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ORIGINAL RESEARCH

A clinical consensus paper on jejunal tube feeding in children

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Abstract

Background: Feeding problems are common in children with complex medical problems or acute critical illness and enteral nutrition may be required. In certain situations, gastric tube feeding is poorly tolerated or may not be feasible. When feed intolerance persists despite appropriate adjustments to oral and gastric enteral regimens, jejunal tube feeding can be considered as an option for nutrition support.

Methods: A multidisciplinary expert working group of the Australasian Society of Parenteral and Enteral Nutrition was convened. They identified topic questions and five key areas of jejunal tube feeding in children. Literatures searches were undertaken on Pubmed, Embase, and Medline for all relevant studies, between January 2000 and September 2022 (n = 103). Studies were assessed using National Health and Medical Research Council guidelines to generate statements, which were discussed as a group, followed by voting on statements using a modified Delphi process to determine consensus.

Results: A total of 24 consensus statements were created for five key areas: patient selection, type and selection of feeding tube, complications, clinical use of jejunal tubes, follow-up, and reassessment.

Conclusion: Jejunal tube feeding is a safe and effective means of providing nutrition in a select group of pediatric patients with complex medical needs, who are unable to be fed by gastric tube feeding. Appropriate patient selection is important as complications associated with jejunal tube feeding are not uncommon, and although mostly minor, can be significant or require tube reinsertion. All children receiving jejunal tube feeding should have multidisciplinary team assessment and follow-up.

KEYWORDS

child, enteral nutrition, jejunostomy, nutrition support practice, pediatrics

INTRODUCTION

Feeding problems are common in children with complex medical problems or acute critical illness, and when oral intake is inadequate, not tolerated, or feasible, enteral nutrition is usually indicated. Gastric tube (GT) feeding is the preferred route, which enables intermittent bolus feeding; flexibility with feed volume, type and osmolarity; and simulates physiological aspects of oral dietary intake.[1,2] When GT feeding is poorly tolerated or not feasible, postpyloric or jejunal tube (JT) feeding should be considered. The terms postpyloric feeding and JT feeding are often used interchangeably. Postpyloric feeding broadly refers to tubes with the tip placement distal to the pylorus (duodenum or jejunum). JT feeding has been defined as postpyloric feeding through a tube with the tip placed at least 40 cm distal to ligament of Treitz[1]; however, in smaller children, this distance may be less.

There is limited high-quality evidence to guide clinician decision-making of JT feeding in children, resulting in varying practices between institutions and individual patients.[1] This article contains consensus statements addressing key areas of JT feeding in children based on literature review of all relevant recent publications by an expert working group of the Australasian Society of Parenteral and Enteral Nutrition (AuSPEN). It will assist clinicians managing children receiving JT feeding, including gastroenterologists, general pediatricians, dietitians, and other allied health professionals.

METHODS

A working group was convened by expression of interest through AuSPEN and included a pediatric gastroenterologist, specialist pediatrician (neurodisability, clinical nutrition), pediatric dietitians (eight), and gastroenterology clinical nurse consultants (two) representing five Australian states and one New Zealand center. All members had active clinical involvement in the care of children receiving JT feeding.

A systematic literature search of Pubmed, Embase, and Medline was undertaken using MeSH/search terms: jejunal, jejunostomy, postpyloric, transpyloric, trans-pyloric, feed, enteral feed, and enteral nutrition, limited to English language and 0–18 years. Studies between January 2000 to September 2022 were included. Results were imported to EndNote and duplicate articles deleted. The remaining 151 articles underwent abstract and reference list reviews by the group lead to remove those not directly related to the topic and identify additional relevant articles. A total of 103 full articles were reviewed in full text by the group.

The five key areas identified by a process of generating topic questions (Table 1) were patient selection, type and selection of feeding tube, complications, clinical use of JTs, follow-up, and reassessment. The working group was divided into subgroups representing each section to review literature and develop evidence summaries and consensus statements graded according to National Health and Medical Research Council guidelines.[3] These were discussed among the main group, followed by voting using a modified Delphi process to determine consensus. Consensus was defined as at least 80% agreement with a 100% response rate. Any statements not reaching consensus were rediscussed to determine need for adjustments or omission.

