

Diarrhoea in Children

The main objective of **this booklet** is to provide a **concise**, easily-digested account of the assessment and management of **acute and chronic diarrhoea in children**.

We discuss the pathophysiology of acute diarrhoea as a basis for therapy and **provide guidance** for health professionals about when to seek further help.

This booklet is intended as a **practical management** guide, not a textbook, so there is little detail about individual causes of chronic diarrhoea.

We have emphasised **when to refer** a child to a **paediatrician**.

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Acute Diarrhoea

Description and Definition

Acute diarrhoea can be defined as a sudden increase in the frequency, fluidity or volume of the stools of less than seven days duration.

In Australia, most acute diarrhoea in children is caused by a self-limiting infective illness, loosely termed gastroenteritis. The most important problem associated with it is dehydration. Normal stool patterns vary in infants but a child with significant diarrhoea will present with illness, either mild or severe. While most have mild to moderate

diarrhoeal disease some Australian children die each year from dehydration caused by gastroenteritis. Other diseases which may cause acute diarrhoea and/or vomiting and must be considered in the differential diagnosis include infections (urinary and respiratory), surgical conditions such as intussusception and pyloric stenosis, and some metabolic diseases such as diabetes. In many of these conditions, the predominance of vomiting is an important clue. Antibiotics are also a common cause of acute diarrhoea in children.

Table 1 summarises the pathogens identified in a survey of gastroenteritis in hospitalised urban Australian children.

TABLE 1. Causes of acute diarrhoea and vomiting in infants and children and Aetiology of gastroenteritis in urban Australian children admitted to hospital.

Enteric Infection		% identified in surveys in urban Australia
Viruses:	Rotavirus	20 - 40
	Norovirus	
	Astrovirus	2 - 4
	Adeovirus	6 - 8
Bacterial:	Salmonella	4 - 8
	Campylobacter	8 - 10
	E.Coli	1 - 2
Protozoa:	Giardia	
	Cryptosporidium	
Systemic Infection		
	Urinary tract Infection	
	Pneumonia	
	Septicaemia	
Surgical Conditions		
	Intussusception	
	Partial Bowel Obstruction	
Other		
	Type 1 Insulin Dependant Diabetes	
	Antibiotic Associated Diarrhoea	

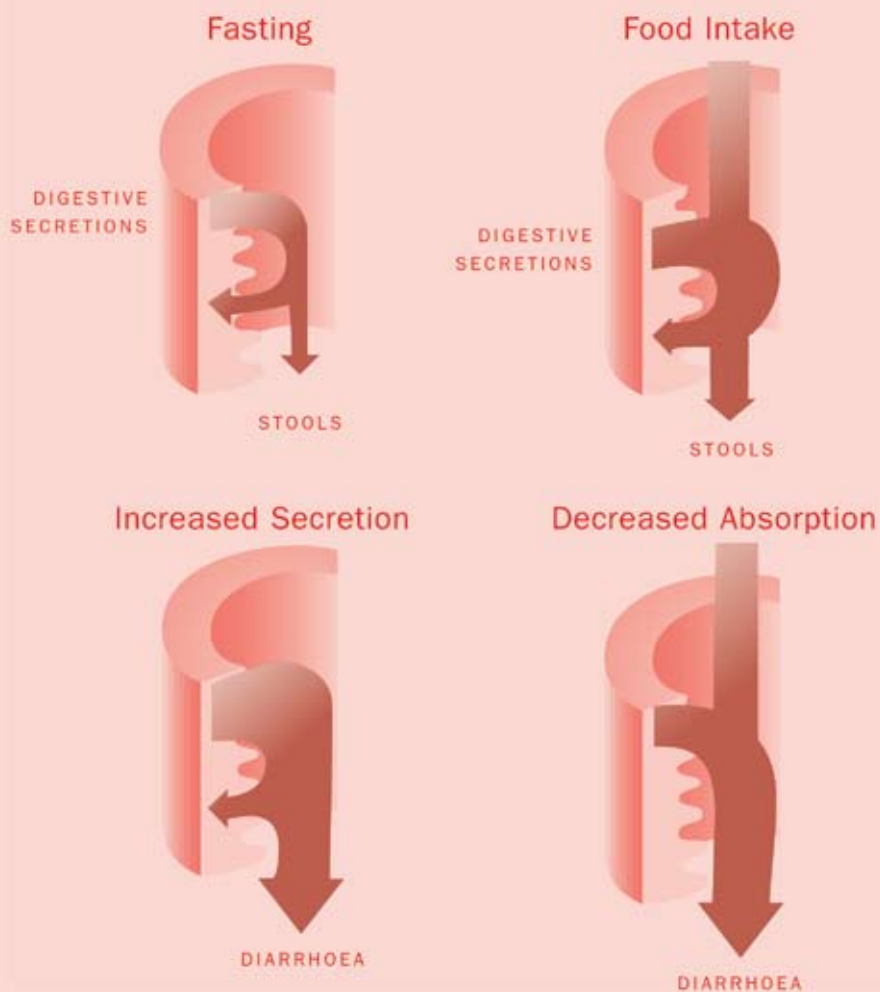
Agents which have been implicated as pathogens in childhood gastroenteritis, their sites of action and mechanisms of damage are shown in **Table 6**.

Clostridium difficile has been implicated in antibiotic diarrhoea. The diarrhoea usually settles by stopping the antibiotic. Severe cases respond to Vancomycin.

Causes and Mechanisms of Diarrhoea

Common pathogens cause diarrhoea by a variety of mechanisms. Water may be actively secreted into the lumen, and not be simply malabsorbed ingested fluid.

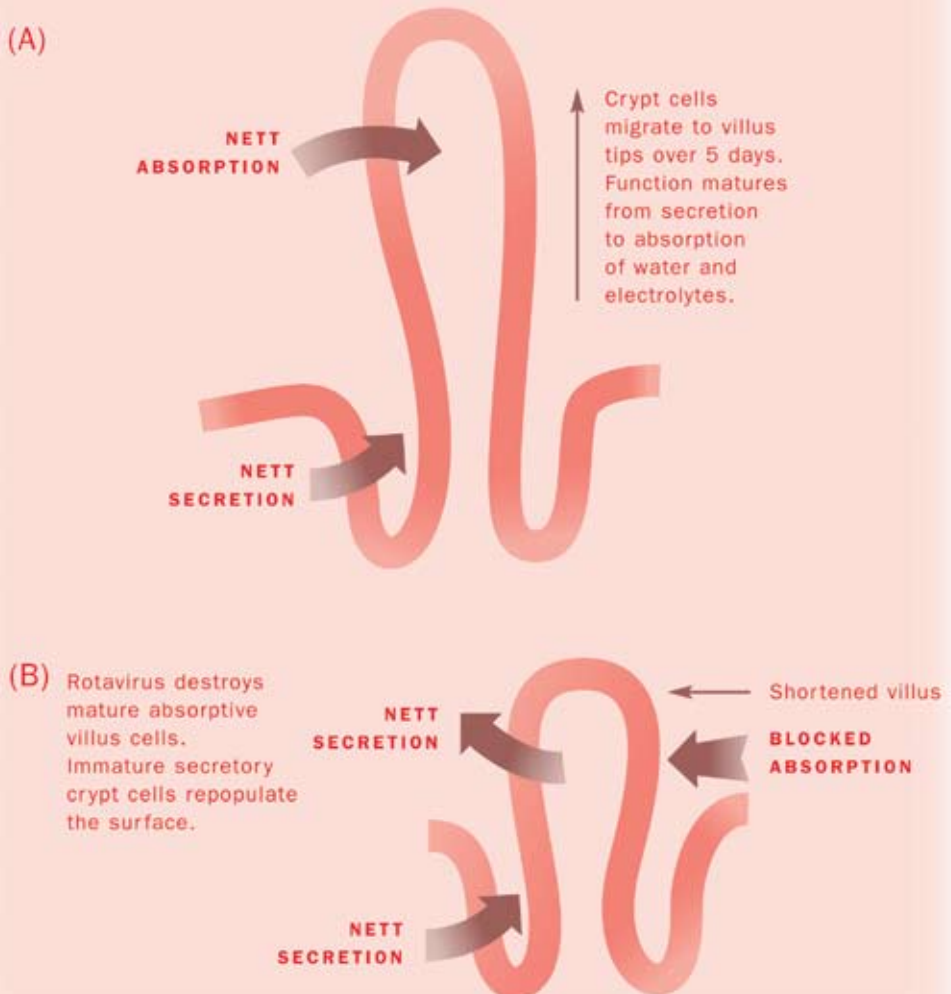
Figure 1 : Fluid balance in the gut



One way in which rotavirus (the commonest cause of gastroenteritis in children) leads to fluid loss is illustrated in **Figure 2**. Rotavirus infection produces both malabsorption and active secretion.

There have been few studies in outpatients but generally the same pathogens have been found in the same frequency. For example Rotavirus was found in 33% of non-hospitalized children with acute diarrhoea in Melbourne, at a time when it was present in 51% of those who had been admitted.

