ORIGINAL ARTICLE

Intravenous and nebulised magnesium sulphate for acute asthma: systematic review and meta-analysis

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Objectives: To estimate the effect of intravenous and nebulised magnesium sulphate upon hospital admissions and pulmonary function in adults and children with acute asthma.

Methods: We undertook a systematic review and meta-analysis of randomised and quasi-randomised trials of intravenous or nebulised magnesium sulphate in acute asthma. Trials were identified by searches of the electronic literature, relevant journal websites and conference proceedings, and contact with authors and experts. Data were pooled using random effects meta-analysis of the relative risk (RR) of hospital admission and the standardised mean difference (SMD) in pulmonary function.

Results: 24 studies (15 intravenous, 9 nebulised) incorporating 1669 patients were included. Intravenous treatment was associated in adults with weak evidence of an effect upon respiratory function (SMD 0.25, 95% confidence interval (CI) −0.01 to 0.51; p = 0.05), but no significant effect upon hospital admission (RR 0.87, 95% CI 0.70 to 1.08; p = 0.22), and in children with a significant effect upon respiratory function (SMD 1.94, 95% CI 0.80 to 3.08; p<0.001) and hospital admission (RR 0.70, 95% CI 0.54 to 0.90; p = 0.005). Nebulised treatment was associated in adults with weak evidence of an effect upon respiratory function (SMD 0.17, 95% CI −0.02 to 0.36; p = 0.09), and hospital admission (RR 0.68, 95% CI 0.46 to 1.02; p = 0.06), and in children with no significant effect upon respiratory function (SMD −0.26, 95% CI −1.49 to 0.98; p = 0.69) or hospital admission (RR 2.0, 95% CI 0.19 to 20.93; p = 0.56).

Conclusion: Intravenous magnesium sulphate appears to be an effective treatment in children. Further trials are needed of intravenous and nebulised magnesium sulphate in adults and nebulised magnesium sulphate in children.

Asthma affects 5.2 million people in the UK, including 1.1 million children,[1] and is responsible for around 60 000 hospital admissions per year.[2] Guidelines from the British Thoracic Society (BTS) and Scottish Intercollegiate Guidelines Network (SIGN) advise a stepwise approach to the management of exacerbations.[3] Initially all patients should receive oxygen; nebulised β2-agonists; nebulised anticholinergic agent and corticosteroids. However, bronchodilators act within minutes whereas corticosteroids require hours. This discrepancy suggests a role for magnesium as an alternative treatment option in patients resistant to standard therapy. Magnesium's pharmacological action is based upon its ability to inhibit the release of calcium from vesicles in the sarcoplasmic reticulum, resulting in bronchial smooth muscle relaxation.[4]

Magnesium has been evaluated in both the intravenous and nebulised dosage form. The aerosolised route offers the advantage of a quick onset of action and lower incidence of side effects. Its disadvantages include a lower percentage of drug being delivered to the site of action and the patient requiring some respiratory effort to maximise its effectiveness. The intravenous route provides direct access to the venous system, allowing the delivery of high drug concentrations. The disadvantages include a cannula being sited and the drug being administered over 20 min.

Four meta-analyses have compared intravenous magnesium sulphate to placebo.[5–8] Rowe *et al*[5] identified five adult and two paediatric trials and concluded that magnesium sulphate therapy did not significantly improve peak expiratory flow rate or reduce admission to hospital, but subgroup analysis suggested that in trials of severe asthma, magnesium sulphate treatment was effective. Alter *et al*[6] identified seven adult and two paediatric trials and found that magnesium sulphate was associated with a significant improvement in spirometric airway function by 16% of a standard deviation, but concluded that the clinical significance of this effect was uncertain. Rodrigo *et al*[7] identified five adult trials and found no significant effect from magnesium sulphate upon pulmonary function or hospital admissions. Cheuk *et al*[8] undertook a meta-analysis of five trials in children and concluded that intravenous magnesium sulphate was effective in reducing hospital admissions, and improving pulmonary function tests and clinical symptoms. Two reviews have compared nebulised magnesium sulphate to placebo.[9 10] Both included six trials and concluded that current evidence could not clearly determine the role of nebulised magnesium sulphate in acute asthma.

The most recent (2007) BTS/SIGN guidelines state that a single dose of intravenous magnesium sulphate has been shown to be safe and effective in adults, and should be considered in adults with life threatening features or acute severe asthma that has not responded to inhaled bronchodilator treatment. The guidelines for children are more equivocal, suggesting that intravenous magnesium sulphate is safe but its place in management is not yet established. Nebulised magnesium sulphate is not discussed in either adults or children.

