The Use of Nonpharmacologic Techniques to Prevent Postoperative Nausea and Vomiting: A Meta-Analysis

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We assessed the efficacy of nonpharmacologic techniques to prevent postoperative nausea and vomiting (PONV) by systematic review. These studies included acupuncture, electroacupuncture, transcutaneous electrical nerve stimulation, acupoint stimulation, and acupressure. Of the 24 randomized trials retrieved by a search of articles indexed on the MEDLINE and EMBASE databases (1980–1997), 19 were eligible for meta-analysis. The primary outcomes were the incidence of nausea, vomiting, or both 0–6 h (early efficacy) or 0–48 h (late efficacy) after surgery. The pooled relative risk (RR) and numbers needed to treat (NNT) were calculated. In children, no benefit was found. Some results in adults were significant. Nonpharmacologic techniques were similar to antiemetics in preventing early vomiting (RR = 0.89 [95% confidence interval 0.47–1.67]; NNT = 63 [10-∞]) and late vomiting (RR = 0.80 [0.35–1.81]; NNT = 25 [5-∞]) in adults. Nonpharmacologic techniques were better than placebo at preventing early nausea (RR = 0.34 [0.20–0.58]; NNT = 4 [3–6]) and early vomiting in adults (RR = 0.47 [0.34–0.64]; NNT = 5 [4–8]). Nonpharmacologic techniques were similar to placebo in preventing late vomiting in adults (RR = 0.81 [0.46–1.42]; NNT = 14 [6-∞]). Using nonpharmacologic techniques, 20%–25% of adults will not have early PONV compared with placebo. It may be an alternative to receiving no treatment or first-line antiemetics. **Implications:** This systematic review showed that nonpharmacologic techniques were equivalent to commonly used antiemetic drugs in preventing vomiting after surgery. Nonpharmacologic techniques were more effective than placebo in preventing nausea and vomiting within 6 h of surgery in adults, but there was no benefit in children.

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Postoperative nausea and vomiting (PONV) are common complaints after general, regional, or local anesthesia (1). Drug therapy is only partially effective in preventing or treating PONV (2). Nonpharmacologic techniques, such as acupuncture, electroacupuncture, transcutaneous electrical nerve stimulation, acupoint stimulation, and acupressure, have been examined as alternatives to antiemetic drugs (3–22). It is believed that stimulation of the wrist at the pericardium (P6) acupuncture point minimizes nausea and vomiting. The P6 acupoint lies between the tendons of palmaris longus and flexor carpii radialis muscles 4 cm proximal to the wrist crease (13).

The role of nonpharmacologic techniques in the prevention of PONV has not been determined (1). Although there is growing interest in the use of alternative approaches to the prevention of emesis, the efficacy of nonpharmacologic techniques is unclear. For example, acupressure significantly reduced the incidence of postoperative vomiting in one study (17), but not in others (8,10,16). Vickers (23) suggests that acupuncture may not be effective in preventing PONV, but this was potentially misleading because the "vote counting" approach used in that qualitative systematic review did not adequately account for the existence of trials with conflicting results.

We had two objectives in performing this systematic review. The first was to quantify the efficacy of nonpharmacologic techniques compared with antiemetics in preventing PONV. The second was to quantify the efficacy of nonpharmacologic techniques compared with placebo in preventing PONV. Placebo was considered as sham point acupuncture or no treatment. The outcome measures were early nausea, early vomiting, late nausea, and late vomiting. In this systematic review of published randomized controlled trials, we attempt to identify evidence-based recommendations for clinical practice and further research.

