the prescribed commercial formula or an appropriately prepared mixed feeding regimen rather than unregulated blenderised food alone, administering a prescribed bolus within the unit's usual range of 200 to 350 mL, and providing feeds within the prescribed frequency of four to six times per day. Feed volume and frequency were interpreted in relation to the patient's clinical prescription because nutritional requirements may vary according to age, body size, tolerance, comorbidities, and overall nutritional needs. Knowledge and technique scores ranged from zero to five and were converted into percentages. Because a five-item scale does not allow an exact score of 70%, a score of at least four correct items, equivalent to 80%, was classified as adequate knowledge or safe technique. Scores of three or fewer were classified as inadequate knowledge or unsafe technique.

The primary study outcomes were adequate caregiver knowledge and safe nasogastric feeding technique, both analysed as binary variables. The caregiver-reported occurrence of any feeding-related difficulty or complication was evaluated as a secondary descriptive outcome. Data were analysed using R statistical software, version 4.x. Continuous variables were summarised as mean and standard deviation when approximately normally distributed and as median and interquartile range when distributions were skewed. Categorical variables were presented as frequencies and percentages. Associations between categorical variables were examined using Pearson's chi-square test, while independent-samples t-tests were used to compare mean scores between two groups. The Mann–Whitney U test was applied when the assumptions required for parametric testing were not satisfied. Two multivariable binary logistic regression models were constructed separately for adequate knowledge and safe technique. Variables considered clinically relevant or associated with the respective outcome at a p-value below 0.10 in bivariate analysis were entered into the multivariable models. Findings were reported as adjusted odds ratios with 95% confidence intervals. All tests were two-sided, and a p-value below 0.05 was considered statistically significant.

The study protocol was reviewed and approved by the Institutional Research and Ethics Board of Hayatabad Medical Complex before data collection. Written informed consent was obtained from every participating caregiver after an explanation of the study objectives, procedures, voluntary nature of participation, and right to withdraw without affecting the patient's treatment. Interviews were conducted privately where possible, responses were anonymised, and all collected information was kept confidential. No directly identifiable patient or caregiver information was included in the analytical dataset or disclosed outside the research team.

RESULTS

A total of 280 caregivers were included in the analysis. Their mean age was 39.0 ± 10.0 years. Most participants were close relatives of the patients, including 118 sons or daughters (42.1%), 72 other family members (25.7%), and 59 spouses (21.1%), while 31 participants (11.1%) were paid attendants. Forty-two caregivers (15.0%) had received no formal education, 59 (21.1%) had completed primary education, 74 (26.4%) had secondary education, 53 (18.9%) had higher-secondary education, and 52 (18.6%) were graduates or had attained a higher qualification. Overall, 165 caregivers (58.9%) lived in urban areas and 115 (41.1%) lived in rural areas. The mean age of the patients receiving nasogastric feeding was 61.4 ± 11.5 years. The median duration since stroke was 7 weeks (IQR: 4–12), while the median duration of nasogastric tube feeding was 19 days (IQR: 11–32). Prior training in nasogastric tube feeding had been received by 119 caregivers (42.5%). Only 69 caregivers (24.6%) reported being confident in performing nasogastric feeding, whereas 104 (37.1%) were somewhat confident and 107 (38.2%) were not confident. Regarding longer-term enteral access, 72 caregivers (25.7%) stated that they would prefer percutaneous endoscopic gastrostomy if clinically advised, 118 (42.1%) would not prefer it, and 90 (32.1%) were unsure. Among the 276 caregivers who responded to the question concerning staff guidance, 88 (31.9%) were satisfied with the information provided, 111 (40.2%) were partially satisfied, and 77 (27.9%) were dissatisfied.