The evidence base for intravenous and nebulised magnesium sulphate has increased since these meta-analyses were published, with the recent publication of additional randomised trials. It is also apparent that magnesium sulphate may have a

Abbreviations: BTS, British Thoracic Society; CI, confidence interval; RR, relative risk; SIGN, Scottish Intercollegiate Guidelines Network; SMD, standardised mean difference

different role in adults and children. We therefore aimed to undertake a systematic review and meta-analysis of both intravenous and nebulised magnesium sulphate to determine their role in adults and children with acute asthma. Our specific objectives were to estimate the effect of each treatment upon pulmonary function and hospital admission.

METHODS

We planned to identify all randomised or quasi-randomised trials of intravenous or nebulised magnesium sulphate in adults or children with acute asthma that reported a measure of pulmonary function or hospital admission as an outcome.

The search terms ''asthma'' OR ''wheeze'' AND ''magnes'' were used to search the following databases: Cochrane Airways Review Group asthma register; Cochrane Clinical Trials Registry; Medline (1966-present); Medline in process (1966–present); EMBASE (1988–present); CINAHL (1982–present); AMED (1985–present); Research Registers of ongoing trials (MetaRegister of Current Controlled Trials (controlled-trials.com); National Research Register (NRR) and Centerwatch.com); Conference Papers Index; Web of Science; Dissertation Abstracts and the World Wide Web using the Google search engine.

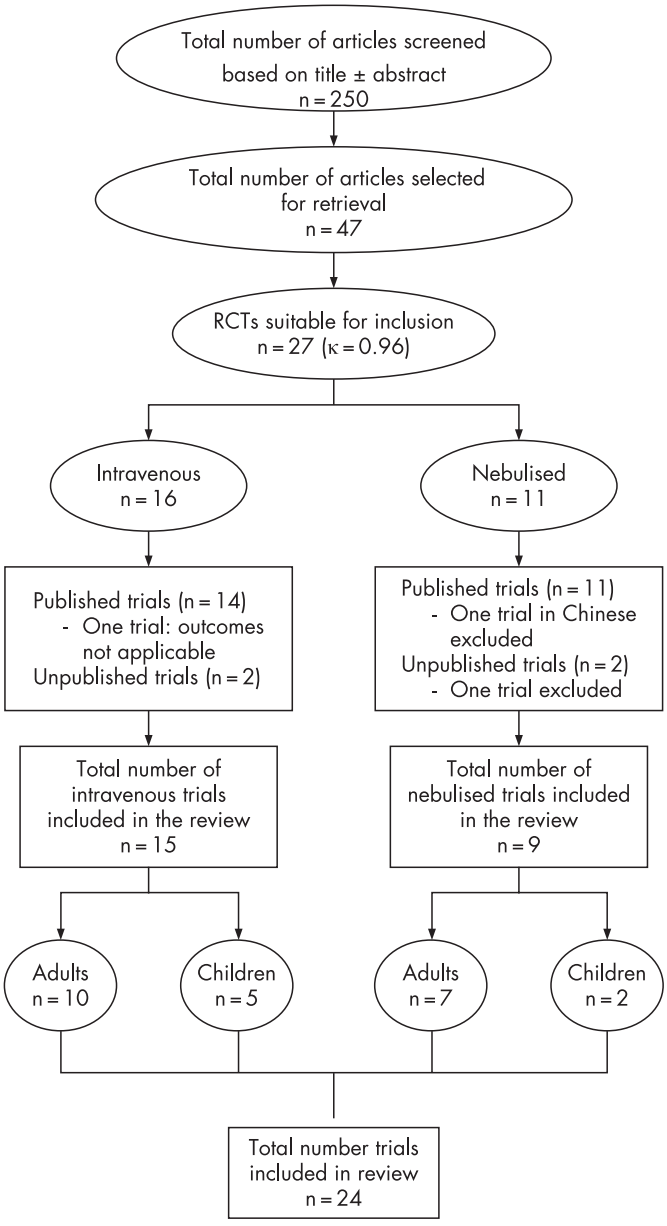

Figure 1 Flow chart showing the selection of trials in the review. RCTs, randomised controlled trials.

