

Herbal Medicines and Perioperative Care

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THERE IS ENORMOUS PUBLIC ENTHUSIASM for herbal medications. Two recent surveys have found widespread use among the presurgical population.^{1,2} Morbidity and mortality associated with herbal medications may be more likely in the perioperative period because of the polypharmacy and physiological alterations that occur.³ Such complications include myocardial infarction, stroke, bleeding, inadequate oral anticoagulation, prolonged or inadequate anesthesia, organ transplant rejection, and interference with medications indispensable for patient care.

Of the herbal medications that clinicians are likely to encounter, we have identified 8 of the herbs that potentially pose the greatest impact to the care of patients undergoing surgery. These herbs account for more than 50% of all single herb preparations among the 1500 to 1800 herbal medications sold in the United States.^{4,5} Nonherbal dietary supplements, such as vitamins, minerals, amino acids, and hormones, are beyond the scope of this review. Some of these nonherbal dietary supplements that patients undergoing surgery are most likely to take, such as glucosamine and chondroitin for osteoarthritis,^{6,7} appear to be safe. Limited information is available, however, on the use of these supplements in the presurgical population.

In this article, we consider safety and US regulatory issues for herbal medications; review the literature on the identified 8 commonly used herbal

Context Widespread use of herbal medications among the presurgical population may have a negative impact on perioperative patient care.

Objectives To review the literature on commonly used herbal medications in the context of the perioperative period and provide rational strategies for managing their preoperative use.

Data Sources The MEDLINE and Cochrane Collaboration databases were searched for articles published between January 1966 and December 2000 using the search terms *herbal medicine*, *phytotherapy*, and *alternative medicine* and the names of the 16 most commonly used herbal medications. Additional data sources were obtained from manual searches of recent journal articles and textbooks.

Study Selection We selected studies, case reports, and reviews addressing the safety and pharmacology of 8 commonly used herbal medications for which safety information pertinent to the perioperative period was available.

Data Extraction We extracted safety, pharmacodynamic, and pharmacokinetic information from the selected literature and reached consensus about any discrepancies.

Data Synthesis Echinacea, ephedra, garlic, ginkgo, ginseng, kava, St John's wort, and valerian are commonly used herbal medications that may pose a concern during the perioperative period. Complications can arise from these herbs' direct and pharmacodynamic or pharmacokinetic effects. Direct effects include bleeding from garlic, ginkgo, and ginseng; cardiovascular instability from ephedra; and hypoglycemia from ginseng. Pharmacodynamic herb-drug interactions include potentiation of the sedative effect of anesthetics by kava and valerian. Pharmacokinetic herb-drug interactions include increased metabolism of many drugs used in the perioperative period by St John's wort.

Conclusions During the preoperative evaluation, physicians should explicitly elicit and document a history of herbal medication use. Physicians should be familiar with the potential perioperative effects of the commonly used herbal medications to prevent, recognize, and treat potentially serious problems associated with their use and discontinuation.

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medications as they affect perioperative care; and propose rational strategies for managing the preoperative use of these agents. The prevention, recognition, and treatment of complications begin with explicitly eliciting and documenting a history of herbal medicine use. Familiarity with the scientific literature on herbal medications is necessary because the current US regulatory mechanism for commercial herbal preparations sold in the United States does not necessarily protect the population against unpredictable or un-

desirable effects. Our goal is to provide a framework for physicians practicing in the contemporary environment where widespread herbal medicine use occurs.

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Preoperative Use of Herbal Medications

The most extensive surveys on the use of complementary and alternative medicine use in the United States revealed that approximately 12% of the population used herbal medications in 1997,^{8,9} representing a 380% increase from 1990. Patients undergoing surgery appear to use herbal medications significantly more frequently than the general population. For instance, Tsen et al¹ reported that 22% of patients who underwent evaluation in their preoperative clinic took herbal medications. Also, Kaye et al² found that 32% of patients in an ambulatory surgery setting admitted to using herbal medications.