Methods

We performed MEDLINE (1980–1997) and EMBASE (1988–1997) searches in September 1997. Published randomized controlled trials that evaluated the effect of nonpharmacologic techniques compared with control (placebo or antiemetic drugs) in preventing PONV

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were identified. All nonpharmacologic techniques stimulated the P6 acupuncture point. An initial list of studies was obtained using the terms (MESH and text search) "postoperative complications," "nausea and vomiting," "acupuncture," and "acupressure." Additional reports were identified from reference lists of retrieved papers, review articles, and the Cochrane register of controlled trials. The retrieved articles were compared with a comprehensive database of published trials provided by the National Library of Medicine in October 1997 (24). Non-English language studies were included. Excluded from this systematic review were cost-effectiveness studies and the use of nonpharmacologic techniques in the treatment of established PONV.

To rate the quality of retrieved articles, a reliable and validated scale was used (25). Studies that were described as randomized were given one point. A further point was given if the method of randomization was described and was appropriate, such as the use of a random numbers table. If randomization was inappropriate, one point was deducted. Studies that were described as double-blinded were given one point. A further point was given if blinding was appropriate, such as matched placebos; one point was deducted if blinding was inappropriate. If the number and reasons for withdrawals were described in the study, one point was given. The minimal and maximal scores for an included study were 1 and 5, respectively. Data were abstracted independently by the authors using a standardized collection form. An intraclass correlation coefficient for the study quality was calculated using an analysis of variance method for studies published in English (26). The raters met to agree on consensus scores and inclusion of studies for the meta-analyses. Disagreement was to be resolved by reviewing the study and discussing the discrepancy. Reports without an adequate method of randomization (e.g., date of birth, hospital registration number) were excluded from the analysis. Studies were examined for duplicate data. If this occurred, the study with the most information was included. Adult and pediatric studies were included.

The type of antiemetic drugs, patient population, type of surgery, and anesthetic details were recorded. All invasive (manual rotation of needles, electrical stimulation of needle) and noninvasive (transcutaneous electrical stimulation and acupressure) nonpharmacologic techniques were included in the analysis. The diverse techniques stimulated the P6 acupuncture point and were considered as one entity, consistent with the concept that stimulating the right acupuncture point is more important than the nature of the stimulus (27).

PONV was defined as nausea, vomiting, or both. The primary outcome measures were early (0–6 h) and late (0–48 h) PONV as defined by a previous study (28). When event rates were reported at other times, those times nearest to the 6th and 48th hour were used. The event rates to the nearest 6th or 48th hour were collected. In Barsoum et al.'s study (8), the number of patients who vomited in the first 24 h in each of the groups was reestimated from the percentages presented in a table in their article. Different grades of nausea, the number of episodes of vomiting, and the number of patients who required rescue antiemetics were not considered.

In the four studies (3,6,12,15) with multiple treatment and control arms, one treatment and control arm was used from each study. Sham treatment was chosen in preference to no treatment as the control in two studies (3,15). Where there were two nonpharmacologic techniques (electroacupuncture and transcutaneous electrical nerve stimulation), electroacupuncture was randomly chosen by tossing a coin for comparison with the control in one study (6). In Yentis et al.'s study (12), there were three comparative groups: Group 1 (acupuncture), Group 2 (acupuncture plus droperidol), and Group 3 (droperidol). Group 2 was randomly chosen by tossing a coin over Group 1 for comparison with the droperidol control (12). For each outcome, only one comparison from each study was pooled.

Dundee et al.'s study (5) was considered to consist of two studies involving comparisons of manual/electroacupuncture versus no treatment and manual/electroacupuncture versus metoclopramide/cyclizine. A third treatment arm (acupressure) was excluded because there was no control group, it was conducted later than the rest of the study, and, unlike the rest of the study, it was descriptive. The incidence of early PONV (0–6 h) in the antiemetic control arm of Dundee et al.'s study (5) was estimated from a table in their abstract.[1]

The DerSimonian and Laird random-effects model was used because we expected that the treatments and conditions in these studies would be heterogeneous (29). This model incorporates both between-study (different treatment effects) and within-study (sampling error) variability (29). It is more conservative than the fixed-effect model, which assumes that all studies measure a single effect and considers only within-study variability. Meta-regression (30) to adjust for confounders associated with PONV was not performed because of its limitations.