We searched the websites of the following relevant journals: *Emergency Medicine Journal*; *Academic Emergency Medicine*; *Thorax*; *Chest*; *European Respiratory Journal*; Internet Scientific Journals/Journal Medical Internet Research (Emergency Medicine; Asthma, Allergy, Immunology; Pulmonary Medicine); *Journal of Allergy and Clinical Immunology*; *Lancet*; *European Journal of Emergency Medicine*; *Annals of Emergency Medicine*; *American Journal Emergency Medicine*; *American Journal Respiratory and Critical Care Medicine*; *Journal of the American Medical Association*; *Journal of Asthma*; *British Medical Journal*; *Achives of Internal Medicine*; *Journal of Emergency Medicine*. We also searched relevant conference proceedings for the previous 5 years for relevant trials: Society for Academic Emergency Medicine Annual Conference; Annual Thoracic Society International Conference; Annual Congress of European Respiratory Society; American College of Chest Physicians.

The reference lists of all articles selected were reviewed for relevant studies. The primary authors of included studies were contacted (where possible, determined by availability of an email address) for information on additional trials, both published and unpublished. Finally, clinicians, collaborators, colleagues and trialists were contacted to identify additional potentially relevant studies.

A single reviewer (SM) scanned titles and abstracts, searched journals, and contacted experts, and selected potentially relevant articles for review. When possible we retrieved the full version of selected articles. Two independent reviewers (SM and SG) then reviewed potentially relevant articles and selected definitely relevant articles for inclusion. Each reviewer also independently assessed the quality of each included study using the five point Jadad score. This scale is used to assess randomisation, double blinding and withdrawals/dropouts. All trials were scored using a scale of 1 to 5 (score of 5 being the highest).

The following data were extracted from each study: design (method of randomisation, withdrawals/dropouts, inclusion and exclusion criteria); participants (age, gender, severity of asthma); interventions (route of administration, dose, timing and duration of therapy, co-interventions); control (agents and doses used); outcomes (types of outcome measures and the timing of their measurements, hospital admission rates and side effects) and results. Unpublished data were requested from the primary author by email.

Data were analysed using RevMan statistical software (version 4.0). Since a variety of different pulmonary function measures were used in the trials, these measures were analysed as a standardised mean difference (SMD). Hospital admission was analysed as a relative risk. Both outcomes were pooled using a random effects model. Initially all studies were analysed together, then studies of adults and children were analysed separately.

RESULTS

The flow of identified studies through the selection process is shown in fig 1. The reviewers only disagreed on inclusion of one study.[11] This study included patients with chronic obstructive pulmonary disease and was excluded after discussion. We thus identified 27 trials[12–38] (23 published[12–14 16–22 24–27 29–37] and four unpublished[15 23 28 38]) for inclusion. Three could not be included: one was only available in Chinese[36] (nebulised magnesium, 75 patients), another did not report any of the outcome measures we intended to analyse[37] (intravenous magnesium, 50 patients), and another was only available in abstract form and the

Table 1 Characteristics of studies of intravenous magnesium sulphate

Study	Location	Publication year	Total sample	Age range (years)	Sex %F:M	Asthma severity	Jadad score	Reported outcomes
Bijani	Iran	2002	81	12–85	47:53	Acute exacerbation	3	PEFR and asthma score
Silverman	USA	2002	248	18–60	42:58	Severe	5	PEFR*, FEV_1, Borg index and admissions
Porter	USA	2001	42	18–55	64:36	Moderate–severe	5	PEFR, L admissions and Borg index
Bilaceroglu	Turkey	2001	81	16–65	69:31	Moderate–severe	2†	FEV_1 (% predicted) and admissions
Boonyavorakul	Thailand	2000	33	15–65	88:12	Severe	5	Admissions and Fischl index
Scarfone	USA	2000	54	1–18	48:52	Moderate–severe	5	Admissions and pulmonary index score
Ciarallo	USA	2000	30	6–18	40:60	Moderate–severe	4	PEFR (change in % predicted)*, FEV_1, FVC and admissions
Gurkan	Turkey	1999	20	6–16	45:55	Moderate– severe	3	PEFR (% change from baseline)* and asthma score
Devi	India	1997	47	1–12	23:77	Severe	4	PEFR (% predicted) and pulmonary index score
Ciarallo	USA	1996	31	6–18	55:45	Moderate–severe	4	PEFR (% change from baseline)*, FEV_1, FVC and admissions
Bloch	USA	1995	135	18–65	72:28	Moderate–severe	5	FEV1 (% predicted), Borg index and admissions
Matusiewicz	UK	1994	129	>16	57:42	Moderate–life threatening	5	PEFR and admissions
Tiffany	USA	1993	48	18–60	59:41	Severe	4	PEFR* and FEV_1
Green	USA	1992	120	18–65	77:23	Acute exacerbation	1	PEFR and admissions
Skobeloff	USA	1989	38	18–70	74:26	Moderate–severe	5	PEFR and admissions