Figure 2 : Rotavirus and Fluid Balance



Agents which have been implicated as pathogens in childhood gastroenteritis, their sites of action and mechanisms of damage are shown in **Table 2**.

TABLE 2: Pathophysiology of infectious causes of acute diarrhoea

Agent	Rotavirus	Salmonella Campylobacter	Shigella E Coli (enteroinvasive)	Cholera E Coli (enterotoxigenic)
Mechanism	Invasion	Invasion	Invasion	Toxin
Site	Jejunum Ileum	Jejunum Ileum Colon	Ileum Colon	Jejunum Ileum
Mucosal Change	Invasion of enterocytes Villous injury	Invasion of lamina propria Inflammation Minimal lysis	Invasion of enterocytes Lysis Local spread	Nil
Systemic Spread	No	Yes especially young infants	No	No
Stool	Few cells Watery Na ~45mmol/L	Red cells White cells	Red cells White cells Mucus (dysentery)	No cells Rice water stools Na~ 100mmol/L

Diagnosis

In taking a history, it is important to ask about:

- the frequency and nature of the diarrhoea
- the frequency and nature of vomiting
- fever
- fluid intake and urine output
- recent contact with diarrhoeal disease
- recent use of antibiotics

The following points help to differentiate between gastroenteritis and other causes of acute diarrhoea. (See table 3)

- Intermittent abdominal pain, pain in the right iliac fossa, bile-stained vomiting and marked abdominal distension suggest a surgical cause.
- Duration, number, consistency, colour and content of stools. Sudden onset of watery stools associated with fever suggests viral enteritis. Blood or mucus suggests bacterial enteritis such as campylobacter jejuni or a surgical condition such as intussusception.
- Stools in infancy may be so watery that they are thought to be urine.
- Duration, frequency and content (food or bile) of vomit.
- Bile in vomit may mean a bowel obstruction such as malrotation - a surgical emergency.

- Past history of diarrhoea, malnutrition may suggest an underlying disorder such as coeliac disease or parasitic infection.

In many cases, the diagnosis only becomes clear with time. **Keep an open mind until the child is better. Most children improve within 24 hours and if not think again.** (Table 3)

TABLE 3: Think again if...

- Vomiting of bile or blood
- Severe abdominal pain
- high fever
- very unwell

Abdominal signs :

- distension
 - tenderness
 - guarding
 - mass
 - hepatomegaly
-
- Child is a neonate
 - Failure to thrive

Hydration Assessment

The key to successful management of gastroenteritis in children is to prevent and correctly treat dehydration.

Infants and children have a relatively large extra cellular fluid volume and surface area so dehydration, acidosis and shock can progress much more rapidly than in adults.

The assessment of dehydration can be difficult and the degree of dehydration is sometimes underestimated. It is important to take an accurate history (see Diagnosis) and look for clinical signs of dehydration

(Table 4). Acute weight loss is an accurate parameter. Child Health records may have a recent weight for infants who are at highest risk for dehydration, and can be useful to assess weight loss.

If physical examination suggests that dehydration is less severe than the parent history indicates, believe the parent. Dehydration in the obese child is invariably underestimated. A moderately dehydrated three-month old infant may become moribund in a few hours. Malnourished children are at greater risk of dehydration and electrolyte disturbance.

TABLE 4: Assessment of dehydration in children

No dehydration	Mild- moderate dehydration	Severe Dehydration
Loss of body weight:	Loss of body weight:	Loss of body weight:
None to ≤ 4%	~ 5%-6%(mild) ~ 7 - 9% (medium)	≥10%
Clinical signs: *	Clinical signs: *	Clinical signs: *
None	Two or more of: <ul style="list-style-type: none"> • Restlessness • Irritability • Sunken eyes (also ask parent) • Thirsty and drinks eagerly 	Two or more of: <ul style="list-style-type: none"> • Abnormally sleepy or lethargic • Sunken eyes • Drinking poorly or not at all
Pinch Test (Measuring skin turgor) †		
Normal:	Slow:	Very Slow:
• Skin fold retracts immediately	• skin fold visible <2 seconds	• skin fold visible >2 seconds

* Additional signs of severe dehydration include circulatory collapse (e.g., weak rapid pulse, cool or blue extremities or hypotension), rapid breathing, or sunken anterior fontanelle.

† Skin turgor is assessed by pinching the skin of the abdomen or thigh between the thumb and the bent forefinger in a longitudinal manner. The sign is unreliable in obese or severely malnourished children.

Management Decisions

When the illness is quite mild or very severe, it is relatively easy to make a decision about management.

It is much more difficult to decide on management for the large group which is between these extremes.

Factors that influence management decisions include the age of the child, diagnostic doubts, family circumstances and geography. If treatment is to be at home, there should be positive reasons for such a decision, not just the lack of any obvious reason for consultation or admission.

TABLE 5: Management decisions in gastroenteritis in children

When to treat at home	Family able to cope Absence of dehydration Vomiting not interfering with fluid intake
When to consult	Diagnosis in doubt Therapy in doubt Infant under three months of age Pre-existing disease : Diabetes cyanotic heart disease chronic renal disease previous bowel resection Malnutrition Failure to improve
When not to treat at home	Moderate Dehydration Diagnosis in doubt Family unable to cope Deterioration Persistent vomiting Profuse diarrhoea
When to request stool microbiology	Suspected epidemic or food poisoning Recent overseas travel Child in residential institution/ childcare centre Hospitalised child Blood in stool Persistent diarrhoea (beyond 7 days)

Treatment

The aims of treatment are:

- prevention of dehydration
- restoration and maintenance of fluid and electrolyte balance,
- ongoing replacement of losses (diarrhoea, vomiting) and
- restoration of normal nutrition.

Management depends on the state of hydration and pre-existing nutritional status.

Breast feeding should be continued wherever possible and extra fluids given as below.

1: The child with no evidence of dehydration

Continue their normal fluid intake and they can be safely monitored at home. The objective is to provide at least as much fluid as in a normal day.

It is not necessary to restrict food. Some children do not feel like eating but, if hungry, should be offered their normal diet.

Do not give drinks that have a high sugar content and hence osmolality such as fruit juice, soft drinks (lemonade or cola), cordial, Lucozade or sports drinks. These may increase diarrhoea and the risk of dehydration. Diet drinks may also increase diarrhoea.

Messages for Parents: Breast feeding should be continued.

2 : The dehydrated child 2a) Mild dehydration:

Most children with mild dehydration can be managed at home with oral rehydration solutions (Table 7). (Parents should be advised that if children have ongoing losses through diarrhoea and vomiting they should return for review.) The child will need to be rehydrated (see example) but will also require normal maintenance fluids (Table 6).

TABLE 6-1 Body Weight Method for Calculating Maintenance Fluid Volume

Body Weight	Fluid per Day
0–10kg	100mL/kg
11–20kg	1,000mL + 50mL/kg for each kg > 10kg
> 20g	1,500mL + 20mL/kg for each kg > 10kg *

* The maximum total fluid per day is normally 2,400mL.

TABLE 6-2 Maintenance Water Rate

0–10 kg: 4 mL/kg/hr
10–20 kg: 40 mL/hr + 2 mL/kg/hr × (wt-10 kg)
>20 kg: 60 mL/hr + 1 mL/kg/hr × (wt-20kg)
The maximum fluid rate rate is normally 100ml/hr for maintenance fluids.

Aim for at least 5-7 mL/kg body weight per hour. In practice this would mean giving a 10 kilogram 1 year old infant 50-70mL an hour and 100-150 mL every two hours during the night.

2b) Moderate dehydration:

Most children with moderate dehydration can be rehydrated using oral rehydration solutions (Table 7) given either by mouth or nasogastric tube. These children should be referred to a specialist paediatric centre for **assessment** or seek specialist advice.

Table 7: Oral rehydration solutions commercially available in Australia

Name	Glucose mmol/L	Sodium mmol/L	Chloride mmol/L	Potassium mmol/L	Base mmol/L	Osmolarity mOsm/L
Glucose-electrolyte solutions						
Gastrolyte	90	60	60	20	Citrate 10	240
Hydralyte	90	45	45	20	Citrate 30	240
Pedialyte	126	45	35	20	Citrate 10	246
Repalyte new formulation	90	60	60	20	Citrate 10	240
Rice-based electrolyte solutions						
Gastrolyte-R	6 g precooked rice/L	60	50	20	Citrate 10	226
European Society, of Paediatric Gastroenterology, Hepatology and Nutrition recommendation						
	74-111	60	Not<30	20	Citrate 10	200-250

Reintroduction of food should begin when the child is hungry, even if diarrhoea has not settled. Starvation beyond 24 hours may delay recovery.

Parent education is essential. The concept that water being taken by mouth at the top end is not the cause of water out at the bottom end is often difficult to get across.