The mean knowledge score was 67.0% ± 28.0%. The indication for nasogastric tube feeding was correctly identified by 218 caregivers (77.9%), and 204 (72.9%) named at least two recognised complications. Correct positioning of the patient with head-of-bed elevation of 30° to 45° was identified by 193 caregivers (68.9%), while 169 (60.4%) correctly reported the tube-replacement interval used in the unit protocol. Confirmation of tube placement through gastric aspiration and pH testing was the least frequently recognised safety measure, with 154 caregivers (55.0%) answering correctly and 126 (45.0%) providing an incorrect response or reporting that they did not know. Overall, 145 caregivers (51.8%) answered at least four of the five knowledge items correctly and were classified as having adequate knowledge, while 135 (48.2%) had inadequate knowledge. The mean technique score was 59.5% ± 30.2%, which was lower than the mean knowledge score. Hand hygiene before handling the nasogastric tube was reported by 178 caregivers (63.6%), whereas 102 (36.4%) did not routinely perform hand hygiene. Flushing before and after every feed was reported by 153 participants (54.6%); 91 (32.5%) flushed the tube only after feeding, and 36 (12.9%) reported that they never flushed it. Blenderised home food alone was administered by 118 caregivers (42.1%), a combination of home-prepared food and commercial formula was used by 102 (36.4%), and commercial formula alone was used by 60 (21.4%). A bolus volume within the defined range of 200–350 mL was reported by 169 caregivers (60.4%), while four responses to this item were missing. Feeding within the defined frequency of four to six times daily was reported by 171 caregivers (61.1%). Overall, 115 caregivers (41.1%) met the operational criterion of at least four safe practices, while 165 (58.9%) were classified as having unsafe technique. Feeding-related difficulties or complications were reported by 130 caregivers (46.4%).

Adequate knowledge differed significantly according to educational attainment. It was identified in 31 of 101 caregivers (30.7%) with primary education or below, 37 of 74 (50.0%) with secondary education, and 77 of 105 (73.3%) with higher-secondary or graduate-level education ($\chi^2 = 37.62$, $p < 0.001$). Adequate knowledge was also more frequent among urban than rural caregivers, affecting 102 of 165 (61.8%) and 43 of 115 (37.4%), respectively ($\chi^2 = 15.23$, $p < 0.001$). Similarly, 79 of 119 trained caregivers (66.4%) had adequate knowledge compared with 66 of 161 untrained caregivers (41.0%; $\chi^2 = 16.67$, $p < 0.001$). The mean knowledge score was higher among trained caregivers than among those without training (75.8% vs 60.5%; $t = 4.68$, $p < 0.001$). Knowledge was not significantly associated with caregiver age group ($p = 0.451$) or relationship to the patient ($p = 0.745$). Safe technique was demonstrated by 74 of 119 trained caregivers (62.2%) compared with 41 of 161 untrained caregivers (25.5%; $\chi^2 = 36.62$, $p < 0.001$). Safe technique was recorded in 48 of 69 confident caregivers (69.6%), 46 of 104 somewhat confident caregivers (44.2%), and 21 of 107 caregivers who lacked confidence

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(19.6%; $\chi^2 = 43.91$, $p < 0.001$). It was also more frequent among caregivers with higher-secondary or graduate education (65/105; 61.9%) than among those with secondary education (28/74; 37.8%) or primary education and below (22/101; 21.8%; $\chi^2 = 34.68$, $p < 0.001$). Urban caregivers demonstrated safe technique more frequently than rural caregivers (47.3% vs 32.2%; $\chi^2 = 5.77$, $p = 0.016$). The mean technique score was higher among trained than untrained caregivers (73.4% vs 49.2%; $t = 7.22$, $p < 0.001$).

After adjustment, higher-secondary or graduate education was associated with greater odds of adequate knowledge than primary education or below (aOR = 7.80, 95% CI: 3.99–15.26; $p < 0.001$). Secondary education (aOR = 2.32, 95% CI: 1.18–4.58; $p = 0.015$), prior training (aOR = 2.14, 95% CI: 1.23–3.74; $p = 0.007$), and longer nasogastric feeding duration measured per log-day (aOR = 1.55, 95% CI: 1.09–2.20; $p = 0.015$) were also independently associated with adequate knowledge. Rural residence was associated with lower odds of adequate knowledge (aOR = 0.31, 95% CI: 0.18–0.56; $p < 0.001$), whereas caregiver age was not significant (aOR = 1.22, 95% CI: 0.71–2.11; $p = 0.466$). Prior training independently increased the odds of safe technique (aOR = 3.82, 95% CI: 2.15–6.81; $p < 0.001$). Higher education (aOR = 3.71, 95% CI: 2.07–6.66; $p < 0.001$) and high confidence (aOR = 2.71, 95% CI: 1.39–5.29; $p = 0.003$) were also independently associated with safe technique. Rural residence was not statistically significant after adjustment (aOR = 0.61, 95% CI: 0.34–1.10; $p = 0.103$). Feeding-related difficulties or complications were reported by 80 of 135 caregivers with inadequate knowledge (59.3%) and 50 of 145 caregivers with adequate knowledge (34.5%; $\chi^2 = 16.27$, $p < 0.001$).