More than 70% of the patients in the study by Kaye et al² failed to disclose their herbal medicine use during routine preoperative assessment. Explanations for this lack of disclosure include patient-held beliefs that physicians are not knowledgeable about herbal medications or are prejudiced against their use.¹⁰ Some patients may fear admitting to their physicians their use of unconventional therapies.¹¹ Others may neglect to mention that they are taking herbal medications when they are using them for reasons perceived as unrelated to their medical care.¹² Still other patients would not consider these substances to be medications, and they may neglect to report them during routine preoperative questioning. For these reasons, it is necessary for physicians to specifically seek out a history of herbal medicine use in presurgical patients.

Regulation and Safety of Herbal Medications

Herbal medications were classified as dietary supplements in the Dietary Supplement Health and Education Act of 1994.¹³ This law exempts herbal medications from the safety and efficacy requirements and regulations that prescription and over-the-counter drugs must fulfill (ie, preclinical animal studies, premarketing controlled clinical trials, or postmarketing surveillance). The burden is shifted to the US Food and

Drug Administration to show that a product is unsafe before it can be removed from the market.¹⁴ In addition, the inability to patent herbal medications discourages the manufacturers from performing the costly research required for conventional drugs.¹⁵

The current US regulatory mechanism provides little assurance that commercial herbal preparations have predictable pharmacological effects and that product labels provide accurate information. The potency of herbal medications can vary from manufacturer to manufacturer and from lot to lot within a manufacturer.¹⁶⁻¹⁸ Plants may be misidentified or deliberately replaced with cheaper or more readily available alternatives.¹⁹⁻²² Moreover, herbal medications, especially those of Eastern origin, can be adulterated with heavy metals, pesticides, and even conventional drugs.²³⁻²⁵ Some herbal manufacturers have tried to standardize their herbal products to fixed concentrations of selected chemical constituents.²⁶ The benefit of this effort is uncertain, however, because many products achieve their effects through the combined or synergistic actions of different compounds.²⁷ Even when advertised and labeled as standardized, potency can still vary considerably.²⁸

Because there is no mechanism for postmarketing surveillance, the incidence and exact nature of adverse events is unknown. Empirical evidence gained from a long history of herbal medication use supports the notion that most are safe.²⁹ Nevertheless, some of these medications have been associated with serious harm.^{30,31} More than 5000 suspected herb-related adverse reactions were reported to the World Health Organization before 1996.³² Between January 1993 and October 1998, 2621 adverse events, including 101 deaths, associated with dietary supplements were reported to the US Food and Drug Administration.³³ However, adverse events are underreported because there is no central mechanism for mandatory reporting as there is for conventional medications. Other factors that contribute to underreporting are that physi-

cians do not always recognize adverse events associated with herbal medication use³⁴ and that patients are reluctant to report and seek treatment for the adverse reactions.³⁵ This reluctance has been attributed to the belief that physicians cannot be consulted in the use of unconventional therapies and that patients are unwilling to admit the use of these remedies to physicians. The deficiencies in monitoring adverse events for herbal medicines mean that safety profiles are usually limited to animal studies, case reports, or predictions derived from known pharmacological results.

METHODS

We identified the most commonly used herbal medications by 1999 sales data and surveys in the literature.^{1,2,4} The MEDLINE and Cochrane Collaboration databases were searched for articles published between January 1966 and December 2000, using the search terms *herbal medicine*, *phytotherapy*, *alternative medicine*, and the names of the most commonly used herbal medications (*aloe*, *bilberry*, *cascara*, *cranberry*, *echinacea*, *ephedra*, *garlic*, *ginseng*, *ginkgo*, *goldenseal*, *kava*, *milk thistle*, *saw palmetto*, *soy*, *St John's wort*, and *valerian*). Additional sources included manual searches of textbooks and recent surgery, anesthesiology, and alternative medicine journals.

