5. Gradin M, *et al*. Pain reduction at venipuncture in newborns: oral glucose compared with local anesthetic cream. *Pediatrics* 2002; **110:** 1053–7.
6. Rabago D, *et al*. A systematic review of prolotherapy for chronic musculoskeletal pain. *Clin J Sport Med* 2005; **15:** 376–80.
7. Dagenais S, *et al*. Prolotherapy injections for chronic low-back pain. Available in The Cochrane Database of Systematic Reviews; Issue 2. Chichester: John Wiley; 2007 (accessed 23/06/08).
8. Topol GA, *et al*. Efficacy of dextrose prolotherapy in elite male kicking-sport athletes with chronic groin pain. *Arch Phys Med Rehabil* 2005; **86:** 697–702.

Preparations

BP 2008: Glucose Intravenous Infusion; Glucose Irrigation Solution; Potassium Chloride and Glucose Intravenous Infusion; Potassium Chloride, Sodium Chloride and Glucose Intravenous Infusion; Sodium Chloride and Glucose Intravenous Infusion;
Ph. Eur.: Anticoagulant Acid-Citrate-Glucose Solutions (ACD); Anticoagulant Citrate-Phosphate-Glucose Solution (CPD);
USNF 26: Dextrose Excipient; Liquid Glucose;
USP 31: Alcohol in Dextrose Injection; Anticoagulant Citrate Dextrose Solution; Anticoagulant Citrate Phosphate Dextrose Adenine Solution; Anticoagulant Citrate Phosphate Dextrose Solution; Dextrose and Sodium Chloride Injection; Dextrose Injection; Half-strength Lactated Ringer's and Dextrose Injection; Lactated Ringer's and Dextrose Injection; Multiple Electrolytes and Dextrose Injection Type 1; Multiple Electrolytes and Dextrose Injection Type 2; Multiple Electrolytes and Dextrose Injection Type 3; Multiple Electrolytes and Dextrose Injection Type 4; Potassium Chloride in Dextrose and Sodium Chloride Injection; Potassium Chloride in Dextrose Injection; Potassium Chloride in Lactated Ringer's and Dextrose Injection; Ringer's and Dextrose Injection; Sodium Chloride and Dextrose Tablets.

Proprietary Preparations (details are given in Part 3)

Arg.: Glucolin; Glucotem; Kissimin; Nutrosa; ***Austral.:*** Insta-Glucose†; ***Austria:*** Glucosteril; ***Canad.:*** Glucodex†; ***Cz.:*** Ardeanutrisol G; Spofagnost†; ***Fin.:*** Glucosteril; ***Ger.:*** Glucosteril; ***Hung.:*** Isodex; ***Indon.:*** Otsu-D5; Wida D5 and D10; ***Ital.:*** Energen; ***Pol.:*** Maltan; ***Port.:*** Glucosada; Glucosado; Glucosteril; ***Rus.:*** Glucosteril (Глюкостерил); ***Spain:*** Apir Glucosado; Biberon; Flebobag Glucosa; Fleboflex Glucosa; Fleboplast Glucosa; Freeflex Glucosa; Glucosmon; Meinvenil Glucosa; Plast Apyr Glucosado; Suero Glucosado Isotonico; ***UK:*** GlucoGel; ***USA:*** Dex4 Glucose; Glutose; Insulin Reaction.

Multi-ingredient: ***Arg.:*** High Energy; Sucaryl; Suimel; ***Austral.:*** BSS Plus; Dexsal; Emetrol†; No Doz Plus; Nyal Chesty Cough†; Vig†; ***Austria:*** BSS Plus; Gluco-Salzlosung; ***Braz.:*** Dramin B-6 DL; Glicofisiologica†; ***Canad.:*** BSS Plus; Sclerodex; ***Fr.:*** BSS Plus; Coramine Glucose; Notabac; ***Ger.:*** BSS Plus; Kochsalz mit Glucose; ***Hong Kong:*** BSS Plus†; ***Hung.:*** BSS Plus; ***India:*** Toniazol†; ***Irl.:*** Venos Expectorant; Venos Honey & Lemon; ***Israel:*** BSS Plus; Peptical; ***Ital.:*** Alcalosio; Apergan; Fosfarsile Forte; ***Malaysia:*** BSS Plus; ***Mex.:*** Combinacion PI†; ***Norw.:*** Salidex; ***Pol.:*** Glucardiamid; ***Port.:*** Glucosalino; ***Rus.:*** Gluconeodesum (Глюконеодез); ***S.Afr.:*** BSS Plus; ***Singapore:*** BSS Plus; ***Spain:*** Acetuber; Apir Glucosalino; Flebobag Glucosalina; Fleboplast Glucosalina; Freeflex Glucosalina; Glucopotasico; Glucosalina; Glucosalino; Meinvenil Glucosalina; Plast Apyr Glucosalino; Suero Glucosalino; ***Switz.:*** BSS Plus†; Glucosalin; Glucosaline; Gly-Coramin; ***Thai.:*** BSS Plus; Euro-Collins; Gluco-Calcium; ***UK:*** Buttercup Infant Cough Syrup; Buttercup Syrup (Blackcurrant flavour); Buttercup Syrup (Honey and Lemon flavour); Lockets Medicated Linctus; PEP; Venos Cough Mixture; Venos Expectorant; Venos Honey & Lemon; ***USA:*** BSS Plus; Emetrol; Formula EM; Nausetrol; ***Venez.:*** BSS Plus†; Dextro-Sal†; Glucofisiologica†.