FEV_1, forced expiratory volume in 1 s; FVC, forced vital capacity; PEFR, peak expiratory flow rate.
*When more than one pulmonary function test was used, the measure marked with an asterisk was used in analysis.
†Based on abstract alone.

authors could not be contacted[38] (nebulised magnesium, 71 patients). We ultimately included 24 studies (15 intravenous and 9 nebulised) incorporating 1669 patients (1137 intravenous and 532 nebulised). Three of the studies were only available as abstracts[15 23 28] but further details were obtained by contact with the authors. We also identified one ongoing trial of nebulised magnesium sulphate in children.[39]

Tables 1 and 2 show the characteristics of the studies: year of publication, country of origin, population characteristics, outcome measures and Jadad score. The studies showed heterogeneity in the age groups, severity of asthma and the exclusion criteria. Pulmonary function tests were used as the primary outcome measure by most studies. Hospital admissions were used as an outcome measure in 11/15 intravenous studies and 7/9 nebulised studies. The overall methodological quality of the studies included was generally high, with 16 out of 24 having a Jadad score of 4 or 5 ($\kappa = 0.83$).

Tables 3 and 4 show the interventions and co-interventions used in each study. Studies of intravenous magnesium used bolus doses ranging from 1.2–2 g (25–100 mg/kg for children). Only one study[24] followed this with an infusion. Studies of nebulised magnesium showed substantial variation in the doses and number of nebulisations used. A placebo was used in all but two studies[34 35] where magnesium alone was compared directly to a β-agonist (salbutamol).

Figure 2 shows the estimated effect of intravenous magnesium sulphate upon respiratory function and fig 3 shows the estimated effect upon hospital admission. In adults, treatment is associated with weak evidence of an effect upon respiratory function (SMD 0.25, 95% confidence interval (CI) −0.01 to 0.51; $p = 0.05$), but no significant effect upon hospital admission (relative risk (RR) 0.87, 95% CI 0.70 to 1.08; $p = 0.22$). In children, treatment is associated with a significant effect upon respiratory function (SMD 1.94, 95% CI 0.80 to 3.08; $p<0.001$) and hospital admission (RR 0.70, 95% CI 0.54 to 0.90; $p = 0.005$).

Figure 4 shows the estimated effect of nebulised magnesium sulphate upon respiratory function and fig 5 shows the estimated effect upon hospital admission. In adults, there is weak evidence of an effect upon respiratory function (SMD 0.17, 95% CI –0.02 to 0.36; $p = 0.09$) and hospital admission (RR 0.68, 95% CI 0.46 to 1.02; $p = 0.06$). In children, treatment is not associated with a significant effect upon respiratory function (SMD −0.26, 95% CI −1.49 to 0.98; $p = 0.69$) or hospital admission (RR 2.0, 95% CI 0.19 to 20.93; $p = 0.56$).

Two studies of nebulised magnesium sulphate[34 35] compared magnesium sulphate to salbutamol instead of placebo. We reanalysed respiratory function data with these studies excluded. The results for adults were essentially unchanged (SMD 0.17, 95% CI –0.05 to 0.39; $p = 0.13$), whereas in children the one

Table 2 Characteristics of studies of nebulised magnesium sulphate

Study	Location	Publication year	Total sample	Age range (years)	Sex %F:M	Asthma severity	Jadad Score	Outcome measure
Aggarwal	India	2006	100	13–60	40:60	Severe–life threatening	5	PEFR and admissions
Drobina	USA	2006	110	12–60	43:67	Mild–severe	5	PEFR and admissions
Kokturk	Turkey	2005	26	18–60	73:27	Moderate–severe	2	PEFR (% predicted) and admissions
Mahajan	USA	2004	62	5–17	45:55	Mild–moderate	4	FEV_1 (% predicted) and admissions
Hughes	New Zealand	2003	52	16–65	52:48	Severe–life threatening	5	FEV_1 and admissions
Bessmertny	USA	2002	74	18–65	73:27	Mild–moderate	5	FEV_1 (% predicted)
Nannini	Argentina	2000	35	>18	63:37	Acute exacerbation	3	PEFR and admissions
Mangat	India	1998	33	12–60	70:30	Acute exacerbation	3	PEFR (% predicted) and admissions
Meral	Turkey	1996	40	Children	Unknown	Acute asthma	0	PEFR (% change from baseline) and respiratory score

FEV_1, forced expiratory volume in 1 s; FVC, forced vital capacity; PEFR, peak expiratory flow rate.

