

REVIEW

Examining the evidence for the use of vitamin C in the prophylaxis and treatment of the common cold

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Abstract

Purpose: To present a critical evaluation of the current evidence concerning the therapeutic value of vitamin C for the prophylaxis and treatment of the common cold.

Data sources: Cochrane, PubMed, Natural Standard, and the National Center for Complementary and Alternative Medicine databases were searched to identify and acquire primary research reports, literature reviews, and secondary analyses related to the clinical objective. Published clinical trials, literature reviews, meta-analyses, and systematic reviews were evaluated for evidence-based practice implications.

Conclusions: Vitamin C is frequently used for the treatment and prophylaxis of the common cold; however, no published recommendations were found in a review of the nurse practitioner literature that specifically address the efficacy of vitamin C for the common cold. Our literature review revealed that vitamin C is not effective at preventing the common cold in the general adult population; however, it is effective at preventing colds when consumed regularly by athletes training in subarctic conditions. We also found that regular vitamin C consumption may reduce the duration of cold symptoms in both adults and children, but it does not decrease the severity of cold symptoms.

Implications for practice: NPs should counsel their patients that regular vitamin C consumption may decrease the duration of cold symptoms, but does not affect symptom severity or act as a prophylaxis.

Background

The common cold, also known as nasopharyngitis or non-specific upper respiratory infection (URI), is one of the world's most prevalent illnesses and is a leading cause of acute morbidity in the community (Monto, 1995). Every year, Americans experience an estimated 1 billion cases of the common cold, with the average person experiencing two to six colds per year (Gwaltney, 2002). The common cold is a frequent reason why people seek primary care, resulting in approximately 22 million clinician visits per

year (Braun et al., 2000). The rhinovirus is the most prevalent causative agent for nasopharyngitis, followed by the coronavirus, respiratory syncytial virus (RSV), adenovirus, parainfluenza, and influenza (Prasad, Fitzgerald, Bao, Beck, & Chandrasekar, 2000); less than 5% of the cases stem from a bacterial etiology (Makela et al., 1998).

The common cold presents a major nuisance to activities of daily living and is one of the most recurrent and common causes of morbidity (Taverner & Latte, 2007). It is associated with direct and indirect costs related to health care and loss of productive activity through missed

work and school (Fendrick, Monto, Nightengale, & Sarnes, 2003). For example, a study of the effects of the common cold on 3249 U.S. college students found that between November and April most students had experienced 2 bedridden days, 1 1/2 days of missed school, and 1 missed day of work (Nichol, D'Heilly, & Ehlinger, 2005). Furthermore, 22.2% had one or more health-care visits, 27.8% performed poorly on a test, and 46.3% had performed poorly on a class assignment, all of which were attributed to the effects of the common cold (Nichol et al.). In addition, Fendrick et al. found that expenditures of approximately 40 billion dollars each year are directly or indirectly associated with non-influenza-related viral respiratory tract infections.

Treatment for the common cold is primarily limited to symptomatic relief and includes pharmacological agents such as pseudophedrine and guaifenesin as well as popular marketed herbal preparations containing vitamin C, including Airborne[®] and Halls Defense Vitamin C Drops[®]. However, the efficacy of many of the commonly used cold treatments is inconclusive in the research-based literature (Monto, 1995).

Vitamin C, also known as ascorbic acid, is a water-soluble vitamin found in fruits and vegetables, particularly citrus fruits. It is necessary for iron absorption, wound healing, and collagen formation (Natural Standard, 2006). Vitamin C is also recognized as important to the successful production of neurotransmitters and improvement of glucose metabolism; its deficiency results in the neurological disease of scurvy (Harvard Medical School, 2006). Vitamin C's association with immune strengthening is derived from its ability to enhance the function of the immune system, including antimicrobial and natural killer cell activities, macrophages, lymphocyte proliferation, chemotaxis, and delayed-type hypersensitivity (Wintergerst, Maggini, & Hornig, 2006). The U.S. Food and Nutrition Board of the Institute of Medicine recommends that adult males consume 75 mg of vitamin C/day and the adult females consume 90 mg/day (Natural Standard). Recommendations for children, persons with certain medical conditions, and smokers are found in Table 1.

Vitamin C used for medicinal purposes is classified as complementary and alternative medicine (CAM), and the purported benefits of vitamin C have been generally well accepted by the public (Maughan, King, & Lea, 2004). The National Center for Complementary and Alternative Medicine (NCCAM, n.d., π 2) defines CAM as:

A group of diverse medical and health care systems, practices, and products that are not presently considered to be part of conventional medicine. While some scientific evidence exists regarding some CAM therapies, for most there are key questions that are yet to be answered through well-designed scientific

studies—questions such as whether these therapies are safe and whether they work for the diseases or medical conditions for which they are used.

