When Food is Feared: A Systematic Review of Enteral Feeding by Nasogastric Tube in Young People with Eating Disorders

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Abstract

Background

Adolescents with severe restrictive eating disorders often require enteral feeding. Nasogastric feeding is occasionally used during hospitalisation to treat medical instability as a result of malnourishment, or in a specialist setting to supplement minimal oral intake by underweight patients. There is minimal guidance for clinicians to determine when nasogastric feeding should be implemented, how it should be provided and how to complement feeding with a nasogastric tube. This systematic review sets out to determine best practice for NG feeding.

Methods

A systematic review following PRISMA guidelines was conducted by searching AMED, EMBASE and MEDLINE databases from 2000-2020. Inclusion terms used were as follows: enteral feeding by nasogastric tube, under 18 years, eating disorders, and primary research. Exclusion terms: mental disorders other than eating disorders; non-primary research; no outcomes specific to NG feeding and over 18 years. Titles and abstracts were screened by all authors before reviewing full length articles.

Results

28 studies met the full criteria. 51.7% of studies were deemed high risk of bias due to the type of study: 37.9% retrospective cohort and 10.3% RCT; 17.2% were qualitative. Studies identified 1) 6-66% required NG feeding; 2) staff and young people understand its necessity but generally view it negatively; 3) there are 3 main types of feeding regime: continuous, nocturnal and bolus; 4) high calorie feeds are not associated with increased risk of refeeding syndrome; 5) Common complications were nasal irritation, epistaxis, electrolyte disturbance, distress and tube removal; 6) length of stay in hospital may be longer in patients requiring NG feeding; 7) psychiatric and medical wards differ in approach; 8) concurrent therapy reduces NG use and aids recovery.

Conclusions

All studies which reviewed the use of NG over a period of time found that it had increased significantly in recent years. Due to the possibility of patient removal of the tube, it may be beneficial in practice to deliver feeds using a bolus regime which has been tailored to the individual caloric needs of the patient. This review enables cautious recommendations to be made and highlights the lack of high-quality evidence around the use of NG feeding in eating disordered young people.

Plain English Summary

Young people with eating disorders often restrict dietary intake to a degree which is detrimental to their physical health. During hospital admission dietary intake is usually encouraged however occasionally the young person may continue to decline foodstuff. In these circumstances, a nasogastric tube may be placed from nose to stomach to pass foodstuff without requiring the young person to eat. Currently there is minimal guidance on protocols for nasogastric feeding in a clinical setting. This systematic review sets out to review the current evidence and collate a guideline for clinicians to refer to in order to treat young people with eating disorders. Results have shown that nasogastric feeding may be administered through different methods, such as continuously, multiple single meals (bolus), or overnight to supplement day-time oral intake. Side effects are minimal but may include bleeding from the nose, irritation to the nose, imbalances in blood electrolytes which can be reduced by providing supplementation. Due to the possibility of the young person removing the tube, it may be beneficial in practice to deliver NG feeding using bolus regime. Support to patients and staff is indicated from delivery of NG feeds.

1. Background

The number of young people diagnosed with an eating disorder (ED) has increased by approximately 27% since 2000.[1] EDs usually manifest prior to adulthood, with an average age of onset at approximately 15 years, although this is decreasing. [2,3] Compared to other mental illnesses, EDs have a high mortality rate with young people (YP) with anorexia nervosa (AN) on average 6–10 times more likely to die than the general population.[4] Nasogastric (NG) feeding use in YP with ED is generally seen as a “last resort” to provide lifesaving treatment.[5,6] However, refeeding is a critical component to recovery and NG feeding will often be utilised if a young person has been unable to manage oral intake.[7,8]

NG feeding involves a fine bore tube passed via the nasal passage into the stomach to administer nutrition. There is a low risk of complications associated with NG feeding if staff receive adequate training and protocols are in place to ensure that the tube has been passed correctly.[9] Research has indicated that NG feeding in YP with an ED may be helpful in aiding recovery, however, there has also been concerns raised due to the invasive nature and possible trauma related to the procedure.[10] Some research has indicated that YP may find NG feeding motivational to eat an oral diet,[11] nevertheless, between 13%-44% refuse consent[12] and a significant minority will require restraint for NG feeding to occur successfully.[13] Recent guidance from the British Dietetic Association[14] for NG feeding under restraint advised 1–2 bolus feeds per day even in those with high risk of refeeding syndrome (RS); it also concluded further research into this area was required.

