Probiotics for the prevention of Clostridium difficile-associated diarrhea in adults and children

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Abstract

Background

Antibiotics are widely prescribed; however they can cause disturbances in gastrointestinal flora which may lead to reduced resistance to pathogens such as *Clostridium difficile* (*C. difficile)*. Probiotics are live organisms thought to balance the gastrointestinal flora.

Objectives

The primary objectives were to assess the efficacy and safety of probiotics for preventing *Clostridium difficile*-associated diarrhea (CDAD) or *C. difficile* infection in adults and children.

Search methods

On February 21, 2013 we searched PubMed (1966-2013), EMBASE (1966-2013), Cochrane Central Register of Controlled Trials (*The Cochrane Library* 2013, Issue 1), CINAHL (1982-2013), AMED (1985-2013), and ISI Web of Science. Additionally, we conducted an extensive grey literature search including contact with industry representatives.

Selection criteria

Randomized controlled (placebo, alternative prophylaxis, or no treatment control) trials investigating probiotics (any strain, any dose) for prevention of CDAD, or *C. difficile* infection were considered for inclusion.

Data collection and analysis

Two authors independently and in duplicate extracted data and assessed risk of bias using pre-constructed, and piloted, data extraction forms. Any disagreements were resolved by a third adjudicator. For articles published in abstract form only, further information was sought by contacting principal authors. The primary outcome was the incidence of CDAD. Secondary outcomes included the incidence of *C. difficile* infection, adverse events, antibiotic-associated diarrhea (AAD) and length of hospital stay. Dichotomous outcomes (e.g. incidence of CDAD) were pooled using a random-effects model to calculate the relative risk and corresponding 95% confidence interval (95% CI). Continuous outcomes (e.g. length of hospital) were pooled using a random-effects model to calculate the mean difference and corresponding 95% CI. Sensitivity analyses were conducted to explore the impact of missing data on efficacy and safety outcomes. For the sensitivity analyses, we assumed that the event rate for those participants in the control group who had missing data was the same as the event rate for those participants in the control group who were successfully followed. For the probiotic group we calculated effects using the following assumed ratios of event rates in those with missing data in comparison to those successfully followed: 1.5:1, 2:1, 3:1, and 5:1. To explore possible explanations for heterogeneity, *a priori* subgroup analysis were conducted on probiotic species,

dose, adult versus pediatric population, and risk of bias.The overall quality of the evidence supporting each outcome was assessed using the GRADE criteria.

Main results

A total of 1871 studies were identified with 31 (4492 participants) meeting eligibility requirements for our review. Overall 11 studies were rated as a high risk of bias due mostly to missing outcome data. A complete case analysis (i.e. participants who completed the study) of those trials investigating CDAD (23 trials, 4213 participants) suggests that probiotics significantly reduce this risk by 64%. The incidence of CDAD was 2.0% in the probiotic group compared to 5.5% in the placebo or no treatment control group (RR 0.36; 95% CI 0.26 to 0.51). Sixteen of 23 trials had missing CDAD data ranging from 5% to 45%. These results proved robust to sensitivity analyses of plausible and worst-plausible assumptions regarding missing outcome data and were similar whether considering trials in adults versus children, lower versus higher doses, different probiotic species, or higher versus lower risk of bias. Our judgment is that the overall evidence warrants moderate confidence in this large relative risk reduction. We downgraded the overall quality of evidence for CDAD to ‘moderate’ due to imprecision. There were few events (154) and the calculated optimal information size (n = 8218) was more than the total sample size. With respect to the incidence of *C. difficile* infection, a secondary outcome, pooled complete case results from 13 trials (961 participants) did not show a statistically significant reduction. The incidence of *C. difficile* infection was 12.6% in the probiotics group compared to 12.7% in the placebo or no treatment control group (RR 0.89; 95% CI 0.64 to 1.24). Adverse events were assessed in 26 studies (3964 participants) and our pooled complete case analysis indicates probiotics reduce the risk of adverse events by 20% (RR 0.80; 95% CI 0.68 to 0.95). In both treatment and control groups the most common adverse events included abdominal cramping, nausea, fever, soft stools, flatulence, and taste disturbance. For the short-term use of probiotics in patients that are not immunocompromised or severely debilitated, we consider the strength of this evidence to be moderate.

Authors' conclusions

Based on this systematic review and meta-analysis of 23 randomized controlled trials including 4213 patients, moderate quality evidence suggests that probiotics are both safe and effective for preventing *Clostridium difficile*-associated diarrhea.

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Plain language summary

The use of probiotics to prevent *C. difficile* diarrhea associated with antibiotic use

Antibiotics are among the most prescribed medications worldwide. Antibiotic treatment may disturb the balance of organisms that normally inhabit the gut. This can result in a range of symptoms, most notably, diarrhea. *Clostridium difficile* is one particularly dangerous organism that may colonize the gut if the normal healthy balance has been

disturbed. *Clostridium difficile*-related disease varies from asymptomatic infection, diarrhea, colitis, and pseudo-membranous colitis to death. The cost of treatment is expensive and the financial burden on the medical system is substantial.

Probiotics are organisms thought to improve the balance of organisms that inhabit the gut, counteract disturbances to this balance, and reduce the risk of colonization by pathogenic bacteria. They are becoming increasingly available as capsules and food supplements sold in health food stores and supermarkets. As "functional food" or "good bacteria", probiotics have been suggested as a means of both preventing and treating *C. difficile*-associated diarrhea (CDAD).

This review includes 31 randomized trials with a total of 4492 participants. Twenty-three studies (4213 participants) assessed the effectiveness of probiotics in preventing CDAD in participants taking antibiotics. Our results suggest that when probiotics are given with antibiotics they reduce the risk of developing CDAD by 64%. Side effects were assessed in 26 studies (3964 participants) and our results suggest that probiotics decrease the risk of developing side effects. The most common side effects reported in these studies include abdominal cramping, nausea, fever, soft stools, flatulence, and taste disturbance. The short-term use of probiotics appears to be safe and effective when used along with antibiotics in patients who are not immunocompromised or severely debilitated.