The NCCAM estimates that Americans spend approximately \$36 billion to \$47 billion a year on CAM and that the common cold is second only to back pain as the most common disease or condition for which CAM is used in the United States (NCCAM, n.d.). In 1992, Read, Klomp, Mather, and Todd (2002) found that 46% of Americans reported using vitamin or mineral supplements. Since then, Carlson and Krahn (2006) found that 19% of persons with physical disabilities used CAM, and Kim et al. (2005) found that 57% of emergency department patients reported CAM use in the past year. Wilson et al. (2006) reported that 79% of adolescents had used CAM in their lifetime and 29.1% in the past month. Such prevalent use of CAM is not limited to the United States. A study in England by Thomas, Nicholl, and Coleman (2001) discovered that one third of the population had used CAM in the past 12 months and one half of the population had used CAM in their lifetime. Because of the extensive use of CAM throughout western culture, it is crucial to establish the efficacy of such therapy in regard to its various uses, such as its use for the common cold.

Proponents of vitamin C claim that its use reduces the suffering and economic costs associated with the common cold (Harvard Medical School, 2006). In addition, it has also been used as a CAM for the treatment of asthma, dementia, tooth plaque/calculus, vaginitis, cataracts, and impaired lung function in smokers. As an antioxidant, it has been proposed that vitamin C can aid in the prophylaxis of cancer, heart disease, various neurological diseases, memory loss, and the aging process. The majority of these claims, however, lack evidential support (Natural Standard, 2006).

In a qualitative study regarding knowledge and beliefs concerning the common cold and the use of CAM, Braun et al. (2000) found that nearly half of their 506 adult participants believed that bacteria were the cause of the common cold. This belief was strongly associated with the belief that antibiotics are helpful for the treatment of the common cold. Additionally, nearly half of the participants believed that vitamin C is useful for the symptomatic treatment of the common cold. Although this was a small study, its results combined with the abundance of consumer advertisements recommending vitamin C for the common cold make it crucial that the nurse practitioner (NP) be familiar with the evidence regarding the use of vitamin C for the common cold.

Purpose

At present, the NP literature appears to be devoid of information regarding the use of vitamin C for the treatment or prophylaxis of the common cold, and NPs are

Table 1 Dietary guidelines for vitamin C consumption

Recommended daily allowance (RDA)	Maximum level of intake	Contraindications	Food sources	Adverse reactions with excessive consumption
Adult male: 75 mg/day	Adult male or female: 2000 mg/day	High doses should not be administered with the following conditions:	Citrus fruits (lemons and oranges), tomatoes, apples, asparagus, berries, broccoli, cabbage, melon (cantaloupe, honeydew, and watermelon), cauliflower, fortified breads/grains/cereal, kale, kiwi, potatoes, spinach, and tomatoes	Kidney stones
Adult female: 90 mg /day	Pediatric: 14–18 years 1800 mg/day	kidney stones, cirrhosis, gout, glucose 6-phosphate		Excessive iron absorption
Pediatrics: 1–3 years 15 mg	9–13 years 1200 mg/day	dehydrogenase deficiency, renal tubular acidosis, or paroxysmal nocturnal hemoglobinuria		Headache
4–8 years 25 mg	4–8 years 650 mg/day			Gastrointestinal disturbances:
9–13 years 45 mg	1–3 years 400 mg/day			nausea, vomiting,
14–18 years 75 mg males	0–12 months only derived from food.			heartburn,
65 mg females	Pregnancy and lactating: 2000 mg/day			abdominal cramps
Pregnancy: RDA for age group	Doses greater than 500 mg at one time are nonbeneficial.			
Smokers: Additional 35 mg/day				
Nonsmokers regularly exposed to tobacco smoke: Ensure they meet the RDA for age group				

Goldenring, 2006; Health Link, 2006; Natural Standard, 2006.

faced with the dilemma of how to advise patients regarding its use. Thus, the purpose of this article is to review and discuss the available evidence regarding the use of vitamin C for the treatment and prophylaxis of the common cold and to offer evidence-based practice suggestions.

Methods

A review of the literature regarding the efficacy of vitamin C for the prophylaxis and treatment of the common cold was conducted. The Cochrane Library, Medline (PubMed®), the Natural Standard, and the NCCAM were used to identify primary research reports, literature reviews, systematic reviews, and secondary analyses related to the clinical question. The keyword of “vitamin C” was used in combination with the keywords “upper respiratory infection,” “acute respiratory infection,” “cold,” and “nasopharyngitis.” The search was limited to documents that contained original research, meta-analyses, or systematic reviews. Before full-text documents were obtained or examined, document titles and abstracts were assessed for their relevance to the clinical question.