Table 1. Baseline characteristics of caregivers and stroke patients receiving nasogastric tube feeding

Characteristic	Category or measure	n (%) or summary
Caregiver characteristics		
Age, years	Mean ± SD	39.0 ± 10.0
Relationship to patient	Son or daughter	118 (42.1)
	Spouse	59 (21.1)
	Other family member	72 (25.7)
	Paid attendant	31 (11.1)
Educational level	No formal education	42 (15.0)
	Primary	59 (21.1)
	Secondary	74 (26.4)
	Higher secondary	53 (18.9)
	Graduate or above	52 (18.6)
Residence	Urban	165 (58.9)
	Rural	115 (41.1)
Previous training in NG feeding	Yes	119 (42.5)
	No	161 (57.5)
Confidence in NG feeding	Confident	69 (24.6)
	Somewhat confident	104 (37.1)
	Not confident	107 (38.2)
Preference for PEG if clinically advised	Yes	72 (25.7)
	No	118 (42.1)
	Unsure	90 (32.1)
Satisfaction with information provided by staff*	Satisfied	88 (31.9)
	Partially satisfied	111 (40.2)
	Not satisfied	77 (27.9)
Patient and feeding characteristics		

Patient age, years	Mean ± SD	61.4 ± 11.5
Duration since stroke, weeks	Median (IQR)	7 (4–12)
Duration of NG feeding, days	Median (IQR)	19 (11–32)

*Values for satisfaction were calculated from 276 valid responses.

Abbreviations: SD, standard deviation; IQR, interquartile range; NG, nasogastric; PEG, percutaneous endoscopic gastrostomy.

Table 2. Caregiver knowledge, feeding practices, and overall competency outcomes

Domain and assessment item	Response category	n/N (%) or summary
Knowledge assessment		
Overall knowledge score, %	Mean ± SD	67.0 ± 28.0
Understood the indication for NG feeding	Correct	218/280 (77.9)
Knew the tube-replacement interval used in the unit protocol	Correct	169/280 (60.4)
Identified head elevation of 30°–45° as the appropriate feeding position	Correct	193/280 (68.9)
Identified gastric aspiration and pH testing as the appropriate placement check	Correct	154/280 (55.0)
Identified at least two recognised complications	Correct	204/280 (72.9)
Overall knowledge classification	Adequate knowledge, ≥4 of 5 items	145/280 (51.8)
	Inadequate knowledge, ≤3 of 5 items	135/280 (48.2)
Feeding practices and technique		
Overall technique score, %	Mean ± SD	59.5 ± 30.2
Performed hand hygiene before handling the tube	Yes	178/280 (63.6)
	No	102/280 (36.4)
Flushing frequency	Before and after every feed	153/280 (54.6)
	Only after feeding	91/280 (32.5)
	Never	36/280 (12.9)
Type of feed administered	Blenderised home food alone	118/280 (42.1)
	Mixed regimen	102/280 (36.4)
	Commercial formula alone	60/280 (21.4)
Bolus volume within the defined range of 200–350 mL*	Yes	169/276 (61.2)
Feeding frequency within the defined range of 4–6 feeds/day	Yes	171/280 (61.1)
Overall technique classification	Safe technique, ≥4 of 5 practices	115/280 (41.1)
	Unsafe technique, ≤3 of 5 practices	165/280 (58.9)
Reported feeding-related difficulty or complication	Yes	130/280 (46.4)
	No	150/280 (53.6)

*Four responses regarding bolus volume were missing; the percentage was calculated using 276 valid responses.
Abbreviations: SD, standard deviation; NG, nasogastric.