Most EDs will be treated in an outpatient setting with hospitalisation generally reserved for those with severe malnutrition resulting in symptoms such as bradycardia, low blood pressure or dehydration as set out in the Junior MARSIPAN guidance.[15] Research on NG feeding in YP has tended to focus on the acute refeeding phase in paediatric or psychiatric wards to reduce the risk of RS.[16] RS can manifest as hypophosphatemia (HP), hypomagnesemia, hypokalemia. and other electrolyte imbalances that result in cardiac arrhythmias, seizures and in some cases sudden death.[17] During the acute refeeding phase the need for weight restoration must be balanced against the risk of developing RS. Although there is a significant body of research into this, the role of

NG feeding remains ill-defined.[16] The National Institute for Clinical Excellence has produced guidance for providing nutrition recommending a graded approach:[18]

1. Increasing calorific intake orally with food
2. Increasing calorific intake using high calorie oral nutritional supplements
3. Enteral nutrition given if the patient has a functioning gastrointestinal tract
4. Parenteral nutrition

There is currently no guidance on how to manage NG feeding in YP with ED, in particular how and when to transition between oral and NG feeding. This has resulted in a variety of NG feeding practices across different settings, with many paediatric and medical inpatient settings providing continuous feeds and sometimes restricting oral intake.[19]In contrast specialist mental health inpatient settings are more likely to use syringe bolus feeds over shorter periods of time to mimic meals, aiding normalisation of eating.[20]

This will be the first systematic review on the use of NG feeding in YP with ED. This review aims to examine NG feeding as a treatment to aid recovery, its role in acute refeeding, complications and the level of acceptability for YP requiring it. The different settings NG is used in will be compared, as well as the different types of feeding technique (for example bolus and continuous feeds), and any indications given about how and when to commence or cease NG feeding.

2. Methods

A comprehensive database search of AMED, EMBASE, APA Psychinfo and MEDLINE was performed with no language restriction from January 2000 to July 2020. Search strategies combined keywords with controlled vocabulary terms (MeSH, Thesaurus); both quantitative and qualitative research were included. The search criteria was peer reviewed by a researcher from the University of York's Child and Adolescent Mental Health Intervention Centre. References were exported and duplicates were removed using the title and abstract.

2.1 Screening for Eligible Studies

The full search is available in Appendix 1. The inclusion criteria were: NG feeding, under 18 years, eating disorders, published since 2000 and primary research. The outcomes of interest were: Opinions of YP and staff using NG, amount of YP requiring NG, any interventions that impacted on NG feeding, complications of NG feeding, interventions to mitigate the complications, the setting (paediatric hospital, psychiatric unit or outpatient), the NG method and whether this changed when restraint was required. The exclusion criteria included: No ability to discern results specific to NG feeding, mental disorders other than eating disorders being the focus, where the results do not focus on YP under 18 or it is impossible to separate results for adults from YP, reviews or other non-primary research and research published before 2000.

Studies published in languages other than English were translated prior to being reviewed. The PRISMA flowchart was used (Figure 1). Abstracts identified from the initial search were screened in a secondary review process, and full text papers were obtained of those meeting the inclusion criteria or where there was uncertainty. One article published prior to 2000 was included in the full text review due to it requiring translation prior to assessing it against the criteria. Key studies were manually reviewed for additional research, but none were identified that were not already included. There was no disagreement between CF and KH who assessed which studies were included.

2.2 Assessing Study Quality

There is no validated method to assess the retrospective and qualitative nature of studies included therefore we could not conduct a formal quality assessment or statistical method to evaluate the results. The risk of bias was estimated into high, medium or low using an adapted version of the Agency for Healthcare Research and Quality risk of bias tool as described in Myers.[21]The studies were analysed for risk of bias independently by CF, KH and JM. The risk of bias was deemed to be medium or high for the majority of the studies included due to the nature of their design, being case series or retrospective cohort studies (see Table 1).

3. Results

3.1 Prevalence and Epidemiology

In 13 studies in which NG was not the independent variable, the proportion of ED YP requiring NG feeding was between 6% - 66%.[3, 7, 17, 22-26,31-33,38,42] Nehring and colleagues[26] found that NG feeding was more likely to be required in: patients of a lower age at admission (14.3 compared to 15.3 years old, $P<0.05$), those with a shorter time period between disease onset and admission to hospital ($P<0.0001$), and longer time since last discharge ($P<0.05$). NG feeding is required more commonly in Early onset (EO) AN than adult onset (20% compared to 0%, $P<0.05$).[3] Clausen[13] described NG as the most frequently used involuntary measure in practice and is most commonly used in 15-17 year olds. Bayes and colleagues[38] indicated that male requirements for NG is similar to that of females. According to Maginot and colleagues[17] NG was more likely to be required in severely malnourished patients. O'Connor and colleagues[42] found no correlation with high calorie initial feeding plans and increased risk of requiring NG feeding.

