

Interventions for preoperative smoking cessation (Review)

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[Intervention Review]

Interventions for preoperative smoking cessation

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ABSTRACT

Background

Smokers have a substantially increased risk of postoperative complications. Preoperative smoking intervention may be effective in decreasing this incidence, and surgery may constitute a unique opportunity for smoking cessation interventions.

Objectives

The objective of this review was to assess the effect of preoperative smoking intervention on smoking cessation at the time of surgery and 12 months postoperatively and on the incidence of postoperative complications.

Search strategy

The specialized register of the Cochrane Tobacco Addiction Group was searched using the free text and keywords (surgery) or (operation) or (anaesthesia) or (anesthesia). MEDLINE, EMBASE and CINAHL were also searched, combining tobacco- and surgery-related terms. Most recent search April 2010.

Selection criteria

Randomized controlled trials that recruited people who smoked prior to surgery, offered a smoking cessation intervention, and measured preoperative and long-term abstinence from smoking and/or the incidence of postoperative complications.

Data collection and analysis

The authors independently assessed studies to determine eligibility. Results were discussed between the authors.

Main results

Eight trials enrolling a total of 1156 people met the inclusion criteria. One of these did not report cessation as an outcome. Two trials initiated multisession face to face counselling at least 6 weeks before surgery whilst six used a brief intervention. Nicotine replacement therapy (NRT) was offered or recommended to some or all participants in seven trials. Six trials detected significantly increased smoking cessation at the time of surgery, and one approached significance. Subgroup analyses showed that both intensive and brief intervention significantly increased smoking cessation at the time of surgery; pooled RR 10.76 (95% confidence interval (CI) 4.55 to 25.46, two trials) and RR 1.41 (95% CI 1.22 to 1.63, five trials) respectively. Four trials evaluating the effect on long-term smoking cessation found a significant effect; pooled RR 1.61 (95% CI 1.12 to 2.33). However, when pooling intensive and brief interventions separately, only intensive intervention retained a significant effect on long-term smoking cessation; RR 2.96 (95% CI 1.57 to 5.55, two trials).

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Five trials examined the effect of smoking intervention on postoperative complications. Pooled risk ratios were 0.70 (95% CI 0.56 to 0.88) for developing any complication; and 0.70 (95% CI 0.51 to 0.95) for wound complications. Exploratory subgroup analyses showed a significant effect of intensive intervention on any complications; RR 0.42 (95% CI 0.27 to 0.65) and on wound complications RR 0.31 (95% CI 0.16 to 0.62). For brief interventions the effect was not statistically significant but CIs do not rule out a clinically significant effect (RR 0.96 (95% CI 0.74 to 1.25) for any complication, RR 0.99 (95% CI 0.70 to 1.40) for wound complications).

Authors' conclusions

There is evidence that preoperative smoking interventions including NRT increase short-term smoking cessation and may reduce postoperative morbidity. The optimal preoperative intervention intensity remains unknown. Based on indirect comparisons and evidence from two small trials, interventions that begin four to eight weeks before surgery, include weekly counselling, and use NRT are more likely to have an impact on complications and on long-term smoking cessation.

PLAIN LANGUAGE SUMMARY

Can people be helped to stop smoking before they have surgery?

Smoking is a well-known risk factor for complications after surgery. Studies of interventions to encourage smokers to stop smoking before their operation show that short- and long-term quitting can be achieved. Evidence from two small trials indicates that interventions that begin four to eight weeks before surgery, which include weekly counselling and use NRT, support smoking cessation and may reduce complication rates. Brief interventions support short-term smoking cessation but there is insufficient evidence from this review to determine whether they reduce complications. This may be due to the longer period of pre-operative abstinence that can be achieved when interventions begin four to eight weeks before surgery.

BACKGROUND

Complications related to anaesthesia and surgery are important to patients and expensive for the healthcare system. Postoperative complications result in increased morbidity and mortality, and extended hospital stay and convalescence.

Five to ten percent of a population may annually undergo surgery and anaesthesia. Pulmonary or cardiovascular complications occur in up to 10% of the cases (Pedersen 1994), with people who smoke having a considerably increased risk of intra- and post-operative complications (Bluman 1998). In a retrospective study, smokers were found to have a three- to six-fold increased risk of intra-operative pulmonary complications (Akrawi 1997; Schwilk 1997). Smokers with chronic heart or lung disease have a two- to five-fold increased risk of perioperative complications.

Smoking has many effects on heart function and circulation, both in the short and long term. Short-term effects may be due to increased amounts of carbon monoxide and nicotine in the blood. The harmful effects of these substances disappear 24 to 48 hours after smoking cessation (Kambam 1986; Pearce 1984). The long-term effects include the development of generalized atherosclerotic changes in the vasculature. Short-term effects are more significant in those who suffer from generalized atherosclerosis (Klein

1984; Nicod 1984; Sheps 1990). The harmful effects of carbon monoxide (CO) are primarily caused by the effect of CO on oxygen metabolism, because CO binds to the haemoglobin molecules instead of oxygen. This reduces the availability of oxygen to the tissues by 3 to 12% (Pearce 1984). Furthermore, CO changes the structure of the haemoglobin molecules, shifting the oxygen-haemoglobin curve to the left, further reducing the oxygen availability, and also increases the risk of cardiac arrhythmias (Sheps 1990). Nicotine stimulates the surgical stress response and increases blood pressure, pulse rate and systemic vascular resistance, increasing the work of the heart. In summary, the effects of nicotine and CO in common tend to create an imbalance between the oxygen consumption and the oxygen availability in smokers (Kaijser 1985; Roth 1960). The effect of nicotine replacement therapy (NRT) on oxygen consumption is unclear (Benowitz 1997; Keeley 1996). A recent study demonstrated a significant increase in tissue oxygen and a limited vasoactive effect of NRT when administered intravenously (Sorensen 2008). There is no evidence indicating that NRT negatively affects postoperative outcome (Sorensen 2003b). NRT must therefore be considered a better alternative than smoking.

As anaesthesia and surgery cause an increased strain on cardiac

and circulatory functions, an existing oxygen imbalance can be worsened in smoking patients, potentially resulting in hypoxemia in vital organs.

Smoking also impairs pulmonary function. Smokers have increased mucus production, with damage to the tracheal cilia, which impedes the clearance of mucus. This is the explanation for the accumulation of mucus in the airways, which eventually may lead to pulmonary infections (Lourenco 1971). These effects may be exaggerated by reductions in immune function associated with smoking (Cohen 1993; Pearce 1984; Sorensen 2004). Immobilization during surgery and anaesthesia and in the immediate postoperative period worsens the reduced pulmonary function and the mucus accumulation. Pulmonary function generally improves after approximately eight weeks' smoking cessation (Bode 1975; Buist 1976; Camner 1973; McCarthy 1972, Mitchell 1982). In a retrospective study in patients undergoing pulmonary surgery, Nakagawa 2001 found that the risk of postoperative pulmonary complications was significantly higher compared to never-smokers for both current smokers and for recent smokers who had been smoke-free for two to four weeks before their operation. Warner 1989 found, in a prospective, descriptive and uncontrolled study, that patients who stopped smoking about eight weeks prior to operation reduced their risk of postoperative pulmonary complications. The optimal timing of smoking cessation before surgery to reduce postoperative pulmonary complications remains poorly defined (Mason 2009).

Smoking impairs wound healing after surgery (Haverstock 1998; Jorgensen 1998, Silverstein 1992; Sorensen 2002), and has been shown to increase the risk of anastomotic leakage after colorectal surgery (Sorensen 1999).

Shannon-Cain 2002 found that patients were not routinely informed of the risk of tobacco use or the potential of benefit of abstinence before surgery, and concluded that the preoperative period might be a window for smoking intervention. Owen 2007 found that patients were largely not referred preoperatively to smoking cessation services and that non-vascular surgeons underestimated the potential benefit of preoperative smoking cessation on postoperative outcome.

The potential reduction of complications would be related to the success rate of a preoperative smoking cessation intervention. Motivation for smoking cessation might be increased, if a potential reduction of complications is possible (Moller 2004; Thomsen 2009). On the other hand, some patients tend to be nervous immediately prior to and after surgery and might feel that they need to smoke during this period, in order to deal with the stress of impending surgery and waiting for the results of the surgery (Moller 2004; Thomsen 2009). Brief smoking intervention delivered within routine daily care may not be powerful enough to influence highly dependent smokers (Hajek 2002). More intensive interventions may be required (Rice 2008; Rigotti 2007).

A successful preoperative smoking intervention could potentially reduce perioperative complications and lead to long-term health gains if cessation were sustained.

OBJECTIVES

The objectives of this review were to assess the evidence for an effect of preoperative smoking intervention on smoking cessation at surgery and 12 months postoperatively, and on the incidence of postoperative complications.

METHODS

Criteria for considering studies for this review

Types of studies

Randomized controlled trials.

Types of participants

Smokers of any age, who are scheduled for elective surgery.

Types of interventions

Any preoperative intervention to help patients awaiting surgery to stop smoking. We considered any intervention, whether brief or more intensive, including both behavioural and pharmacological strategies, with or without face-to-face contact, provided at least 48 hours before the operation. Trials of intra-operative and postoperative smoking interventions were not considered. In this update to the review we categorised interventions into two subgroups according to intensity of counselling:

1. Intensive preoperative intervention consisting of weekly counselling sessions over a period of four to eight weeks.
2. Brief preoperative intervention provided in relation to routine preoperative evaluation and consisting of one face-to-face and/or telephone counselling session and/or interactive computer counselling or one letter about the risks of smoking in relation to surgery before surgery .

Types of outcome measures

Smoking cessation:

Prevalence of smoking cessation at the time of surgery, and 12 months postoperatively. We used the most conservative measure of quitting at surgery and at 12 months postoperatively, i.e. we preferred self-reported continuous abstinence to self-reported point prevalence abstinence.