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Table 3. Bivariate and multivariable factors associated with adequate knowledge and safe feeding technique

Outcome and predictor	Category	Outcome n/N (%)	χ^2	Bivariate p-value	Adjusted OR	95% CI	Adjusted p-value
Adequate knowledge							
Educational level	Primary or below	31/101 (30.7)	37.62	<0.001	Reference	—	—
	Secondary	37/74 (50.0)			2.32	1.18–4.58	0.015
	Higher secondary or graduate	77/105 (73.3)			7.80	3.99–15.26	<0.001
Residence	Urban	102/165 (61.8)	15.23	<0.001	Reference	—	—
	Rural	43/115 (37.4)			0.31	0.18–0.56	<0.001
Previous NG-feeding training	No	66/161 (41.0)	16.67	<0.001	Reference	—	—
	Yes	79/119 (66.4)			2.14	1.23–3.74	0.007
Caregiver age	<40 years	73/148 (49.3)	0.57	0.451	Reference	—	—
	≥40 years	72/132 (54.5)			1.22	0.71–2.11	0.466
Relationship to patient	Four-category comparison	—	1.23	0.745	Not included	—	—
Duration of NG feeding	Per log-day increase	—	—	—	1.55	1.09–2.20	0.015
Safe feeding technique							
Previous NG-feeding training	No	41/161 (25.5)	36.62	<0.001	Reference	—	—
	Yes	74/119 (62.2)			3.82	2.15–6.81	<0.001
Confidence in NG feeding	Not confident	21/107 (19.6)	43.91	<0.001	—	—	—
	Somewhat confident	46/104 (44.2)			—	—	—
	Confident	48/69 (69.6)			2.71†	1.39–5.29	0.003
Educational level	Primary or below	22/101 (21.8)	34.68	<0.001	—	—	—
	Secondary	28/74 (37.8)			—	—	—
	Higher secondary or graduate	65/105 (61.9)			3.71‡	2.07–6.66	<0.001
Residence	Urban	78/165 (47.3)	5.77	0.016	Reference	—	—
	Rural	37/115 (32.2)			0.61	0.34–1.10	0.103

†Adjusted odds ratio compared confident caregivers with caregivers who were not confident or only somewhat confident.
‡Adjusted odds ratio compared caregivers with higher-secondary or graduate education with caregivers having lower educational attainment.
The adequate-knowledge model had a pseudo-R^2 of 0.194, while the safe-technique model had a pseudo-R^2 of 0.205. The χ^2 statistics for 2 × 2 comparisons were continuity-corrected.
Abbreviations: OR, odds ratio; CI, confidence interval; NG, nasogastric.

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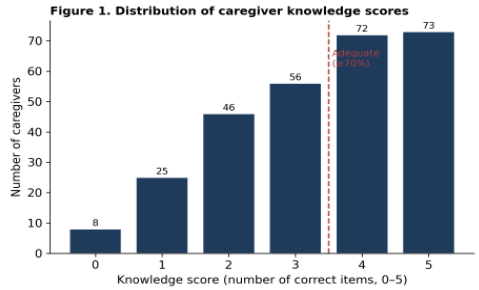

Figure 1. Distribution of caregiver knowledge scores (0 to 5 correct items). The dashed line marks the 70% threshold for adequate knowledge; 145 of 280 caregivers (51.8%) scored at or above it.

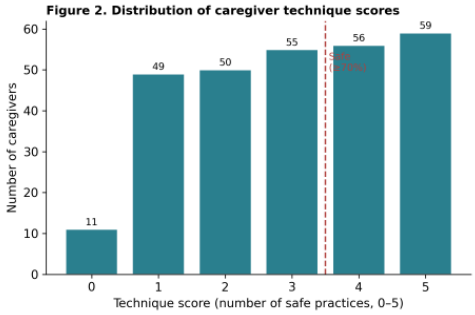

Figure 2. Distribution of caregiver technique scores (0 to 5 safe practices). The dashed line marks the 70% threshold for safe technique; 115 of 280 caregivers (41.1%) scored at or above it.

