imbalance should be corrected before contrast media are given. Particular care is needed in patients with multiple myeloma since dehydration resulting from use of contrast media may cause precipitation of protein in the renal tubules, leading to anuria and fatal renal failure.

Caution is also necessary in patients with severe hypertension, advanced cardiac disease, phaeochromocytoma, sickle-cell disease, or hyperthyroidism or epilepsy, and in debilitated, severely ill, very old, or very young patients.

Amidotrizoates and other hypertonic contrast media are neurotoxic and should not be given intrathecally; patients with subarachnoid haemorrhage may be at risk with any intravascular use. Intravascular contrast media should also be used with caution in any patient with occlusive vascular disease. Iodinated contrast media should not be used for hysterosalpingography in the presence of infection or inflammation of the pelvic cavity, nor during menstruation or in pregnancy (although any abdominal radiography should be avoided during pregnancy because of the risks of radiation to the fetus).

Iodine-containing contrast media may interfere with thyroid function tests. There may also be interference with blood coagulation tests and certain urine tests.

Breast feeding. No adverse effects have been seen in breast-feeding infants whose mothers were receiving amidotrizoates and the American Academy of Pediatrics considers[1] that they are therefore usually compatible with breast feeding.

1. American Academy of Pediatrics. The transfer of drugs and other chemicals into human milk. *Pediatrics* 2001; **108:** 776–89. Correction. *ibid.*; 1029. Also available at: http://aappolicy.aappublications.org/cgi/content/full/pediatrics%3b108/3/776 (accessed 27/03/06)

Neonates. Although amidotrizoates may be used in the management of some forms of intestinal obstruction (see below), meglumine amidotrizoate was considered[1] a possible contributory factor in the deaths of 2 infants who developed bowel necrosis, perforation, and peritonitis after its use for meconium ileus.

1. Leonidas JC, *et al*. Possible adverse effects of methylglucamine diatrizoate compounds on the bowel of newborn infants with meconium ileus. *Radiology* 1976; **121:** 693–6.

Pharmacokinetics

Amidotrizoates are very poorly absorbed from the gastrointestinal tract. Amidotrizoates in the circulation are not significantly bound to plasma proteins. If renal function is not impaired, unchanged amidotrizoate is rapidly excreted by glomerular filtration; over 95% of an intravascular dose is reported to be excreted in urine within 24 hours, and about 1 to 2% of a dose may be excreted in faeces. Trace amounts may be detected in other body fluids including tears and saliva. Faecal excretion may increase to 10 to 50% in severe renal impairment. The half-life of amidotrizoates has been reported to be 30 to 60 minutes, which can increase to 20 to 140 hours in severe renal impairment. They are removed by haemodialysis and peritoneal dialysis.

The amidotrizoates cross the placenta and are distributed into breast milk.

Uses and Administration

The amidotrizoates are ionic monomeric iodinated radiographic contrast media (p.1474). Both the sodium and the meglumine salt have been widely used in diagnostic radiography; however, adverse effects may be reduced by using a mixture of both salts, and this is often preferred. Preparations are available containing a wide range of strengths. Mixtures containing sodium amidotrizoate 10% w/v with meglumine amidotrizoate 66% w/v, or sodium amidotrizoate 4% with meglumine amidotrizoate 26%, are commonly used. For use alone, preparations containing sodium amidotrizoate 25 to 50% w/v, or meglumine amidotrizoate 60% w/v, may be appropriate.

The amidotrizoates are used in an extensive range of procedures, although in many cases lower osmolality contrast media are now preferred. The dose and route depend on the procedure and the degree and extent of contrast required. They are given intravenously for urography, for venography, and in computed tomography; for urography, they have also been given by intramuscular or subcutaneous injection, but these routes are not generally recommended. They may be given intra-arterially for angiography, by intra-articular injection for arthrography, or by intra-osseous injection for imaging of the vasculature of the bones. For other procedures they may be instilled into body cavities, or injected into the gallbladder, biliary ducts, or spleen. Amidotrizoates have also been given orally or rectally for imaging of the gastrointestinal tract.

Solutions of amidotrizoates have also been given as an enema in the treatment of uncomplicated meconium ileus.

Calcium amidotrizoate and lysine amidotrizoate have also been used as contrast media.