Morbidity and mortality:

Wound-related complications; secondary surgery; cardiopulmonary complications; admission to intensive care; intra- and postoperative mortality; length of stay.

Search methods for identification of studies

The specialized register of the Cochrane Tobacco Addiction Group was searched using the topic related terms 'surgery' or 'operation' or 'operative' or 'anaesthesia' or 'anesthesia'. See the Specialized Register section of the [Tobacco Addiction Group Module](#) in the Cochrane Library for full details of search strategies for this resource. We conducted additional searches of MEDLINE, EMBASE and CINAHL combining topic related and smoking related keywords. See [Appendix 1](#) for full search strategies. The register and additional databases were last searched on 18 April 2010.

Data collection and analysis

Three authors (TT, AAM and NV) evaluated all references retrieved through electronic searches. All authors retrieved in full and appraised all relevant studies identified from abstracts. We resolved disagreement by consensus.

We reported the following information about each study in the table "Characteristics of Included Studies".

- Country; site
- Type of surgical procedure if reported
- Method of randomization and adequacy of concealment
- Number and characteristics of study participants
- Therapist types
- Description of experimental interventions, including timing and duration in relation to operation; description of control interventions
 - Outcomes: definition of smoking abstinence at each follow-up point, use of biochemical validation
 - Data on postoperative complications.

Evaluation of risk of bias

We evaluated studies according to the Cochrane Collaboration's tool for assessing risk of bias. Items in the Risk of Bias table were judged 'adequate' (yes), 'unclear', or having the 'potential for bias' (no) for each study. Blinding of participants in smoking cessation trials involving counselling is not possible, and complete blinding of personnel is considered difficult to uphold. We therefore judged blinding as adequate if outcome assessors were blinded.

Analysis of data

We have reported relevant outcomes in the text as percentages. For graphical display and pooling we have expressed the outcomes as

a risk ratio (RR). For beneficial outcomes a value greater than one indicates that the intervention is better than the control, that is, the rate of quitting is higher in the intervention than in the control group. For unfavourable outcomes such as wound infection, a value less than one indicates that the intervention is better, that is, risk of an unfavourable outcome is lower in the intervention group.

We calculated RRs for smoking cessation and postoperative complications using intention to treat and available-case analysis ([Higgins 2008](#)). For the smoking cessation outcome, we used as the denominators the number of patients randomized, excluding those whose surgery was cancelled or postponed, those who were erroneously included, those who withdrew from the trial immediately after randomization before receiving any intervention, and, finally, those who died. Those otherwise lost to follow up were assumed to be smokers ([Higgins 2008](#)). For the complications outcome we used data only on those whose results were known, using as the denominator the total number of people who had data recorded for the outcome in question.

Where it was appropriate to pool studies, we used the Mantel-Haenszel fixed-effect method for pooling RRs, with 95% confidence intervals. Two tests for heterogeneity were used: the chi squared test for heterogeneity, with $P < 0.1$ considered significant, and the I^2 statistic, with values above 75% interpreted as considerable heterogeneity ([Higgins 2008](#)). The I^2 statistic can be interpreted as the proportion of total variation observed between the studies attributable to differences between studies rather than to sampling error (chance) ([Higgins 2008](#)).

To assess the impact of missing data, we performed sensitivity analyses excluding trials with more than 20% drop-out. We also performed sensitivity analyses excluding trials that did not supplement self-reported smoking cessation with biochemical evaluation in order to explore any potential impact on smoking cessation at the time of surgery and at 12-month follow up.

There is evidence that high-intensity interventions support successful smoking cessation while briefer interventions have a non-significant effect on smoking cessation in hospitalised patients ([Rigotti 2007](#)). We further hypothesised that successful smoking cessation is a prerequisite for reducing complications. We therefore conducted exploratory subgroup analyses to assess potential differences in smoking cessation and postoperative complications in surgical patients receiving intensive versus brief preoperative interventions.

Earlier versions of this review reported effects as odds ratios. The Tobacco Addiction group now recommends the use of risk ratios as being easier to interpret.

RESULTS

Description of studies

See: [Characteristics of included studies](#); [Characteristics of excluded studies](#).

The search identified 15 potentially eligible randomized controlled studies. Eight trials conducted in Denmark, Australia, Canada, the UK and Sweden between 2002 and 2009 were included in the review. The update includes four new studies. Two studies had different outcomes reported in additional papers. [Moller 2002](#) reported long term follow up in [Villebro 2008](#), and [Lindström 2008](#) reported postoperative outcomes in [Sadr Azodi 2009](#). We report outcomes using the main study identifiers ([Moller 2002](#), [Lindström 2008](#)).

Drop-out rates in the included studies ranged from 1% to 29%. One study ([Ratner 2004](#)) had more than 20% drop-out.

Trial participants

[Moller 2002](#) enrolled 120 patients six to eight weeks before scheduled elective hip or knee joint replacement. [Sorensen 2003](#) enrolled 60 patients two to three weeks before colorectal surgery involving an enteric anastomosis. [Ratner 2004](#) enrolled 237 patients attending a presurgical assessment clinic one to three weeks prior to cardiovascular, ophthalmologic, plastic and urologic surgery. [Wolfenden 2005](#) enrolled 210 patients attending a preoperative clinic one to two weeks prior to non-cardiac surgery (nervous, ear, nose, throat, digestive, hepatobiliary, pancreas, musculoskeletal, connective tissue, skin, subcutaneous tissue, breast, gynaecologic systems). [Andrews 2006](#) enrolled 102 patients four weeks prior to elective surgery, the type of surgery was not specified. [Sorensen 2007](#) enrolled 180 patients at least four weeks prior to elective open incisional or inguinal day-case herniotomy. Additionally, they recruited another 64 people who smoked as a control group, some before and some after the trial period. The latter group is not included in the analyses because of the absence of randomization. [Lindström 2008](#) enrolled 117 patients at least four weeks prior to elective inguinal and umbilical hernia repair, laparoscopic cholecystectomy, or a hip or knee prosthesis. [Thomsen 2009](#) enrolled 130 patients at least one week prior to elective breast cancer surgery.

Interventions

Experimental interventions

In five trials, patients were offered face-to-face advice and counselling before surgery. This was supplemented by telephone calls, written materials and other aids in some cases (see also table "Characteristics of Included Studies" for further details). Nicotine replacement therapy was offered to all participants in these five trials ([Moller 2002](#); [Sorensen 2003](#); [Ratner 2004](#); [Lindström 2008](#); [Thomsen 2009](#)). [Moller 2002](#) counselled patients face-to-face on a weekly basis over a period of six to eight weeks. [Sorensen 2003](#)

called patients the day after expected smoking cessation, provided one counselling session before surgery and informed patients that they were free to call for additional telephone support during normal working hours. [Ratner 2004](#) offered one 15-minute face-to-face counselling session and provided patients with a telephone number to call for further assistance. [Lindström 2008](#) counselled patients either face-to-face or by telephone on a weekly basis over a period of four weeks. Additionally, patients were provided with the telephone number to a quitline. [Thomsen 2009](#) offered one counselling session lasting between 45-90 minutes. Three trials did not provide face-to-face counselling ([Wolfenden 2005](#); [Andrews 2006](#); [Sorensen 2007](#)). [Wolfenden 2005](#) offered one interactive counselling session lasting 17 minutes via computer, one telephone counselling call, and nursing and anaesthetic staff were prompted via computer to provide brief advice. Only patients who smoked more than 10 cigarettes per day (CPD) were offered NRT. [Andrews 2006](#) sent a letter stating that stopping smoking before surgery has huge benefits such as less time for recovery, lower chance of wound infection, and containing information on contact details of a smoking cessation service. [Sorensen 2007](#) counselled patients one month before surgery, either face-to-face in a 20-minute meeting, including advice to use NRT, or via a 10-minute long telephone reminder.

We have categorised the interventions with weekly face-to-face or telephone counselling over a period of four to eight weeks prior to surgery provided by [Moller 2002](#) and [Lindström 2008](#) as intensive; and interventions initiated in relation to routine preoperative evaluation of patients and consisting of one face-to-face and/or telephone counselling session and/or interactive computer counselling or letter about the risks of smoking in relation to surgery as brief ([Sorensen 2003](#); [Ratner 2004](#); [Wolfenden 2005](#); [Andrews 2006](#); [Sorensen 2007](#); [Thomsen 2009](#)).

Interventions were provided by research nurses/assistants in all but one study ([Andrews 2006](#)).

Control interventions

In [Moller 2002](#) and [Lindström 2008](#), control group patients received standard care with little or no information about smoking cessation or the potential harm of tobacco smoking. Control group patients in [Ratner 2004](#) received standard care with inconsistent and uncoordinated smoking cessation advice. [Andrews 2006](#); [Sorensen 2007](#) and [Thomsen 2009](#) gave control group patients standard advice about the risks of smoking in relation to surgery. [Wolfenden 2005](#) gave clinical staff the option to provide smoking cessation advice and prescribe NRT to control group patients. [Sorensen 2003](#) asked control group patients to maintain daily smoking habits.

Outcomes

Smoking cessation

Smoking cessation was defined as either self-reported point prevalence or self-reported continuous abstinence (see table “Characteristics of Included Studies” for further details). Smoking status was assessed at the time of surgery in all studies but one (Sorensen 2003). Sorensen 2003 did not distinguish between cessation and reduction; we have therefore not included these combined data in the review. Four studies assessed cessation at 12 months (Moller 2002; Ratner 2004; Lindström 2008; Thomsen 2009).

Postoperative/postoperative complications

Postoperative complications were defined as wound-related, cardiopulmonary and other complications requiring treatment. Five studies assessed complications of surgery (Moller 2002; Sorensen 2003; Sorensen 2007; Lindström 2008; Thomsen 2009).