RECOMMENDATIONS AND DISCUSSION

Patient selection

- JT feeding can be used across a range of pediatric age groups, but caution should be exercised in preterm infants younger than 37 weeks gestation. (LoE IV) 100% agreement
- JT feeding should be considered in the following circumstances (Table 2):
  - Gastric feeding is not possible
  - Persistent or severe intolerance to gastric feeding
  - Gastric feeding has unacceptable consequences.

  (LoE III-3) 100% agreement

- JT feeding, when indicated, is possible as a short-, medium-, or long-term option of nutrition support. (LoE III-2) 100% agreement
- JT feeding is not recommended in the presence of mechanical intestinal obstruction, ileus, perforation, or active gastrointestinal bleeding. (LoE V) 100% agreement

Children requiring JT feeding fall into three main groups: neonates, children with chronic medical problems, and critically ill infants/children.[1,4,11] Children with neurological impairment make up a significant proportion of the medium- to long-term JT feeding population, with reported rates as high as 62%[4] and 82%[5] in single-center cohort studies.

A recent retrospective review of patients undergoing gastro-jejunal tube (GJT) placement (excluding surgical jejunostomy [SJ]) over 10 years in a pediatric hospital in France identified gastroesophageal reflux disease (GORD) as the most common indication (91/107; 85%).[6] JT feeding may be considered as a management option in the context of severe or refractory GORD, either to minimize aspiration risk associated with directly feeding into the stomach or to reduce symptoms of feed intolerance. In some children, aspiration can still occur despite JT feeding, related to either saliva (oropharyngeal dysfunction) or gastric secretions, and assessment of children with recurrent aspiration pneumonia should include careful consideration about which underlying

mechanisms are present and whether specific investigations are indicated, for example, formal swallow assessment. JT feeding is a feasible alternative to surgical fundoplication for severe GORD; however, there are risks of ongoing GORD associated with both techniques in children with neurological impairment, related to fundoplication tightness or ongoing reflux of gastric secretions.[7] A moderate proportion of children receiving JT feeding are reported to have a history of previous fundoplication (between 12% and 69%).[4,5,12,13]

Table 2 classifies different indications for JT feeding.[1,4–10] Individual patient circumstances and factors such as comorbidities or presence of underlying intestinal dysmotility should be considered in decision-making and counseling about goals of JT feeding, (for example, provision of complete nutrition requirements in children with severe GORD and aspiration vs partial or trophic feeding, and medication administration in pediatric intestinal pseudo-obstruction).

Babbit assessed children requiring JT feeding in the intensive care unit and found respiratory illness was the most common diagnosis, followed by children with neurological and cardiac conditions.[14] Nasojejunal feeding tubes (NJT) have been successfully used in perioperative cardiac patients with gastric feed intolerance or aspiration risk, encouraging early enteral feeding[11] and enabling energy requirements to be met in a timely manner.[15]

JT feeding may assist with the weaning of parenteral nutrition (PN) in children who are PN dependent[5] and reduce or avoid the need for PN in children with temporary contraindications to gastric feeding, for example, infants postsurgical repair of congenital proximal intestinal obstructions,[16] critical illness, and trauma,[17,18] or children with central nervous system tumors undergoing aggressive chemotherapy.[19]

There are few studies specifically related to patient assessment or workup prior to commencement of JT feeding. Investigations may overlap with those done as part of fundoplication assessment. An upper

TABLE 1 Topic questions.

Section	Topic questions
Patient selection	What are the indications for use of jejunal tube feeding in children? Which pediatric patient populations currently receive jejunal tube feeding? What are the contraindications for jejunal tube feeding in children? What assessment should occur prior to the use of jejunal tube feeding in children?
Type and selection of feeding tube	What are the different options available for provision of jejunal tube feeding? What are the different insertion methods for nasojejunal feeding tubes? What are the different insertion methods for gastrojejunal feeding tubes? What are the different insertion methods for direct jejunal feeding tubes?
Complications	What complications are associated with jejunal tube insertion? What issues can occur with jejunal tube equipment or stoma-related concerns? What patient-related factors can influence tolerance of jejunal tube feeding?
Clinical use of jejunal tubes (feeding and medication)	How should jejunal tube feeding be initiated after tube insertion? What are the goals of jejunal tube feeding? What type and amount of formula should be used for jejunal tube feeding? How should jejunal tube feeds be administered? How should patients be monitored when receiving jejunal tube feeding? What considerations should be given to administration of medications via jejunal feeding tubes?
Patient follow-up and reassessment	What proportion of children are able to wean from jejunal tube feeding? What follow-up should occur in children receiving long-term jejunal tube feeding? What are the outcomes of children receiving long-term jejunal tube feeding?