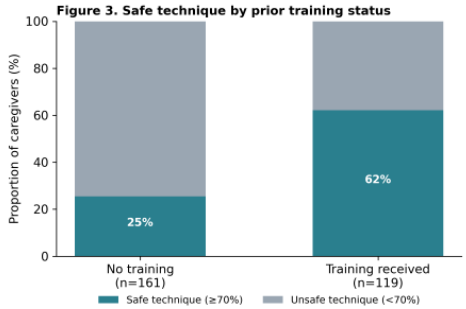

Figure 3. Proportion of caregivers achieving safe technique by prior training status. Safe technique was reached by 62% of trained caregivers (n = 119) versus 25% of untrained caregivers (n = 161); chi-square 36.6

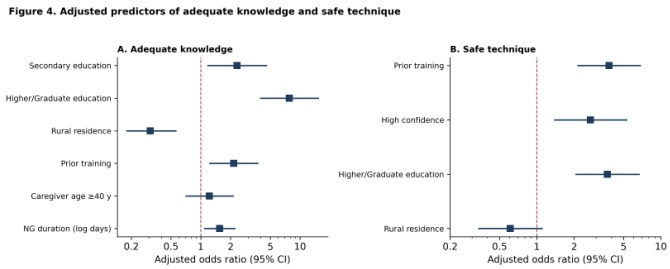

Figure 4. Adjusted odds ratios (95% CI) from the two multivariable logistic regression models, for adequate knowledge (panel A) and safe technique (panel B). The dashed reference line is at OR = 1.

DISCUSSION

The study identified substantial gaps in both the knowledge and practical technique of caregivers responsible for nasogastric tube feeding among patients with stroke. Although slightly more than half of the caregivers achieved the predefined level of adequate knowledge, fewer than half demonstrated safe feeding technique. The lower technique score suggested that awareness of recommended practices did not consistently translate into their correct application. This distinction was clinically important because nasogastric feeding depended on the repeated performance of several safety-sensitive steps, including hand hygiene, appropriate patient positioning, confirmation of tube placement, controlled delivery of feed, and adequate flushing. A caregiver might have recognised the importance of a particular step but still failed to perform it regularly because of limited supervision, uncertainty, time pressure, or reliance on practices learned informally from other attendants. The most prominent knowledge gaps involved confirmation of tube placement and the recommended interval for tube replacement. Only slightly more than half of the caregivers correctly identified gastric aspiration with pH testing as the appropriate method of checking tube position. This finding had direct patient-safety implications because feeding through a displaced tube could lead to aspiration, respiratory complications, and potentially serious harm. Previous literature had similarly shown that informal or inconsistent training often resulted in continued use of unreliable methods, particularly air insufflation followed by abdominal auscultation (21). Evidence-based guidance had supported aspirate pH testing as the preferred bedside method for confirming gastric placement before feeding, while imaging remained necessary when placement could not be confirmed safely (19,20). Although ultrasound and other bedside technologies had been investigated for tube verification, such methods had limited practicality for caregivers outside monitored healthcare environments (19).

The findings also indicated that education was strongly associated with caregiver knowledge. Caregivers with higher-secondary or graduate-level education had markedly greater adjusted odds of achieving adequate knowledge than those with primary education or no formal education. This association was consistent with the expectation that literacy, comprehension of health information, and familiarity with written instructions could influence the acquisition and retention of feeding-related knowledge. However, educational attainment alone did not guarantee safe performance. Even among more educated caregivers, technique could have remained incomplete without structured demonstration and supervised practice. Educational status therefore appeared useful as a marker for identifying caregivers who required additional support, but it should not have been treated as a substitute for competency-based training. Rural residence was independently associated with lower odds of adequate knowledge, although its association with safe technique was no longer statistically significant after adjustment. This pattern may have reflected differences in access to health information, continuity of follow-up, literacy, prior exposure to hospital-based procedures, or availability of community support. Caregivers travelling from rural districts may also have faced greater difficulty returning for repeated counselling or tube-related review. Nevertheless, residence itself did not explain individual competence and should not have been used to make assumptions about a caregiver's ability. Rather, it provided a practical

indicator for services to offer clearer discharge instructions, locally understandable educational materials, and stronger follow-up arrangements.