The relative risk (RR) is the ratio of the event rate in the treatment group to the event rate in the control group. The RR was used rather than the odds ratio, which would have overestimated the RR (31). A RR

[1] Dundee JW, Fitzpatrick KTJ, Ghaly RG. Is there a role for acupuncture in the treatment of postoperative nausea and vomiting? [abstract]. Anesthesiology 1987;87:A165.

<1 suggested that the fewer patients in the acupuncture group experienced PONV compared with patients in the control group. Similarly, a RR >1 suggested that PONV was greater in the acupuncture than in the control group. Although the RR gives a quantitative sense of the treatment effect in proportional terms, it does not indicate the size of an effect on an absolute scale.

In contrast, the number needed to treat (NNT) provides information different from the RR because it takes into account the baseline frequency of the outcome. The NNT (32) is a useful method of indicating how many patients receiving the treatment, compared with control, require an intervention before one patient will have an effective response. The NNT is the reciprocal of the absolute risk reduction. Absolute risk reduction is the difference between the occurrence rates of an outcome in the treated and placebo groups in a randomized controlled study (32). A NNT ≤5, equivalent to a 20% absolute risk reduction, has been defined as a clinically relevant effect for prophylaxis of PONV (28). Confidence intervals around the RR and NNT were calculated.

The χ^2 test for heterogeneity ($\alpha = 0.10$) was used to assess the effect-size variance among the trials (33). Where heterogeneity (interstudy variation) was found, the studies that seemed to be the major contributors to the heterogeneity were evaluated in an attempt to discover the reasons. A sensitivity analysis (34) was used to test how robust the results were in the following situations: (a) sham and no-treatment groups were used separately as controls; (b) high-quality studies (quality score >2) versus low-quality studies (quality score ≤2); and (c) large studies (sample size >50) versus small studies (sample size ≤50). A subgroup analysis was performed on pediatric studies because children were twice as likely as adults to experience PONV (35). All calculations were performed using the Arcus Quickstat program (Arcus Quickstat Biomedical; Research Solutions, Cambridge, UK).

Results

Of the 24 studies identified, 5 were excluded because of inadequate randomization (36,37), inadequate blinding and a quality of study score of 0 (38), poor study design and inadequate reporting of results (39), and acupressure for preventing intraoperative nausea during spinal anesthesia (40). Data from 19 randomized controlled studies involving 1679 patients (739 given nonpharmacologic techniques) were therefore analyzed. There were 17 studies in English, 1 in Chinese (7), and 1 in German (15). The median score for the quality of studies was 3 (range 1–5). There was high reliability (0.79) between the two authors in judging the quality of the studies published in English.

Variability among the 19 studies eligible for the meta-analysis (Table 1) was: nonpharmacologic techniques, timing and duration of the stimulation of the P6 acupoint, definitions of PONV, follow-up time for assessing PONV, patient populations, and the controls used. There were five nonpharmacologic techniques: manual rotation of needles (3–5,7,9,11–13,20), semipermanent needles (18), electrical simulation of needles (5,6), transcutaneous electrical stimulation (6,14,19), and acupressure (8,10,15–17,21).

Sham acupressure was used as the control in 10 studies (3,8–10,14–18,21). No treatment was the control group in 10 studies (3–7,11,13,15,19,20). Antiemetics used as a control group included metoclopramide or cyclizine (5), prochlorperzine (6,8), and droperidol (12,13).

Vomiting was the only outcome in eight studies (6,8,10–14,19). Two studies used early nausea and vomiting as a single outcome (4,21). The duration of follow-up varied (Table 1). Three studies (10,12,19) reported both early (0–6 h) and late (0–48 h) emetic rates.

Nonpharmacologic procedures were administered preoperatively (3,5,9,10,14–16,18), intraoperatively (4,7, 11–13,17,19–21), and postoperatively (6,8). The duration of treatment varied from 5 min with invasive acupuncture (3,5,9,11,12) to 7 days postoperatively with acupressure wristbands (8).