TABLE 2 Different indications for jejunal tube feeding in children.[1,4–10]

Problem	Mechanism	Examples
Gastric feeding not possible	Mechanical obstruction	Gastric outlet obstruction Duodenal hematoma
	Mucosal inflammation	Severe corrosive injury
Gastric feeding not tolerated	Foregut dysmotility—Acute or chronic	Critical illness Postop abdominal surgery Severe gastroparesis Pediatric intestinal pseudoobstruction
Gastric feeding has unacceptable complications	Severe gastroesophageal reflux disease	Aspiration pneumonia Poor growth Vomiting postfundoplication
	Stoma-related	Severe peristomal leakage

gastrointestinal contrast study may be considered to exclude mechanical obstruction.[1,20] The indication for upper gastrointestinal endoscopy prior to JT feeding varies depending on individual patient circumstances, and in children with unexplained intolerance to gastric feeding or significant gastrointestinal symptoms, it may be helpful to exclude underlying mucosal inflammation or malabsorptive disorders.[1] A review of results of preoperative evaluation done at the time of GT insertion found that no specific diagnostic test reliably predicted whether patients remained on GT feeding or required conversion to JT feeding. However, this was a retrospective study with incomplete data and further prospective research is needed to help understand the value and role of diagnostic evaluation prior to enteral feeding.[21]

Contraindications to JT feeding are not specifically discussed in detail in the literature; however, some studies describe local experience and practices. General contraindications to enteral feeding should apply to JT feeding, with vigilance advised in the presence of active gastrointestinal bleeding and/or high stool/stoma output.[1] Caution is recommended with JT feeding in neonates aged <37 weeks gestation because of reported potential risks, including perforation and hypoxemia.[22] However, notably, other studies have conversely reported early postpyloric feeding being associated with reduced risk of death or bronchopulmonary dysplasia in extremely low birth weight infants.[23,24] Literature specific to this age group is limited, with common methodological weaknesses, thus caution should be exercised when interpretating findings, and further research is needed.[25]

Tube choice and selection

- JT feeding can occur via an NJT, GJT, direct percutaneous endoscopic jejunostomy, or SJ tube. The anticipated duration of jejunal feeding (among other factors) should be considered when deciding on type of tube/route of access, prior to insertion. (LoE IV) 100% agreement
- There are various methods for JT placement, including endoscopic, radiological, and surgical techniques. Decisions regarding method of tube insertion should be made with consideration of the clinical context, physician expertise, local resources, and individual circumstances of the child and family. (LoE V) 100% agreement

There are three main approaches to support feed administration via JT. NJT is the tube of choice when the expected duration of JT feeding is short-term. Definition of short-term differs between institutions, with a recent position paper[1] and narrative review[26] recommending NJT use for <1 month and 30 days duration of enteral feeding, respectively.

When the expected duration of JT feeding is medium to long-term, the appropriateness of GJT or direct jejunostomy tube (DJT) should be considered. GJTs have a jejunal extension from a gastrostomy device (with or without a gastric outlet), placed through a new or existing gastrostomy. When compared with NJT, GJT have additional benefits of gastric access for medication administration and/or decompression of gastric air or fluid. DJTs are inserted using either percutaneous placement of a tube from the abdominal wall directly into the proximal jejunum or by bringing a Roux-en-Y loop up from below the duodenojejunal flexure to the skin to form a stoma for catheterization with a feeding tube or button device.[27–29]

Various insertion methods for jejunal feeding tube placement are described using endoscopic, radiological, and surgical techniques, as well as bedside approaches (for NJT),[26] and combined approaches may be used.[5,30] A recent review article by Jazayeri et al addressed individual insertion methods in detail, including associated risks and confirmation of tube position.[26]