The message is that children can be successfully rehydrated even in the presence of ongoing diarrhoea, i.e. the gut can still absorb water and electrolytes. This is analogous to watering a pot plant. The plant absorbs the water it needs even if there is water pouring out the holes in the bottom of the pot.

2c) Severe dehydration:

Severe dehydration without shock

Most children with severe dehydration will need intravenous rehydration.

- Dehydration can be corrected over 6 to 24 hours
- Give intravenous 5% dextrose in N/2 saline.
- Electrolytes should always be checked before and 4-6 hours after starting intravenous fluids to identify hypernatraemia (over 150mmol/L) or hyponatraemia (less than 120mmol/L)
- if the serum sodium is over 150mmol/L correct dehydration over 48 hours
- Potassium should only be added after the electrolytes have been checked and the child is passing urine.

In some settings rehydration therapy can be given by the nasogastric route.

Intravenous rehydration should be used if the child has severe dehydration with ileus or persistent severe vomiting.

Severe dehydration with shock

Severely dehydrated children with shock will require intravenous resuscitation before rehydration therapy commences. If intravenous access is not possible intraosseous infusion may be used. (See page below)

Children with shock have poor peripheral circulation with pale, cold hands and feet and a weak rapid pulse; they are drowsy or comatose and may have deep, acidotic breathing (Kussmaul respiration). To correct shock, parenteral fluids **MUST** be used.

The treatment of shock requires **rapid** volume expansion using normal saline (20ml/kg). Additional boluses may be required. Observe the effect, and then give another bolus if required to restore the circulation. A total of 40-60mL/kg may be needed in severe shock.

For example, in a 10 kilogram child with 15% dehydration and shock:

- **Treatment of shock:** 200ml normal saline bolus (10kg x 20ml/kg normal saline = 200ml)
- **Rehydration:** Total fluid deficit = 10kg x 15 % = 1.5L = 1500mL
- **Maintenance fluid requirement:** 100mL/kg/day = 10kg x 100 = 1000mL.
- **Total Fluid in 24hr** after treatment of shock = rehydration + maintenance = 1500 + 1000= 2500mL = 105mL/hr.

The malnourished child:

The malnourished child often requires electrolyte replacement and nutritional rehabilitation. They are more likely to have coexisting diseases and to have had multiple infections. Referral to a major treatment centre is desirable.

Intraosseous Infusion

It can be difficult to insert an intravenous catheter in a child with shock. Do not waste time with repeated attempts to insert an IV. In an emergency, parenteral fluid can be given through a needle inserted into the bone marrow, which is an intravascular space.

Inject local anaesthetic into the periosteum if the child is conscious.

Use an intraosseous needle or a 20 or 21 gauge lumbar puncture needle. Hold it perpendicular to the bone. Twist the needle back and forth about its long axis and apply gentle pressure to slowly push the needle through the cortex of the bone. You will feel the needle give as the tip enters the marrow. Remove the trocar, and aspirate a little marrow with the syringe to check that the tip of the needle is in the correct position.

Make a small plaster-of-Paris splint to hold the needle in position.

Fluid can be infused through the needle just like a normal drip, or syringed in if rapid infusion is required. Any fluid that can be given intravenously can be given into the marrow.

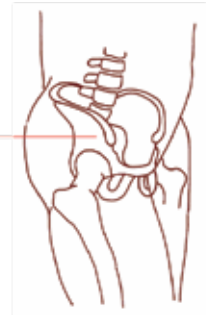
It is often possible to establish intravenous access after initial resuscitation by the intraosseous route. As a general rule, intraosseous needles should not be left in place for longer than 48 hours because of the risk of osteomyelitis.

*< 1year:
junction of upper and
middle third of tibia*



*1 - 5 years :
medial malleolus
of tibia
(just above the ankle)*

*>5 years :
iliac crest
(do not use
the sternum
in children)*



Emergency Treatment of the Dehydrated Child

Detailed advice about emergency treatment and transport is always available by telephone.

All Australian children's hospitals and most outback medical services offer such advice

24 hours a day.

Emergency transport with trained staff can be provided if necessary after discussion

Advice to Carers:

Breastfeeding

Ideally, breast feeding should be continued during a diarrhoeal illness. Extra fluid should also be given to replace continuing losses.

Even with lactose intolerance, breast milk seems to be better tolerated than proprietary formulae with lower lactose levels. Breast feeding offers comfort and fluids, and is accepted by children with diarrhoea better than artificially fed nutrients.

Severe diarrhoeal illness may necessitate a delay of 24 hours before recommencing breast feeding.

Advice to the Family:

Thorough hand washing with soap after changing nappies, toileting and before preparing food minimises the risk of spread to other members of the family. More elaborate precautions are unnecessary.

Reintroduction of Normal Diet

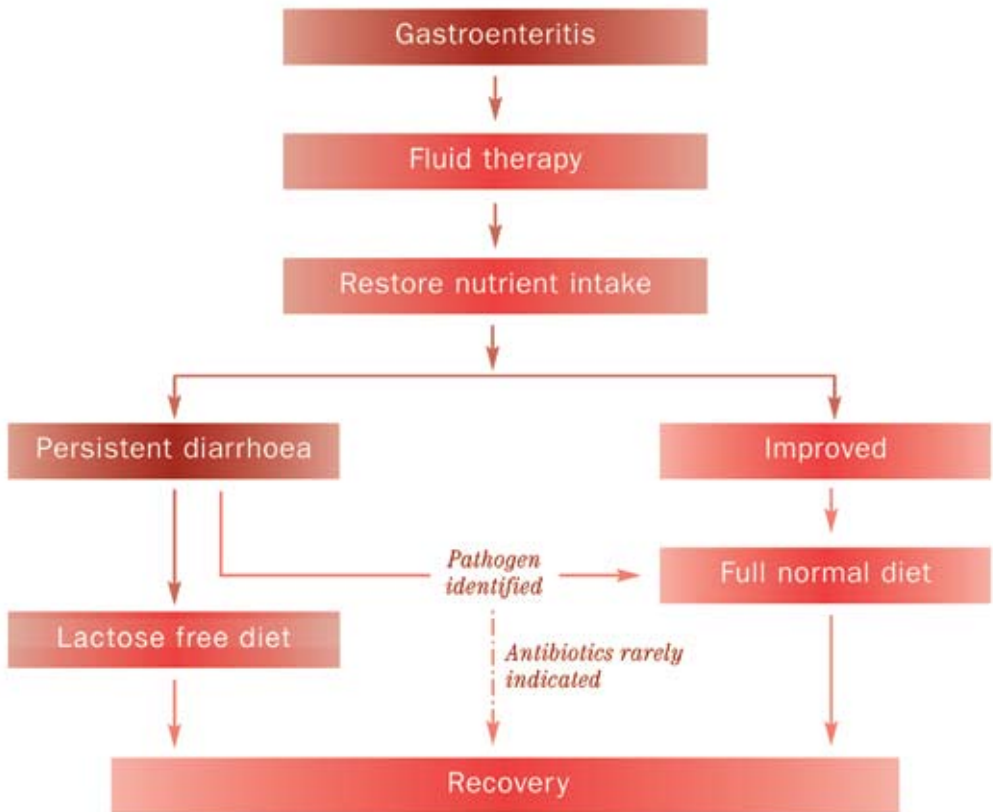
The child should be recommenced on adequate balanced nutrient intake as soon as possible.

Continuing diarrhoea alone is not a contraindication to the reintroduction of a normal diet. If the child has been receiving solids before the illness, a graded return of these foods is recommended, ensuring that fats and protein (meats, cereals) are given. The milk or formula that the baby had been receiving can be restarted. If the infant is under six months of age or if diarrhoea increases with full strength formulas, use a short graded approach from half to full strength.

Special formulas are rarely necessary and it makes sense to first try the child's usual inexpensive, palatable feeding. For the rare child who is truly intolerant of lactose, a more expensive and perhaps less palatable special formula prepared without lactose can be tried.

If reintroduction of normal diet is not in progress within two days of onset - review. (See Figure 4)

FIGURE 4 : Restoration of nutrient intake after gastroenteritis



Antibiotics, Antidiarrhoeals and antiemetics are not recommended for infants with gastroenteritis.

(a) Antibiotics can exacerbate viral diarrhoea and may prolong the carrier state of bacterial gastroenteritis (e.g. in salmonella diarrhoea) without altering the course of the disease. Broad spectrum antibiotics have a limited role which is usually confined to the treatment of neonates, critically ill infants with toxic symptoms that may be related to bacteraemia, and in proven shigellosis.

Broad spectrum antibiotics such as trimethoprim or ampicillin are usually appropriate in these circumstances.

(b) Antidiarrhoeals (loperamide

e.g. Imodium, diphenoxylate e.g. Lomotil, kaolin and pectin, aspirin) do not influence fluid losses significantly, may prolong intestinal recovery and can have severe side-effects. Deaths have been associated with Diphenoxylate in children.

