

**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.

- Usual recommended dose is 200–400 mg 2–3 times daily or 1000–1200 mg as a single daily dose. Higher doses have been used in clinical trials with no evidence of increased efficacy.
- Glucosamine 1500 mg is commonly combined with chondroitin in commercial preparations taken either once daily or in three divided doses. The optimal dose of CS, alone or in conjunction with glucosamine, is unclear from current literature.

### Assessment Points

System	Drug Effect	Assessment by Hx	PE	Test
MS	Anti-inflammatory, reduction in joint degeneration	Assessment of pain and functionality scores	Joint tenderness and mobility	Radiologic loss of joint space
GI	Nausea or diarrhea (low incidence)	Subjective reporting of GI upset	Abdominal bloating	
CV	Arrhythmia, peripheral edema	Description of arrhythmia	Irregular pulse	ECG
DERM	Hair loss, periorbital swelling			

**Key References:** Singh JA, Noorbaloochi S, MacDonald R, et al.: Chondroitin for osteoarthritis, *Cochrane Database Syst Rev* 1:CD005614, 2015; Abe A, Kaye AD, Gritsenko K, et al.: Perioperative analgesia and the effects of dietary supplements, *Best Pract Res Clin Anaesthesiol* 28(2):183–189, 2014.

### Anticipated Problems/Concerns

- Caution with anticoagulant medications

## Chromium

Lee A. Fleisher

### Uses

- Body building (ineffective)
- May aid in glycemic control of type II DM and gestational DM
- Hyperlipidemia
- Hypoglycemia (reactive)
- Obesity

### Perioperative Risks

- Risks minimal
- Chronic ingestion associated in one case with thrombocytopenia, hepatic dysfunction, renal dysfunction

### Worry About

- Nephrotoxicity

### Overview

- A trace mineral
- Improves glucose tolerance in type II DM and gestational DM (in some studies)
- Shown to increase insulin sensitivity and decrease serum triglycerides
- Shown to alleviate symptoms of reactive hypoglycemia
- Popular as weight-loss and body-building supplement, but effect not supported in clinical trials

### Drug Class/Mechanism of Action/Usual Dose

- Hypothesis: In normal functioning, it increases circulating insulin, resulting in binding of chromium to peripheral insulin-sensitive tissue; increases insulin receptor number; and activates insulin receptor kinase.
- Usual dosage recommended: 50–200 µg/d.
- Available orally or IV
- Taken as supplement of 200–1000 µg/d
- Mixed results in randomized clinical tests

### Assessment Points

System	Effect	Test
RENAL	Nephrotoxicity	Cr
ENDO	Insulin sensitivity	Glucose

**Key References:** Hummel M, Standl E, Schnell O: Chromium in metabolic and cardiovascular disease, *Horm Metab Res* 39(10):743–751, 2007; Suksomboon N, Poolsup N, Yuwanakorn A: Systematic review and meta-analysis of the efficacy and safety of chromium supplementation in diabetes, *J Clin Pharm Ther* 39(3):292–306, 2014.

### Perioperative Implications

- No known interaction

## Cranberry

Christopher J. Cullom | Alan David Kaye

### Uses

- Many cranberry juice consumers are aware of a beneficial link between cranberry juice and the prevention of UTIs.
- High in polyphenol activity.
- Potentially beneficial for prevention of upper GI ulcers, reducing the risks of CV disease, and improving oral hygiene.
- Native Americans and early American sailors used cranberries for treating wounds and blood poisoning,

urinary illnesses, diarrhea, DM, and as an antiscorbutic agent.

### Perioperative Risks

- Cytochrome P-450 inhibitor based on in vitro evidence, specifically CYP3A4 and CYP2C9.
- Based on in vivo studies, interaction with warfarin, midazolam, fluconazole, or drugs dependent on CYP enzymes appear unlikely, unless cranberry is consumed at large quantities or long durations, yet not excluded completely.

- There is some evidence for alteration in INR with administration of cranberry that warrants consideration.

### Worry About

- Theoretical risk of oxalate urinary stone formation (if large volumes consumed daily).
- Consider potential interaction with anticoagulation effects of warfarin or other drugs dependent on CYP enzymes.