3.2 Patient and Staff Opinions on NG Feeding

5 studies used qualitative methods to analyse patient, parent and professional opinions on NG feeding.[8,22,30,36,40] Hospital staff had greater levels of satisfaction when a joint care model between CAMHS and paediatrics was implemented for hospitalised YP with ED.[22] Nursing assistants views centred

around: NG being an unpleasant practice, becoming sensitized or desensitized, and the importance of developing coping mechanisms to manage the distress.[36] Injuries were also described from head butting, hitting and abuse. 82% of Dietitians considered NG feeding a necessary procedure if oral diet is inadequate.[8]

YP viewed being NG fed as: an unpleasant experience, a necessary intervention, a psychological signifier of illness and a focus in a struggle for control by Halse and colleagues.[36] Some described NG feeds as easier than eating as it "disguised" the amount due to no swallowing; others felt it was a form of punishment for not gaining enough weight. YP described manipulating the tube or syringing out the feed to prevent weight gain. Others found NG feeding a helpful motivator for oral intake.[30] Nierderman and colleagues[30] found 71% of YP in the study did not consent to being NG fed and 66% had to be restrained to NG feed, however later in their treatment many reflected that they understood the necessity of the procedure.

3.3 Feeding Regime and Calorie Intake

A variety of different feeding regimes were identified in this review which are summarised in Table 2. Refeeding protocols daily calorie intake varied greatly between studies particularly as many studies were evaluating the outcome of higher calorie refeeding protocols. [7,17,19,39,42] Most studies tailored the calorie requirements to the individual patient, accounting for initial weight for height percentage and signs of medical instability. They tended to start on daily intake of less than 2000kcal and increase periodically.

3.4 Nutritional Information

Only 3 studies reported nutritional information in the review. YP in the NG cohort in Maginot and colleagues [17] and Agostino and colleagues[35] were supplied with a formulation containing 44% carbohydrate. In Paccagnella and colleagues[37] all YP displaying signs of medical instability were commenced on solely NG feeding again using a formulation containing 44% carbohydrate with 19.7% protein and 36% lipids.

3.5 Length of Time on NG feeding / Weaning

Agostino and colleagues[35] delivered nutrition solely via NG for 14 days before commencing oral diet in addition to NG feeding. The average length of time on NG feeding in this study was 20.7 days; NG was terminated as YP accepted more than 50% oral caloric quota compared to theoretical reported quota. Conversely to this, Akgul and colleagues[24] stated that the average time YP required NG feeding was 2.5 days when treated on a paediatric ward.

3.6 Complications

Complications associated with NG feeding found in this review are summarised in Table 2, the most common being nasal irritation or epistaxis, anxiety related to the procedure and electrolyte disturbance (which occurred with both oral and NG refeeding). Overall, this review found 5 studies[7,17,25,35,39] reported some incidence of electrolyte disturbance, 3 studies[25,28,29] described epistaxis and 2 studies[29,30] described behavioural problems associated with the procedure. No study reported a YP developed RS and Nehring and colleagues[26] concluded that NG feeding had no impact on growth, recovery or presence of psychiatric co-morbidities.

3.7 Phosphate Supplementation

7 studies implemented supplementary oral phosphate either to reduce risk of hypophosphatemia or to treat it once detected to prevent the development of refeeding syndrome. This is summarised in Table 3.

3.8 Setting

3 studies[20,22,24] reviewed NG treatment for YP in different settings. Fuller and colleagues[20] demonstrated discrepancies in treatment provided to YP in different settings with specialist ED units being less likely to use pumps to deliver continuous feeds, tending to give bolus feeds of higher volume. Akgul and colleagues[24] concluded the paediatric ward was a viable alternative for treatment (including NG) of YP with ED when specialist units are not available. In contrast Robb[29] discovered that YP staying on a general hospital ward had a longer duration of admission in total than those on a specialist psychiatric ward.

3.9 Length of Stay

Hospital admission was significantly longer ($P<0.0001$) for YP requiring NG feeding compared to those managing an oral diet in Nehring and colleagues[26] study. Conversely, Strik Lievers and colleagues[33] highlighted that supplemental overnight NG feeding was associated with a shorter length of stay (LOS) than those consuming oral intake alone (36 days compared to 39.9 days). Agostino and colleagues[35] supported this, demonstrating that YP consuming NG feeds had a mean LOS of 33.8 days compared to those having on an oral diet who had a mean of 50.9 days, however, the oral diet was lower in calories.

Strik Lievers and colleagues[33] concluded that factors affecting LOS on a psychiatric inpatient ward included duration of AN, need for intensive care, adherence to oral intake, presence of a comorbidity, and requirement for NG feeding. In this study the mean LOS was 117 days for YP managing oral intake compared to 180 days for those requiring NG. Madden and colleagues[19] indicated that a short admission with discharge upon medical stabilisation, compared to discharge on restoration of weight, resulted in no difference in readmission rates but reduced the LOS from 31.9 days to 21.7 days ($P<0.05$). From the studies in this review the length of admission varies from 19 to 180 days for YP with ED requiring NG.