Gastrointestinal obstruction. Amidotrizoates and other water-soluble contrast media have been given rectally as osmotic agents in the management of gastrointestinal obstruction due to meconium ileus;[1] however, adverse effects have been reported in neonates (see above). They have also been used as an alternative to barium sulfate enemas in the management of intussusception (see below). Amidotrizoates given orally have been used in the management of adhesive small bowel obstruction;[2] they allow identification of patients who require surgery and, although they have not been shown to relieve obstruction, they may reduce length of hospital stay in patients treated without surgery.

1. Murshed R, *et al*. Meconium ileus: a ten-year review of thirty-six patients. *Eur J Pediatr Surg* 1997; **7:** 275–7.
2. Abbas S, *et al*. Oral water soluble contrast for the management of adhesive small bowel obstruction. Available in The Cochrane Database of Systematic Reviews; Issue 3. Chichester: John Wiley; 2007 (accessed 14/07/08).

Preparations

BP 2008: Meglumine Amidotrizoate Injection; Sodium Amidotrizoate Injection;
USP 31: Diatrizoate Meglumine and Diatrizoate Sodium Injection; Diatrizoate Meglumine and Diatrizoate Sodium Solution; Diatrizoate Meglumine Injection; Diatrizoate Sodium Injection; Diatrizoate Sodium Solution.

Proprietary Preparations (details are given in Part 3)
Arg.: Angiografina; Densopax; Hypaque 60%†; Hypaque 76%†; MD-76; MD-Gastroview; Plenigraf; Temistac; Tomoray; Triyosom; Urografina; Urovisona; ***Austral.:*** Angiografin†; Gastrografin; MD-60†; MD-76; MD-Gastroview; Urografin; ***Austria:*** Gastrografin; Urografin†; ***Belg.:*** Gastrografin; Urografine†; ***Braz.:*** Hypaque; Hypaque-M; Urografina; ***Canad.:*** Hypaque-M†; Hypaque†; MD-76; ***Chile:*** Angiovist; Hypaque 60%†; Hypaque 76%†; Pielograf†; Reliev; Reliev 76%; ***Cz.:*** Urografin†; ***Denm.:*** Urografin; Urografin Meglumin; ***Fin.:*** Gastrografin; ***Fr.:*** Gastrografine; Radioselectan; ***Ger.:*** Ethibloc; Gastrografin; Gastrolux; Peritrast; Peritrast comp; Peritrast-Infusio 160/32%†; Peritrast-Infusio 180/31%; Peritrast-Oral CT; Peritrast-Oral-GI; Peritrast-RE; Urolux; Urolux Retro; Urovison†; ***Gr.:*** Gastrografin; ***Hung.:*** Gastrografin; Peritrast; ***India:*** Urografin; ***Israel:*** Urografin†; ***Ital.:*** Gastrografin; ***Neth.:*** Angiografin†; Gastrografin; Urografin; Urovison†; ***Norw.:*** Gastrografin; ***NZ:*** Gastrografin; Urografin; ***Port.:*** Gastrografina; Urografina; ***Rus.:*** Hypaque (Гипак)†; Trazograph (Тразограф); Urographin (Урографин); ***S.Afr.:*** Angiografin†; Gastrografin; Urografin; ***Spain:*** Gastrografin; Pielograf; Plenigraf; Radialar 280; Trazograf; Uro Angiografin; Urografin; ***Swed.:*** Gastrografin; Urografin; ***Switz.:*** Gastrografin; Urografin†; ***UK:*** Gastrografin; Hypaque; Urografin 150 and 370; ***USA:*** Cystografin; Gastrografin; Hypaque; Hypaque-M, Hypaque-76; MD-76; MD-Gastroview; Reno-M; Renografin; ***Venez.:*** Hypaque-M†.

Multi-ingredient: ***USA:*** Sinografin.

Barium Sulfate

Barii sulfas; Barii Sulphas; Bario sulfatas; Barium Sulfuricum; Barium Sulphate; Bariumsulfaatti; Bariumsulfat; Bárium-szulfát; Baru siarczan; Baryum (Sulfate de); Baryum, sulfate de; Síran barnatý; Sulfato de bario.

$BaSO_4$ = 233.4.

CAS — 7727-43-7.

ATC Vet — QV08BA02.

Pharmacopoeias. In *Chin.*, *Eur.* (see p.vii), *Int.*, *Jpn*, *US*, and *Viet*.