Excluded studies

Of the possibly eligible studies, five were excluded because they involved preoperative smoking cessation interventions but did not use random allocation to intervention and control groups (Basler 1981; Haddock 1997; Munday 1993); Rissel 2000 used historical controls; Moore 2005 used a prospective cohort design. Three were excluded because the intervention was delivered in the postoperative period (Griebel 1998; Simon 1997; Wewers 1994). One study evaluated a training intervention for surgical residents and did not have patient-based outcomes (Steinemann 2005). One study evaluated a multicomponent intervention including drinking, obesity and physical activity in addition to smoking, and recruited both smokers and nonsmokers. Perioperative outcomes were not evaluated (McHugh 2001).

One study (Myles 2004) comparing bupropion to placebo for preoperative cessation was excluded because there were high levels of drop-out in each group, and only a small number of those who remained in the study were admitted for surgery within the six-month study period. Data on perioperative cessation and complications were available for only 20 of the 47 people originally randomized. Cessation rates and wound infection rates were low and similar in each group.

One study was excluded because the intervention consisted of the application of a nicotine patch immediately before surgery with no additional counselling (Warner 2005).

We listed Sadr Azodi 2009 and Villebro 2008 as excluded, but the outcomes reported in these papers are included under Lindström 2008 and Moller 2002 respectively.

Risk of bias in included studies

All studies reported a method for random sequence generation and allocation concealment that we judged adequate to avoid selection bias. Four studies reported blinding of assessors (Moller 2002;

Sorensen 2003; Ratner 2004; Wolfenden 2005). In the remaining four studies, outcome assessment was not regularly blinded; Andrews 2006 did not report using blinded outcome assessment; Sorensen 2007 used a study nurse to initially evaluate wound infections; Thomsen 2009 and Lindström 2008 used parallel blinded and unblinded outcome assessment. These studies may therefore be at some risk of detection bias. In all studies, smoking cessation was self-reported. Six studies validated self-reported smoking cessation with measurements of CO in exhaled air and/or cotinine in urine/saliva. Five of seven studies did so at the time of surgery (Moller 2002; ; Ratner 2004; Sorensen 2007; Lindström 2008; Thomsen 2009); two of four studies at 12-month follow up (Moller 2002; Ratner 2004). Moller 2002 however, only did so partly in patients participating in focus group interviews. All studies recruited participants on the basis of a convenience sample. Participation rates (i.e. the proportion of those eligible and approached who agreed to take part in the trial) were reported in all but one study (Andrews 2006), and ranged from 51% to 96%. Patients were similar across interventions in terms of baseline smoking data and comorbidity. Thomsen 2009 found a longer duration of surgery in intervention patients which may have introduced a difference between groups in postoperative complications.

Effects of interventions

Effect on smoking behaviours

Cessation at the time of surgery

In all studies but one (Sorensen 2007), the intervention achieved a significant increase in smoking cessation at the time of surgery. We identified substantial heterogeneity ($I^2 = 84\%$) amongst the seven studies testing the effect of intervening on smoking cessation at the time of surgery, so we did not consider pooling of all results appropriate. Heterogeneity was lower when we grouped the studies by the intensity of the intervention, therefore we pooled these subgroups Figure 1 (Analysis 1.1). The relative risk (RR) for smoking cessation at the time of surgery was 10.76 (95% CI 4.55 to 25.46, $I^2 = 0\%$) for intensive intervention. The relative effect was smaller, RR 1.41 (95% CI 1.22 to 1.63, $I^2 = 39\%$) for brief intervention. We suggest that differences in relative effects on smoking cessation at the time of surgery may be in part attributed to the intensity of the support given, and in part to the differing definitions of smoking cessation at the time of surgery. Because the absolute rates for smoking cessation and the definitions used were so varied we summarise them in Table 1. Excluding two trials (Wolfenden 2005; Andrews 2006) that had no biochemical validation of self-reported cessation did not substantively change the pooled estimate for brief intervention.

Figure 1. Effect of intervention on smoking cessation at time of surgery

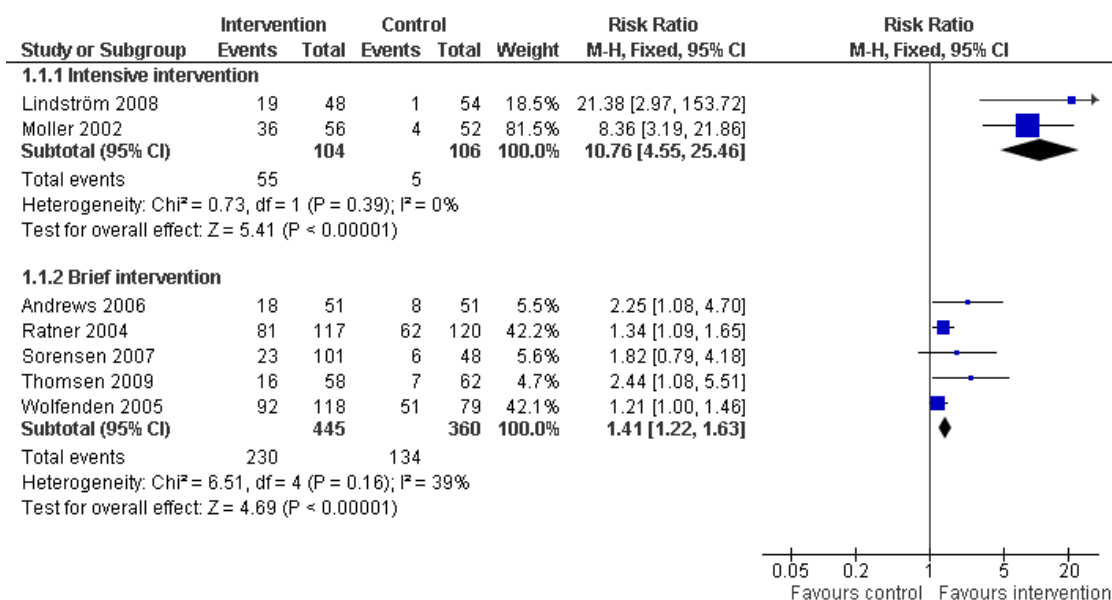


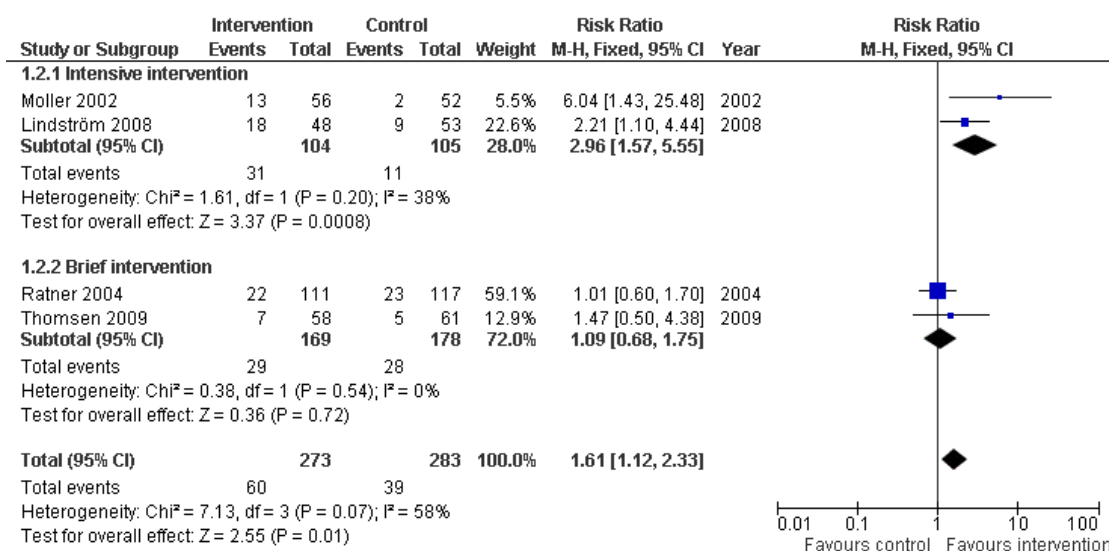
Table 1. Short term cessation outcomes

Study identifier	Intervention % quit	Control % quit	Abstinence Definition	Validation
Brief Intervention				
Ratner 2004	69%	52%	At least 24 hours before surgery	CO
Wolfenden 2005	78%	64%	At least 24 hours before surgery	None
Andrews 2006	35%	16%	No puff on day of surgery	None
Sorensen 2007	23%	12%	At least 1 month before surgery	Saliva cotinine
Thomsen 2009	28%	11%	From 2 days before to 10 days after surgery	CO
Intensive intervention				
Lindström 2008	39%	2%	From at least 3 weeks before surgery to 4 weeks after surgery	CO
Moller 2002	64%	7.7%	Continuous for at least 4 weeks prior to surgery	Weekly CO

Cessation postoperatively at 12-month follow up

Four of the eight studies monitored longer term postoperative cessation, i.e. smoking cessation at 12-month follow up [Figure 2 \(Analysis 1.2\)](#). The two trials of intensive interventions retained significantly higher quit rates in intervention versus control group patients; 23% versus 4% ([Moller 2002](#)), and 37% versus 17% ([Lindström 2008](#)). The pooled RR was 2.96 (95% CI 1.57 to 5.55) for intensive intervention. Quit rates in the remaining two studies decreased over time and significant differences between intervention and control groups were not maintained at 12 months; 20% versus 20% in [Ratner 2004](#); 12% versus 8% in [Thomsen 2009](#), pooled RR 1.09 (95% CI 0.68 to 1.75).

Figure 2. Effect of intervention on smoking cessation at 12-month follow up



Sensitivity analyses excluding Ratner 2004 which had over 20% loss to follow up, or excluding two studies that did not biochemically evaluate smoking cessation at 12-month follow up ([Lindström 2008](#); [Thomsen 2009](#)), did not substantially affect the subgroup estimates, but left only a small amount of data.