3.10 Concurrent Therapy

5 studies[17, 25,27,29,41] discussed therapy in adjunct to refeeding. In Madden and colleagues[41] YP participated in family-based therapy (FBT) during their admission. Couturier and Mahmood [25] highlighted that meal support therapy reduced the requirement for NG feeding from 66.7% to 11.1%. In Robb and colleagues study[29] YP were provided with meal support, planned group activities, daily group therapy, individual therapy, FBT three times per week, and expressive therapy twice per week. Gusella and colleagues[31] compared parent led therapy (PLT) to non-specific therapy (psychologist led talking therapy). PLT was based on FBT and included parents reducing child exercise and increasing oral intake. Results demonstrated that YP receiving PLT had a significantly reduced requirement for NG ($P<0.05$). Maginot and colleagues[17] concluded that YP requiring NG often required behavioural interventions in the acute refeeding phase to manage the refusal of oral intake.

4. Discussion

There are a number of limitations to the conclusions that can be drawn from this review. The majority of studies included were retrospective and based around case note reviews which are subjective and therefore likely to be biased. A retrospective design also creates selection bias as those lost to follow up are not considered. Bias can also occur due to the different treatment groups being recorded at different times thus confounding variables may include different staff working at the setting and different methods of treating YP. Only 48% of studies were conducted prospectively. 3 studies were qualitative interview studies, examining patient or staff feelings towards NG feeding in practice which increases the risk of confirmation bias. The majority also had a relatively small sample size, again introducing the possibility of bias and reducing generalizability. 56% of the studies included only examined the effect of NG feeding as a secondary outcome of their study. It is not possible from these studies to make any comparison between NG feeding and oral intake due to the confounding effect that for the vast majority of studies only high risk, medically unstable YP were considered for NG feeding. Pragmatic, prospective studies that control for this confounder are required for any such comparison to be made.

It is evident that there is a wide variety of practices regarding NG feeding in YP with eating disorders globally.[7,22,28] Most studies identified that between 10–20%[3,7,17,25] of YP admitted to a psychiatric or medical unit for ED treatment required NG nonetheless in some studies this was significantly higher.[32,33] Given that Kodua and colleagues[40] stated the procedure can be painful for YP and can cause complications, there is an urgent need for research exploring this wide variation in use of NG feeds.

From this systematic review it is evident that there are 3 focal methods of NG feeding: continuous,[35,41] nocturnal,[28,29] and bolus meal replacement[7]. It is not possible from this review to discern fully the advantages and disadvantages of each method as no study made a direct comparison. Qualitative studies indicated that YP found that they were able to manipulate the feed or tube if it was left in situ when they were not supervised.[30] NG feeding under restraint used bolus feeds due to concerns around the tube being removed once restraint had ceased.[36] There was no indication from studies that continuous or nocturnal feeds had a significant advantage in terms of health risks such as reducing RS.

No study discussed in detail the weaning strategy used to transition from NG feeds back to an oral diet. Studies using bolus feeds stated that oral intake was encouraged and it was only when this was not fully achieved that supplementary NG was used.[28,29] This appeared to be either after each meal, at set times during the day or once in the evening.[20,34] For nocturnal feeds, oral diet was encouraged during the day. In most studies the NG feed supplemented any deficit in oral intake but occasionally also provided additional calories above those prescribed in the meal plan.[19,29,41] In studies where continuous NG was provided, YP were sometimes not given the option of an oral diet so that their calorie intake could be closely monitored.[19,35,39,42] These studies spoke about ceasing NG feeds after the risk of RS had reduced; most gave a time frame between 2–14 days.[33,39]

The main disadvantage to bolus feeding is that the NG tube requires reinsertion each time a feed is required, however, this should be weighed against the advantages found in this review including reducing the ability for feeds and the tube to be manipulated.[30] It also provides a tangible motivation to eat the full meal plan provided which should always be encouraged over NG feeding. This review indicates there may be some advantages to bolus or nocturnal feeding over continuous NG feeding. If NG insertion is causing pain or epistaxis and there is a low risk of manipulation of the tube, nocturnal feeding could be the preferred option. Further research is required directly comparing the outcomes of continuous, overnight NG and bolus NG to assess which method is the safest and best aids transition back to a fully oral diet.

It is reassuring to find that no study reported YP developing RS despite some studies starting on high calorie NG feeding plans.[7,17,32,34,39] Studies found that abnormal electrolytes tended to occur in YP less than 80%IBW.[7,17,35,39] Vitamin supplements should be provided and this review would support consideration being given to phosphate supplementation in those at high risk of RS requiring NG feeds.