Bedside techniques for NJT insertion with or without assistive devices may use strategies such as patient positioning (right lateral decubitus for gravity assistance), gastric insufflation, pH guidance, prokinetics, or electromagnetic devices.[11,31] A recent systematic review on bedside postpyloric feeding tube insertion in hospitalized children found no conclusive best method but identified safety and efficacy of gastric air insufflation, however, minimal evidence to support efficacy of erythromycin use. They concluded bedside insertion of nasointestinal tubes is best performed by dedicated clinicians with appropriate training and experience.[31] Clinicians performing nasointestinal tube insertion may include different disciplines, including bedside nurses and critical care doctors; training and accreditation will differ depending on individual institutional policies and practices. Correct positioning of nasointestinal tubes should be confirmed by x-ray prior to use for feeding, especially for blind insertion methods.[26]

Singh retrospectively reviewed 48 patients with JT feeding using different tube types and insertion methods, concluding a role for both SJ and GJT depending on individual patient circumstances and consideration of local expertise and resources.[32] In infants, a one-step method for GJT insertion via a de novo gastrostomy has been described in three patients using a neonatal endoscope and guidewire; however, most studies describe NJT use in this age group.[33] Definitive recommendations regarding efficacy or outcomes of insertion methods are difficult given heterogeneity of current literature, and varying practices and patient circumstances, as well as local expertise, should be considered.

Complications of JT feeding

- Complications associated with JTs are common and mostly minor but can be significant or require tube reinsertion. (LoE III-3) 100% agreement

- Dislodgement of JTs can occur and clinicians should be aware of the potential cumulative radiation dose associated with multiple JT replacements. (LoE IV) 100% agreement
- Intestinal perforation associated with JT insertion is uncommon, but the risk may be higher in children younger than 2 years or under 10 kg. (LoE IV) 100% agreement
- Small bowel volvulus and intussusception are uncommon but significant complications that have been associated with JT insertion. (LoE III-3) 92% agreement
- Unsuccessful placement of JTs is uncommon; however, rates vary depending on insertion method, type of JT being used and local experience. (LoE IV) 100% agreement
- Children receiving JT feeding may be at risk of micronutrient deficiencies, in particular iron and copper, which have the greatest absorption in the proximal gastrointestinal tract. (LoE IV) 100% agreement

Complications are common in children receiving JT feeding and can be related to insertion (eg, perforation, intussusception),[6,10,13,32,34,35] patient or stoma/equipment.[4,6] Reported complication rates vary depending on classifications and definitions used, tube types, or insertion methods. Consequently, care should be taken when comparing outcomes between studies or extrapolating findings. Higher rates of major complications (eg, intestinal ischemia, intussusception, volvulus) are reported in children with a neurological impairment,[4] younger than 2 years, or under 10 kg.[36,37] McCann retrospectively reviewed all patients undergoing JT feeding over a 10-year period ($n = 197$), of which 125 had an NJT. They found a significantly lower rate of major complications with NJT compared with GJT or DJT, with all cases of volvulus amongst patients with Roux-en-Y jejunostomy and requiring emergency laparotomy.[4]

Tan compared complications between percutaneous endoscopic transgastric jejunostomy (PEGJ) and balloon transgastric jejunal feeding device and identified higher complication rate with PEGJ. They found overall reduction in complication rates following the introduction of interventions, including a fixative suture to the PEGJ EnFit connector and shift toward balloon GJT as primary preference.[38] A review of 20 patients receiving JT feeding compared outcomes of SJ (85% were Roux-en-Y jejunostomy) vs radiologically inserted GJT and found greater longevity with SJ, with 50% of radiologically placed tubes resulting in SJ at some point because of recurring tube or equipment concerns.[10] A recent systematic review assessing safety and efficacy outcomes of Roux-en-Y jejunostomy in children reported complications in about 50%, including small bowel volvulus around the feeding Roux-en-Y limb, jejuno-colic fistula, abdominal wall infection, and stoma leakage.[20]