Effect on postoperative morbidity and mortality

Any complications

Five studies reported these outcomes. Two studies, both offering intensive preoperative smoking cessation interventions, found a

reduced incidence of postoperative complications. In [Moller 2002](#), 18% intervention versus 52% control patients developed any complication, (P = 0.0003). In [Lindström 2008](#), the corresponding figures were 21% versus 41%, (P = 0.03). The remaining three studies offered brief interventions ([Sorensen 2003](#); [Sorensen 2007](#); [Thomsen 2009](#)). None of these studies found significant differences between intervention and control patients in the incidence of postoperative complications. In [Sorensen 2003](#), 41% intervention versus 43% control patients developed any type of complication, in [Thomsen 2009](#) 61% intervention and 61% control patients. [Sorensen 2007](#) specifically monitored wound infections and did not detect any difference between the intervention and control

groups. The pooled RR for developing any postoperative complication was 0.70 (95% CI 0.56 to 0.88, [Figure 3, \(Analysis 2.1\)](#) and for any wound complication 0.70 (95% CI 0.51 to 0.95, [Figure 4, \(Analysis 2.2\)](#)). Pooling intensive and brief interventions separately, the RR for developing any complication was 0.42 (95% CI 0.27 to 0.65) using intensive interventions and 0.96 (95% CI 0.74 to 1.25) for brief interventions.

Figure 3. Effect of intervention on postoperative morbidity I: Any complication

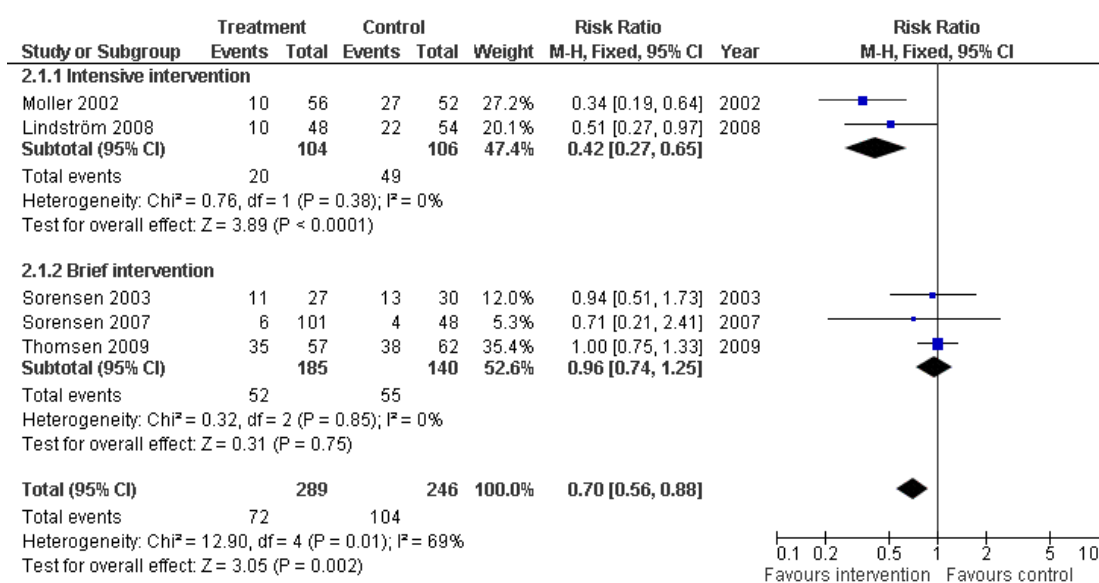
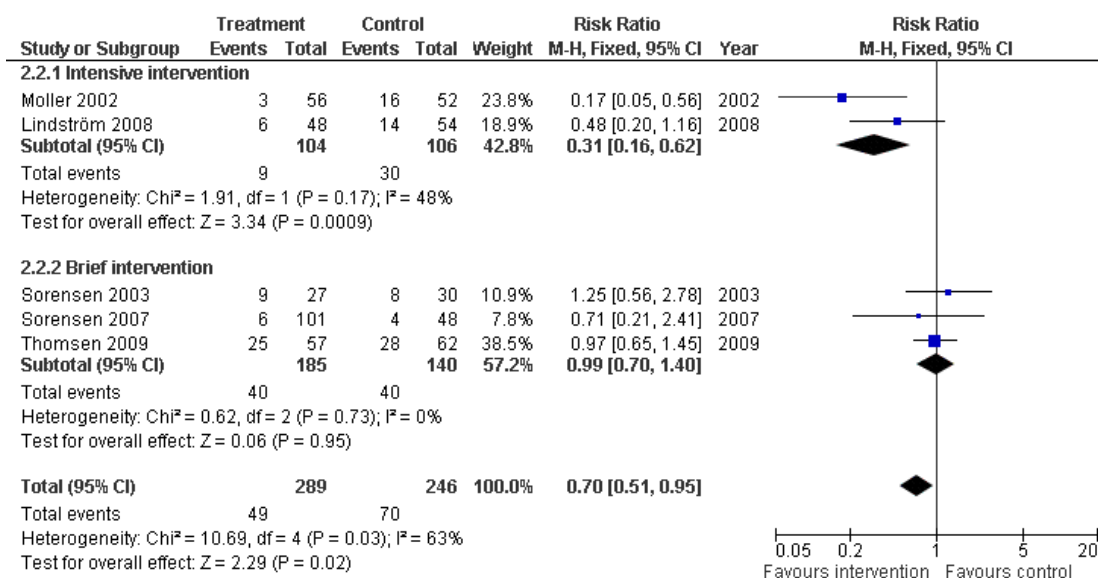


Figure 4. Effect of intervention on postoperative morbidity: 2. Wound complications



Wound complications

Moller 2002 found a significantly reduced incidence of wound-related complications in the intervention group (5% versus 31%, $P = 0.001$). Wound complications were divided into infections (positive culture and antibiotics prescribed), wound haematoma, and wound complication with subfascial involvement. Sorensen 2003 found non-significant differences in wound-related complications in 33% of the intervention group and 27% of the control group. In this study wound-related complications were divided into the following subgroups: anastomotic leakage, fascial dehiscence, wound infection, necrotic stoma, haematoma. Sorensen 2007 monitored wound infections as a secondary outcome and found no significant difference between intervention and control groups in the incidence of these (6% versus 8%).

Lindström 2008 likewise found no significant difference between intervention and control groups in the incidence of wound-related complications (13% versus 26%, $P = 0.13$). In this study, wound-related complications were divided into the following sub-groups: haematoma, wound infection, seroma, other wound complication requiring intervention. Thomsen 2009 found identical incidences of wound-related complications in intervention and control patients (44% versus 45%). Wound related complications were divided into the following subgroups: wound infection, haematoma, seroma, epidermolysis/necrosis requiring intervention.

Pooling studies according to intervention intensity the RR for wound complications was 0.31 (95% CI 0.16 to 0.62) for intensive intervention versus 0.99 (95% CI 0.70 to 1.40) for brief in-

tervention.

Other surgical outcomes

Secondary surgery was performed in 4% of the intervention group and in 15% of the control group patients in Moller 2002. In the intervention group, one patient had reposition of the prosthesis, and one patient had wound-related secondary surgery. In the control group seven patients (13%) had wound-related secondary surgery, and one patient had vascular-related secondary surgery. Although it is evident that some patients in Sorensen 2003 had secondary surgery, no data on this are given in the paper. Sorensen 2007 and Lindström 2008 did not report data on secondary surgery. Thomsen 2009 found no difference between groups in the need for secondary surgery due to complication; one patient in the intervention group due to haematoma versus no patients in the control group.

Cardiopulmonary complications

No studies detected significant differences between groups in regard to postoperative pulmonary or cardiovascular complications. Moller 2002 found two per cent intervention versus two per cent control group patients suffering from respiratory insufficiency, and zero per cent versus ten per cent suffering from cardiovascular insufficiency, needing either ventilatory support or cardiological treatment. Sorensen 2003 found 11% with pulmonary complications in the intervention group versus 16% in the control group.

No cardiac complications were recorded in this study. [Lindström 2008](#) found zero per cent with pulmonary complications in the intervention group versus two per cent in the control group, and two per cent with cardiovascular complications in both the intervention and control groups. [Thomsen 2009](#) found 30% with pulmonary complications in the intervention group versus 34% in the control group. Pulmonary complications were all minor, primarily desaturation requiring supplemental oxygen after transfer from the postoperative recovery room. Furthermore, [Thomsen 2009](#) found three per cent intervention patients with cardiovascular complications versus two per cent control patients.

Intensive care admittance

[Moller 2002](#) states the number of days spent in intensive care in the two groups as two days in the intervention group versus 32 days in the control group. The number of patients was not stated.

Length of stay

No studies detected significant differences in duration of hospital admission. Duration of hospital admission was 11 days (range 7 to 55) in the intervention group and 13 (range 8 to 65) in the control group in [Moller 2002](#). [Sorensen 2003](#) found that the median duration of hospital admission was 11 days in both groups (range 8 to 14). [Lindström 2008](#) reported a median duration of hospital admission of one day (range 0 to 10) for the intervention group versus one day for the control group (range 0 to 11). The corresponding numbers in [Thomsen 2009](#) were two days (range 1 to 7) in the intervention group versus three days (range 1 to 8) in the control group.

Mortality

There were two deaths in the control group during the perioperative period in [Sorensen 2003](#).