Of the 19 studies, 4 studies involved children (10–12,19). Most adult studies were patients undergoing gynecological surgery (3,5,7,9,13–16,18,20). All studies except one (17) used general anesthesia. Adverse effects from either nonpharmacologic techniques or antiemetic drugs were not consistently reported across all studies. Reported adverse effects from nonpharmacologic techniques included drowsiness ("frequent") (6), pain at the acupoint site (5%) (13), and discomfort with prolonged use of acupressure wristbands (8%) (8). One pediatric study reported a higher incidence of restlessness with droperidol than with acupuncture (12). There was no report of long-term adverse events associated with nonpharmacologic techniques.

One study used antiemetics as a control to examine early nausea (5). In this study (5), there was a significant risk reduction (64%) in patients who received acupuncture compared with those who received metoclopramide or cyclizine (RR = 0.36 [95% CI 0.14–0.93]; NNT = 7 [4–53]). The mean incidence of early vomiting in the antiemetic group was 14% (12%–18%). The efficacies of nonpharmacologic techniques were similar to those of antiemetic treatment in preventing early vomiting (5,6,13) (RR = 0.89 [0.47–1.67]; NNT = 63 [10-∞]).

Nonpharmacologic techniques were superior to placebo in preventing early nausea and early vomiting in adults. The mean incidence of early nausea in the control groups was 35% (9%–63%). The combined RR

Table 1. Summary of Studies Included in the Meta-Analysis

Study	Type of patient	Surgery	Blinding	Quality of study	Outcome	Incidence of PONV (%)[b]		
						Nonpharmacologic technique	Placebo	Antiemetic
Dundee et al., 1986 (3)	Adult	Gynecology	Single	1	N 0–6h	3/25 (12)	12/25 (48)	
					V 0–6h	3/25 (12)	5/25 (20)	
Weightman et al., 1987 (4)	Adult	Laparoscopy	Double	4	N 0–1h	5/20 (25)	5/24 (21)	
					N & V 0–1h	4/20 (20)	1/24 (4)	
Dundee et al., 1989 (5)	Adult	Gynecology	Single	1	N 0–6h	5/62 (8)	13/31 (42)	
					N 0–6h	5/62 (8)		14/62 (23)[c]
					V 0–6h	8/62 (13)	8/31 (26)	
					V 0–6h	8/62 (13)		8/62 (13)[c]
Ho et al., 1989 (6)	Adult	Laparoscopy	None	1	V 0–3h	3/25 (12)	11/25 (44)	
					V 0–3h	3/25 (12)		3/25 (12)[d]
Shyr et al., 1990 (7)	Adult	Gynecology	None	1	N 0–3h	2/32 (6)	8/32 (25)	
					V 0–3h	0/32 (0)	2/32 (6)	
Barsoum et al., 1990 (8)	Adult	General	Double	4	V 0–24h	8/49 (16)	11/54 (20)	
					V 0–24h	8/49 (16)		10/49 (20)[d]
Dundee and Ghaly, 1991 (9)	Adult	Gynecology	Double	4	N 0–6h	2/37 (5)	6/37 (16)	
					V 0–6h	5/37 (14)	13/37 (35)	
Lewis et al., 1991 (10)	Children	Strabismus	Double	4	V 0–2h	18/31 (58)	19/33 (58)	
					V 0–24h	29/31 (94)	27/33 (82)	
Yentis and Bissonnette, 1991 (11)	Children	Tonsillectomy	Double	3	V 0–24h	9/23 (39)	8/22 (36)	
Yentis and Bissonnette, 1992 (12)	Children	Strabismus	Double	3	V 0–5h	5/30 (17)		5/30 (17)[e]
					V 0–48h	10/29 (34)		12/29 (41)[e]
Yang et al., 1993 (13)	Adult	Gynecology	None	1	V 0–3h	5/40 (13)	21/40 (53)	
					V 0–3h	5/40 (13)		7/40 (18)[e]
Fassoulaki et al., 1993 (14)	Adult	Gynecology	Double	4	V 0–2h	12/51 (24)	22/52 (42)	
Gieron et al., 1993 (15)	Adult	Gynecology	Single	1	N 0–6h	11/30 (37)	19/30 (63)	
					V 0–6h	9/30 (30)	13/30 (43)	
Allen et al., 1994 (16)	Adult	Gynecology	Single	2	N 0–24h	9/23 (39)	10/23 (43)	
					V 0–24h	9/23 (39)	9/23 (39)	
Ho et al., 1996 (17)	Adult	Cesarean	Double	5	N 0–48h	1/30 (3)	13/30 (43)	
					V 0–48h	0/30 (0)	8/30 (27)	
Andrzejowski and Woodward, 1996 (18)	Adult	Gynecology	Single	2	N 0–8h	11/18 (61)	12/18 (67)	
					V 0–8h	3/18 (17)	1/18 (6)	
Schwagner et al., 1996 (19)	Children	General	Double	4	V 0–0.5h	6/40 (15)	3/40 (8)	
					V 0–24	11/40 (28)	11/40 (28)	
Al-Sadi et al., 1997 (20)	Adult	Gynecology	Double	4	N 0–24h	2/40 (5)	15/41 (37)	
					V 0–24h	8/40 (20)	12/41 (29)	
Fan et al., 1997 (21)	Adult	Mixed[a]	Double	4	N & V 0–6h	25/108 (23)	38/92 (41)	