Although we found no randomized controlled trials that evaluated the effects of prior herbal medicine use on the perioperative period, we identified, based on our judgments, those studies, case reports, and reviews addressing the safety, pharmacokinetics, and pharmacodynamics of the commonly used herbs that may affect the care of these patients.

RESULTS

Eight Commonly Used Herbal Medications

Despite many uncertainties in commercial preparations, herbal medications adhere to modern pharmacological principles. A single herbal medication may adversely affect the patient during the perioperative period

through a number of different mechanisms. These effects are direct (intrinsic pharmacological effects), pharmacodynamic interactions (alteration of the action of conventional drugs at effector sites), and pharmacokinetic interactions (alteration of the absorption, distribution, metabolism, and elimination of conventional drugs).

Echinacea

Three species of echinacea, a member of the daisy family, are used for the prophylaxis and treatment of viral, bacterial, and fungal infections, particularly those of the upper respiratory tract.³⁶ Pharmacological activity cannot be attributed to a single compound, although the lipophilic fraction, which contains the alkylamides, polyacetylenes, and essential oils, appears to be more active than the hydrophilic fraction.

Preclinical studies of echinacea have shown a number of immunostimulatory effects.³⁷⁻³⁹ While no studies specifically addressing interactions between echinacea and immunosuppressive drugs have been conducted, expert opinion generally warns against the concomitant use of echinacea and these drugs because of the probability of diminished effectiveness.^{37,40,41} Therefore, patients who may require perioperative immunosuppression, such as those awaiting organ transplantation, should be counseled to avoid taking echinacea. In contrast to the immunostimulatory effects with short-term use, long-term use of longer than 8 weeks is accompanied by the potential for immunosuppression⁴¹ and a theoretically increased risk of certain postsurgical complications, such as poor wound healing and opportunistic infections.

Echinacea also has been associated with allergic reactions, including 1 reported case of anaphylaxis.⁴² Thus, echinacea should be used with caution in patients with asthma, atopy, or allergic rhinitis. In addition, concerns of potential hepatotoxicity have been raised, although documented cases are lacking.¹⁷ Because of the absence of definitive information, patients with preex-

isting liver dysfunction should be cautious when taking echinacea. Furthermore, since the pharmacokinetics of echinacea have not been studied, it may be prudent for patients to discontinue taking echinacea as far in advance of surgery as possible when compromises in hepatic function or blood flow are anticipated. These situations often occur secondary to concomitant anesthetic drug administration or as an effect of surgical manipulation.

Ephedra

Ephedra, known as ma huang in Chinese medicine, is a shrub native to central Asia. It is used to promote weight loss, increase energy, and treat respiratory tract conditions, such as asthma and bronchitis. Ephedra contains alkaloids, including ephedrine, pseudoephedrine, norephedrine, methylephedrine, and norpseudoephedrine.⁴³ Commercial preparations may be standardized to a fixed ephedrine content.

Ephedra causes dose-dependent increases in blood pressure and heart rate. Ephedrine, the predominant active compound, is a noncatecholamine sympathomimetic agent that exhibits α_1 , β_1 , and β_2 activity by acting directly at adrenergic receptors and by indirectly releasing endogenous norepinephrine. These sympathomimetic effects have been associated with more than 1070 reported adverse events, including fatal cardiac and central nervous system complications.⁴⁴

Although ephedrine is widely used as first-line therapy for intraoperative hypotension and bradycardia, the unsupervised preoperative use of ephedra raises certain concerns. Vasoconstriction and, in some cases, vasospasm of coronary and cerebral arteries may cause myocardial infarction and thrombotic stroke.⁴⁵ Patients who have consumed ephedra and are later anesthetized with halothane may be at risk of developing intraoperative ventricular arrhythmias because halothane sensitizes the myocardium to ventricular arrhythmias caused by exogenous catecholamines.⁴⁶ Ephedra also may affect cardiovascular function by causing

hypersensitivity myocarditis, characterized by cardiomyopathy with myocardial lymphocyte and eosinophil infiltration.⁴⁷ Long-term use results in tachyphylaxis from depletion of endogenous catecholamine stores and may contribute to perioperative hemodynamic instability. In these situations, direct-acting sympathomimetic agents may be preferred as first-line therapy for intraoperative hypotension and bradycardia. Concomitant use of ephedra and monoamine oxidase inhibitors can result in life-threatening hyperpyrexia, hypertension, and coma. Finally, heavy use of ephedra has been documented as a very rare cause of radiolucent kidney stones.^{48,49}