Ph. Eur. 6.2 (Barium Sulphate). A fine, white powder, free from gritty particles. Practically insoluble in water and in organic solvents; very slightly soluble in acids and in solutions of alkali hydroxides.

USP 31 (Barium Sulfate). A fine, white, odourless, bulky powder, free from grittiness. Practically insoluble in water, in organic solvents, and in solutions of acids and of alkalis. pH of a 10% w/w aqueous suspension is between 3.5 and 10.0.

Adverse Effects

Because barium sulfate is almost insoluble it lacks the severe toxicity characteristic of the barium ion; deaths have occurred in patients given the more soluble barium sulfide in error for the sulfate.

Constipation may occur after oral or rectal barium sulfate; impaction, obstruction, and appendicitis have occurred. Surgical removal of faecaliths has sometimes been necessary. Cramping or diarrhoea have also been reported. Venous intravasation has led to the formation of emboli; deaths have occurred. Perforation of the bowel has led to peritonitis, adhesions, granulomas, and a high mortality rate.

ECG abnormalities have occurred during the use of barium sulfate enemas.

Accidental aspiration into the lungs has led to pneumonitis or granuloma formation.

Hypersensitivity. A survey of hypersensitivity reactions to barium preparations found that although barium is inert many of the additives used in formulation have the potential to cause reactions.[1] Of 106 reactions reported or found in the literature, 61% involved the skin and only 8% the respiratory tract; unconsciousness was reported in 8% of cases. In view of the frequency of use of barium preparations, such adverse reactions must be very rare, but radiologists should be aware that they might be somewhat more common than was usually appreciated. A number of severe reactions associated with the use of barium enemas supplied with an inflatable latex cuff may have been due to leaching of components from the latex.[2]

1. Janower ML. Hypersensitivity reactions after barium studies of the upper and lower gastrointestinal tract. *Radiology* 1986; **161:** 139–40.
2. Nightingale SL. Severe adverse reactions to barium enema procedures. *JAMA* 1990; **264**: 2863.

Precautions

Barium sulfate should not be given to patients with intestinal obstruction and care is needed in those with conditions such as pyloric stenosis or lesions that may predispose to obstruction. Adequate hydration should be ensured after the procedure to prevent severe constipation.

It is contra-indicated in patients with gastrointestinal perforation, and should be avoided, particularly when given rectally, in those at risk of perforation, such as patients with acute ulcerative colitis or diverticulitis and after rectal or colonic biopsy, sigmoidoscopy, or radiotherapy.

Uses and Administration

Barium sulfate is used as a radiographic contrast medium (p.1474) for X-ray examination of the gastrointestinal tract involving single- or double-contrast techniques or computed tomography.

The dose of barium sulfate is dependent upon the type of examination and technique used. In the UK typical doses and concentrations used for examination are:

- oesophagus: up to 150 mL of a 50 to 200% w/v suspension given orally
- stomach and duodenum: up to 300 mL of a 30 to 200% w/v suspension given orally
- small intestine: 100 to 300 mL of a 30 to 150% w/v suspension given orally
- colon: 200 mL to 2 litres of a 20 to 130% w/v suspension given as an enema.

A suspension containing 1.6 to 2.2% may be used in gastrointestinal computed tomography.

In the USA, suspensions containing up to 230% w/v barium sulfate may be used; lower concentrations are available for use in computed tomography and usually contain about 1 to 2% w/v.

For double-contrast examination, gas can be introduced into the gastrointestinal tract by using suspensions of barium sulfate containing carbon dioxide; separate gas-producing preparations based on sodium bicarbonate are also available. Air given via a tube may be used as an alternative to carbon dioxide.

◊ Reviews.

1. Nolan DJ, Traill ZC. The current role of the barium examination of the small intestine. *Clin Radiol* 1997; **52:** 809–20.
2. Mendelson RM. The role of the barium enema in the diagnosis of colorectal neoplasia. *Australas Radiol* 1998; **42:** 191–6.
3. de Zwart IM, *et al*. Barium enema and endoscopy for the detection of colorectal neoplasia: sensitivity, specificity, complications and its determinants. *Clin Radiol* 2001; **56:** 401–9.
4. Rubesin SE, Maglinte DD. Double-contrast barium enema technique. *Radiol Clin North Am* 2003; **41:** 365–76.
5. O'Connor SD, Summers RM. Revisiting oral barium sulfate contrast agents. *Acad Radiol* 2007; **14:** 72–80.