The results of this review indicate that high calorie NG feeds can be safely administered and have the advantage of shortening LOS and therefore should be considered for those over 80%IBW where adequate monitoring and vitamin supplementation can be provided. In those YP under 80%IBW there was still evidence to support higher calorie NG feeds.[40] There may be a need for a lower initial feed of between 1000–1900 kcal, however, further research is required.

Intensive meal support and concurrent therapy reduced the number of NG episodes a young person required before managing a full oral diet.[25,31,29] This has the advantage of reducing LOS as well as the distress associated with the use of NG. This review would support intensive support provided from the start of the admission which, in a paediatric ward, may require outreach work or a day treatment centre from children's mental health services.

Studies in this review indicated that a significant number of YP required restraint to NG feed with one study reporting this was required for 66% of YP.[39] NG under restraint was described as causing significant distress for staff and can risk injury to both staff and YP.[40] When NG under restraint is required it may be required for a significant duration; in one study[13] the average was 170 days. Some studies used medication to reduce distress which could be helpful in reducing the need for restraint or the amount of trauma it causes for the YP and staff. A short acting benzodiazepine such as lorazepam was used in two

studies[29,34] and another used an antipsychotic medication.[38] Current guidance from the British Dietetic Association[14] supports the use of medications that could reduce distress with the aim of reducing the need for restraint when NG feeding. This review supports this guidance.

It is of significant concern that all studies which reviewed the use of NG over a period of time found that it had increased significantly in recent years.[13] This review is therefore timely in assessing the current body of evidence to allow cautious recommendations to be made. It also starkly highlights the lack of high quality evidence around the use of NG feeding in ED YP and the need to develop a robust global consensus on the type of NG, feed quantity, use of restraint, weaning technique and support needed for the YP and their family while NG is required.

5. Conclusions

From this review it is evident that NG feeding may be used when deemed necessary in acute admissions of YP with ED. Although different feeding regimes have been utilised in many studies, feeding using a bolus regime to supplement oral dietary intake may be beneficial in terms of reducing side effects such as patient removal of the tube. There is no evidence that refeeding using NG tube increases the risk of refeeding syndrome, although prophylactic phosphate supplementation may reduce the risk of electrolyte disturbance associated with refeeding patients with low %IBW. Patients and staff may require additional support related to NG feeding to address negative emotions. This review may be utilised clinically in guidance of managing NG feeding in acute admissions of YP with restrictive ED. More research may be beneficial to establish the most advantageous feeding regime in the treatment of underweight YP with ED.

Abbreviations

%IBW percentage ideal body weight
AN anorexia nervosa

AOED adolescent onset eating disorder

ED eating disorder

EOED early onset eating disorder

FBT family-based therapy

HP hypophosphataemia

NG nasogastric (feeding)

PLT parent led therapy

RDI recommended daily intake

RS refeeding syndrome

YP young person

Declarations

Ethical Approval and Consent to Participate:

No ethical approval or consent to participate required due to the nature of the study.

Consent for Publication:

All authors have reviewed the document and consent to publication.

Availability of Supporting Data:

All articles analysed in this study can be found in Table 1 and can be traced back to primary articles using References on Page 14.

Competing Interests:

Authors declare no competing interests.

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Authors Contributions:

All authors contributed equally in the review. KH and CF performed search of databases and drafted the initial document. JM edited the document and references.

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Appendix

Appendix 1:

1. Naso-gastric or nasogastric or *enteric or *enteral or tube
2. (Anorexia or bulimia or eat* or feed*) NOT bowel NOT surgery NOT intestin*
3. (child* or paed* or adolescen* or teen* or young) NOT baby NOT toddler NOT infant NOT animal NOT maternal NOT parental NOT learning disabl* NOT learning disabil*
4. 1 AND 2 AND 3

Tables

Table 1.

Studies utilised in systematic review of nasogastric feeding to treat young people with eating disorders.