(c) Antiemetics (prochlorperazine e.g. Stemetil, metoclopramide e.g. Maxolon, ondansetron) should be avoided. Vomiting is usually self-limiting and dystonic reactions to some of these drugs are common especially in the dehydrated child.

Drugs are rarely helpful and may do harm.

Lactose Intolerance:

Fluid diarrhoea which recurs when milk feeds are reintroduced may be due to incomplete recovery of the intestinal epithelium and secondary impairment in the ability to digest lactose. In most children this is a temporary phenomenon with spontaneous recovery. If watery diarrhoea persists beyond 2-5 days check for lactose intolerance. This can be done by Clinitest (see below) or breath hydrogen test.

To test for lactose intolerance:

- Line a napkin with plastic (eg Clingfilm)
- Collect faecal fluid and put 5 drops in a test tube.
- Add 10 drops of water.
- Add a Clinitest tablet.
- If ++ or higher, this indicates lactose intolerance.

If lactose intolerance persists use lactose free milk substitutes, (eg *S26LF*, *Karicare LF*, *Digestelact*, or *Delact*), instead of normal milk for 4-6 weeks. Avoid formulas containing sucrose, such as *Infasoy*.

A return to normal formula can then be attempted. A suggested approach is to follow **Table 8** which uses 200mL feeds as the example.

Tell the mother to return the infant to lactose-free feeding if bowel motions again become watery and try grading back to normal feeding at two to four week intervals.

TABLE 8: Grading back to normal formula

	Lactose-free Milk	Normal Milk
Day 1	150mL	50mL
Day 2	100mL	100mL
Day 3	50mL	150mL
Day 4	0mL	200mL

Volume = mL in each bottle for that day.

The two formulas can be mixed together in each bottle.

Persistent Diarrhoea

Definition:

Diarrhoea which persists for more than seven days, with passage of loose or watery stools at least 3 times in a 24 hour period. Change in stool consistency is as important as alteration in frequency.

Investigation

Before embarking on extensive and invasive investigations, try to arrive at a clinical diagnosis on the basis of:

- 1:** an adequate history
(refer to pg 3)
- 2:** physical examination
- 3:** Stool examination, which should include:
 - inspection
 - microscopy for parasites, red and white blood cells, fat globules and fatty acid crystals
 - culture and sensitivity
 - virology

Assessment of Growth:

The single most important observation is the assessment of growth. Carefully document growth using percentile charts (see pages 26–32).

Failure to thrive can be defined in several ways - It may be defined as growth that crosses downwards across centile lines over a period of time (usually crossing two lines).

Failure to thrive is likely if weight is:

- Less than 6kgs at 6 months
- Less than 8kgs at 1 year
- Less than 10kgs at 2 years
- Less than 16kgs at 5 years

Or

If no weight gain has occurred in the last 3 months

Child Health Records are available for many infants and show recent weights and heights. Poor weight gain or weight loss means that serious disease is more likely. The thriving child with diarrhoea may cause social distress but rarely suffers from serious disease. **Diarrhoea with failure to thrive must always be investigated.**

The initial clinical diagnosis and the results of stool microscopy and culture determine the nature and extent of subsequent management. Based on history, physical examination and results of stool examination, children with chronic diarrhoea can be grouped into the following three categories.

I : Unremarkable physical examination, normal percentiles and negative stool examination

Many of these children are toddlers with chronic non-specific diarrhoea. New knowledge may reduce this group in the future but you can assure parents of an excellent prognosis as serious disease is rare in these children. Some may be drinking excessive amounts of fruit juices or sugary liquids, including cordial and sorbitol-based vitamin-enriched products. If so, advise parents to reduce the quantity to reasonable levels. This usually means halving their intake of such fluids. When first seen, some children may be on highly restricted diets or elimination diets that do more harm than good. These children should be returned to a normal diet. An important differential diagnosis in this group is spurious diarrhoea secondary to chronic constipation.

II : Abnormal Stool examination

Irrespective of whether or not the child has abnormal physical signs, or inadequate growth and nutrition, further investigation without delay is needed.

III : Failure to thrive or significant recent weight loss

These children may have a variety of common or rare causes of chronic, diarrhoea or malabsorption and need further investigation.

When to consult a Paediatrician:

- If you are unable to make a clinical diagnosis
- When simple dietary advice does not resolve the problem in children in group I (see previous column).
- All children in groups II and III.

Measures to avoid:

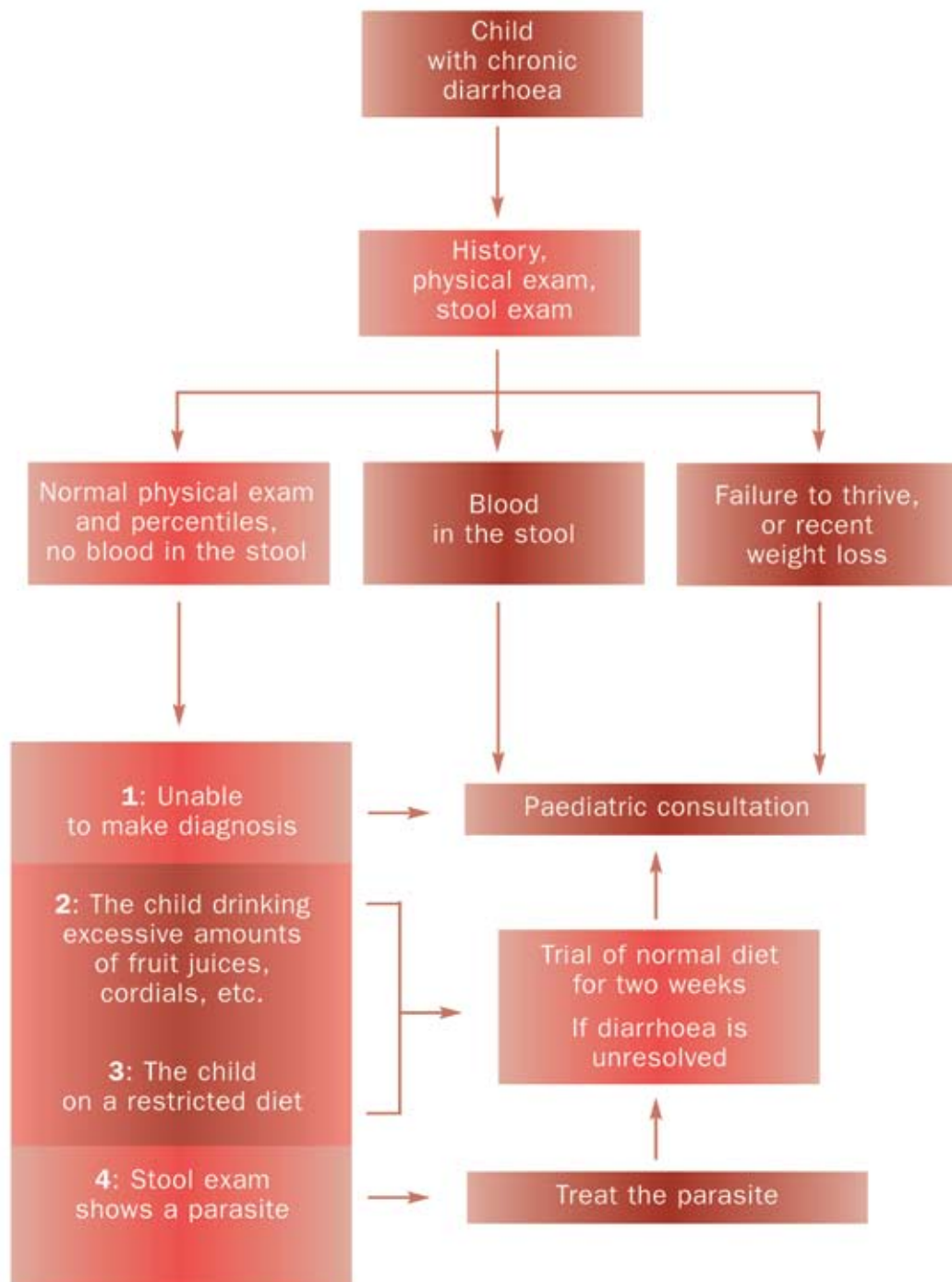
Elimination diets.

This can lead to life threatening starvation. Reducing important sources of nutrients such as milk or cereals should never occur without consultation.

Drug therapy.

Drugs should never be given unless a specific diagnosis has been made after appropriate investigations.

