Assessment Points

System	Effect	Assessment by Hx	PE	Test
HEENT	Mucous membrane irritation	Complaints of oral irritation	Oral mucosa exam	
CV	Ischemia, Htn, tachycardia	Complaints of angina, dyspnea, or palpitations	Cardiac exam	ECG ± ECHO
GI	Increased GI motility, diarrhea, abdominal cramping	Changes in bowel movements (i.e., frequency, consistency), abdominal discomfort	Abdominal exam	
ENDO	Hyperglycemia	Fatigue, polydipsia, polyuria, vision changes, weight loss	Visual acuity exam	Blood glucose
OB/GYN	Uterine stimulation, estrogenic effects	Changes in contractions or menstruation	OB exam	Biophysical profile US, LH levels

Key References: Finkel RS, Zarlengo KM: Blue cohosh and perinatal stroke, *N Engl J Med* 351(3):302–303, 2004; Rader JI, Pawar RS: Primary constituents of blue cohosh: quantification in dietary supplements and potential for toxicity, *Anal Bioanal Chem* 405(13):4409–4417, 2013.

Perioperative Implications

Preoperative Concerns
- Reliable self-reporting of use by pts.
- Enhanced hyperglycemia in diabetics.
- Can be associated with coronary vasoconstriction.
- The ASA recommends holding all herbal products 2–3 wk prior to surgery since the half-life of most of these preparations are unknown, allowing for elimination out of the body.

Monitoring
- Use standard ASA monitors.
- Intraop blood glucose levels.

Airway/Maintenance
- No known effects

Preinduction/Induction
- Coronary vasoconstriction

Adjuvant
- May accentuate the response to vasopressors
- May attenuate effectiveness of antihypertensive medications
- Possible drug-drug interactions due to inhibitory effects on hepatic enzymes

Postoperative Period
- Monitor CV status (i.e., BP, pulse) and blood glucose levels.

Carnitine

Renyu Liu | Dajin Sun

Uses
- Treatment of primary carnitine deficiency and deficiency secondary to complications of several inborn errors of metabolism, such as organic acidemia and fatty acid oxidation defects in children and adults, and acquired medical or iatrogenic conditions such as valproate and zidovudine treatment, cirrhosis, chronic renal failure on dialysis, etc.
- Treatment of valproic acid poisoning and/or overdosing and prevention of valproic acid–induced hepatotoxicity.
- Used for ADHD, erectile dysfunction and male infertility, cardiomyopathy, PVD, CHF, chronic cardiac dysrhythmias, senile dementia, metabolic nerve diseases, HIV infection, tuberculosis, myopathies, renal failure–induced anemia, neuropathy, and neuropathic pain, etc. However, additional studies are needed to confirm these potential benefits.
- Experimental data indicated that carnitine might have neuronal protective effects against hypoxia/ischemia and neuronal inflammation. Clinical applications of these finding are unknown.

Perioperative Risks
- Periop risks are related to carnitine deficiency rather than carnitine itself.
- Hypoglycemia, lactic acidosis, and muscle weakness related to carnitine deficiencies and discontinuation of carnitine supplement.
- Case report indicates that pts with carnitine deficiencies may develop symptoms similar to those assoc with propofol infusion syndrome. Periop usage of carnitine as a metabolic supplement might be related to periop outcome.

Worry About
- Individuals with L-carnitine deficiency should continue this medication as scheduled preop to avoid acute hypoglycemia, lactic acidosis, etc. IV carnitine or dextrose-containing solutions may be needed for fasting individuals with L-carnitine deficiencies.

Overview/Pharmacology
- Carnitine (3-hydroxy-4-trimethylamino-butyric acid or β-hydroxy-gamma-N-trimethylamino-butyrate) is a quaternary ammonium compound biosynthesized from the amino acids lysine and methionine.
- Carnitine exists in two stereoisomers: L-carnitine, the biologically active form, and D-carnitine, the biologically inactive form, which may be harmful.
- About 75% of L-carnitine comes from the diet, particularly from red meat and dairy products. Endogenous synthesis combined with high tubular reabsorption is enough to prevent deficiency in healthy people. Thus carnitine deficiency is uncommon in healthy, well-nourished adults.
- Most of the body's carnitine is stored in skeletal muscle, but it is also found in other high-energy-demanding tissues such as those in the myocardium, liver, and adrenal glands. Carnitine is excreted in urine. Thus carnitine and its metabolite may accumulate in pts with renal failure.

Pharmacokinetics
- Formula: $C_7H_{15}NO_3$
- Mol. mass: 161.199 g/mol
- Bioavailability: <10%
- Protein binding: None
- Metabolism: Slightly
- Half life: 15 h
- Excretion: Urine (>95%)

Drug Class/Usual Dose
- Carnitine is available both as a prescription drug and as a food supplement.
- Pregnancy: Category B. Studies in bacteria have found no evidence of mutagenicity. No human data are available. Carnitine occurs naturally in human breast milk.
- Dosing: The usual supplementation dose is 100–300 mg/kg/d. For infants and children, recommended dosage is between 50–100 mg/kg per d in divided doses with a maximum of 3 g/d. IV L-carnitine is used for treatment of lactic acidosis and cardiomyopathy secondary to L-carnitine deficiency. The recommended dosage is a 50 mg/kg bolus injection over 2–3 min followed by an equivalent dosage over the next 24 h (divided every 3-4 h). Subsequent dosages would be based on responses.
- Overdosage: There have been no reports of toxicity from L-carnitine overdosage. Oral doses of 15 g/d have been well tolerated.