N = nausea, V = vomiting.
[a] Laparoscopic and gynecologic procedures, tonsillectomy, open cholecystectomy.
[b] Cumulative incidence to 6th and 48th h after surgery.
[c] Metoclopramide or cyclizine.
[d] Prochlorperazine.
[e] Droperidol.

of all available studies (3–5,7,9,15) with placebo controls, using early nausea as the outcome measure, favored nonpharmacologic treatment (RR = 0.40 [0.23–0.71]; NNT = 5 [3–8]). However, there was heterogeneity among the study results ($\chi^2_5 = 9.14$, $P = 0.10$). Without the smallest study that included laparoscopic patients (4), the combined RR for early nausea was 0.34 (0.20–0.58; NNT = 4 [3–6]), and there was no heterogeneity ($\chi^2_4 = 5.52$, $P = 0.24$) (Figure 1). The sensitivity analysis showed that this summary estimate was not affected by the types of control (sham or no treatment) or by the sample size of the studies pooled (Figure 1). However, the quality of the study affected the overall result, with poorer studies showing a significant effect (Figure 1).

There was a significant reduction in the incidence of early vomiting in the nonpharmacologic treatment groups compared with placebo groups (Figure 2). The mean incidence of early vomiting in adult controls was 35% (6%–53%). The combined RR in the adult studies (3,5–7,9,13–15) was 0.47 (0.34–0.64). The NNT was 5 (4–8). The overall effect was not affected by sample size, quality of the study, or controls used (Figure 2).

Only one adult study (8) examined late vomiting when acupressure was compared with an antiemetic