Tube- or equipment related complications are common.[6] The cumulative radiation exposure for patients requiring frequent GJT replacement can be significant and may be underrecognized.[39] For short-term JT feeding, insertion of NJT using certain bedside techniques or under direct endoscopic vision may reduce radiation exposure. In some institutions, nasal tube retaining systems are used as a retention device for NJT to avoid accidental dislodgement and further radiation exposure with tube reinsertions; however, care should be taken with nasal tube retaining systems to avoid excessive pressure or trauma to the nasal passage.[26] Michaud retrospectively reviewed 29 children requiring conversion from GT feeding to JT feeding between 2001 and 2008 and identified 31 tube dislodgements, 16 blocked tubes, and seven patients with stomal leakage.[35] Blocked tubes and faulty or broken equipment frequently require troubleshooting by clinicians or trained carers experienced in feeding tube management, and tube replacement may be required. Williams reported a median of four tube replacements per patient in a 4-year study period in 33 children with neurological impairment.[40] Stoma leakage may occur related to equipment factors (eg, mechanical obstruction from device balloon in intestinal lumen or incorrectly sized tubes), stoma factors (eg, granulation tissue or chronic inflammation at stoma site) or patient factors (eg, delayed gastric emptying). Buried bumpers should be considered: a single-center review over a 3-year period found a higher rate of buried bumpers in PEGJ compared with GTs without jejunal extension.[41]

JT feeding bypasses the preferred sites for absorption of certain micronutrients; hence, patients receiving JT feeding may be at risk of micronutrient deficiencies, particularly copper[42,43] and iron.[44] However, possible confounding factors, such as underlying mucosal inflammation, gastrointestinal blood or fluid losses, and concurrent zinc supplementation, should be considered.

Patients may experience feeding-related complications with JT feeding, including ongoing GORD, partial gastric outlet obstruction, or diarrhea/dumping syndrome; however, confounding factors should be considered.[17,45] Direct administration of medications into the jejunum via JT may contribute to blocked tubes or gastrointestinal symptoms, for example, bloating or diarrhea, when liquid suspensions are used (osmotic effect). Spacing medication administration times or minimizing volume may reduce patient discomfort.

Caution should be exercised with transpyloric feeding in children postcardiac surgery or with cyanotic cardiac disease. Intestinal ischemia (necrotizing enterocolitis) has been reported in a small number of children.[14,15] A prospective observational study of children receiving transpyloric feeds in an intensive care unit over 8 years reported higher rates of abdominal distension and diarrhea in children postcardiac surgery compared with critically unwell children with noncardiac causes.[15]

Clinical use of JT

- An age-appropriate isotonic whole-protein feed, or human milk, should be the first choice as a jejunal feed (unless contraindicated eg, allergy). (LoE V) 100% agreement
- Nonsterile blenderised tube feeds are not appropriate or safe for jejunal feeding. (LoE V) 100% agreement
- Prethickened feeds or addition of thickener to feeds should not be required, and if indicated, should be used with caution. (LoE V) 100% agreement
- If required, higher osmolality feeds into the jejunum should be introduced in a stepwise manner, with close monitoring for gastrointestinal symptoms of intolerance. (LoE V) 100% agreement
- JT feeds should be delivered continuously, using a feeding pump. (LoE V) 100% agreement
- Manufacturer's instructions and/or local guidelines should be followed for JT feeding preparation and feed hang times. (LoE V) 92% agreement
- JTs should be flushed regularly with an appropriate volume of sterile or cooled, boiled water to avoid tube blockage. (LoE V) 100% agreement

The use of feeds based on hydrolyzed protein or amino acids, those with added modular supplements or concentrating feeds, increases the osmolality, creating an osmotic gradient, which draws water into the gastrointestinal tract lumen and may cause symptoms of nausea, cramping, vomiting, or diarrhea. Bolus feeds into the jejunum can be associated with dumping syndrome causing hypoglycemia.[46] Children receiving JT feeding should be fed continuously given the limited reservoir of the jejunum compared with the stomach and monitored for signs of intolerance; particularly if hydrolyzed, modular or concentrated feeds are used or in the context of intestinal dysmotility. Signs of intolerance may include vomiting, abdominal distension, abdominal pain/discomfort, and retrograde passage of feed into the stomach (evident by milky GT aspirates or vomits).

Feeding into the jejunum bypasses the acidic environment and digestive mechanisms of the stomach, increasing infection risk.[47,48] There is insufficient evidence to support the use of nonsterile blenderized feeds in children receiving JT feeding.[47,48] Furthermore, the consistency of blenderized or thickened feeds cannot be made completely homogeneous, increasing the risk of tube blockage.[48]

The decision to administer medication directly into the jejunum via a feeding tube should be guided by a physician, supported by a pharmacist or drug-prescribing guideline.