Prior training emerged as one of the most important modifiable determinants. Trained caregivers had higher mean knowledge and technique scores, and prior training remained independently associated with both outcomes after adjustment for educational level and residence. The association was particularly strong for safe technique, with trained caregivers having almost four times the adjusted odds of meeting the required standard. This finding agreed with previous studies in which structured teaching programmes improved knowledge and performance related to nasogastric tube care among nurses and family caregivers (19). The persistence of the association after adjustment suggested that training contributed beyond the advantages associated with formal education. However, the cross-sectional design prevented confirmation that training itself caused the improvement, as caregivers who were more engaged, experienced, or confident may also have been more likely to receive or seek training. Confidence was independently associated with safe technique, but this relationship required careful interpretation. Confidence may have developed through repeated successful performance and formal instruction, although it could also have represented self-perception rather than actual competence. Some caregivers may have been confident despite using unsafe methods, while others may have performed correctly but remained uncertain because they had not received reassurance from healthcare staff. Confidence therefore had value when considered alongside observed performance, but it should not have been used as a stand-alone measure of readiness for independent feeding. A return-demonstration or teach-back approach would have provided a more reliable assessment by requiring the caregiver to explain and perform each essential step under supervision (16).

Nearly half of the caregivers reported a feeding-related difficulty or complication, and these reports were more frequent among caregivers with inadequate knowledge. This association was clinically plausible and aligned with previous complication-surveillance studies involving patients with stroke who received nasogastric feeding (18). Nevertheless, the finding remained descriptive because the reported complications were not independently verified, and the cross-sectional design did not establish whether poor knowledge preceded the difficulties. It was also possible that caregivers who had experienced complications subsequently became more aware of feeding risks. Future prospective studies should therefore document aspiration events, tube blockage, vomiting, diarrhoea, accidental removal, respiratory infection, and unplanned tube replacement using clinical records and predefined diagnostic criteria. The findings supported the introduction of a brief, standardized caregiver-training programme before discharge. Such training should have included hand hygiene, safe positioning, tube-placement verification, flushing, feed preparation, medication administration, recognition of warning signs, and instructions on when to seek medical assistance. Demonstration followed by caregiver return-demonstration would likely have been more effective than verbal counselling alone. Pictorial instructions and materials in locally understood languages could have improved accessibility for caregivers with limited literacy. Caregivers with lower educational attainment, no previous training, low confidence, or limited access to follow-up services would have required particular attention. For patients expected to need prolonged enteral feeding, counselling should also have included balanced information about continued nasogastric feeding and possible transition to gastrostomy, with decisions based on clinical prognosis, swallowing recovery, patient preference, and family circumstances (15).

The study had several strengths. It focused on the individuals who were directly responsible for feeding rather than assuming that bedside care was performed by trained personnel. It assessed both knowledge and technique, applied predefined scoring criteria, and included a sample large enough to support adjusted analyses. The inclusion of an observational checklist also strengthened the intended assessment by allowing reported behaviour to be compared with actual performance. Several limitations remained. The single-centre design and consecutive non-probability sampling limited generalisability and introduced the possibility of selection bias. The cross-sectional design established associations but not temporal or causal relationships. Technique was assessed partly through self-report, which was vulnerable to recall and social-desirability bias, while direct observation may have produced a Hawthorne effect because caregivers could have improved their behaviour while being watched. The number of directly observed feeding episodes and agreement between self-reported and observed practice were not reported and should be included in future analyses. The knowledge and technique scales contained only five items each and therefore may not have captured the full complexity of safe enteral feeding. In addition, feeding difficulties and complications were caregiver-reported rather than clinically confirmed. Future multicentre prospective research should validate the assessment instrument, include repeated direct observations, evaluate clinically confirmed complications, and test whether structured caregiver training produced sustained improvements in feeding safety and patient outcomes.

CONCLUSION

The study concluded that important gaps remained in both the knowledge and practical technique of caregivers responsible for nasogastric tube feeding in stroke care. Lower educational attainment, rural residence, lack of prior training, and limited confidence identified caregivers who were more likely to require additional support. These findings highlighted the need for structured, practical, and easily understandable caregiver education before discharge, supported by demonstration, return-demonstration, and clear instructions on safe feeding practices and recognition of complications. Such an approach may strengthen caregiver competence, reduce preventable feeding-related problems, and improve the continuity and safety of care after hospital discharge.

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