Glutamic Acid *(USAN, rINN)*

Acide glutamique; Ácido glutámico; Acidum glutamicum; E; E620; Glu; L-Glutamic Acid; Glutamiinihappo; Glutaminic Acid; Glutaminsav; Glutaminsyra; Glutamo rūgštis; Kwas glutaminowy; Kyselina glutamová. L-(+)-2-Aminoglutaric acid.

Глутаминовая Кислота

$C_5H_9NO_4$ = 147.1.

CAS — 56-86-0.

Pharmacopoeias. In *Chin.* and *Eur.* (see p.vii).
Ph. Eur. 6.2 (Glutamic Acid). A white or almost white, crystalline powder or colourless crystals. Freely soluble in boiling water; slightly soluble in cold water; practically insoluble in alcohol, in acetic acid, and in acetone. Protect from light.

Glutamic Acid Hydrochloride *(rINNM)*

Acide Glutamique, Chlorhydrate de; Acidum Glutamicum Hydrochloridum; Aciglumin; Glu Hydrochloride; Hidrocloruro del ácido glutámico. L-(+)-2-Aminoglutaric acid hydrochloride.

Глутаминовой Кислоты Гидрохлорид

$C_5H_9NO_4$,HCl = 183.6.

CAS — 138-15-8.

ATC — A09AB01.

ATC Vet — QA09AB01.

Pharmacopoeias. In *Ger.*

Glutamine *(USAN, rINN)*

Gln; Glutamina; L-Glutamine; Glutaminum; Levoglutamida; Lévoglutamide; Levoglutamide; Levoglutamidum; Q. L-Glutamic acid 5-amide; L-(+)-2-Aminoglutaramic acid.

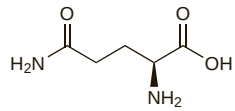
Левоглутамид

$C_5H_{10}N_2O_3$ = 146.1.

CAS — 56-85-9.

ATC — A16AA03.

ATC Vet — QA16AA03.



Pharmacopoeias. In *Ger.* and *US.*
USP 31 (Glutamine). White crystals or crystalline powder. Soluble in water; practically insoluble in alcohol and in ether. Store at a mean temperature not exceeding 25°.

Profile

Glutamic acid is a non-essential amino acid which is degraded readily in the body to form glutamine (levoglutamide). Glutamic acid and glutamine are used as dietary supplements. The dipeptides *N*(2)-L-alanyl-L-glutamine (Ala-Gln) and glycyl-L-glutamine (Gly-Gln) are used similarly.

Glutamic acid hydrochloride, which releases hydrochloric acid in the stomach, has been used in the symptomatic treatment of achlorhydria or hypochlorhydria in usual oral doses of 250 to 750 mg with meals.

A glutamine-based oral suspension is under investigation for the treatment of oral mucositis.

Antineoplastic toxicity. Vincristine neurotoxicity has been reduced by the use of oral glutamic acid (see Administration Error, p.787).

Oral supplementation with glutamine may also have a role in alleviating the diarrhoea associated with irinotecan (see Effects on the Gastrointestinal System, p.737).

A glutamine-based oral suspension is under investigation for the treatment of oral mucositis associated with cancer chemotherapy (p.640). In breast cancer patients with moderate to severe oral mucositis glutamine reduced both the incidence and severity of the mucositis.[1] A literature review[2] reported variable results with glutamine supplementation for chemotherapy-induced mucositis, but stated that higher doses may be beneficial.