DISCUSSION

Two questions need to be answered in order to investigate the possible prevention of smoking-related postoperative complications. The first is whether preoperative smoking intervention reduces smoking by patients before surgery. The second is whether successful preoperative smoking cessation reduces the incidence of postoperative complications. This review includes eight studies addressing the first question but only five of them address the second. Of these five studies, two trials offering intensive smoking cessation interventions ([Moller 2002](#); [Lindström 2008](#)), one of which ([Moller 2002](#)), conducted by two of the authors of this review, achieved a large change in smoking behaviour in the intervention group, and a lower incidence of complications. Among

the remaining three trials offering brief interventions, one did not distinguish between smoking reduction and smoking cessation ([Sorensen 2003](#)); one had a non-significant effect on smoking cessation at the time of surgery ([Sorensen 2007](#)); and finally, one had a modestly significant effect on smoking cessation at the time of surgery ([Thomsen 2009](#)). The latter trial ([Thomsen 2009](#)) was also conducted by two of the authors of this review. None of the three trials ([Sorensen 2003](#); [Sorensen 2007](#); [Thomsen 2009](#)) identified an effect of brief intervention on postoperative complications. Exploratory subgroup analyses according to the intensity of the provided interventions suggest that differences between the studies in the intensity of the preoperative smoking cessation interventions might explain this. The smoking cessation intervention began six to eight weeks before scheduled surgery in [Moller 2002](#), and in [Lindström 2008](#) it began four weeks before surgery and continued for four weeks postoperatively. In [Sorensen 2003](#), patients were counselled two to three weeks before surgery; in [Sorensen 2007](#), a brief intervention was provided one month before surgery; and in [Thomsen 2009](#), patients received a brief intervention shortly before surgery. This suggests that intensive counselling is needed to support and sustain smoking cessation; furthermore that a longer period of abstinence is required to achieve a reduction in some, or all, types of complication. Based on indirect comparisons the effects of brief interventions are likely to be smaller than more intensive ones. Although no significant effects on postoperative complications or long-term cessation were detected, the confidence intervals do not exclude small effects of brief interventions on these outcomes. These comparisons between intensities are exploratory.

Pathophysiologically, smoking-induced reduction in lung function may be significantly improved by six to eight weeks smoking abstinence ([Buist 1976](#)). The smoking-related impairment of immune function may likewise be reversed by six to eight weeks of abstinence ([Beckers 1991](#); [Akrawi 1997](#)). These studies suggest that smoking cessation interventions are likely to be more beneficial when offered at least six weeks before surgery than in the immediate preoperative period, if possible. This parallels the results of this review. Intensive intervention for four to eight weeks preoperatively, including provision of NRT, supported smoking cessation and reduced postoperative complications. [Rigotti 2007](#) concluded similarly in a review of the effect of smoking interventions on smoking cessation in hospitalized patients. Such interventions may, however, be difficult to achieve unless there is a partnership between surgical services and other branches of the health service, particularly primary care.

The interventions were tested in heterogeneous surgical populations which increases the external validity of the review. However, different surgical procedures and underlying pathologies may have diverse impacts on the incidence of postoperative complications and on motivation for and ability to stop smoking. This might have influenced the type of complications likely to occur as well as smoking cessation rates.

The studies were overall assessed to be at low risk of bias. However, assessment of postoperative complications may have been subject to intra- and interobserver variation (Bruce 2001). Differences between studies in definitions of postoperative complications and smoking cessation, specifically smoking cessation at the time of surgery, may be a potential source of heterogeneity affecting the strength of the conclusions that can be drawn. Interventions were furthermore primarily provided by research nurses or assistants specifically allocated to this task. This raises the question of whether intervention effects will persist when administered by staff within routine clinical settings.

The studies were conducted between 2002 and 2009. Within this time range, attitudes to smoking have changed and many countries, and hence hospitals, have implemented restrictive smoking policies, including those from which the studies originate. This may have influenced control interventions in the more recent studies with control patients receiving brief cessation advice and NRT (Wolfenden 2005; Sorensen 2007; Thomsen 2009). This could potentially have rendered the relative additional effect of brief interventions smaller, thus making detection of any incremental benefit more difficult. Small sample sizes may further make the detection of smaller, but potentially clinically important, intervention effects difficult.

The validity of using composite outcomes to assess the effect of smoking intervention on postoperative morbidity is also debatable (Montori 2005). Two studies (Moller 2002; Lindström 2008) identified a significant effect on composite outcomes for postoperative complications and wound complications. When assessing intervention effects, careful consideration should be given to those complications comprising the composite outcomes that are of clinical significance and greatest importance to patients (Montori 2005).

The results support that interventions that help people to stop smoking in other settings also work in perioperative patients. These include measures to increase motivation and treat nicotine dependence, and intensive behavioural support (Rigotti 2007) and, nicotine replacement therapy (Stead 2008).

Whether the perioperative period is a particularly suitable time for smoking interventions, however, warrants further investigation. Schwartz 1987 demonstrated that patients may be more likely to comply with smoking cessation advice during the time of an acute illness. Recently Shi 2010 reported an association between undergoing surgery and an increased likelihood for smoking cessation in older US citizens, specifically the association was strong for patients undergoing major surgery. Patients reported that the possibility of reducing perceived vulnerability to postoperative complications promoted motivation to quit or reduce smoking prior to operation (Moller 2004; Thomsen 2009). Lindström 2010 found that patients randomized to the control intervention were disappointed with this allocation. On the other hand, some smokers

found it more difficult to quit when facing the stress of an operation (Moller 2004; Thomsen 2009). Two studies recruited substantially fewer patients than planned (Lindström 2008; Sorensen 2003), and Thomsen 2009 recruited only 51% of eligible patients. This may reflect a lack of motivation among some smokers to stop smoking in relation to surgery.

None of the studies included in this review reported any adverse effects of preoperative smoking intervention. It has been claimed that recent quitters may suffer from pulmonary symptoms such as cough and sputum production, but we could find no evidence about the relevance of this to surgical patients.

AUTHORS' CONCLUSIONS

Implications for practice

The results of this updated review indicate that preoperative smoking intervention is beneficial for changing smoking behaviour perioperatively and in the long term, and for reducing the incidence of complications. Exploratory subgroup analyses of two smaller trials suggest that intensive intervention over a period of four to eight weeks before surgery and including NRT, may support smoking cessation and reduce postoperative morbidity. Six trials testing brief interventions, on the other hand, increased smoking cessation at the time of surgery but failed to detect a statistically significant effect on postoperative morbidity.

Based on this evidence, intensive interventions for 4-8 weeks before surgery, and including NRT, appear relevant for patients scheduled to undergo surgery 4 weeks or more after diagnosis. We suggest that smokers scheduled for surgery less than 4 weeks after diagnosis, like all smokers, be advised to quit and offered effective interventions, including behavioural support and pharmacotherapy.

Implications for research

We need to establish the effect on postoperative morbidity and smoking cessation of interventions that are initiated immediately before or after surgery and continued for at least eight weeks. The effect on postoperative complications of intensive interventions before higher morbidity surgical procedures, for example upper abdominal and thoracic surgery, also needs to be established. We furthermore need to know how preoperative smoking intervention affects long-term smoking abstinence rates, so future studies should include at least 12-month follow up. In addition we need to evaluate the effect of different methods of smoking intervention, including other pharmacotherapies than NRT (Cahill 2008; Hughes 2007) in order to find the most effective way of supporting smoking cessation in surgical patients. Finally, the perspectives of smokers who decline to participate in smoking cessation trials in relation to surgery warrant research.

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* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies [ordered by study ID]

Andrews 2006

Methods	Country: United Kingdom Randomized controlled trial	
Participants	102 smoking patients (51 intervention, 51 control) routinely attending the preoperative ward 4 weeks before surgery. The types of surgery were not specified.	
Interventions	Intervention: In addition to booklet and nurse advice given to all patients when they are routinely seen 4 weeks prior to surgery, intervention group patients received a letter from the patient's consultant stating that stopping smoking 1-2 weeks before surgery has huge benefits. Patients were furthermore provided with contact details for Stop Smoking Service. Control: Booklet and nurse advice	
Outcomes	Self-reported abstinence from smoking, defined as not smoking a single puff on the day of surgery. No biochemical confirmation of smoking status.	
Notes	Smoking cessation defined as point prevalence	
Risk of bias		
Item	Authors' judgement	Description
Adequate sequence generation?	Yes	Numbers drawn from opaque bag
Allocation concealment?	Yes	"Each patient agreeing to participate on the pre-operative ward that day was numbered sequentially. The corresponding numbers were put in an opaque bag and the first number drawn out was assigned to intervention status." Although this system is open to manipulation we did not judge the risk of bias to be high in this study.
Blinding? All outcomes	No	No blinding of participants or personnel, assessors of smoking status not stated as blinded,
Incomplete outcome data addressed? All outcomes	Yes	All intervention group patients completed, 1/51 missing from control group
Free of selective reporting?	Yes	All outcomes as pre-specified in the article are reported.

Andrews 2006 (Continued)

Free of other bias?	Yes
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Lindström 2008

Methods	Country: Sweden Randomized controlled trial
Participants	117 daily smokers undergoing elective surgery for primary hernia repair, laparoscopic cholecystectomy and hip or knee prosthesis.
Interventions	Intervention: weekly sessions, face-to-face or by telephone, with a trained smoking cessation counsellor and NRT 4 weeks pre- and 4 weeks postoperatively. Control: Standard care
Outcomes	Smoking cessation from 3 weeks before to four weeks after surgery Postoperative complications requiring intervention within 30 days postoperatively; Wound complications requiring intervention within 30 days postoperatively.
Notes	Smoking cessation was validated by CO in exhaled air.

Risk of bias

Item	Authors' judgement	Description
Adequate sequence generation?	Yes	Stratified block randomization
Allocation concealment?	Yes	Opaque sealed envelopes
Blinding? All outcomes	No	Outcomes assessed by study nurses who were not blinded and by the study physicians who were unaware of group allocation; no blinding of participants or personnel
Incomplete outcome data addressed? All outcomes	Yes	No losses to 30-day follow-up. 7/48 intervention and 3/54 controls lost to 12-month follow up.
Free of selective reporting?	Yes	Reports all pre-specified outcomes.
Free of other bias?	Yes	

Moller 2002

Methods	Country: Denmark Randomized controlled trial
Participants	120 daily smokers (60 intervention, 60 control) who underwent elective hip or knee replacement surgery.
Interventions	Intervention: Weekly meetings initiated 6-8 weeks prior to surgery. Personalised nicotine substitution schedule. Patients were strongly encouraged to stop smoking but also had the option to reduce tobacco consumption by at least 50%. Advice about smoking cessation/reduction, benefits, side-effects, how to manage withdrawal symptoms, and how to keep weight gain to a minimum. Patients could also discuss other issues related to smoking intervention or hospitalisation. The intervention was provided by a research nurse trained as a smoking cessation counsellor. Control: Standard care which was little or no information about the risks of tobacco smoking or smoking cessation counselling.
Outcomes	Smoking cessation before surgery, 4 weeks after surgery and 1 year after surgery. Outcome assessor blinded; long-term smoking cessation was validated in those who participated in focus group interviews by measurements of CO in exhaled air.
Notes	Randomized participants who did not have surgery are not included in denominators; long term cessation is reported in Villebro et al 2008 and included in the text and analyses under this study identifier.