References	Study Design	Country Set	Time Frame / Follow up years (months)	N total (Female)	Age Range (years)	Setting	Aims	NG Primary or Secondary Outcome?	Main Outcomes
22	Case Reports (prospective)	England	TF 3 FU 1-2	31 (30)	10 - 17	Paediatric ward	Evaluate joint care ED pathway between CAMHS and paediatric wards	Secondary	Time-limited admissions with boundaried-care pla are easier to manage an enjoyed feeling supporte by CAMHS
23	Case Series (retrospective)	Turkey	TF 4	13 (0)	11-17	CAMHS	Describe medical, psychiatric, cultural features of adolescent males with an ED	Secondary	Male:female increased (3.6:1 F:M); 2/13 given N due to refusal to eat in hospital
24	Cohort Study (retrospective)	Turkey	TF 6	35 (28)	11-17	Paediatric Ward	Explore paediatric unit where no specific ED unit for to discuss refeeding approaches and goals for discharge	Primary	Paediatric ward is acceptable where specialist ED inpatient u not viable; specialist uni better however limited resources
7	Cohort Study (retrospective)	Australia	TF 1	29 (not stated)	12-18	Adolescent Ward	Assess whether more aggressive refeeding leaves patients at greater risk of HP	Secondary	HP associated with lowe %IBW and lower number hospital admissions; 15% required NG feeding
25	Cohort Study (retrospective)	Canada	TF 2 FU 1	21 (19)	11-17	Psychiatric Inpatient Unit	Understand whether implementing meal support therapy reduced need for NGT	Primary	Meal support therapy reduces need for NGT (66.7% to 11.1% after implementation (P<0.02
26	Cohort Study (retrospective)	Germany	TF 10 FU 1-12	208 (208)	12-18	Psychiatric Inpatient Unit	Short-term and long-term outcomes of treating with EN compared to no EN	Primary	No significant difference recovery following EN; 34% had EN during at lea 1 hospitalisation
27	Case reports (prospective)	England	FU 1	4 (3)	13-16	Adolescent Unit	Report of gastrostomy or jejunostomy use in 4 cases of AN	Secondary	4/4 patients required NG feeding and progressed require gastrostomy/jejuonosto due to complications
28	Retrospective Cohort Study (retrospective)	USA	TF 10	14 (0)	12-18	Adolescent Inpatient Unit	Determine outcomes of supplementing oral refeeding with nocturnal NGT supplementation	Primary	Maximum kcals were greater, weight achieved discharge greater in treatment group compar to oral refeeding only
29	Cohort Study (retrospective)	USA	TF 6	100 (100)	12-18	Paediatric Hospital	Compare short-term outcomes of oral vs. supplemental nocturnal nasogastric refeeding	Primary	Weight gain significantly increased in treatment group, no significant difference in length of hospital stay
30	Cross-Sectional Study (retrospective)	UK	TF 1-18	58 (21 patients 37 parents) (19/21)	Patients 9-17 at start of study	Paediatric Ward	Analyse patient and parent views on NG feeding	Primary	71% patients said they d not consent to NG feedir patients feared weight g and loss of control over calorie intake
31	Retrospective Cohort Study (retrospective)	Canada	TF 13 FU 1	46 (43)	9-15	Outpatient ED team	Compare parent led treatment (PIC) to conventional treatment	Secondary	PIC had greater increase %IBW, fewer hospitalisations, shorter admissions, less likely to receive NG feeding
32	Cross-	Australia	TF 3	101	5-13	Inpatient	Collect	Secondary	Most were hospitalised

	Sectional Study (prospective)			(74)		and outpatient	epidemiological data on EOED		(78%), mean duration of hospitalisation was 24.7 days; 58% inpatients NG tube fed.
3	Cohort Study (prospective)	Germany	TF 3	120 (120)	9-19	Specialist ED unit	Evaluate characteristics of EO-AN compared with AO-AN.	Secondary	NG tube feeding required more in EO-AN than AO-A Restrictive more commo in EO.
19	RCT (prospective)	Australia/ USA	TF 3	82 (78)	12-18	Paediatric Ward	Long term outcomes of treating to restore weight rather than just to medically stabilise	Secondary	No difference in hospita days used after initial admission, however therefore total fewer day in hospital for MS.
33	Cohort Study (prospective)	France	TF 8	213 (213)	12-22	Psychiatric Hospital Ward	Clinical variables influencing the length of stay (LOS) of inpatient treatment for AN	Secondary	Requirement for tube feeding was predictor fo LOS (longer) tube feedin required in 27% admissions.
34	Case Series (prospective)	UK	TF 1	3 (2)	11-14	Specialist ED unit	Evaluate new dietetic guidelines for AN in clinical practice	Primary	Different use of NGT feeding to suit individua use of continuous and single bolus feeds via N tube
35	Cohort Study (retrospective)	Canada	TF 8 FU 0 (6)	165 (158)	10-18	Paediatric Hospital	Difference in LOS between adolescent ED treated with short-term continuous NG feeding vs. managed with lower calorie meals	Primary	LOS reduced in the NG-f cohort; No significant difference in complicatio or electrolyte abnormalit (90% NG cohort received prophylactic phosphate)
20	Cross-Sectional Study (prospective)	UK/ Ireland	TF 1	134 (n/a)	n/a	Variety of Settings	Identify common current practice and if specialist ED units are managing AN differently to other inpatient settings	Primary	43.3% reported that they were able to facilitate NG feeding; 79% of units providing N feeding were able to facilitate physical interventions
36	Cross-Sectional Study (prospective)	Australia	TF 1	23 (23)	12-20	Adolescent Medical Unit	Examine the meanings that patients attached to NGF	Primary	Categories: unpleasant physical experience, a necessary intervention, a physical and psychologi signifier of AN, a focus i struggle for control.
37	Cohort Study (prospective)	Italy	TF 1	24 (24)	11-32	Hospital	Define minimal criteria for "lifesaving" treatment and submit a patient to EN	Secondary	Symptomatology improv the day after EN; is beneficial especially whe used for life saving treatment initially
13	Cross-Sectional Study (retrospective)	Denmark	TF 13	4727 (4387)	10-40+	Psychiatric/ Medical Ward	Frequency of various involuntary measures in AN patients	Secondary	Involuntary tube feeding was most frequent measure used.
38	Case Series (retrospective)	Australia	TF 2	10 (0)	10-13	Paediatric Hospital	Demographic and clinical features of male inpatients with EOED	Secondary	Only 3/10 participants m full criteria for AN; 60% required NG feeding.
39	Cohort Study (retrospective)	Australia	TF 3	167 (152)	14-19	Adolescent ED unit	Weight gain and complications associated with refeeding prescribed greater initial calories	Secondary	Mean starting intake wa 2611.7 kcal/day (58.4 kcal/kg) With inclusion o phosphate supplementation no increased risk of RS.
40	Case Reports (prospective)	UK	TF 1	8 (n/a)	n/a	ED inpatient	Nursing assistants'	Primary	3 primary themes were gathered: an unpleasant