The pharmacokinetics of ephedrine have been studied in humans.^{50,51} Ephedrine has an elimination half-life of 5.2 hours with 70% to 80% of the compound excreted unchanged in urine. Based on the pharmacokinetic data and the known cardiovascular risks of ephedra, including myocardial infarction, stroke, and cardiovascular collapse from catecholamine depletion, patients taking this herb should discontinue use at least 24 hours prior to surgery.

Garlic

Garlic is one of the most extensively researched medicinal plants. It has the potential to modify the risk of developing atherosclerosis by reducing blood pressure and thrombus formation and lowering serum lipid and cholesterol levels.⁵² These effects are primarily attributed to the sulfur-containing compounds, particularly allicin and its transformation products. Commercial garlic preparations may be standardized to a fixed alliin and allicin content.

Garlic inhibits platelet aggregation in a dose-dependent fashion. The effect of 1 of its constituents, ajoene, appears to be irreversible and may potentiate the effect of other platelet inhibitors, such as prostacyclin, forskolin, indomethacin, and dipyridamole.^{53,54} Although these effects have not been consistently demonstrated in volunteers, there

is one case in the literature of an octogenarian who developed a spontaneous epidural hematoma that was attributed to heavy use of garlic.⁵⁵ In addition to concerns about bleeding, garlic has the potential to lower blood pressure. In laboratory animals, allicin decreased systemic and pulmonary vascular resistance⁵⁶ and lowered blood pressure.⁵⁷ In humans, however, the antihypertensive effect of garlic is marginal.⁵⁸

Although there are insufficient pharmacokinetic data of the constituents of garlic, the potential for irreversible inhibition of platelet function may warrant patients to discontinue use of garlic at least 7 days prior to surgery, especially if postoperative bleeding is a particular concern or other platelet inhibitors are given.

Ginkgo

Ginkgo is derived from the leaf of *Ginkgo biloba*. It has been used for cognitive disorders, peripheral vascular disease, age-related macular degeneration, vertigo, tinnitus, erectile dysfunction, and altitude sickness. Studies suggest that ginkgo may stabilize or improve cognitive performance in patients with Alzheimer disease and multi-infarct dementia.^{59,60} The compounds believed to be responsible for its pharmacological effects are the terpenoids and flavonoids. The 2 ginkgo extracts used in clinical trials are standardized to ginkgo-flavone glycosides and terpenoids.

Ginkgo appears to alter vasoregulation,⁶¹ act as an antioxidant,⁶² modulate neurotransmitter and receptor activity,⁶³ and inhibit platelet-activating factor.⁶⁴ Of these effects, the inhibition of platelet-activating factor raises the greatest concern for the perioperative period since platelet function may be altered. Clinical trials with small numbers of patients have not demonstrated complications from bleeding, but 4 cases of spontaneous intracranial bleeding,⁶⁵⁻⁶⁸ 1 case of spontaneous hyphema,⁶⁹ and 1 case of postoperative bleeding following laparoscopic cholecystectomy⁷⁰ have been attributed to ginkgo use.

Terpenoids are highly bioavailable when administered orally. Glucuronidation appears to be part of the metabolism of the flavonoids.⁷¹ The elimination half-lives of the terpenoids after oral administration are between 3 and 10 hours.⁷² Based on the pharmacokinetic data and the risk of bleeding, particularly in the surgical population, patients should discontinue taking ginkgo at least 36 hours prior to surgery.