Risk of bias

Item	Authors' judgement	Description
Adequate sequence generation?	Yes	Stratified block randomization
Allocation concealment?	Yes	Opaque sealed envelopes
Blinding? All outcomes	Yes	Blinded outcome assessment; no blinding of participants or personnel
Incomplete outcome data addressed? All outcomes	Yes	4/60 intervention patients and 8/60 control patients missing due to cancellation of surgery; 0/56 intervention and 11/52 controls were missing at 1-year follow-up.
Free of selective reporting?	Yes	All outcomes as prespecified in the article are reported.
Free of other bias?	Yes	

Ratner 2004

Methods	Country: Canada Randomized controlled trial
Participants	237 patients awaiting surgery; 228 assessed postoperatively, 202 at 6 months, 169 at 12 months.
Interventions	Intervention: One ; 15 min face-to-face counselling from a trained study nurse 1-3 weeks before surgery and written materials, nicotine gum, quit kit, hotline number. Post -op counselling in hospital and via telephone. Control: usual care
Outcomes	Smoking cessation (abstinence for at least 24 hours before surgery, 6 months, 12 months) Validated by CO (face-to-face) or urine cotinine Post-op complications not assessed
Notes	

Risk of bias

Item	Authors' judgement	Description
Adequate sequence generation?	Yes	Computer-generated
Allocation concealment?	Yes	Sealed envelopes with computer-generated random allocation
Blinding? All outcomes	Yes	Blinded assessment of smoking status; No blinding of participants, not stated whether personnel were blinded.
Incomplete outcome data addressed? All outcomes	Yes	24/117 intervention patients and 11/120 control patients missing at 6-month follow up; 36/117 and 32/120 control patients missing at 12-month follow up.
Free of selective reporting?	Yes	All primary and secondary outcomes as pre-specified in the article are reported.
Free of other bias?	Unclear	50% of participants returned nicometer strips at 6-month follow up, 45% returned nicometer strips at 12-month follow up.

Sorensen 2003

Methods	Country: Denmark Randomized controlled trial
Participants	60 patients awaiting colorectal surgery. 57 completed, 3 withdrew from intervention group.
Interventions	Intervention: Initiated 15 days (inter quartile range 8-24) before surgery from a research nurse. One telephone support call + one additional support session + telephone number to research nurses during normal working hours. NRT available up to 24 hours before surgery. Control: told to continue smoking.
Outcomes	Smoking cessation defined as abstaining or reduction by more than half of daily tobacco smoking on day before surgery, at suture removal, validated by CO and cotinine; post-op complications up to 30 days requiring medical or surgical intervention
Notes	The authors did not distinguish between smoking cessation and reduction so smoking cessation outcomes are not included in the review.

Risk of bias

Item	Authors' judgement	Description
Adequate sequence generation?	Yes	Randomized, envelopes in blocks of 10
Allocation concealment?	Unclear	Sealed, opaque envelopes
Blinding? All outcomes	Yes	Primary outcome assessed by blinded assessor; no blinding of participants or personnel
Incomplete outcome data addressed? All outcomes	Yes	3/30 intervention patients and 0/30 control patients missing at 30 days follow-up.
Free of selective reporting?	Yes	All outcomes as prespecified in the article are reported.
Free of other bias?	Yes	

Sorensen 2007

Methods	Country: Denmark Randomized controlled trial with a supplemental non-randomized consecutive group of smokers
Participants	244 patients: 180 patients who were daily smokers and scheduled for elective open incisional or inguinal day-case herniotomy randomized to one of 2 interventions or control; 64 consecutive, non-randomized control group patients who were daily smokers and

Sorensen 2007 (Continued)

	who underwent inguinal or incisional herniotomy without advice to quit smoking. 46 of these patients were recruited prior to the trial period, 18 were recruited 3 months after the trial period.
Interventions	Interventions: 1) Standard advice + one telephone reminder to stop smoking (10 min conversation with a study nurse) 1 month before surgery 2) Standard advice + one reminder to stop smoking in the outpatient clinic 1 month before surgery (face-to-face counselling for 20 minutes with a study nurse) including NRT until 24 hrs before surgery. Control: Standard advice to stop smoking at least 1 month before surgery and until removal of skin sutures 10 days after surgery; non-randomized, consecutive historical control received no advice to stop smoking (data from this group are not included in the review).
Outcomes	Self-reported smoking on day of surgery, day of skin suture removal and at 3-month follow up validated by CO in expired air at all contacts with the study nurse, sputum cotinine on the day of surgery. Postoperative complications defined as swollen, red, hot, painful wound with or without pus discharge and postoperative clinical intervention including antibiotics, extensive wound care or re-operation. LASA-scale to assess patients' motivation for smoking cessation.
Notes	The 64 consecutive, non-randomized control group patients are not included in the meta-analyses. Patients receiving standard advice to stop smoking are included as a control group. Patients receiving interventions 1 and 2 are pooled and included as an intervention group.

Risk of bias

Item	Authors' judgement	Description
Adequate sequence generation?	Yes	Computer-generated random numbers
Allocation concealment?	Yes	Sealed, opaque, consecutively arranged envelopes
Blinding? All outcomes	No	Self-reported smoking status validated by CO/cotinine measurements administered by the study nurse Postoperative wound infection initially assessed by the study nurse and in the event of clinical signs of infection referred for further blinded assessment; no blinding of participants or personnel.
Incomplete outcome data addressed? All outcomes	Yes	19/120 intervention patients and 12/60 intervention patients missing at 3-month fol-

Sorensen 2007 (Continued)

		low up. Reasons for withdrawal reported but not related to the specific interventions. Drop-out analysis showed no significant difference between those who dropped out or had their surgery cancelled and the included patients - these data are not shown.
Free of selective reporting?	Yes	All outcomes as prespecified in the article are reported.
Free of other bias?	Yes	

Thomsen 2009

Methods	Country: Denmark Randomized controlled trial
Participants	130 smoking women scheduled for breast cancer surgery
Interventions	Intervention: One-time intervention 3-7 days before surgery including counselling from a study nurse using the principles of motivational interviewing and including NRT (45-90 minutes duration); standard care: Standard preoperative information + info that control patients were free to access smoking cessation support if they wished.
Outcomes	Postoperative complications defined as death or postoperative morbidity requiring treatment within 30 days after surgery. Short-term smoking cessation defined as continuous abstinence from 2 days before to 10 days after surgery supplemented by measurements of exhaled CO on the day of surgery and again 10 days postoperatively. Long-term smoking cessation defined as continuous abstinence from 2 days before surgery to 12 months postoperatively.
Notes	

Risk of bias

Item	Authors' judgement	Description
Adequate sequence generation?	Yes	Shuffling envelopes in blocks varying in size from 4-10
Allocation concealment?	Yes	Opaque sealed envelopes
Blinding? All outcomes	No	Parallel blinded and unblinded assessment of primary outcome; smoking cessation evaluated by blinded assessors; no blinding of participants and blinding of personnel difficult to uphold

Thomsen 2009 (Continued)

Incomplete outcome data addressed? All outcomes	Yes	10/65 intervention patients and 7/65 control patients were missing at 12-month follow up.
Free of selective reporting?	Yes	All outcomes as prespecified in the article are reported.
Free of other bias?	Unclear	Duration of surgery bordered on being significantly longer in intervention patients.

Wolfenden 2005

Methods	Country: Australia Randomized controlled trial
Participants	210 patients awaiting surgery, 197 included in preoperative assessment.
Interventions	Intervention: 1-2 weeks before surgery one interactive counselling session lasting 17 minutes via computer, one telephone counselling, and nursing and anaesthetic staff were prompted via computer to provide intervention patients with brief advice. NRT in the dependent group (>10 CPD); Control group: staff could provide advice and NRT at their discretion.
Outcomes	Smoking cessation, for >24 hr before admission, at 3-month follow up. No validation. Outcomes reported to a blinded assessor at 3 months; post-op complications not assessed.
Notes	13 randomized participants who did not have surgery are not included in denominators for perioperative abstinence.

Risk of bias

Item	Authors' judgement	Description
Adequate sequence generation?	Yes	Computer random number generator
Allocation concealment?	Yes	Web-based randomisation
Blinding? All outcomes	Yes	Primary and secondary outcomes assessed by blinded assessor; personnel and patients not blinded to group allocation.
Incomplete outcome data addressed? All outcomes	Yes	16/124 intervention and 10/86 control group patients missing at 3-month follow up.

Wolfenden 2005 (Continued)

Free of selective reporting?	Yes	All outcomes as pre-specified in the article are reported.
Free of other bias?	Yes	

CO: carbon monoxide

CPD: cigarettes per day

NRT: nicotine replacement therapy

Characteristics of excluded studies [ordered by study ID]

Basler 1981	Patient allocation not randomized.
Griebel 1998	Intervention takes place during the course of postoperative recovery.
Haddock 1997	Quasi-experimental design.
McHugh 2001	Not all patients allocated to treatment and control group were smokers. The intervention was directed not only at smoking habits, but also drinking habits, obesity, physical activity etc.
Moore 2005	Not a randomized trial. Compared perioperative complication rates between non smokers and smokers who received a perisurgical cessation programme using a prospective cohort design.
Munday 1993	Patient allocation not randomized.
Myles 2004	Outcome assessment not immediately prior to surgery. Change of protocol within the study.
Rissel 2000	Historical controls.
Sadr Azodi 2009	Reports long term outcomes from Lindström 2008. Outcomes included in review under Lindström 2008 study identifier.
Simon 1997	Intervention postoperative, not preoperative.
Sorensen 2003b	Not a clinical trial - experimental test of surgical procedures on volunteers.
Steinemann 2005	Intervention was training of surgical residents. No patient-related outcomes assessed.
Villebro 2008	Reports long term outcomes from Moller 2002. Outcomes included in review under Moller 2002 study identifier.
Warner 2005	Intervention consisted of a nicotine patch applied immediately prior to surgery with no additional counselling or support.