FIGURE 5 : Investigation flow diagram



Causes of Chronic Diarrhoea in Children

Table 9 Clinical Findings and Causes of chronic diarrhoea:

I : Unremarkable physical examination, normal percentiles and negative stool examination	II : Abnormal Stool examination	III : Failure to thrive or significant recent weight loss
<ul style="list-style-type: none">• Chronic non specific diarrhoea (Toddler's diarrhoea)• Excessive ingestion of fluids: fruit juice, cordial etc,• Sucrase-isomaltase deficiency	<ul style="list-style-type: none">• Ulcerative Colitis• Crohn's disease• Dietary protein-induced colitis• Polyposis syndromes• Amoebiasis	<ul style="list-style-type: none">• Coeliac disease• Giardiasis• Cystic fibrosis• Cow's milk and soy protein intolerance

1. Toddler Diarrhoea (Chronic non-specific diarrhoea)

A large group of children have frequent loose stools (often containing undigested food such as peas and carrots), but no evidence of impairment of growth and no other apparent cause for the diarrhoea. Their symptoms may be due to underlying immaturity of gastrointestinal motility. Some cases are associated with excessive intake of fruit juice, "juice-aholics" or sugary liquids, including cordial and sorbitol-based products (e.g. diet sweets, chewing gum) which may lead to osmotic diarrhoea. Parents should be advised to reduce the quantity of these products.

The presence of diarrhoea with no other apparent cause may lead to some of these children being placed on highly restricted or

elimination diets that do more harm than good. These children should be returned to a normal diet.

Toddler diarrhoea is benign and self-limited and usually resolves between two and four years of age. Parents will often insist on further investigations so early consultation is helpful. Small bowel biopsy is occasionally required to exclude coeliac disease and giardiasis.

2. Spurious Diarrhoea

Constipation with overflow is a common cause of diarrhoea in children. This often requires prolonged treatment and it is desirable to refer the child to a paediatrician.

3. Carbohydrate Intolerance:

Damage to the gut mucosa can lead to secondary lactose intolerance. Mucosal damage can have various causes but viral gastroenteritis is the most common. Clinical lactose intolerance may persist for weeks or months following acute infection even when the mucosa appears to have recovered (For management see pg 18)

When mucosal damage is severe, other disaccharidases may also be affected and occasionally monosaccharide malabsorption may occur.

Sucrose intolerance is less common than lactose intolerance. It can be due to a complete or partial congenital deficiency of sucrase-isomaltase enzyme but can also occur after mucosal injury, such as viral gastroenteritis.

Theoretically, sucrose-containing formulae (eg Infasoy) are not suitable for treatment of disaccharide intolerance, as lactase and sucrase deficiency often coexist.

Fructose malabsorption has increased in incidence with the introduction of fructose as a major dietary sweetener. Small intestinal absorption of fructose is limited. This condition is best diagnosed by breath hydrogen testing and seems to be more common in children with associated atopic disease.

4. Giardiasis

Symptoms and signs are extremely variable, sometimes minimal and at other times severe enough to mimic coeliac disease. A recurrent, variable pattern is common and frequently leads to erroneous beliefs that dietary changes cause remissions or relapses. Children who have these symptoms should have appropriate diagnosis by stool examinations, or biopsy/duodenal juice collection if stool examinations are negative. Treatments of choice include Metronidazole and Tinidazole. Empirical treatment is not recommended. Improvement is often in spite of, rather than because of treatment.

5. Dietary Protein Intolerance

Dietary protein intolerance (allergy) remains poorly understood. Cases of true allergy have been well documented but are rare. Gastrointestinal signs of allergy are usually delayed and not IgE mediated and so correlation of gut symptoms with skin and RAST tests is poor. Precise diagnosis is difficult and requires blinded challenges. Multiple dietary proteins may be involved. Blood tests are of little value in gut allergy.

The majority of cases are transient and resolve between two and six years of age. If diagnosing food allergy, be careful to avoid unnecessary anxiety and imposing special diets. Response to soy formula does not mean that milk allergy is present.

6. Coeliac Disease

Gluten-sensitive enteropathy has an Australian incidence of about 1 in 100. The classical presentation is of progressive diarrhoea, failure to thrive and malnutrition beginning after the introduction of gluten into the diet, but there is a wide variation in the clinical expression and age of presentation. Normal stools do not exclude coeliac disease and you should maintain a high index of suspicion if symptoms are present. The basis of diagnosis is intestinal biopsy and clinical features are not a reliable way to make or exclude the diagnosis. Tissue transglutaminase and serum IgA are useful in screening for

coeliac disease. However diagnosis must be confirmed by biopsy. Gluten challenge and follow-up biopsies may be required for confirmation of the diagnosis. A clinical trial of a gluten-free diet is never indicated. Where a diagnosis of coeliac disease is made, treatment is needed for life.

7. Pancreatic Insufficiency

The most common cause of pancreatic insufficiency in children is cystic fibrosis but other rare disorders such as Shwachman-Diamond syndrome do occur. Gastrointestinal symptoms vary but steatorrhoea is the hallmark. The diagnosis of cystic fibrosis depends on a sweat test.

Prevention

Hygiene

Table 10 Prevention of food borne gastroenteritis: Safe Food for Children¹

Rule	How?	Why?
Keep clean	Keep hands, kitchen surfaces and equipment clean; Protect food from insects, pests and animals.	Raw meat, animal and human faeces contain dangerous organisms that can be transferred to other food via knives, boards and handling
Separate raw and cooked food	Store raw food away from cooked food e.g. in containers; Use separate utensils, chopping boards for raw food.	
Cook thoroughly	Cook food thoroughly for children, especially meats, poultry, eggs, seafood and chicken. Soups and stews should be boiling Avoid undercooked hamburgers, fermented uncooked meats. Reheat food to 70°C.	Cooking food to >70°C kills most dangerous organisms
Keep food at a safe temperature	Refrigerate perishable food (<5°C). Do not leave food at room temperature >2h Serve hot food at >60°C. Thaw frozen food in the refrigerator, not at room temperature.	Growth of most organisms that multiply at room temperature is slowed or stopped at <5°C and >60°C.
Use safe water and raw materials	Use fresh food, clean water, pasteurized milk and cheese. Wash raw fruit and vegetables. Use food with an expiry date.	Washing and peeling decreases risk from food and water contaminated by organisms and chemicals.

¹ Adapted from Five keys to safer food. Food Safety. World Health Organization. WHO/SDE/PHE/FOS/01.1 (Accessed September 2006).

Vaccines

Rotavirus

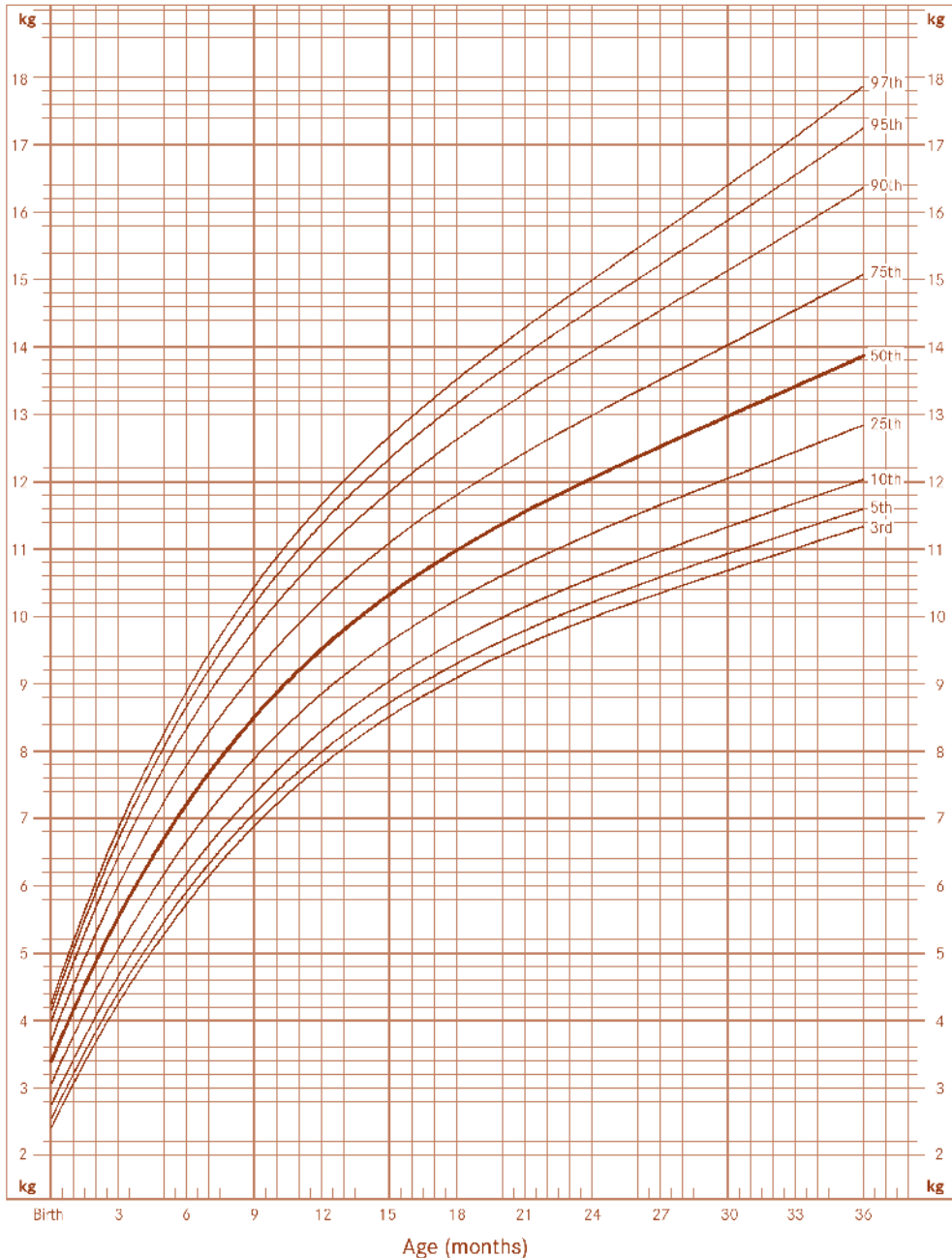
Good hygiene and sanitation are not sufficient to control the transmission of rotavirus. Oral rehydration therapy is effective and can be life saving, however, unlike vaccination it can treat only the symptoms not the cause. Two rotavirus vaccines, both of which are administered orally, have been approved for use in Australia; Rotarix® *Rotavirus vaccine live attenuated* (GlaxoSmithKline) and RotaTeq® *Rotavirus Vaccine, Live, Oral, Pentavalent* (CSL Biotherapies/Merck & Co Inc). Both vaccines are funded, i.e., provided free of charge, by the Australian government under the National Immunisation Program (NIP). The rotavirus NIP commenced in July 2007 for babies born on or after 01 May 2007. Each State and Territory Health Authority decides which rotavirus vaccine to use for their State and Territory NIP. The two vaccines are different, both in the virus strain used and the number of doses in the course. Rotarix contains a live attenuated human strain derived from the most common human rotavirus strain G1P[8]. The vaccine course, consisting of two doses, needs to be completed by 24 weeks of age. RotaTeq is a live attenuated pentavalent vaccine containing five animal (bovine)-human reassortant strains. The vaccine course, consisting of 3 doses, needs to be completed by 32 weeks of age.