Intussusception. Contrast media enemas and ultrasound are both used in the diagnosis of intussusception, a condition in infants where part of the intestine prolapses into the lumen of an adjacent part causing an obstruction.[1,2] However, some consider ultrasound to be superior for diagnosis and reserve enemas for the therapeutic reduction of intussusception. Reduction is achieved as a result of the hydrostatic pressure of the enema pushing the intestine back into its natural position. Although there is extensive experience using barium enemas for reduction some centres prefer to use water-soluble contrast media so as to minimise the risk of chemical peritonitis if perforation of the bowel occurs. Other agents used instead of barium for reduction include air enemas or ultrasound guided saline enemas, both of which avoid or reduce radiographic exposure. Surgery is indicated when enema therapy fails or is considered unsuitable.

1. del-Pozo G, *et al*. Intussusception in children: current concepts in diagnosis and enema reduction. *Radiographics* 1999; **19:** 299–319.
2. Sorantin E, Lindbichler F. Management of intussusception. *Eur Radiol* 2004; **14** (suppl 4): L146–L154.

Preparations

BP 2008: Barium Sulphate for Suspension; Barium Sulphate Oral Suspension;
USP 31: Barium Sulfate for Suspension; Barium Sulfate Paste; Barium Sulfate Suspension; Barium Sulfate Tablets.

Proprietary Preparations (details are given in Part 3)
Arg.: Barigraf; Bario; Bariofarma; Barosperse; E-Z-Cat; Entero VU; Gastropaque; Novopacum; Opti-Up†; Scheribar; Tixobar; Top-Cat; ***Austral.:*** Medebar; Medescan; Tixobar†; ***Austria:*** Barilux; Prontobario; Scannotrast; ***Belg.:*** E-Z-Paque; Micropaque; Microtrast; Polibar; ***Braz.:*** Bariogel; Celobar†; ***Chile:*** Barigraf†; ***Cz.:*** E-Z-Cat; E-Z-HD; E-Z-Paque†; Micropaque; Microtrast; Polibar; Prontobario†; ***Denm.:*** Micropaque; Microtrast; Mixobar; ***Fin.:*** Mixobar; ***Fr.:*** Micropaque; Microtrast; ***Ger.:*** Barilux; Micropaque; Microtrast; ***Gr.:*** Barilux; Micropaque; Unibaryt-R; ***Hung.:*** E-Z-Cat; E-Z-HD; Micropaque; Microtrast; Polibar ACB; Polibar Rapid; ***Israel:*** E-Z-Cat; E-Z-HD; E-Z-Paque; Entero VU; Liquid Polibar Plus; Polibar ACB; ***Ital.:*** Mixobar†; Prontobario; TAC Esofago; ***Neth.:*** Baricol; E-Z-HD; Micropaque; Polibar; ***Norw.:*** Mixobar; ***NZ:*** Medebar†; ***Port.:*** E-Z-Cat; E-Z-HD; Gastrobario; Micropaque; Microtrast; Polibar; ***Spain:*** Barigraf; Bario Dif; Bario Llorente†; Disperbarium; Justebarin†; Micropaque†; ***Swed.:*** Mixobar; ***Switz.:*** CAT-Barium (E-Z-CAT); Microbar-HD (E-Z-HD); Micropaque; Polibar ACB; ***UK:*** Baritop; E-Z-Cat; E-Z-HD; E-Z-Paque; Polibar; Polibar Rapid; ***USA:*** Anatrast; Baricon; Baro-cat; Barobag; Barosperse; Bear-E-Yum; CheeTah; Enecat; Enemark; Enhancer; Entrobar; Epi-C; Flo-Coat; HD 200 Plus; HD 85; Introp aste; Liqui-Coat HD; Liquipake; Medebar; Medescan; Prepcat; Scan C; Tomocat; Tonojug; Tonopaque; ***Venez.:*** Barin; Bariogel†; Bariotin†; Sulfobarina†.

Ferristene *(BAN, USAN)*

Ferristeno.

$C_8H_{11}NO_3S,(Fe_2O_3)_{0.725}$.

CAS — 155773-56-1.

ATC — V08CB02.

ATC Vet — QV08CB02.

Description. Ferristene contains about 23.4% of Fe.