(Continued)

Wewers 1994	Intervention postoperative, not preoperative.
Yang 2003	Commentary on Sorensen 2003b.

DATA AND ANALYSES

Comparison 1. Effect of intervention on smoking behaviour

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Smoking cessation at time of surgery	7		Risk Ratio (M-H, Fixed, 95% CI)	Subtotals only
1.1 Intensive intervention	2	210	Risk Ratio (M-H, Fixed, 95% CI)	10.76 [4.55, 25.46]
1.2 Brief intervention	5	805	Risk Ratio (M-H, Fixed, 95% CI)	1.41 [1.22, 1.63]
2 Smoking cessation at 12-month follow up	4	556	Risk Ratio (M-H, Fixed, 95% CI)	1.61 [1.12, 2.33]
2.1 Intensive intervention	2	209	Risk Ratio (M-H, Fixed, 95% CI)	2.96 [1.57, 5.55]
2.2 Brief intervention	2	347	Risk Ratio (M-H, Fixed, 95% CI)	1.09 [0.68, 1.75]

Comparison 2. Effect of intervention on postoperative morbidity

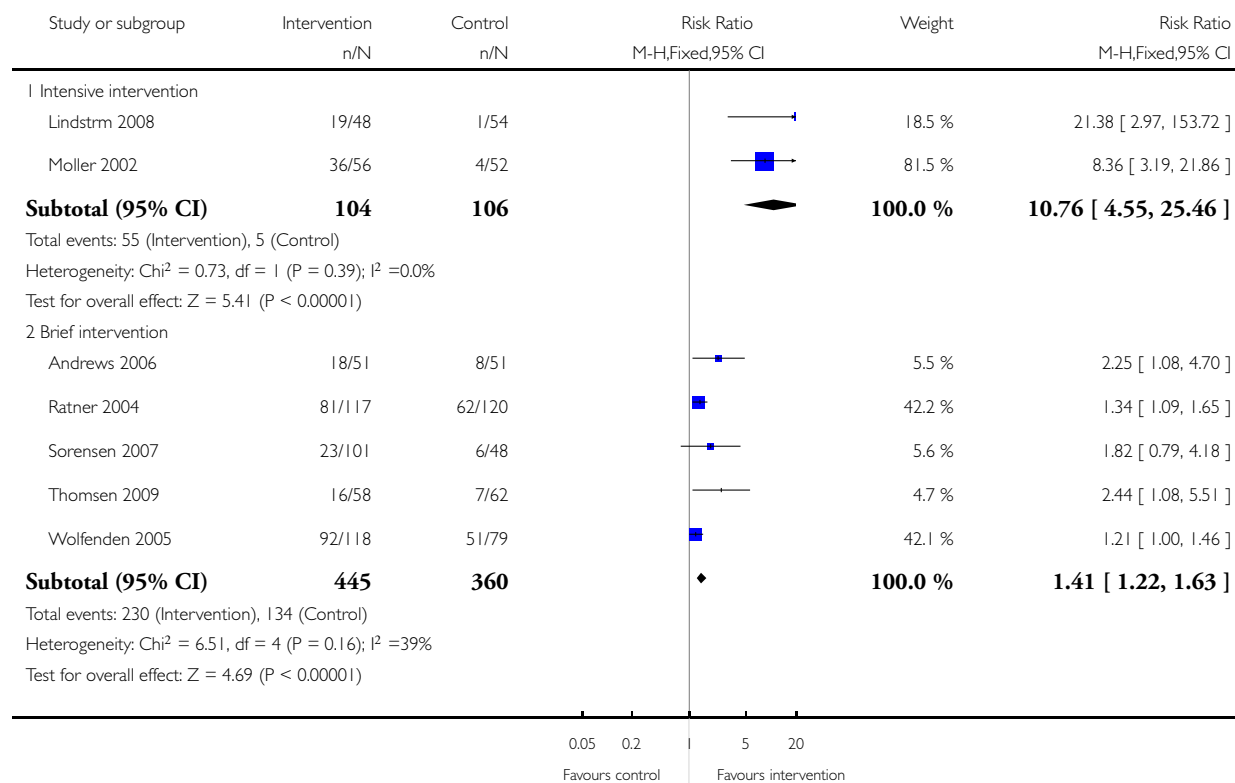
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Any complication	5	535	Risk Ratio (M-H, Fixed, 95% CI)	0.70 [0.56, 0.88]
1.1 Intensive intervention	2	210	Risk Ratio (M-H, Fixed, 95% CI)	0.42 [0.27, 0.65]
1.2 Brief intervention	3	325	Risk Ratio (M-H, Fixed, 95% CI)	0.96 [0.74, 1.25]
2 Wound complications	5	535	Risk Ratio (M-H, Fixed, 95% CI)	0.70 [0.51, 0.95]
2.1 Intensive intervention	2	210	Risk Ratio (M-H, Fixed, 95% CI)	0.31 [0.16, 0.62]
2.2 Brief intervention	3	325	Risk Ratio (M-H, Fixed, 95% CI)	0.99 [0.70, 1.40]

Analysis 1.1. Comparison 1 Effect of intervention on smoking behaviour, Outcome 1 Smoking cessation at time of surgery.

Review: Interventions for preoperative smoking cessation

Comparison: 1 Effect of intervention on smoking behaviour

Outcome: 1 Smoking cessation at time of surgery

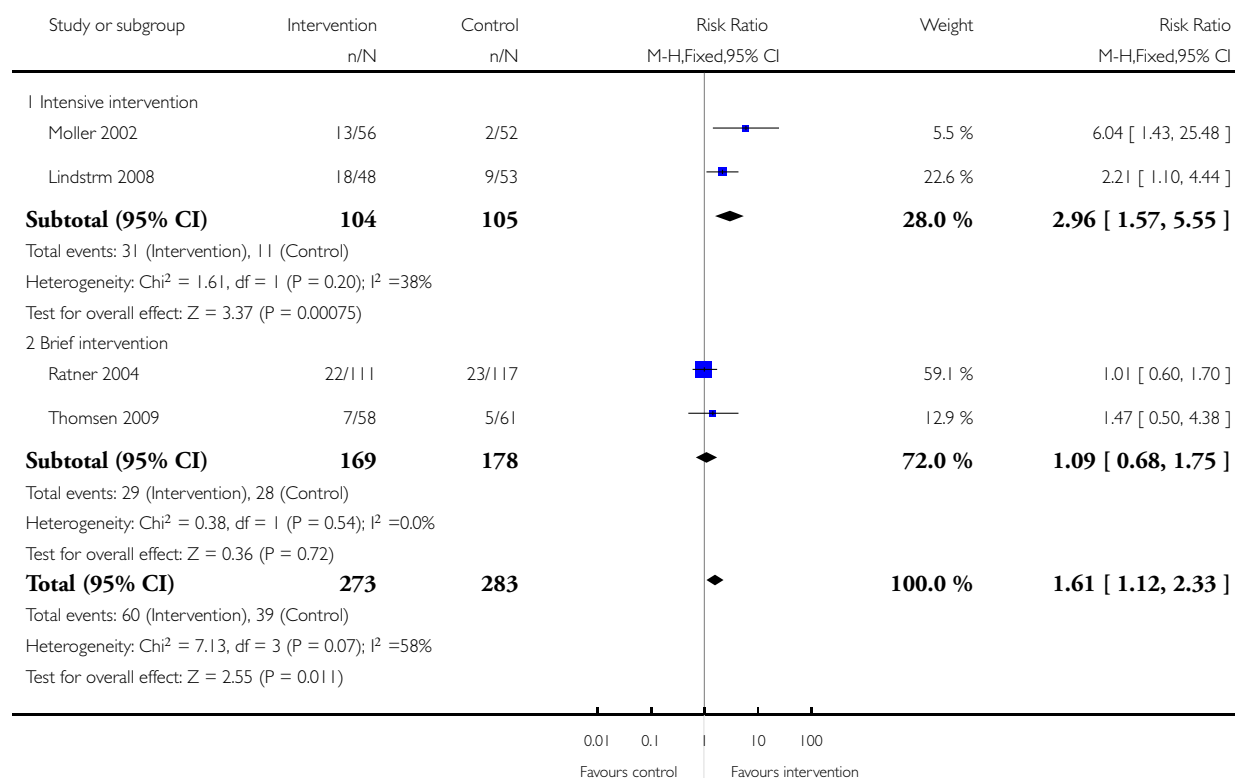


Analysis 1.2. Comparison 1 Effect of intervention on smoking behaviour, Outcome 2 Smoking cessation at 12-month follow up.