Ginseng

Among the several species used for pharmacologic effects, Asian ginseng and American ginseng are the most commonly described. Ginseng has been labeled as an "adaptogen," since it reputedly protects the body against stress and restores homeostasis.⁷³ Most pharmacological actions are attributed to the ginsenosides that belong to a group of compounds known as *steroidal saponins*. Commercially available ginseng preparations may be standardized to ginsenoside content.

Ginseng has a broad but incompletely understood pharmacological profile because of the many heterogeneous and sometimes opposing effects of different ginsenosides.⁷⁴ The underlying mechanism appears to be similar to that classically described for steroid hormones. A potential therapeutic use for this herb has to do with its ability to lower postprandial blood glucose in both patients with type 2 diabetes mellitus and without diabetes,⁷⁵ but this effect may create unintended hypoglycemia, particularly in patients who have fasted before surgery. There is a concern about the effect of ginseng on coagulation pathways. Ginsenosides inhibit platelet aggregation in vitro^{76,77} and in laboratory rats, prolong both coagulation time of thrombin and activated partial thromboplastin.⁷⁸ One early study suggests that the antiplatelet activity of panaxynol, a constituent of ginseng, may be irreversible in humans.⁷⁹ These findings await further confirmation. Although ginseng may inhibit the coagulation cascade, ginseng use was associated with a significant decrease in warfarin anticoagulation in 1 reported case.⁸⁰

The pharmacokinetics of ginsenosides Rg₁, Re, and Rb₂ have been investigated in rabbits, with elimination half-lives between 0.8 and 7.4 hours.⁸¹ These data suggest that patients should discontinue ginseng use at least 24 hours prior to surgery. However, because platelet inhibition caused by ginseng may be irreversible, it is probably prudent to recommend that patients discontinue ginseng use at least 7 days prior to surgery.

Kava

Kava is derived from the dried root of the pepper plant *Piper methysticum*. Kava has gained widespread popularity as an anxiolytic and sedative. Results from clinical trials suggest that kava has a therapeutic potential in the symptomatic treatment of anxiety.⁸² The kavalactones appear to be the source of the pharmacological activity of kava.⁸³

Because of its psychomotor effects, kava was one of the first herbal medications expected to interact with anesthetics. The kavalactones have dose-dependent effects on the central nervous system, including antiepileptic,⁸⁴ neuroprotective,⁸⁵ and local anesthetic properties.⁸⁴ Kava may act as a sedative-hypnotic by potentiating γ -aminobutyric acid (GABA) inhibitory neurotransmission. The kavalactones increased barbiturate-induced sleep time in laboratory animals.⁸⁶ This effect may explain the mechanism underlying the report of a case of coma attributed to an alprazolam-kava interaction.⁸⁷ Although kava has abuse potential, whether long-term use can result in addiction, tolerance, and acute withdrawal after abstinence has not been satisfactorily investigated. With heavy use, kava produces a condition called *kava dermatopathy*, characterized by reversible scaly cutaneous eruptions.⁸⁸

Peak plasma levels occur 1.8 hours after an oral dose, and the elimination half-life of kavalactones is 9 hours.⁸³ Unchanged kavalactones and their metabolites are eliminated through urine and feces.⁸⁹ The pharmacokinetic data and possibility for the potentiation of the sedative effects of anesthetics sug-

gest that patients taking kava should discontinue use at least 24 hours prior to surgery.

St John's Wort

St John's wort is the common name for *Hypericum perforatum*. A number of clinical trials have reported efficacy in the short-term treatment of mild-to-moderate depression.⁹⁰ However, a recent multicenter clinical trial concluded that St John's wort is not effective in the treatment of major depression.⁹¹ The compounds believed to be responsible for pharmacological activity are hypericin and hyperforin.⁹² Commercial preparations are often standardized to a fixed hypericin content of 0.3%.