						units	experiences of manual restraint for NG feeding		practice, importance of coping, becoming (de)sensitized to NG feeding.
17	Cohort Study (retrospective)	USA	TF 1	87 (73)	8-20	Medical Behavioural Unit	Safety of higher calorie nutritional rehabilitation protocol (NRP)	Secondary	Lower %IBW on admissi more important predicto of HP than initial calorie Malnourished patients started on lower calories more likely to have NG tube.
8	Cross-Sectional Study (prospective)	Australia	TF 0 (3)	17 (n/a)	n/a	Variety of Settings	Describe practices of Australian dietitians in management of AN	Secondary	All dietitians stated OR was offered first with supplementation. 82% recommended implementing NG feedin as part of re-feeding process.
41	RCT (prospective)	Australia	TF 1 (9)	78 (74)	12-18	Paediatric Hospital ED service	More rapid refeeding protocol promotes initial weight recovery and medical stability.	Primary	Adequate weight gain ar minimal adverse effects were observed. All patier gained weight in week 1 with no cases of HP or R
42	RCT (prospective)	UK	TF 2	36 (34)	10-16	Paediatric Ward	Higher calorie refeeding anthropometric outcomes, cardiac and biochemical markers	Secondary	Adolescents on high energy intake had greate weight gain. 11% participants required NG feeding for failure to me 80% oral intake.

Table displaying all 29 studies in which data has been gathered for this systematic review. Data included is reference number, type of study, country of setting, time frame and follow up in years (months) where information has been given, setting, risk of bias and primary outcomes from each study. Primary data from studies can be found by following reference. Key: N = number of participants; FU = follow up; TF = Time Frame; NG = Nasogastric (Feeding); LOS = Length of Stay; ED = Eating disorder; EO = Early onset; AN = Anorexia nervosa; RS = refeeding syndrome; %IBW = percentage ideal bodyweight; HP = hypophosphataemia; OR = oral refeeding; RCT = randomised control trial.

Table 2.

Nasogastric Feeding Protocol and Complications Identified in Studies.