The vaccines have a similar level of efficacy and are effective in protecting against severe Rotavirus gastroenteritis (RVGE).

Some infants may experience RVGE, subsequent to vaccination, however they are likely to experience a less severe form of the disease. Vaccine efficacy for Rotarix and RotaTeq during the first rotavirus season following vaccination ranges from 74% to 87% against RVGE of any severity and from 85 to 98% against severe RVGE. Both vaccines provide maintenance of protection over two rotavirus seasons, albeit with a slightly lower efficacy during the second RV season. The use of these vaccines for post-exposure prophylaxis has not been studied, however, there is evidence of vaccine efficacy prior to course completion. The predominance and severity of rotavirus is evidenced by the vaccines preventing 42 - 59% of all admissions of young children to hospital due to gastroenteritis of any cause; the vaccines do not prevent diarrhoea or vomiting caused by other infectious agents.

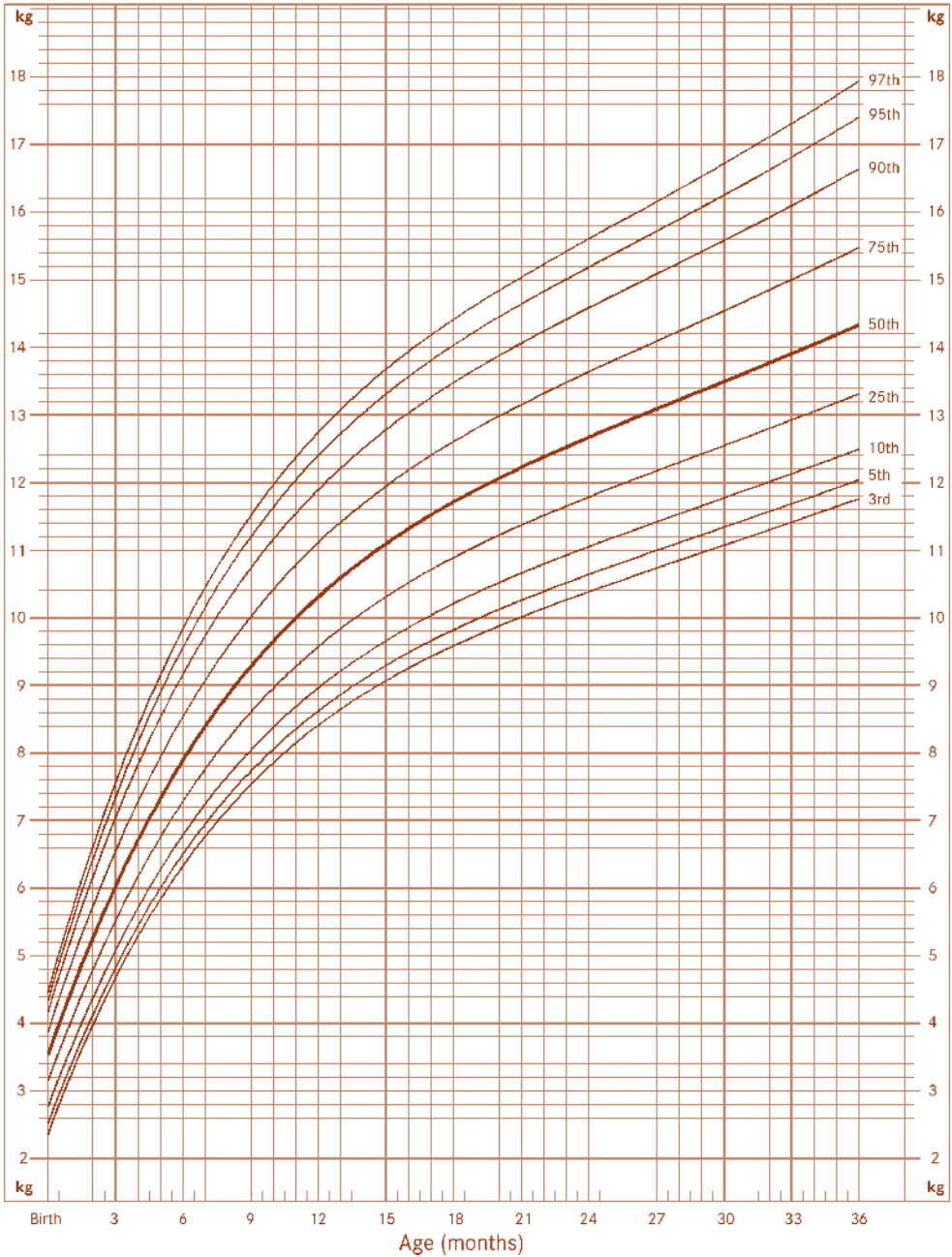
Both Rotarix and RotaTeq were generally well tolerated in clinical trials.. These trials showed that neither vaccine was associated an increased risk of intussusception. Intussusception had been a concern with a previous rotavirus vaccine called RotaShield® that was withdrawn from the US market in 1999. The possibility of an association between Rotarix, RotaTeq and intussusception cannot be completely ruled out until the vaccines are used in the broader public health setting. Post-marketing surveillance to date for RotaTeq does not suggest an association with intussusception.