Follow-up and reassessment

- All patients receiving JT feeding should have anthropometric data monitored over time, as appropriate for the individual patient, to ensure nutritional adequacy. (LoE V) 100% agreement
- The definition of feed intolerance is highly variable among the literature. Clinical markers of tolerance in patients receiving JT feeding can include details of stool output, vomiting, abdominal distension, abdominal pain/discomfort, and retrograde flow of feed into the stomach. (LoE V) 100% agreement
- Children receiving long-term JT feeding should have a nutritional assessment at least annually, or more frequently if clinically indicated, which may include nutritional bloods screening for micronutrient deficiencies (eg, iron and copper). (LoE IV-V) 100% agreement
- For children receiving JT feeding (including those in the community), a multidisciplinary team is important in ongoing management and support. (LoE V) 100% agreement
- All children receiving JT feeds should have interval reassessment of the ongoing indication for jejunal feeding and whether a retrial of oral or gastric feeding may be appropriate. (LoE V) 100% agreement

Follow-up of all children receiving JT feeding should adopt a multidisciplinary team (MDT) approach, including medical and dietetic involvement, and many children will benefit from broader allied health input.[49,50]

The need for ongoing JT feeding and adjustments to feeding regimens should be reassessed at regular intervals. A retrospective review of 33 children with neurological impairment fed by GJT during a 4-year period found 6.1% (2 out of 33) reverted to oral feeding and 18.2% (6 out of 33) to gastric feeding during the study period.[40] Michaud retrospectively reviewed a cohort of 29 children requiring conversion from GT feeding to JT feeding between 2001 and 2008 and found three patients weaned back to GT feeding during the follow-up period; however, two patients required PN.[37] Children who require frequent GJT replacement for dislodgement or equipment issues or who have challenging GJT placement may benefit from consideration of a SJ.[26]

There are several limitations related to this consensus paper, including inconsistency with definitions and classifications of JTs in the literature, heterogeneity, and low number of high-quality studies identified on this topic (many retrospective, with small sample sizes and lacking a comparator group). Although a systematic search

strategy of multiple databases was undertaken, this study was not a systematic review and studies were included based on relevance and quality.

CONCLUSION

Recent medical and surgical advancements have improved outcomes in children with complex medical needs such as severe neurological impairment. Although there is an identified need for more high-quality studies, JT feeding appears to be a safe and effective means of providing nutrition in a select group of these children and may avoid unnecessary malnutrition, feeding-associated discomfort, or need for PN. Innovations in feeding tube design and insertion methods, increased awareness of the potential role of JT feeding, and greater acceptance of this feeding strategy have resulted in larger numbers of children being considered for JT feeding. Appropriate patient selection is important, as JT feeding-associated complications are common and, although mostly minor, can be significant or require tube reinsertion. Follow-up should be through an MDT approach with interval reassessment of the ongoing indication for JT feeding.

Suggested further research includes comparison of efficacy and outcomes with different tube types/insertion techniques, particularly bedside insertion of NJT; clinical outcomes in children with GORD (with and without neurodisability) using JT feeding compared with alternative treatments such as fundoplication, for example, duration of JT feeding, rates of aspiration pneumonia both with and without JT feeding; observational studies of stoma-specific complications such as leakage between tube types, and their impact on both patient and carer (eg, quality of life, skin integrity).

AUTHOR CONTRIBUTIONS

Kathleen H. McGrath contributed to conceptualization, writing—original draft, methodology, writing—review & editing, and investigation; Tanya Collins contributed to writing—original draft, writing—review & editing, investigation, and conceptualization; Annabel Comerford, Zoe McCallum, Michaela Comito, Kim Herbison, and Olivia Rose Cochrane contributed to writing—original draft, writing—review & editing, and investigation; Deirdre Mary Burgess, Sarah Kane, Keryn Coster, Michele Cooper, and Kathryn Jesson contributed to investigation and writing—review & editing. All authors read and approved the final manuscript.

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CONFLICT OF INTEREST STATEMENT

KH McGrath: advisory board & speaker for Takeda (Revestive).

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