Profile
Ferristene consists of iron ferrite crystals carried on monosized spheres of cross-linked poly(ammonium styrenesulfonate). It has superparamagnetic properties and has been used orally as a magnetic resonance contrast medium (p.1474) for imaging of the abdomen.

Preparations
Proprietary Preparations (details are given in Part 3)
UK: Abdoscan†.

Ferucarbotran *(BAN, USAN)*

Ferrixan; Ferucarbotrano; SHU-555A; ZK-132281.

Profile
Ferucarbotran is a colloidal aqueous suspension of iron oxide (magnetite and maghemite) particles coated with carboxydextran. It has superparamagnetic properties and is used similarly to ferumoxides (below) as a magnetic resonance contrast medium (p.1474) for imaging of the liver; the particles are taken up by the reticuloendothelial system of the liver and spleen and provide contrast enhancement. It is given intravenously as a solution containing 28 mg/mL of iron. The usual dose is 0.9 mL for patients weighing less than 60 kg and 1.4 mL for patients weighing 60 kg and over.

◊ References.

1. Reimer P, Balzer T. Ferucarbotran (Resovist): a new clinically approved RES-specific contrast agent for contrast-enhanced MRI of the liver: properties, clinical development, and applications. *Eur Radiol* 2003; **13:** 1266–76.

Preparations
Proprietary Preparations (details are given in Part 3)
Austral.: Resovist†; ***Austria:*** Resovist; ***Belg.:*** Resovist; ***Cz.:*** Resovist; ***Denm.:*** Resovist; ***Fin.:*** Resovist†; ***Ger.:*** Resovist; ***Gr.:*** Resovist; ***Israel:*** Resovist†; ***Ital.:*** Resovist; ***Neth.:*** Resovist; ***Norw.:*** Resovist; ***Port.:*** Resovist; ***Spain:*** Resograf; Resovist; ***Swed.:*** Resovist; ***Switz.:*** Resovist.

Ferumoxides *(BAN, USAN)*

AMI-25; Ferumóxidos.

$(Fe_2O_3)_m(FeO)_n$.

CAS — 119683-68-0.

Adverse Effects and Precautions
The most common adverse effects with ferumoxides are pain, vasodilatation, and hypotension; paraesthesia may also occur. Hypersensitivity reactions have developed. Extravasation may lead to discoloration of the skin around the injection site. Ferumoxides should not be used in patients with known hypersensitivity to iron and should be used with caution in patients with iron overload disorders.

Uses and Administration
Ferumoxides consists of colloidal particles of magnetite (iron oxide). It has superparamagnetic properties and is used as a magnetic resonance contrast medium (p.1474) for imaging of the liver; the particles are taken up by the reticuloendothelial system of the liver and spleen and provide contrast enhancement. It is available as a suspension containing 11.2 mg/mL of iron, which should be diluted in 100 mL of glucose 5% before use and given intravenously over at least 30 minutes. The dose is expressed in terms of iron. In Europe, the usual dose is 0.84 mg/kg; in the USA, a dose of 0.56 mg/kg is used.

◊ Reference to the use of ferumoxides followed by a gadolinium-based contrast medium.[1]

1. Qayyum A, *et al.* Detection of hepatocellular carcinoma by ferumoxides-enhanced MR imaging in cirrhosis: incremental value of dynamic gadolinium-enhancement. *J Magn Reson Imaging* 2006; **23:** 17–22.

Preparations
USP 31: Ferumoxides Injection.

Proprietary Preparations (details are given in Part 3)
Arg.: Feridex†; ***Austria:*** Endorem; ***Belg.:*** Endorem; ***Denm.:*** Endorem; ***Fin.:*** Endorem; ***Fr.:*** Endorem; ***Ger.:*** Endorem; ***Gr.:*** Endorem; ***Israel:*** Feridex†; ***Ital.:*** Endorem; ***Jpn:*** Feridex; ***Neth.:*** Endorem; ***Norw.:*** Endorem; ***Port.:*** Endorem; ***Spain:*** Endorem; ***Swed.:*** Endorem; ***Switz.:*** Endorem; ***USA:*** Feridex.

Ferumoxsil *(BAN, USAN)*

AMI-121; Ferumoksiili; Ferumoxil; Férumoxsil; Ferumoxsilum.

ATC — V08CB01.

ATC Vet — QV08CB01.

Adverse Effects and Precautions
The most common adverse effects with ferumoxsil are diarrhoea, nausea, vomiting, and abdominal pain; oral paraesthesia has also been reported. Ferumoxsil should be used with caution in patients with iron overload disorders.