Thirty original research reports were initially obtained; however, the majority of these studies were covered either in a systematic review (Hemila, 2004) or at least one of two meta-analyses (Douglas, Chalker, & Treacy, 2000; Douglas, Hemila, D’Souza, Chalker, & Treacy, 2004). There were no published original research reports on the use of vitamin C in the treatment and prophylaxis of the common cold between 2004 and the first months of 2007, with the exception of a trial by Sasazuki et al. (2006), which was excluded from this review because of its lack of general clinical applicability. In July 2007, Douglas, Hemila, Chalker, and Treacy published an updated meta-analysis to include studies completed after 2004.

Systematic reviews and meta-analyses are recognized as the highest level of clinical evidence (Straus, Richardson, Glasziou, & Haynes, 2005); thus, after assessing the one systematic review (Hemila, 2004) and three meta-analyses (Douglas et al., 2004; 2007) for validity, importance, and clinical applicability, the final literature review was narrowed to these four documents.

Assessment of the systematic review and three meta-analyses revealed that each of these studies met Straus et al.’s (2005) criteria for validity, including inclusion of randomized controlled trials; comprehensive and detailed search for relevant trials; and assessment of each individual trial’s validity. The only criterion not met was that group versus individual patient data were extracted and used for the analyses; however, this criterion is extremely difficult to meet and is absent from many respected meta-analyses and systematic reviews. Assessment of the importance of the systematic review and three meta-analyses revealed that the results were consistent across all reported studies. Lastly, in terms of clinical applicability, subjects from all of the reported studies seemed similar to the general patient population with the exception of six trials in the Douglas et al. (2004) meta-analysis that included extreme conditions and Hemila’s study of individuals living in military-like conditions.

Results

Prophylaxis

In a review of 30 trials included in their two published reviews, Douglas et al. (2000) found that daily vitamin C supplementation in dosages as high as 1 g/day for several months during the fall to spring seasons did not prevent the common cold. Four years later, the same authors published an updated meta-analysis to assess whether vitamin C in daily doses of 200 mg or more reduced the incidence of the

common cold. This analysis involved 29 placebo controlled trials with 11,077 subjects and found no difference in the incidence of the common cold among those who regularly supplemented with vitamin C versus those who did not (Douglas et al., 2004). In the most recent meta-analysis by Douglas et al. (2007), 30 placebo controlled trials with 11,350 subjects concurred with the previous findings.

Interestingly, six of the placebo-controlled clinical trials reviewed in the Douglas et al. 2004 analysis involved 642 marathon runners, skiers, and soldiers who were engaging in these activities in subarctic conditions. Compared to the placebo group, athletes who supplemented with 200 mg or more per day of vitamin C had a relative risk of 0.50 (95% CI 0.38 to 0.66) of developing the common cold. Additionally, Hemila (2004) conducted a systematic review of 12 studies regarding the efficacy of vitamin C as a prophylaxis for respiratory infections experienced by military personnel and those living under conditions that were comparable to military recruits. Seven studies of military personnel, three trials of students in crowded lodging, and two trials of marathon runners were evaluated. Five of the trials found a statistically significant reduction in the incidence of the common cold ranging from 45% to 91% in those supplementing with vitamin C, and the remaining seven found no difference in the incidence of colds experienced by the vitamin C and placebo groups. One possible explanation for the different study findings could be that the subjects living in military studies consumed relatively equal amounts of vitamin C on a daily basis, which one would not expect to find in studies involving the general population

Treatment

Duration of symptoms

The Douglas et al. (2000) aforementioned analysis of 30 trials found that regular daily vitamin C supplementation in dosages as high as 1 g a day reduced the number of days with cold symptoms by -0.07% to 39% . When considering that the average maximal length of a cold is 10 days, a non-significant reduction of cold symptoms by -0.07% to 39% equates into a range of a 10-min increase in the length of symptoms to a 4 day decrease. Similarly, the updated meta-analysis by Douglas et al. (2004) found that regular consumption of vitamin C in dosages of 200 mg daily or more reduced cold durations by 8% in adults and 13.5% in children, which equates into approximately 24 h. The Douglas et al. (2007) most recent meta-analysis reported similar findings. With regard to vitamin C taken at the initial onset of cold symptoms (as opposed to daily supplementation), the Douglas et al. (2004) analysis of the efficacy of vitamin C versus placebo found no difference in symptom duration.