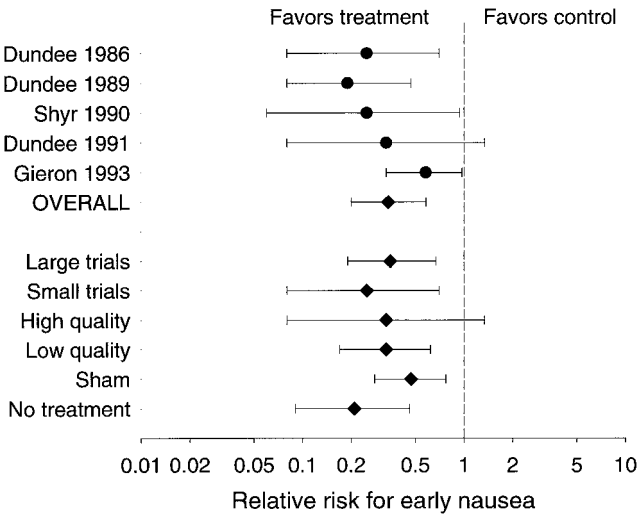

Figure 1. Effect of nonpharmacologic techniques on the risk of early postoperative nausea in adults. ● = relative risk for individual study, ♦ = overall summary effect. The control was sham or no treatment. Large trials = $n > 50$, small trials = $n \leq 50$, high-quality studies = quality score > 2, low-quality studies = quality score ≤2.

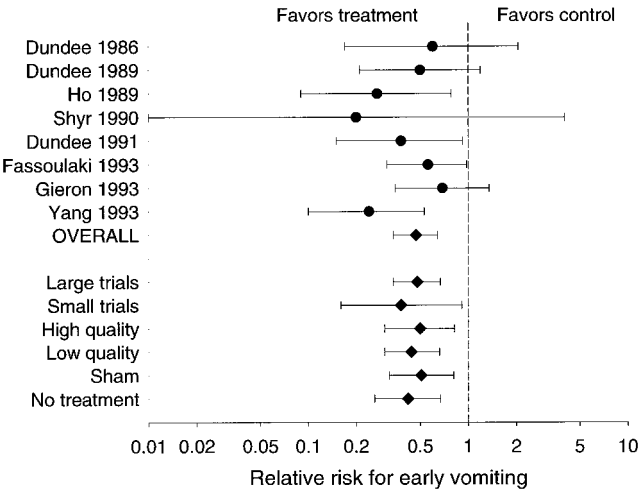

Figure 2. Effect of nonpharmacologic techniques on risk of early postoperative vomiting in adults ● = relative risk for individual study, ♦ = overall summary effect. The control was sham or no treatment. Large trials = $n > 50$, small trials = $n \leq 50$, high-quality studies = quality score > 2, low-quality studies = quality score ≤2.

control (RR = 0.80 [0.35–1.81]; NNT = 25 [5-∞]). The studies of late nausea using nonpharmacologic treatment versus placebo (16–18,20) were considered separately because of heterogeneity (χ^2_3 = 17.06, $P < 0.001$). Differences included the type of anesthetics used and type of surgery. The time of follow-up was 8–48 h (17,18). Nonpharmacologic treatments significantly reduced late nausea in two studies (17,20), but not in others (16,18) (Table 1). Compared with placebo, nonpharmacologic treatments did not significantly prevent late vomiting in five studies (8,16–18,20) (RR = 0.81 [0.46–1.42]; NNT = 14 [6-∞]). There was no statistical heterogeneity among the studies

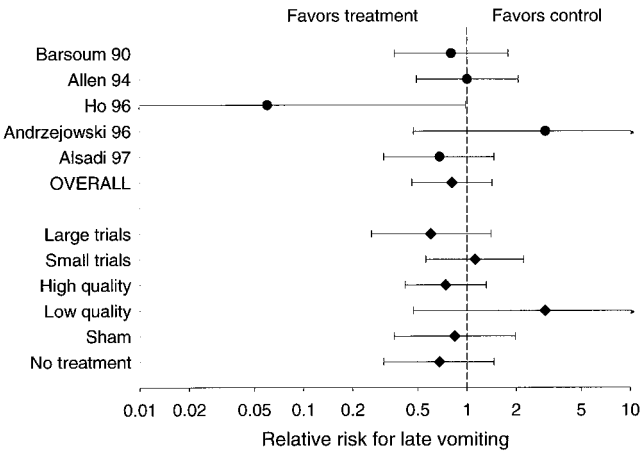

Figure 3. Effect of nonpharmacologic techniques on risk of late postoperative vomiting in adults. ● = relative risk for individual study, ♦ = overall summary effect, → = confidence interval beyond scale favoring control, ← = confidence interval beyond scale favoring treatment. The control was sham or no treatment. Large trials = $n > 50$, small trials = $n \leq 50$, high-quality studies = quality score > 2, low-quality studies = quality score ≤2.