Uses and Administration
Ferumoxsil consists of a silicone polymer bonded to colloidal particles of magnetite (iron oxide). It has superparamagnetic properties and is used as a magnetic resonance contrast medium (p.1474) for imaging of the gastrointestinal tract; the particles remain in the stomach and intestine when given orally or rectally and provide contrast enhancement. It is given as a suspension containing 175 micrograms/mL of iron. The usual dose is 600 to 900 mL by mouth, or 300 to 600 mL rectally.

Preparations
USP 31: Ferumoxsil Oral Suspension.

Proprietary Preparations (details are given in Part 3)
Austria: Lumirem; ***Braz.:*** Lumirem†; ***Denm.:*** Lumirem; ***Fin.:*** Lumirem; ***Fr.:*** Lumirem; ***Ger.:*** Lumirem; ***Ital.:*** Lumirem; ***Neth.:*** Lumirem; ***Port.:*** Lumirem; ***Swed.:*** Lumirem; ***USA:*** Gastromark.

Ferumoxtran-10 *(USAN)*

AMI-227; BMS-180549; Code 7227.

CAS — 189047-99-2.

Profile
Ferumoxtran-10 consists of colloidal particles of magnetite (iron oxide) coated with a low-molecular-weight dextran. It has superparamagnetic properties and is under investigation as a magnetic resonance contrast medium for imaging of the lymphatic system.

Gadobenic Acid *(BAN, rINN)*

Acide Gadobénique; Ácido gadobénico; Acidum Gadobenicum; B-19036; Gd-BOPTA. Dihydrogen [(±)-4-carboxy-5,8,11-tris(carboxymethyl)-1-phenyl-2-oxa-5,8,11-triazatridecan-13-oato(5–)]gadolinate(2–).

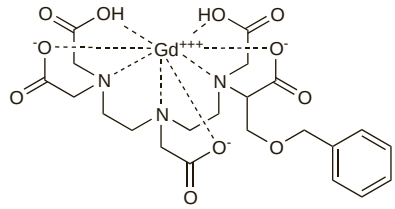
Гадобеновая Кислота

$C_{22}H_{28}GdN_3O_{11}$ = 667.7.

CAS — 113662-23-0.

ATC — V08CA08.

ATC Vet — QV08CA08.



Meglumine Gadobenate *(BANM, rINNM)*

B-19036/7; Gadobenaattidimeglumiini; Gadobenatdimeglumin; Gadobénate de Méglumine; Gadobenate Dimeglumine *(USAN)*; Gadobenato de meglumina; Gadobenatum Dimegluminum; Meglumini Gadobenas.

Меглумина Гадобенат

$C_{22}H_{28}GdN_3O_{11},2C_7H_{17}NO_5$ = 1058.1.

CAS — 127000-20-8.

ATC — V08CA08.

ATC Vet — QV08CA08.

Adverse Effects and Precautions
As for Gadopentetic Acid, p.1479.

◊ References.

1. Kirchin MA, *et al.* Safety assessment of gadobenate dimeglumine (MultiHance): extended clinical experience from phase I studies to post-marketing surveillance. *J Magn Reson Imaging* 2001; **14:** 281–94.
2. Shellock FG, *et al.* Safety of gadobenate dimeglumine (MultiHance): summary of findings from clinical studies and postmarketing surveillance. *Invest Radiol* 2006; **41:** 500–9.

Pharmacokinetics
Gadobenate is rapidly distributed into the extracellular space after intravenous injection. An elimination half-life of about 1.2 to 1.7 hours has been reported. It is not metabolised and about 78 to 94% of a dose is excreted in the urine within 24 hours; about 2 to 4% is excreted in the faeces.

Uses and Administration
Gadobenic acid is an ionic gadolinium chelate with actions and uses similar to those of gadopentetic acid (p.1480). It has paramagnetic properties and is used as a magnetic resonance contrast medium (p.1474). It distributes mainly into extracellular fluid, but does not cross the blood-brain barrier, and is used in imaging of the liver and CNS.

Gadobenic acid is given intravenously as the meglumine salt. It is available as a solution containing meglumine gadobenate 529 mg/mL (0.5 mmol/mL). Usual doses for imaging are:

- liver: 0.1 mL/kg (0.05 mmol/kg) intravenously
- brain or spine: 0.2 mL/kg (0.1 mmol/kg) intravenously.