Severity of symptoms

In their analysis of 15 trials involving 7045 cases of the common cold, Douglas et al. (2004) reported an insignificant decrease in cold severity scores when vitamin C versus placebo was consumed regularly. They found a significant decrease, however, in the number of missed work and school days among those taking vitamin C ($p = 0.02$), with the actual number of days not reported. In addition, they found no differences in symptom severity or number of missed work and school days in studies that implemented vitamin C supplementation at the first onset of cold symptoms.

Discussion

The majority of studies included in the Douglas et al. (2000, 2004, 2007) reviews did not include children; thus, recommendations from this review apply only to adults over 18 years. Additionally, none of the studies took into account subjects' dietary intake of vitamin C. Other limitations include the relatively small number of subjects in the individual studies as well as the subjective nature of the data regarding cold duration and severity, which were gathered through self-report.

Further study of the efficacy of vitamin C in the treatment and prophylaxis of the common cold is needed, specifically featuring a broad range and substantial number of subjects including children. Ideally, these studies should have an increased number of subjects with varied education, socioeconomic levels, and immune status.

By definition, the clinical trials included in the systematic review and meta-analyses measured the efficacy of vitamin C in the prophylaxis and treatment of URIs. However, one should note that effectiveness may also have been measured in the sense that the vitamin C in these trials was self-administered in uncontrolled settings and that the data were recorded through subjective self-report. As a result, the study's subjects all ingested vitamin C in a "common use" or naturalistic design.

Implications for practice

Although vitamin C is frequently used for the prophylaxis and treatment of the common cold, current research-based evidence does not support its use for the prophylaxis of the common cold, with the possible exception of those engaging in high-intensity physical activity in extreme cold weather climates. In addition, the evidence does not support that vitamin C taken acutely or as a supplement decreases the severity of cold symptoms. Although the evidence does not support the acute use of vitamin C for the treatment of the common cold, results from two large meta-analyses demonstrated that regular supplementation of vitamin C in

Table 2 Summary of clinical recommendations for the use of vitamin C for the common cold

	Prophylaxis	Treatment: Severity	Treatment: Duration vitamin C supplementation on a regular basis	Treatment: Duration vitamin C supplementation at onset of symptoms
<i>Efficacy</i>	Generally no	Generally no	Generally yes	Generally no
<i>Special consideration</i>	Exception: Extreme physical exertion or extreme environment such as persons who undergo subarctic exercises, skiers, and marathon runners a possible 50% reduction in developing URIs. Consider possibly for elite athletes or military personnel.	Predominately no advantage over placebo.	In those who developed a cold while taking vitamin C on a regular basis, a small but significant reduction in the duration of the URI was noted.	Predominately no advantage over placebo.

Douglas et al., 2000, 2004, 2007; Hemila, 2004.

doses greater than 200 mg/day may reduce the duration of cold symptoms insignificantly by 1 to 4 days.

NPs counseling patients about vitamin C use for the common cold can advise them that routine supplementation of vitamin C in doses of 200 mg/day or more will probably not prevent the common cold or decrease the severity of cold symptoms. Routine supplementation may, however, decrease the duration of symptoms. In addition, NPs may want to advise their patients who engage in regular, high-intensity cold weather activities that some studies have shown that regular vitamin C supplementation decreases the incidence of the common cold. See Table 2 for a summary of these recommendations.

Each of the four reports reviewed for this article monitored for adverse effects associated with supplemental vitamin C use and found it to be generally well tolerated. Known adverse effects of vitamin C supplementation include nausea, vomiting, heartburn, diarrhea, abdominal cramps, and headache (Natural Standard, 2006). Increasing intake of vitamin C to greater than 2000 mg/day increases the risk for gastrointestinal side effects, and one study found that dental erosion could occur in those chronically chewing vitamin C tablets (Giunta, 1993). It is also important to note that because vitamin C is a water-soluble vitamin, large doses will not be absorbed; thus, Goldenring (2007) recommends consuming no more than 500 mg of vitamin C at a time. In addition, it is recommended that high-dose vitamin C be avoided in patients with conditions that can be precipitated by acid loading such as gout and cirrhosis (Natural Standard).

Future studies involving vitamin C for the treatment and prophylaxis of the common cold should take into account subjects' daily dietary intake of vitamin C. Consideration should also be made regarding the best methods for evaluating the length and severity of the common cold (i.e., self-report versus a more objective tool or laboratory value). In addition, studies are warranted to examine the use of

vitamin C for the prophylaxis and treatment of the common cold in children. This review of literature is intended to disseminate comprehensive knowledge of the efficacy and effectiveness of vitamin C in the prophylaxis, duration, and severity of the common cold into advanced practice nursing and improve primary care recommendations.

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