Weight-for-age percentiles: Girls, birth to 36 months



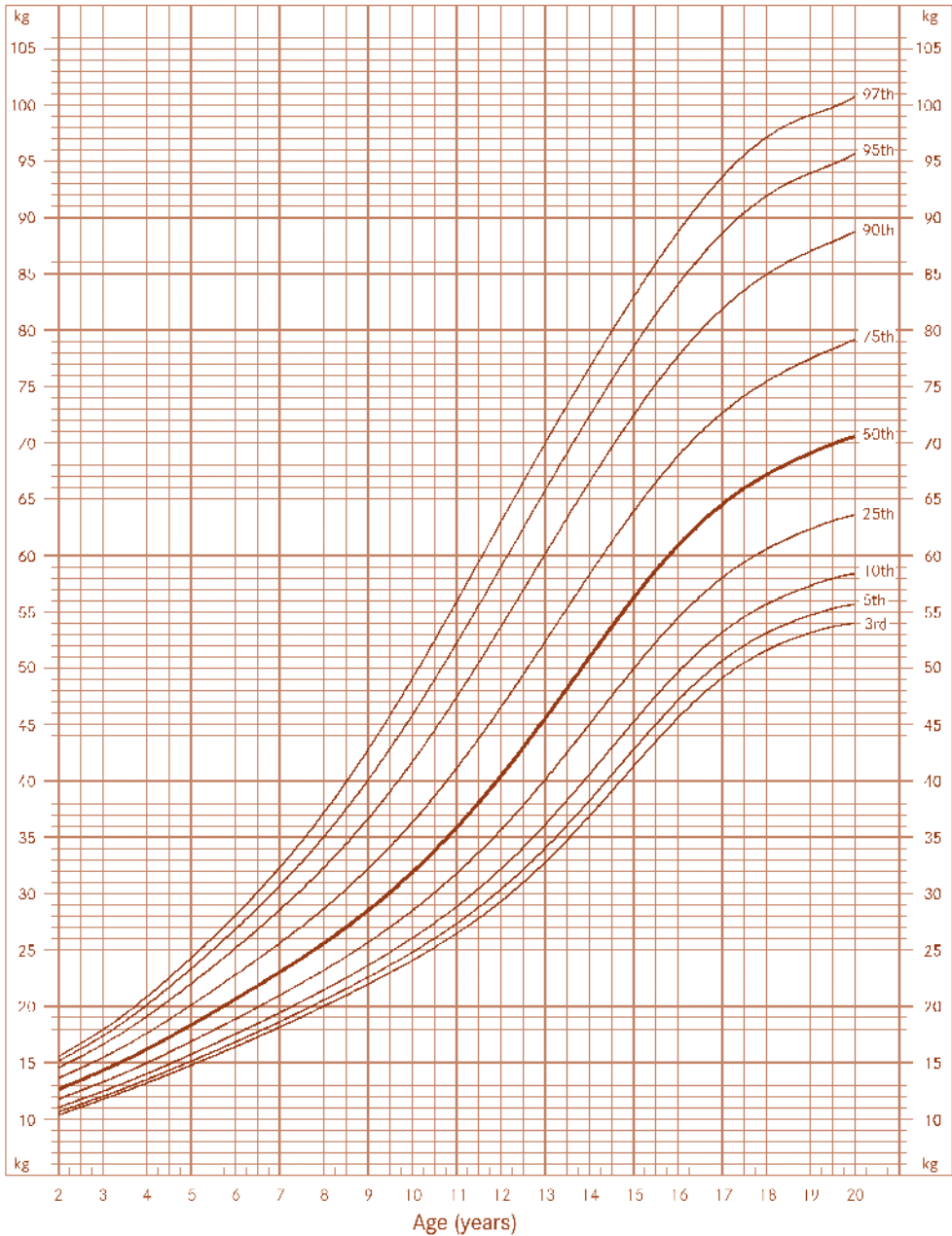
SOURCE: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).

Weight-for-age percentiles: Boys, birth to 36 months



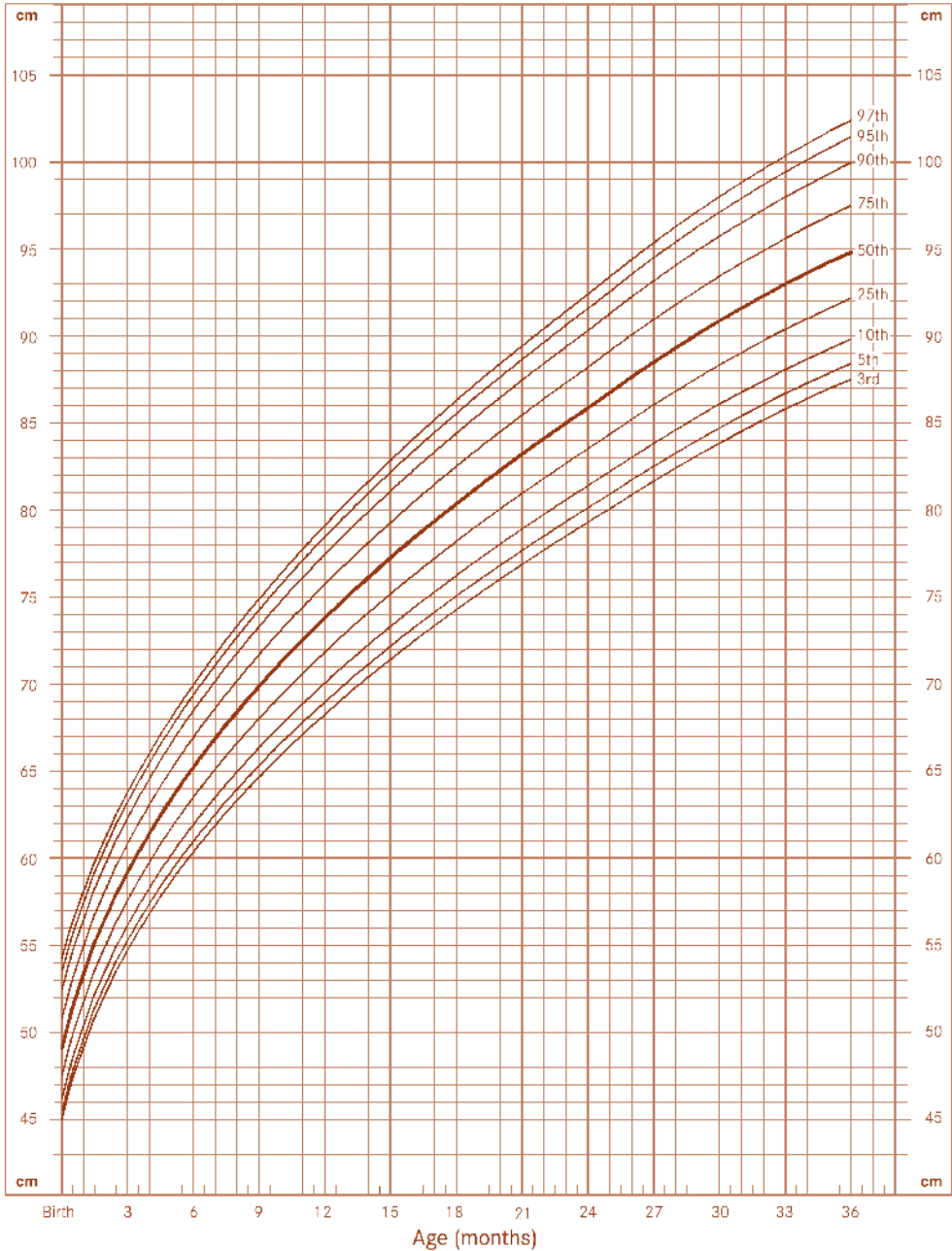
SOURCE: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).

Weight-for-age percentiles: Boys, 2 to 20 years



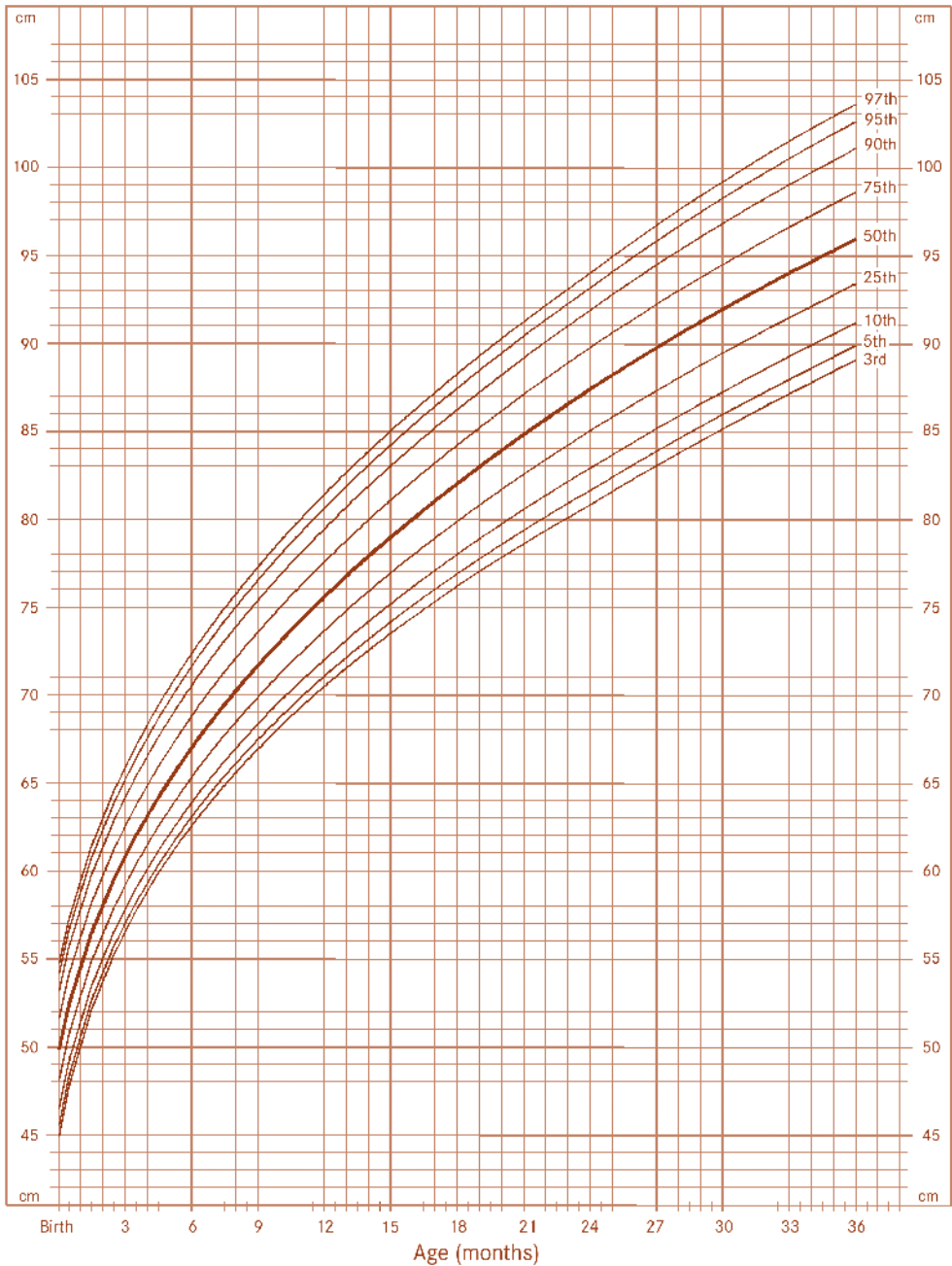
SOURCE: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).