Oral glutamine was found to be of no benefit in alleviating myalgias or arthralgias associated with paclitaxel therapy.[3]

1. Peterson DE, *et al.* Randomized, placebo-controlled trial of Saforis for prevention and treatment of oral mucositis in breast cancer patients receiving anthracycline-based chemotherapy. *Cancer* 2007; **109:** 322–31.
2. Savarese DMF, *et al*. Prevention of chemotherapy and radiation toxicity with glutamine. *Cancer Treat Rev* 2003; **29:** 501–13.
3. Jacobson SD, *et al*. Glutamine does not prevent paclitaxel-associated myalgias and arthralgias. *J Support Oncol* 2003; **1:** 274–8.

Parenteral and enteral nutrition. Evidence that glutamine is involved in the regulation of muscle protein synthesis, maintenance of gut mucosal barrier function, and possibly enhanced immunological response has led to studies of supplementation with glutamine or more stable peptide derivatives in parenteral and enteral nutrition regimens for patients with injury and infection.[1] Although non-essential under normal circumstances, many consider glutamine to be a conditionally essential amino acid in patients with catabolic disease.[2,3]

Supplementation of parenteral nutrition regimens with glutamine has been shown to reduce clinical infection in patients who have undergone bone marrow transplantation[4] or who have suffered multiple trauma.[5] Improved survival has been reported among intensive-care patients given parenteral feeds supplemented with glutamine,[6,7] although a larger study found it difficult to demonstrate benefit.[8] A systematic review,[9] including these studies, inferred that seriously ill patients, with gastrointestinal failure and receiving parenteral nutrition, should receive glutamine supplements for at least 6 days and at a dose of greater than 200 mg/kg daily, in order to derive maximum benefit. Low plasma glutamine concentration upon admission to an intensive-care unit was considered to be an independent risk factor for mortality, and it has been suggested that plasma concentrations be used as an indicator for glutamine supplementation.[10]

In patients undergoing major uncomplicated surgery on the lower gastrointestinal tract, a significantly better postoperative nitrogen balance was achieved in those whose total parenteral nutrition regimen had been supplemented with about 20 g daily of glutamine coupled with alanine (L-alanyl-L-glutamine) (equivalent to about 12 g daily of glutamine) when compared with a control group.[11] Others[12] have shown that supplementation of total parenteral nutrition solutions with a glutamine dipeptide (glycyl-L-glutamine), in quantities equivalent to 230 mg/kg of glutamine daily, prevented the increased intestinal permeability and atrophic changes in the intestinal mucosa associated with unsupplemented solutions. Supplementation of total parenteral nutrition with α-ketoglutarate or a dipeptide, ornithine-α-ketoglutarate, reduced muscle protein depletion in one study,[13] suggesting that this may be a more physiological way of providing glutamine. Although recognising that clinical benefit in terms of infectious complications remained to be established, a review[14] of the use of ornithine-α-ketoglutarate stated that supplementation in the elderly improved clinical outcome in chronic malnutrition, by increasing appetite and body-weight gain and improving healing.

1. Sacks GS. Glutamine supplementation in catabolic patients. *Ann Pharmacother* 1999; **33:** 348–54.
2. Kelly D, Wischmeyer PE. Role of -glutamine in critical illness: new insights. *Curr Opin Clin Nutr Metab Care* 2003; **6:** 217–22.
3. Melis GC, *et al*. Glutamine: recent developments in research on the clinical significance of glutamine. *Curr Opin Clin Nutr Metab Care* 2004; **7:** 59–70.
4. Ziegler TR, *et al*. Clinical and metabolic efficacy of glutamine-supplemented parenteral nutrition after bone marrow transplantation: a randomized, double-blind, controlled study. *Ann Intern Med* 1992; **116:** 821–8.
5. Houdijk APJ, *et al*. Randomised trial of glutamine-enriched enteral nutrition on infectious morbidity in patients with multiple trauma. *Lancet* 1998; **352:** 772–6.
6. Griffiths RD, *et al*. Six-month outcome of critically ill patients given glutamine-supplemented parenteral nutrition. *Nutrition* 1997; **13:** 295–302.
7. Goeters C, *et al*. Parenteral L-alanyl-L-glutamine improves 6-month outcome in critically ill patients. *Crit Care Med* 2002; **30:** 2032–7.
8. Powell-Tuck J, *et al*. A double blind, randomised, controlled trial of glutamine supplementation in parenteral nutrition. *Gut* 1999; **45:** 82–8.
9. Novak F, *et al*. Glutamine supplementation in serious illness: a systematic review of the evidence. *Crit Care Med* 2002; **30:** 2022–9.
10. Wernerman J. Glutamine and acute illness. *Crit Care* 2003; **9:** 279–85.
11. Stehle P, *et al*. Effect of parenteral glutamine peptide supplements on muscle glutamine loss and nitrogen balance after major surgery. *Lancet* 1989; **i:** 231–3.
12. van der Hulst RRWJ, *et al*. Glutamine and the preservation of gut integrity. *Lancet* 1993; **334:** 1363–5.
13. Wernerman J, *et al.* α-Ketoglutarate and postoperative muscle catabolism. *Lancet* 1990; **335:** 701–3.
14. Blonde-Cynober F, *et al*. Use of ornithine α-ketoglutarate in clinical nutrition of elderly patients. *Nutrition* 2003; **19:** 73–5.