(χ^2_4 = 5.72, P = 0.22). However, the overall effect was influenced by study sample size and quality of the study, but not by the type of controls used (Figure 3).

In four pediatric studies (10–12,19), the incidence of early and late vomiting was not significantly different when acupuncture was compared with placebo or antiemetic control groups. Yentis et al. (12) showed that acupuncture treatment was no better than droperidol in preventing early vomiting (RR = 1.00 [0.34–2.95]) or late vomiting (RR = 0.83 [0.43–1.60], NNT = 15 [3-∞]). There was no significant difference between nonpharmacologic treatment and placebo in preventing early vomiting in two studies (10,19) (RR = 1.09 [0.70–1.70]) or late vomiting in three studies (10,11,19) (RR = 1.13 [0.95–1.35]).

Discussion

The main findings of this meta-analysis were that (a) well-designed pediatric studies failed to show a significant benefit using nonpharmacologic techniques; (b) there was a significant reduction in early PONV in adults using nonpharmacologic techniques compared with placebo; and (c) antiemetics (metoclopramide, cyclizine, droperidol, prochlorperazine) versus nonpharmacologic techniques were comparable in preventing early or late PONV in adults. This suggests that there is some clinical role for nonpharmacologic techniques. No study compared nonpharmacologic techniques with the 5-hydroxytryptamine$_3$ receptor (5-HT$_3$) antagonist.

The mechanism by which acupuncture prevents PONV has not been established. Acupuncture may

mediate the release of β-endorphin in the cerebrospinal fluid, potentiating the endogenous antiemetic actions of the μ-receptor (20). The serotonergic and norepinephrinergic fibers may also be activated, and the antiemetic effects of acupuncture may be explained by changes in serotonin transmission (40). No serious side effects of acupuncture were recorded in the studies reviewed; however, potentially life-threatening complications, such as hepatitis and pneumothorax, have been described (41).

There are several limitations to this meta-analysis. One limitation is the problem of combining different nonpharmacologic techniques. Each nonpharmacologic technique that stimulates the P6 acupuncture point may have different efficacies in preventing PONV. Dundee and McMillan (42) classified methods of P6 stimulation as invasive (i.e., manual acupuncture, electroacupuncture) and noninvasive (i.e., transcutaneous electrical stimulation and acupressure). Optimal methods of applying effective nonpharmacologic techniques have not been identified. Acupressure was applied for longer durations than invasive acupuncture techniques. There is no evidence to justify the arbitrary selection of a technique and duration of treatment. The objective of this systematic review was to estimate the overall effect of nonpharmacologic techniques in preventing PONV, rather than to consider the individual techniques. Mann (27) suggests that the stimulating the right point is more important than the nature of the stimulus.

Other issues not covered in the study designs were the use of the dominant versus nondominant arm, needle depth of invasive acupuncture, and duration and timing of its application at the P6 acupoint. In this meta-analysis, the length of treatment varied from 5 min to 7 days depending to the technique. These aspects of nonpharmacologic techniques should have been identified before randomized controlled trials were undertaken. We assumed that these techniques were similar because we were considering the commonality of stimulating the P6 acupoint by any method. There was no statistical heterogeneity among the studies. Future work may prove that there is no justification for this assumption.

As with other meta-analyses, the study characteristics vary. For example, in this review, there were variations in the definitions of early and late PONV, population studied, type of general anesthesia, type of surgery, and type of control. However, because each study considered patients undergoing surgery that carries a high risk of PONV, we believe that it was appropriate to combine the studies using a random-effects model. This is supported by the results of checking the studies for statistical heterogeneity.