Assessment Points

System	Effect	Assessment by Hx	PE	Test
CNS	Seizures (rare)	Oral or IV L-carnitine. Reliable description of a witnessed seizure	Seizure activity Postseizure state Signs of other injuries	Rule out other etiology
GI	N/V, diarrhea	Oral or IV L-carnitine; it is important to differentiate between overdose and deficiency		Blood carnitine level, serum glucose, lactic acid
DERM	Body odor	Oral or intravenous L-carnitine	Odor	

Key References: Odle J, Adams SH, Vockley J: Carnitine. *Adv Nutr* 5:289-290, 2014. Steiber A, Kerner J, Hoppel CL: Carnitine: a nutritional, biosynthetic, and functional perspective, *Mol Aspects Med* 25(5–6):455–473, 2004.

Possible Drug Interactions

- Carnitine has not been thoroughly tested for interactions with other herbs, supplements, drugs, or foods.
- L-carnitine might decrease the need for certain drugs such as glycosides, digoxin, diuretics, beta blockers, calcium channel blockers, hypolipidemia (cholesterol-altering) drugs, and nitroglycerin derivatives.
- L-carnitine might increase the effects of warfarin (Coumadin) and heparin.

Anticipated Problems/Concerns

- None

Chitosan

Joan Spiegel

Uses

- Sustained-release drug carrier (chitosan glutamate)
- Transdermal drug delivery
- Weight-loss agent (poor)
- Decreases cholesterol and triglycerides and increases HDL total cholesterol ratio
- Cleaning petrochemical spills
- Water purification agent
- Hydrogel-based chitosan bandages for hemostasis and antibacterial properties

Risk

- None known

Perioperative Risks

- None known

Worry About

- Theoretical inhibition of absorption of fat-soluble vitamins A, D, E, and K

Overview

- Chitosan is a naturally occurring marine polysaccharide fiber derived from a common byproduct of shellfish processing. (Chitosan is the deacetylated form of chitin, a sugar from the shells of crustaceans.)
- Recently ingenious medical applications have been developed that use chitosan as a pharmaceutical drug carrier (thermogel) effectively encapsulating various anti-inflammatory and chemotherapeutic agents and allowing it to function as a moiety for safe sustained release.

Etiology

- Chitosan is a completely indigestible fiber source with the ability to electrostatically attract and bond with negatively charged dietary lipids, thus prohibiting their absorption.
- The hemostatic activity of chitosan is due to ionic interaction between the positively charged chitosan polymer and the negatively charged cell membrane of the red blood cell. It works irrespective of the presence of fibrin to form a biodegradable plug.

Assessment Points

System	Effect	Test
CV	Improved cholesterol	Lipid profile
HEME	Improved hemostasis	None
GI	Stomach upset, steatorrhea, loss of fat-soluble vitamins	None

Key References: Koide S: Chitin-chitosan properties, benefits and risks, *Nutrition Res* 18:1091–1101, 1998; Ogle OE, Swantek J, Kamoh A: Hemostatic agents, *Dent Clin North Am* 55(3):433–439, 2011.

Perioperative Implications

- None known or studied

Chondroitin Sulfate

Rosemary M.G. Hogg

Uses

- CS has been recommended for use as a nutritional supplement to reduce joint pain and inflammation associated with osteoarthritis.
- CS has been shown to have both anti-inflammatory and antioxidant effects on articular tissue; it modulates the anabolic/catabolic balance of the extracellular matrix.
- CS is commonly used in conjunction with glucosamine to provide an alternative therapeutic option with minimal side effects as compared with traditional treatments such as NSAIDs.
- Studies have demonstrated modest but significant reductions in pain, joint swelling, and effusion with an improvement in functional status after the use of CS, in particular when used in conjunction with glucosamine and with results comparable in efficacy to celecoxib.
- Many such studies, however, are small or of short duration and may be unable to fully assess the long-term effects of CS on joint remodeling.
- The use of exogenous glycosaminoglycans such as chondroitin in novel targeted chemotherapeutic interventions for the treatment of malignancy is in an early phase. Additionally, intravesical CS may be used to reduce bladder pain from interstitial cystitis.

Perioperative Risks

- No specific anesthetic interactions or complications have been identified from the use of CS.
- Use should be avoided in pts with shellfish allergy.
- Hepatotoxicity has been recognized in a number of case reports in pts taking combined G-CS supplements

Worry About

- Markedly similar in structure to heparin; should be avoided in pts at risk of heparin-induced thrombocytopenia and other heparin sensitivities. In addition may cause derangement in INR results in pts concomitantly taking warfarin (Coumadin).
- Worsening of previously well-controlled asthma has been demonstrated with the use of CS.

Overview/Pharmacology

- Chondroitin is a sulfated glycosaminoglycan found in the proteoglycans of the extracellular matrix of many connective tissues including intraarticular cartilage.
- In vitro studies have demonstrated an inhibition of interleukin-1 and metalloproteinases in synovial tissue while increasing type II collagen production in articular chondrocytes. The highly charged sulfate groups found in CS have been shown to generate electrostatic forces, which provide resistance to cartilaginous compression.
- Bioavailability varies from 10% to 20% after oral administration. CS exhibits first-order kinetics at single doses of up to 3000 mg and is not metabolized by cytochrome P450, thus minimizing interactions with other medications.
- Clinical effects are demonstrated within 4 wk in most pts and have been shown to persist for up to 3 mo after discontinuation of treatment.

Drug Class/Usual Dose

- Classified as a nutritional supplement.
- May be manufactured by the enzymatic hydrolysis of a variety of animal sources including shark fins, porcine muzzles, bovine trachea, and chicken bones. Nonanimal chondroitin had been developed from microbial fermentation but is not currently commercially available.