Study	NG feeding type	Feeding regime	Complications
22	Bolus feeds	NG feeds were higher in calories than meals to motivate eating.	Not discussed
23	Not discussed	Initiated at 750kcal per day and increased by 220kcal per day	HP described in 2 cases (unable to determine if this was in those requiring NG)
24	Not discussed, the majority of young people were under 80%IBW	Started on an average of 975kcal. Average duration of NG was 2.5 days	HP described in 2 cases (unable to determine if this was in those requiring NG)
7	Oral intake supplemented with bolus NG feeding if oral RDI not met	Minimum of 1900kcals on day 1 and increased by 300kcal per day	Not discussed
28	Nocturnal NG feeding to supplement daily oral intake vs oral refeeding only (control)	Nocturnal NG feeding regime patients were prescribed calories individually (max 4350kcal) and 3400 in the oral refeeding group (control).	Epistaxis, nasal irritation.
29	Nocturnal NG feeding to supplement daily oral intake	Starting NG feed at 600 kcal. Ratio oral kcal to NG was approximately 2:1. NG feed via pump at 40 cc per hour for 4 hours then 60 cc per hour for 4 hours. Increases to 1200kcal NG feed over 3 nights. Weaned when the young person is 95%IBW.	Epistaxis (11.5%), anxiety (3.8%) treated with Lorazepam, removal of NG tube (5.8%), nasal irritation (28.8%).
42	Supplemental bolus NG feeding if patients failed to meet 80% RDI. At initiation %IBW was <78%	Compared 500kcal starting diet with 1200kcal	HP (28%)
25	Bolus NG feeding if patient failed to gain 1kg/week or acute refusal of meals	Not discussed	Nausea, odynophagia, self-harm, epistaxis, anxiety, sadness.
19	Continuous NG feeding until medically stable; followed by oral intake with supplemental nocturnal NG feeding until biomarkers stabilised.	NG feeding continuously for 1-2 days. Weight gain aim for 1kg per week. Weaning to oral diet occurred as soon as medically stable – average 14 days on NG with feed of 2400-3000kcal per day	Not discussed
41	Continuous NG feeding until medically stable; followed by oral intake with supplemental nocturnal NG feeding until biomarkers stabilised. Average %IBW at initiation was 78	2400-3000kcal to meet weekly target of weight gain of 1kg/week. In the first week average weight gain was 2.79kg.	Stated none developed RS or HP
34	Oral calories supplemented with bolus NG feeds, single bolus of high calorie NG feeding, and 3 smaller single boluses.	Starting feed 1200kcal, increased by 200kcal per day to 2000kcal. 1 NG feed per day under restraint. Also described 1 bolus feed of 2000kcal due to no oral intake for 20 hours	Distress described during the procedure requiring Lorazepam
35	Continuous NG feeding at a higher calorie intake compared to lower calorie standard oral intake.	Starting range for NG cohort 1200-2000kcal increased by 200kcal/day vs. 800-1200kcal increased by 150kcal/day (oral cohort). NG fed for 7 days then weaned over 3 days with kcal via NG reducing as meals replaced	Oral cohort 51% lost weight initially compared to 6% in the NG high kcal cohort. Hypokalaemia (although both cases were abusing laxatives), HP.
20	Syringe bolus; enteral pump.	Volume of bolus feed ranged from 330-1000ml average 564ml per feed. Bolus feed time ranged between 10-40 minutes average being 20 minutes. If delivered by pump it was >1 hour.	N/A
39	Continuous NG feeding or combination of oral intake with supplemental overnight NG feeding, or oral intake alone.	Start feed 2400kcal increasing to 2400-3400kcal/day at 100ml per hour	Peripheral oedema (4%), hypomagnaemia (7%), hypokalaemia (2%), HP (1%). No incidence of RS or delirium.
17	Bolus NG feeds supplemental to oral intake if RDI not met	Average of 1185kcal average which increased to an average of 1781 kcals (range 1500–3000 kcals)	Hypomagnaemia, HP more likely in those under 80% Weight for height and corrected without supplementation of phosphate or magnesium.
8	High energy supplements and NG feeds were commonly used to meet RDI.	The initial calorie intake recommended was between 800-1750kcals advised by dietitians in Australia.	Not discussed
30	N/A	Calories individualised and increased to gain of 1-2kg/week.	Removal of tube (55%).
37	Continuous NG feeding until medically stable	15.9-19.7kcal/kg/day; increased to 30kcal/kg/day after 24 hours.	No patient developed nausea, vomiting, or worsened abdominal symptoms; 2 developed lower limb oedema despite slow infusion.

Table displaying different refeeding methods, regimes and complications evaluated by studies in this review. Key: NG nasogastric; RDI recommended daily intake; HP hypophosphataemia; RS refeeding syndrome; %IBW percentage ideal bodyweight.

Table 3.

Hypophosphataemia and Phosphate Supplementation during Refeeding of Young People with Restrictive Eating Disorders.

Study	Hypophosphataemia (HP)	Phosphate Supplementation
7	38% developed HP. HP associated with lower %IBW on admission and lower number of hospitalisations.	Patients with HP given phosphate supplementation. 6 patients were already being prescribed phosphate upon recognition of HP and the other 14 patients were prescribed phosphate upon recognition.
25	38.4% patients experienced mild HP.	Not described.
35	6 cases of HP in oral intake cohort and 0 in the NG fed cohort.	90.3% patients in the NG cohort were prophylactically prescribed phosphate supplementation
39	1% patients developed HP	All patients prescribed 1g phosphate per day prophylactically
19	No patients developed HP	Prescribed all patients 1g phosphate orally
8	Not discussed.	15/17 dietitians stated that they used supplementation prophylactically or therapeutically. >1/3 reported that they administered regardless of risk of RS.
17	Electrolyte abnormalities observed primarily in patients <80% IBW	Most participants who developed HP did not require supplementation; electrolyte abnormalities stabilised with adequate nutrition.
42	Not discussed	28% in the higher calorie refeeding cohort required phosphate supplementation due to serum electrolyte results.

Table displaying incidence of hypophosphataemia and use of phosphate supplementation upon refeeding of low weight YP with restrictive ED. Primary data can be found in each original article using references. Key: RS refeeding syndrome; HP hypophosphataemia; %IBW percentage ideal bodyweight.