St John's wort exerts its effects by inhibiting serotonin, norepinephrine, and dopamine reuptake by neurons.^{93,94} Concomitant use of this herb with or without serotonin-reuptake inhibitors may create a syndrome of central serotonin excess.^{95,96} Although early in vitro data implicated monoamine oxidase inhibition as a possible mechanism of action,⁹⁷ a number of further investigations have demonstrated that monoamine oxidase inhibition is insignificant in vivo.^{98,99}

The use of St John's wort can significantly increase the metabolism of many concomitantly administered drugs, some of which are vital to the perioperative care of certain patients. For example, the cytochrome isoform P450 3A4 is induced, approximately doubling its metabolic activity.^{100,101} Interactions with substrates of the P450 3A4 isoform, including indinavir sulfate,¹⁰² ethinyl estradiol,¹⁰³ and cyclosporin, have been documented. In 1 series of 45 organ transplant recipients, St John's wort was associated with a mean decrease of 49% in blood cyclosporine levels.¹⁰⁴ Another study reported 2 cases of acute heart transplant rejection associated with this particular pharmacokinetic interaction.¹⁰⁵ Other P450 3A4 substrates commonly used in the perioperative period include alfentanil, midazolam hydrochloride, lidocaine, calcium channel blockers, and serotonin receptor

antagonists. In addition to the P450 3A4 isoform, the cytochrome isoform P450 2C9 also may be induced. In 7 reported cases, the anticoagulant effect of warfarin, a substrate of the P450 2C9 isoform, was reduced.¹⁰³ Other P450 2C9 substrates include the nonsteroidal anti-inflammatory drugs. Furthermore, the enzyme induction caused by St John's wort may be more pronounced when other enzyme inducers, which could include other herbal medications, are taken concomitantly. St John's wort also affects digoxin pharmacokinetics, possibly by inducing the P-glycoprotein transporter.¹⁰⁶

In humans, the single-dose and steady-state pharmacokinetics of hypericin, pseudohypericin, and hyperforin have been determined.^{107,108} After oral administration, peak plasma levels of hypericin and hyperforin were obtained in 6.0 and 3.5 hours, and their median elimination half-lives of were 43.1 and 9.0 hours, respectively. The long half-life and alterations in the metabolism of many drugs make concomitant use of St John's wort a particular risk in the perioperative setting. The pharmacokinetic data suggest that patients taking this herbal medication should discontinue use at least 5 days prior to surgery. This discontinuation is especially important for patients waiting for organ transplantation or in those who may require oral anticoagulation postoperatively; thus, these patients should be counseled to avoid taking St John's wort postoperatively.

Valerian

Valerian is an herb native to the temperate areas of the Americas, Europe, and Asia. It is used as a sedative, particularly in the treatment of insomnia, and virtually all herbal sleep aids contain valerian.¹⁰⁹ Valerian contains many compounds acting synergistically, but the sesquiterpenes are the primary source of the pharmacological effects of valerian. Commercially available preparations may be standardized to valerenic acid.

Valerian produces dose-dependent sedation and hypnosis.¹¹⁰ These effects ap-

pear to be mediated through modulation of GABA neurotransmission and receptor function.^{111,112} In experimental animals, valerian increases barbiturate-induced sleep time.¹¹³ In 1 patient, valerian withdrawal appeared to mimic an acute benzodiazepine withdrawal syndrome after the patient presented with delirium and cardiac complications following surgery and the patient's symptoms were attenuated by benzodiazepine administration.¹¹⁴ Based on these findings, valerian should be expected to potentiate the sedative effects of anesthetics and adjuvants, such as midazolam, that act at the GABA receptor.

The pharmacokinetics of the constituents of valerian have not been studied, although their effects are thought to be short-lived. Caution should be taken with abrupt discontinuation of use in patients who may be physically dependent on valerian because of the risk of benzodiazepine-like withdrawal. In these individuals, with close medical supervision, it may be prudent to taper the dose of valerian during several weeks before surgery. If this is not feasible, physicians can advise patients to continue taking valerian up until the day of surgery. Based on the mechanism of action and a reported case of efficacy,¹¹⁴ benzodiazepines can be used to treat withdrawal symptoms should they develop during the postoperative period.