Length-for-age percentiles: Girls, birth to 36 months



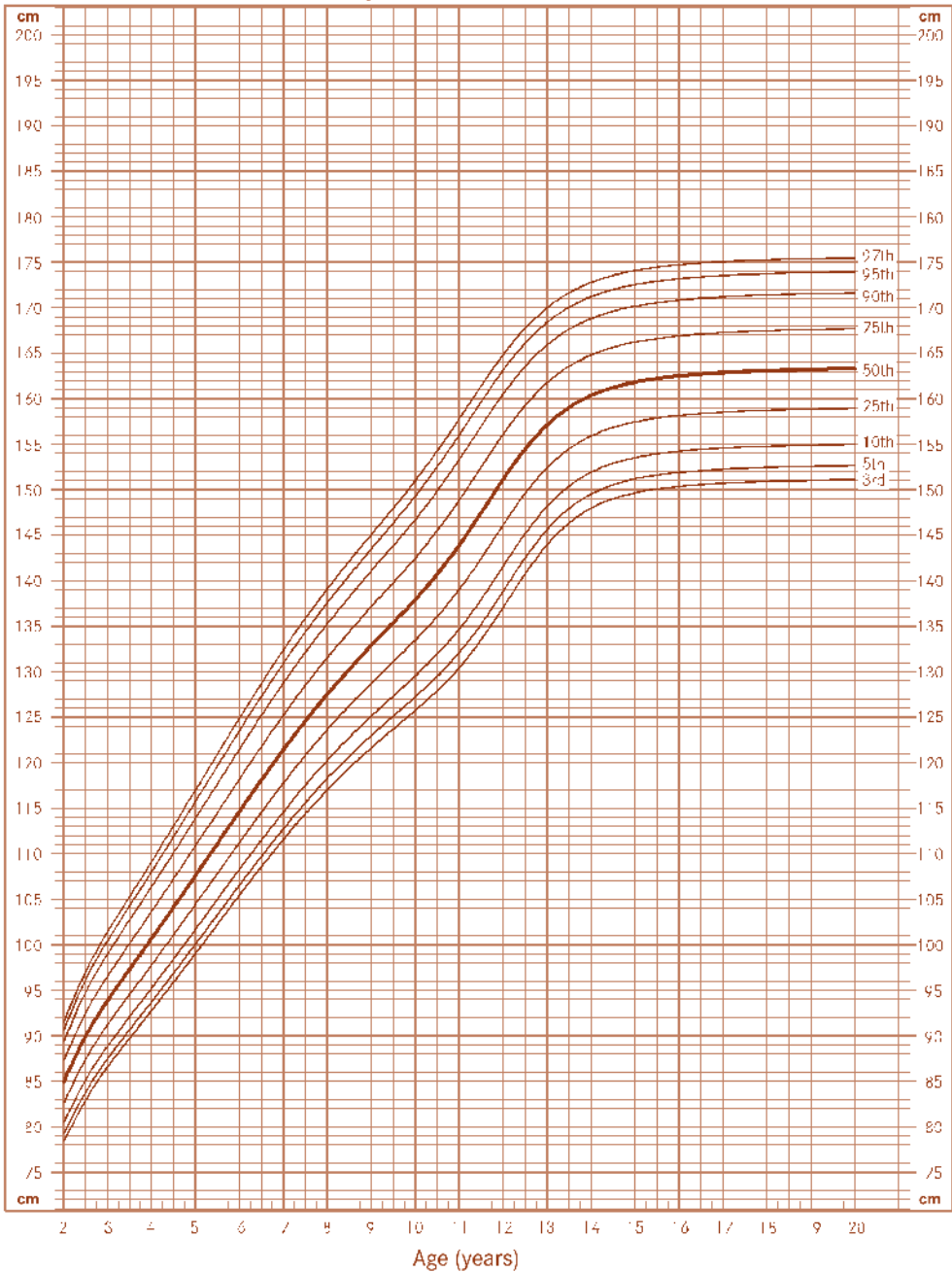
SOURCE: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).

Length-for-age percentiles: Boys, birth to 36 months



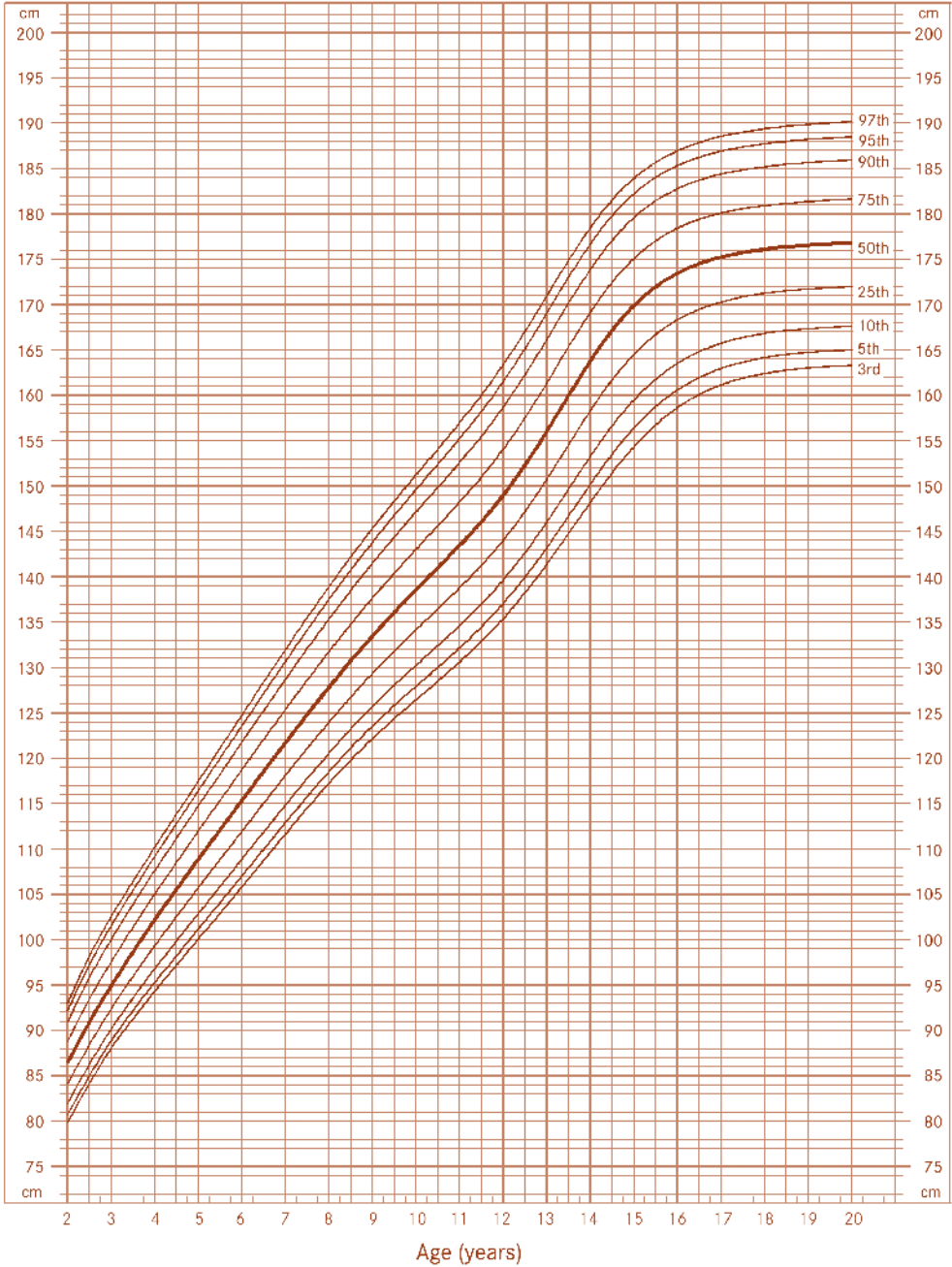
SOURCE: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).

Stature-for-age percentiles: Girls, 2 to 20 years



SOURCE: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).

Stature-for-age percentiles: Boys, 2 to 20 years



SOURCE: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).