The late-outcomes studies had smaller sample sizes than the early outcomes studies. Caution is needed in interpreting the results of meta-analyses that are exclusively based on results of many small trials until a larger trial with sufficient power is conducted to confirm an effect (43). Publication bias can distort the results of a meta-analysis because small positive trials are more likely to be published than negative ones (43). Inadequate power of the combined studies or publication bias could account for the finding that there was no significant difference for late PONV in adults. Although a funnel plot (log relative risks versus sample size) has been widely used to detect potential publication bias (34), the interpretation of a funnel plot for this systematic review was difficult because of the multiple and varied outcomes used in each study. There were also insufficient data to draw a conclusion about the benefit of nonpharmacologic techniques compared with placebo in preventing late PONV in adults, given the lack of follow-up in most studies. Only three studies examined both early and late outcomes.

As noted, results varied between pediatric and adult studies. The pediatric trials comparing acupuncture with placebo or antiemetic treatment found no difference in the prevention of early or late vomiting. Pediatric studies accounted for 20% of the studies in this meta-analysis, with a total pooled sample size of approximately 250 children. This sample size would have been adequate to detect a 20% reduction in PONV if the control rate was assumed to be 50% with a power of 80%. We scored these pediatric studies highly in study design. Therefore, we conclude that acupuncture is not effective in children.

In adults, nonpharmacologic techniques were more effective than placebo in preventing early PONV. Most of these studies used invasive P6 stimulation techniques. Restricting the analyses to either sham or no treatment as the comparative control group did not eliminate the statistical significance of these results; i.e., the types of controls were comparable. Study quality affected the summary estimate for early nausea. Low-quality studies have been shown to overestimate the treatment effect (44), which highlights the importance of performing a sensitivity analysis. This may have arisen from inadequate allocation concealment and/or poor blinding of the investigators.

Approximately one in four to five (20%–25%) adults treated with nonpharmacologic techniques rather than placebo will avoid early PONV. This applies to both invasive and noninvasive modes of "acupuncture" in laparoscopic and gynecological procedures, independent of any significant variation in trial characteristics. The adult studies displayed gender and population bias, as they predominantly included women undergoing surgery that carried a high-risk for PONV.

This meta-analysis implies that further randomized controlled trials with better study methodology are needed in adults. There has been no focus on hydration status or a standardized onset time and duration of nonpharmacologic techniques. Acupressure using

wristbands may be the easiest form to introduce into the clinical setting, as it would require minimal staff training. It may also have greater patient acceptability than invasive P6 stimulation. Gieron et al.(15) showed that acupressure was effective in preventing early nausea, but not early vomiting. There are insufficient data to determine the role of acupressure in preventing late PONV. Studies with adequate power using an acupressure wristband versus placebo acupuncture needle (45) with standardized outcomes are needed. Studies are also required to look at the additive and/or synergistic effects of combining nonpharmacologic techniques and various types of antiemetics, including 5-HT_3 antagonists, in patients at high risk of PONV. An economic analysis of nonpharmacologic techniques would be appropriate once effectiveness has been established.

We undertook this meta-analysis because there has been considerable interest in the effectiveness of nonpharmacologic techniques. The role of nonpharmacologic techniques in preventing PONV differs in children and adults. Nonpharmacologic techniques had an efficacy similar to antiemetic drugs in preventing postoperative early vomiting and late vomiting in adults. Compared with placebo, 20%–25% of adults would benefit from the use of nonpharmacologic techniques in reducing early PONV. There were inadequate data to conclude any effect on late PONV compared with placebo. In children, acupuncture was not effective compared with either placebo or commonly used first-line antiemetics. Nonpharmacologic techniques could be recommended in adults as an alternative to no treatment or to first-line antiemetic drugs to prevent early PONV; for example, in patients with known adverse reactions to antiemetic drugs and in patients who wish to minimize drug intake in the clinical setting.

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