Preparations
Proprietary Preparations (details are given in Part 3)
Austria: MultiHance; ***Belg.:*** MultiHance; ***Cz.:*** MultiHance; ***Denm.:*** MultiHance; ***Fin.:*** MultiHance; ***Fr.:*** MultiHance; ***Ger.:*** MultiHance; ***Gr.:*** MultiHance; ***Hung.:*** MultiHance; ***Irl.:*** MultiHance†; ***Israel:*** MultiHance; ***Ital.:*** MultiHance; ***Neth.:*** MultiHance; ***Norw.:*** MultiHance; ***NZ:*** MultiHance; ***Port.:*** MultiHance; ***Spain:*** MultiHance; ***Swed.:*** MultiHance; ***Switz.:*** MultiHance; ***UK:*** MultiHance; ***USA:*** MultiHance.

Gadobutrol *(rINN)*

Gadobutrolum. {10-[(1*RS*,2*SR*)-2,3-Dihydroxy-1-(hydroxymethyl)propyl]-1,4,7,10-tetraazacyclododecane-1,4,7-triacetato-(3–)}gadolinium.

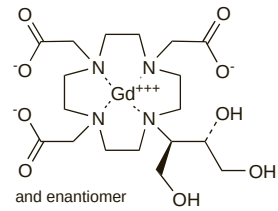
Гадобутрол

$C_{18}H_{31}GdN_4O_9$ = 604.7.

CAS — 138071-82-6.

ATC — V08CA09.

ATC Vet — QV08CA09.



Adverse Effects and Precautions
As for Gadopentetic Acid, p.1479. Gadobutrol may prolong cardiac repolarisation and should not be used in patients with uncorrected hypokalaemia. Caution is required in patients with severe cardiovascular disease, and in those with congenital long QT syndrome or a history of drug-induced arrhythmias.

Pharmacokinetics
Gadobutrol is rapidly distributed into the extracellular space following intravenous injection. It is not significantly bound to plasma proteins. An elimination half-life of about 1.8 hours has been reported. It is not metabolised and more than 90% of a dose is excreted in the urine within 12 hours; less than 0.1% is excreted in the faeces.

Uses and Administration
Gadobutrol is a nonionic gadolinium chelate with actions and uses similar to those of gadopentetic acid (p.1480). It has paramagnetic properties and is used as a magnetic resonance contrast medium (p.1474). It distributes mainly into extracellular fluid, but does not cross the blood-brain barrier, and is used in imaging of the CNS, kidneys, and liver, and in magnetic resonance angiography.

Gadobutrol is available as a solution containing 605 mg/mL (1 mmol/mL). Usual doses are:

- cranial and spinal imaging: 0.1 mL/kg (0.1 mmol/kg) intravenously. A second dose of up to 0.2 mL/kg (0.2 mmol/kg) may be given within 30 minutes if required
- kidneys and liver: 0.1 mL/kg (0.1 mmol/kg) intravenously
- angiography: 0.1 to 0.3 mL/kg (0.1 to 0.3 mmol/kg) intravenously

A solution containing 302.5 mg/mL (0.5 mmol/mL) has also been used.

◊ References.

1. Huppertz A, Rohrer M. Gadobutrol, a highly concentrated MR-imaging contrast agent: its physicochemical characteristics and the basis for its use in contrast-enhanced MR angiography and perfusion imaging. *Eur Radiol* 2004; **14** (suppl 5): M12–M18.

Preparations
Proprietary Preparations (details are given in Part 3)
Austral.: Gadovist; ***Austria:*** Gadovist; ***Belg.:*** Gadovist; ***Canad.:*** Gadovist; ***Cz.:*** Gadovist; ***Denm.:*** Gadovist; ***Fin.:*** Gadovist; ***Ger.:*** Gadovist; ***Gr.:*** Gadovist; ***Hung.:*** Gadovist; ***Ital.:*** Gadovist; ***Neth.:*** Gadovist; ***Norw.:*** Gadovist; ***NZ:*** Gadovist; ***Port.:*** Gadovist; ***Rus.:*** Gadovist (Гадовист); ***S.Afr.:*** Gadovist; ***Spain:*** Gadograf; Gadovist; ***Swed.:*** Gadovist; ***Switz.:*** Gadovist; ***UK:*** Gadovist.