Review: Interventions for preoperative smoking cessation

Comparison: 1 Effect of intervention on smoking behaviour

Outcome: 2 Smoking cessation at 12-month follow up

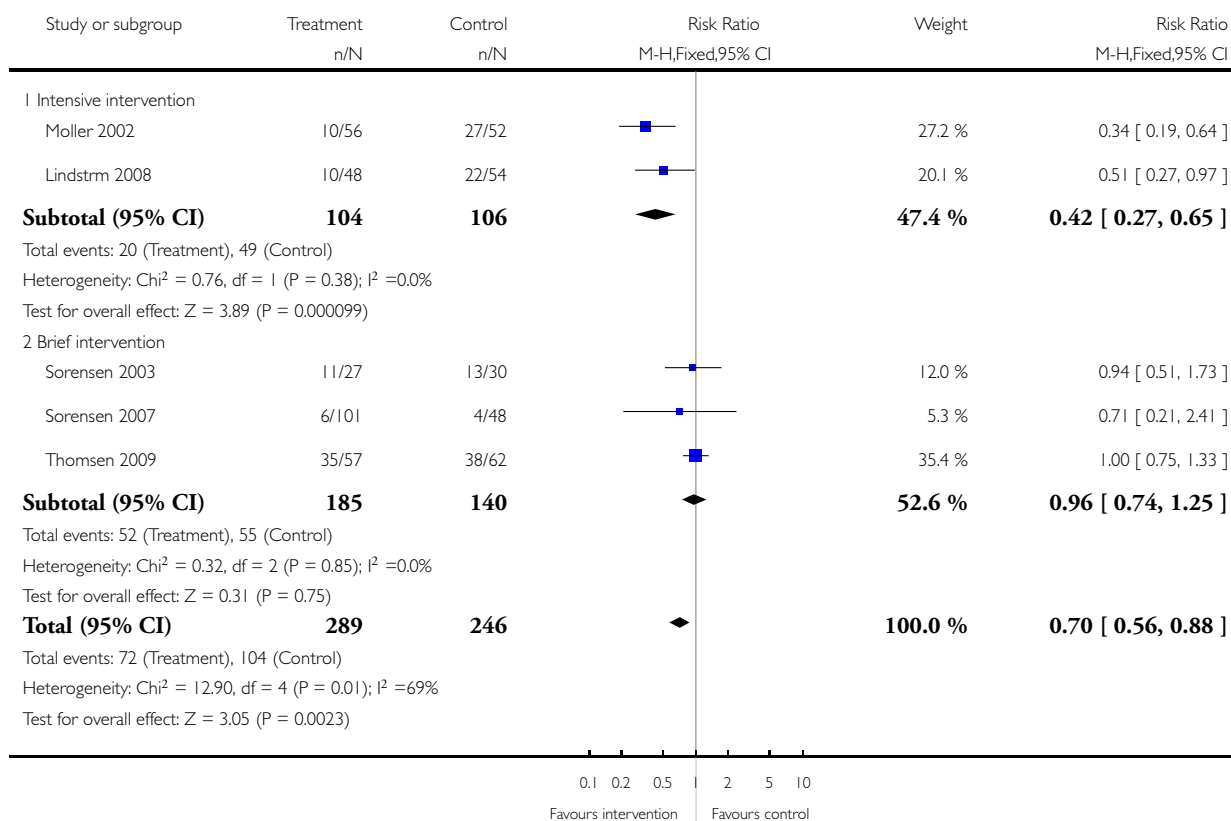


Analysis 2.1. Comparison 2 Effect of intervention on postoperative morbidity, Outcome 1 Any complication.

Review: Interventions for preoperative smoking cessation

Comparison: 2 Effect of intervention on postoperative morbidity

Outcome: 1 Any complication

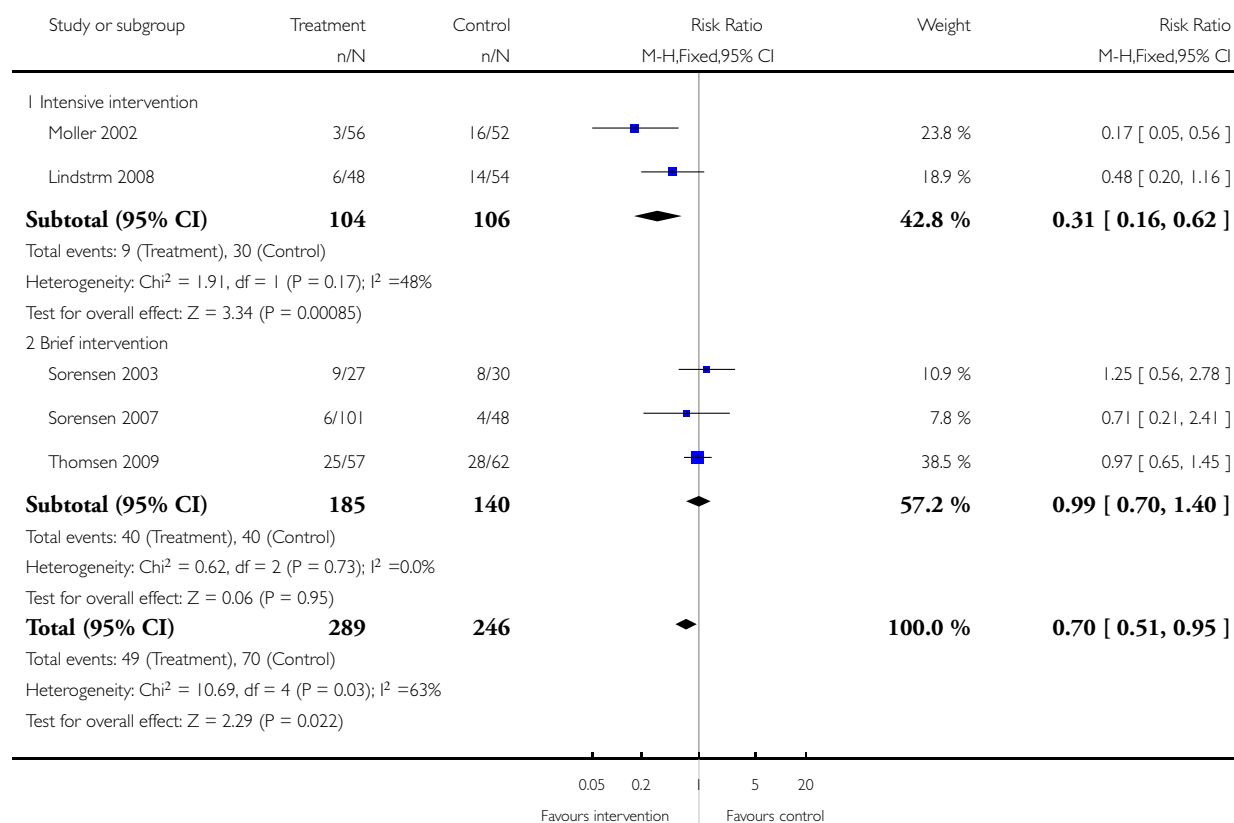


Analysis 2.2. Comparison 2 Effect of intervention on postoperative morbidity, Outcome 2 Wound complications.

Review: Interventions for preoperative smoking cessation

Comparison: 2 Effect of intervention on postoperative morbidity

Outcome: 2 Wound complications



APPENDICES

Appendix I. MEDLINE, EMBASE & CINAHL search strategies

MEDLINE STRATEGY (via OVIDSP)

1. RANDOMIZED-CONTROLLED-TRIAL.pt.
2. CONTROLLED-CLINICAL-TRIAL.pt.
3. CLINICAL-TRIAL.pt.
4. exp Clinical Trial/
5. Random-Allocation/
6. randomized-controlled trials/
7. smoking cessation.mp. or exp Smoking Cessation/
8. "Tobacco-Use-Cessation"/
9. "Tobacco-Use-Disorder"/
10. exp Smoking/pc, th [Prevention & Control, Therapy]
11. (surgery or operation or operativ: or an?esthesia).mp. [mp=title, original title, abstract, name of substance word, subject heading word, unique identifier]
12. exp Postoperative complication/
13. exp Preoperative care/
14. exp Patient education/
15. 12 and (13 or 14)
16. 11 or 15 [topic related terms]
17. 1 or 2 or 3 or 4 or 5 or 6 [design terms]
18. 8 or 7 or 9 or 10 [smoking terms]
19. 16 and 17 and 18

EMBASE STRATEGY (via OVIDSP)

1. smoking cessation.mp. or Smoking Cessation/
2. smoking/
3. ((smok* or tobacco or cigar*) adj3 (stop* or quit* or giv* or refrain* or reduc*)).mp. [mp=title, original title, abstract, name of substance word, subject heading word, unique identifier]
4. 1 or (2 and 3)
5. (surgery or surgical or operation or operativ* or preoperativ* or an?esthesia).ti,an,de.
6. 4 and 5

CINAHL STRATEGY

1. "Smoking-Cessation" OR "Smoking-Cessation-Programs" OR "Smoking"/ prevention-and-control OR (smoking cessation) OR ((smok* or tobacco or cigar*) near (stop* or quit*))
2. surgery or operation or operativ* or an?esthesia
3. #1 AND #2

WHAT'S NEW

Last assessed as up-to-date: 9 May 2010.

18 May 2010	New citation required and conclusions have changed	Updated for Issue 7, 2010 with 4 new trials and clearer evidence on short-term outcomes. Change to authorship.
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HISTORY

Protocol first published: Issue 3, 2000

Review first published: Issue 2, 2001

3 September 2008	Amended	Converted to new review format.
17 May 2005	New citation required and minor changes	Four new trials included.

CONTRIBUTIONS OF AUTHORS

In the updated version Lindsay Stead did the searches and AMM, NV and TT scanned for retrieval of relevant studies and evaluated the identified studies. AMM, NV and TT extracted data and wrote the review.

In the updated version NV and AMM did searches, scanned the results for relevant studies and evaluated the studies found.

AMM and NV did data extraction and wrote the review.

Tom Pedersen was an author of the first version.

DECLARATIONS OF INTEREST

The authors of the review are also authors of two of the included trials ([Moller 2002](#); [Thomsen 2009](#)).

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

In updating the review in 2010 we introduced subgroup analyses of intervention effects on smoking cessation and postoperative complications according to the intensity of interventions. Additionally, we have used sensitivity analyses to assess the impact of studies with high drop-out rates and lacking biochemical evaluation of self-reported smoking cessation.

INDEX TERMS

Medical Subject Headings (MeSH)

*Smoking Cessation; Intraoperative Complications [*prevention & control]; Postoperative Complications [*prevention & control]; Preoperative Care; Randomized Controlled Trials as Topic; Smoking [adverse effects]

MeSH check words

Humans