Preparations

Proprietary Preparations (details are given in Part 3)

Arg.: Dipeptiven; ***Austria:*** Dipeptiven; Neuroglutamin; ***Chile:*** Dipeptiven; ***Cz.:*** Dipeptiven; ***Denm.:*** Dipeptiven; ***Fin.:*** Dipeptiven; Hypochylin; ***Fr.:*** Dipeptiven; ***Ger.:*** Dipeptamin; Glutamin; Gluti-Agil mono; Pepsaletten N; ***Gr.:*** Dipeptiven; ***Hung.:*** Dipeptiven; ***Indon.:*** Dipeptiven; ***Irl.:*** Adamin-G; ***Ital.:*** Dipeptiven; Glutacerebro†; Glutaven; Memoril†; ***Malaysia:*** Dipeptiven; ***Mex.:*** Dipeptiven; ***Neth.:*** Dipeptiven; ***Norw.:*** Dipeptiven; ***Pol.:*** Dipeptiven; ***Port.:*** Cebrotex†; Dipeptiven; ***Rus.:*** Dipeptiven (Дипептивен); ***Spain:*** Dipeptiven; ***Swed.:*** Dipeptiven; Hypochylin; ***Switz.:*** Dipeptiven; ***Thai.:*** Dipeptiven; ***Turk.:*** Dipeptiven; ***UK:*** Dipeptiven.

Multi-ingredient: ***Arg.:*** Normoprost Compuesto; ***Austral.:*** Aspartatol; Bioglan Digestive Zyme; Liv-Detox†; Prozyme†; ***Austria:*** Aslavital; ***Braz.:*** Taludon†; ***Chile:*** Glutacyl Vitaminado; Hexalectol; ***Fr.:*** Phakan†; Vita-Dermacide; YSE Glutamique; ***Ger.:*** Glutarsin E†; Vitasprint B †; ***Hong Kong:*** Dipeptiven; Esafosfina Glutammica; ***Hung.:*** Glutarsin E; ***Indon.:*** Proseval; Stamino; ***Ital.:*** Acutil Fosforo; Briogen†; Esaglut†; Fosfo Plus; Glutamin Fosforo; Memovit B12; Vitasprint Complex†; Vitasprint†; ***Philipp.:*** Glutaphos; Spasmo-Canulase; ***Port.:*** Cebrotex Forte; Espasmo Canulase; Phakan†; Relavit Fosforo; ***Rus.:*** Eltacin (Элтацин); ***S.Afr.:*** Dipeptiven; Lentogesic; Spasmo-Canulase; ***Spain:*** Agudil; Gastroglutal†; Nucleserina; Tebetane Compuesto; ***Switz.:*** Phakolen†; Spasmo-Canulase; Vitasprint Complex; ***Venez.:*** Glutapak; Glutapak-R.

Glycine *(rINN)*

Acidum Aminoaceticum; Aminoacetic Acid; Aminoättiksyra; Aminoetikkahappo; E640 (glycine or glycine sodium); G; Glicin; Glicina; Glicinas; Glicyna; Gly; Glycin; Glycinum; Glycocoll; Glysiini; Sucre de Gélatine.

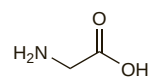
Глицин

$C_2H_5NO_2$ = 75.07.

CAS — 56-40-6.

ATC — B05CX03.

ATC Vet — QB05CX03.



Pharmacopoeias. In *Chin., Eur.* (see p.vii), *Jpn*, and *US.*
Ph. Eur. 6.2 (Glycine). A white or almost white crystalline powder. It exhibits polymorphism. Freely soluble in water; very slightly soluble in alcohol. A 5% solution in water has a pH of 5.9 to 6.4.
USP 31 (Glycine). A white, odourless crystalline powder. Soluble 1 in 4 of water at 25°, 1 in 2.6 at 50°, 1 in 1.9 at 75°, and 1 in 1.5 at 100°; soluble 1 in 1254 of alcohol; very slightly soluble in ether. Its solutions are acid to litmus.

Adverse Effects and Precautions

Systemic absorption of glycine irrigation solutions can lead to disturbances of fluid and electrolyte balance and cardiovascular and pulmonary disorders (see below).