COMMENT

Because most patients may not volunteer that they are taking herbal medications in the preoperative evaluation,² physicians should specifically elicit and document a history of herbal medication use. Obtaining such a history may be difficult. Written questionnaires for information on herbal medication use have not shown to be beneficial in identifying patients taking these remedies, since half of patients who use alternate therapies fail to report this information during an evaluation unless they are questioned in person.¹¹⁵ An oral history, however, also has been shown to be inadequate. Unless this information is directly so-

licited, patients may not be forthcoming. Even when a history of herbal medication use is obtained, 1 of 5 patients is unable to properly identify the preparation they are taking.¹¹⁶ Therefore, patients should be asked to bring their herbal medications and other dietary supplements with them to their preoperative evaluation.

Patients who use herbal medications may be more likely than those who do not to avoid seeking conventional diagnosis and therapy.¹¹⁷ Hence, a history of herbal medicine use should prompt physicians to suspect the presence of undiagnosed disorders causing symptoms that may lead to self-medication using herbal remedies. These recommendations also apply to pediatric patients be-

cause caretakers may treat children with herbal medications without medical supervision.¹¹⁸ In 1 survey, 1 in 6 parents reported giving dietary supplements to their children.¹⁰

Although the American Society of Anesthesiologists has no official standards or guidelines on the preoperative use of herbal medications, public and professional educational information released by this organization suggest that patients discontinue their herbal medications at least 2 to 3 weeks before surgery.^{119,120} Our review of the literature favors a more targeted approach. Pharmacokinetic data on selected active constituents indicate that some herbal medications are eliminated quickly and may be discontinued closer to the time of sur-

gery. Tailoring recommendations for preoperative discontinuation of herbal medications may be necessary since evaluating patients 2 to 3 weeks before elective surgery may be impossible in practice. Moreover, some patients require nonelective surgery or are non-compliant with instructions to discontinue herbal medications preoperatively. These factors and the high frequency of herbal medicine use may mean that many patients will take herbal medications until the time of surgery. Therefore, clinicians should be familiar with commonly used herbal medications to recognize and treat complications that may arise. TABLE 1 summarizes the clinically important effects, perioperative concerns, and recommendations for dis-

Table 1. Clinically Important Effects and Perioperative Concerns of 8 Herbal Medicines and Recommendations for Discontinuation of Use Before Surgery*

Herb: Common Name(s)	Relevant Pharmacological Effects	Perioperative Concerns	Preoperative Discontinuation
Echinacea: purple coneflower root	Activation of cell-mediated immunity	Allergic reactions; decreased effectiveness of immunosuppressants; potential for immunosuppression with long-term use	No data
Ephedra: ma huang	Increased heart rate and blood pressure through direct and indirect sympathomimetic effects	Risk of myocardial ischemia and stroke from tachycardia and hypertension; ventricular arrhythmias with halothane; long-term use depletes endogenous catecholamines and may cause intraoperative hemodynamic instability; life-threatening interaction with monoamine oxidase inhibitors	At least 24 hours before surgery
Garlic: ajo	Inhibition of platelet aggregation (may be irreversible); increased fibrinolysis; equivocal antihypertensive activity	Potential to increase risk of bleeding, especially when combined with other medications that inhibit platelet aggregation	At least 7 days before surgery
Ginkgo: duck foot tree, maidenhair tree, silver apricot	Inhibition of platelet-activating factor	Potential to increase risk of bleeding, especially when combined with other medications that inhibit platelet aggregation	At least 36 hours before surgery
Ginseng: American ginseng, Asian ginseng, Chinese ginseng, Korean ginseng	Lowers blood glucose; inhibition of platelet aggregation (may be irreversible); increased PT-PTT in animals; many other diverse effects	Hypoglycemia; potential to increase risk of bleeding; potential to decrease anticoagulation effect of warfarin	At least 7 days before surgery
Kava: awa, intoxicating pepper, kawa	Sedation, anxiolysis	Potential to increase sedative effect of anesthetics; potential for addiction, tolerance, and withdrawal after abstinence unstudied	At least 24 hours before surgery
St John's wort: amber, goat weed, hardhay, Hypericum, klamatheweed	Inhibition of neurotransmitter reuptake, monoamine oxidase inhibition is unlikely	Induction of cytochrome P450 enzymes, affecting cyclosporine, warfarin, steroids, protease inhibitors, and possibly benzodiazepines, calcium channel blockers, and many other drugs; decreased serum digoxin levels	At least 5 days before surgery
Valerian: all heal, garden heliotrope, vandal root	Sedation	Potential to increase sedative effect of anesthetics; benzodiazepine-like acute withdrawal; potential to increase anesthetic requirements with long-term use	No data

*PT-PTT indicates prothrombin time-partial thromboplastin time.

Table 2. Herbal Medicine and Other Dietary Supplement–Related Sites on the World Wide Web

Organization	Web Address	Site Information
Center for Food Safety and Applied Nutrition, Food and Drug Administration	http://vm.cfsan.fda.gov/~dms/supplmnt.html	Clinicians should use this site to report adverse events associated with herbal medicines and other dietary supplements. Sections also contain safety, industry, and regulatory information.
National Center for Complementary and Alternative Medicine, National Institutes of Health	http://nccam.nih.gov	This site contains factsheets about alternative therapies, consensus reports, and databases.
Agricultural Research Service, United States Department of Agriculture	http://www.ars-grin.gov/duke	The site contains an extensive phytochemical database with search capabilities.
Quackwatch	http://www.quackwatch.com	Although this site addresses all aspects of health care, there is a considerable amount of information covering complementary and herbal therapies.
National Council Against Health Fraud	http://www.ncahf.org	This site focuses on health fraud with a position paper on over-the-counter herbal remedies.
HerbMed	http://www.herbmed.org	This site contains information on more than 120 herbal medications, with evidence for activity, warnings, preparations, mixtures, and mechanisms of action. There are short summaries of important research publications with MEDLINE links.
ConsumerLab	http://www.consumerlab.com	This site is maintained by a corporation that conducts independent laboratory investigations of dietary supplements and other health products.

continuation of the 8 herbal medications before surgery.

Clinicians also should recognize that discontinuation of all herbal medications before surgery may not free a patient from risks related to their use. Since withdrawal of conventional medications is associated with increased morbidity and mortality after surgery, it is conceivable that withdrawal of herbal medications may be similarly detrimental.¹²¹ In patients with alcoholism, preoperative abstinence of alcohol use may result in poorer postoperative outcome than continued preoperative drinking.¹²² The danger of abstinence after long-term use may be similar with herbal medications, such as valerian, which have the potential for producing acute withdrawal after long-term use.

Because the herbal medicine field is rapidly evolving, sources for reliable and updated information are important in helping physicians stay abreast of new discoveries about the effects of herbal medications and other dietary supplements. TABLE 2 lists several resources that are available on the World Wide Web as clinical aides.

In summary, the task of caring perioperatively for patients who use herbal medications is an evolving challenge. The limited evidence-based information about the safety and efficacy of

herbal medications, the absence of a standard regulatory mechanism for herbal medicine approval and surveillance, and improper patient assumptions about herbal medications represent important medical issues. Although there has been initiation of herbal medicine into medical school curricula at several institutions many practicing physicians remain unaware of potential perioperative complications of herbal medication use. Physicians should be familiar with all medications, whether conventional or herbal, their patients are taking. This information is necessary to prevent, recognize, and treat potentially serious problems associated with herbal medications, taken alone or in conjunction with conventional medications.

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The shrewd guess, the fertile hypothesis, the courageous leap to a tentative conclusion—these are the most valuable coin of the thinker at work.

—Jerome Seymour Bruner (1915-)