Table 3 Treatment regimens and co-interventions used in studies of intravenous magnesium sulphate

Study	Magnesium regimen	Control regimen	β-agonist regimen	Corticosteroid regimen	Co-interventions
Bijani	25 mg/kg over 30–45 min	100 ml saline solution	Salbutamol (interval not stated)	Corticosteroids (type not stated)	Aminophylline
Silverman	2 g loading dose over 10–15 min	50 ml saline solution	Albuterol 0, 30, 60, 120, 180 min	125 mg IV MP	None stated
Porter	2 g loading dose over 20 min	50 ml saline solution	Albuterol 20 min intervals	125 mg IV MP	None stated
Bilaceroglu	2 g loading dose	100 ml of 5% dextrose	Salbutamol 0, 30, 60, 120, 180 min	125 mg MP if PEFR <40% predicted	Theophylline
Boonyavorakul	2 g loading dose	2 ml sterile water in 50 ml saline	Salbutamol 0, 20, 40, 60 min	5 mg IV dexamethasone	None stated
Scarfone	75 mg/kg over 20 min (max 2.5 g)	Saline solution	Albuterol 0.15 mg/kg 0, 40, 80, 120 min	1.0 mg/kg MP IV (max 125 mg)	None stated
Ciarallo	40 mg/kg over 20 min (max 2 g)	100 ml saline solution	Albuterol	2 mg/kg MP IV (max 100 mg)	Ipratropium
Gurkan	40 mg/kg over 20 min (max 2 g)	Saline solution equivalent volume	Salbutamol 0.15 mg/kg	2 mg/kg MP IV (max 100 mg)	None stated
Devi	100 mg/kg over 35 min	Saline solution equivalent volume	Salbutamol 0.15 mg/kg	Hydrocortisone IV/oral (no dose provided)	Aminophylline
Ciarallo	25 mg/kg over 20 min (max 2 g)	Saline solution equivalent volume	Albuterol 0.15 mg/kg	2 mg/kg IV MP	None stated
Bloch	2 g loading dose over 20 min	50 ml saline solution	Albuterol 0, 30, 60, 120, 180 min	125 mg IV MP if initial FEV_1 ⩽40% or oral steroids last 6/12	Theophylline
Matusiewicz	1.2 g loading dose over 15 min	50 ml saline solution	Salbutamol at discretion of physician	200 mg IV hydrocortisone	Ipratropium neb, aminophylline IV
Tiffany	2 g loading dose over 20 min followed by infusion of $MgSO_4$ or placebo	Saline solution	Albuterol 30 min intervals	125 mg IV MP	Aminophylline
Green	2 g loading dose over 20 min	No placebo	Albuterol initially then hourly	125 mg IV MP	Theophylline β-agonist injection ephedrine
Skobeloff	1.2 g loading dose over 20 min	50 ml saline solution	Metaproterol/albuterol at physician discretion	125 mg IV MP	Theophylline IV

FEV_1, forced expiratory volume in 1 s; IV, intravenous; MP, methylprednisolone; PEFR, peak expiratory flow rate.

remaining study showed a significant effect from treatment (SMD 0.36, 95% CI –0.14 to 0.86; p = 0.05).

DISCUSSION

This is the most comprehensive review to date of the role of magnesium sulphate in acute asthma. Our analysis suggests that intravenous magnesium sulphate is an effective treatment in children, being associated with a significant improvement in respiratory function and a 30% decrease in hospital admissions. We found weak evidence that intravenous magnesium sulphate improves respiratory function in adults, but no evidence of a significant effect upon hospital admissions, although the data do not exclude a potential reduction in admissions of up to 30%. We found weak evidence that nebulised magnesium sulphate improves respiratory function and reduces hospital admissions in adults. Insufficient data exist to draw reliable conclusions regarding the role of nebulised magnesium sulphate in children. A trial is currently in progress to provide much-needed data on this last issue.[39]

Table 4 Treatment regimens and co-interventions used in studies of nebulised magnesium sulphate

Study	Magnesium regimens	Total amount magnesium used	Control regimen	Bronchodilator regimen	Co-interventions
Aggarwal	1 ml $MgSO_4$ (500 mg) (3 doses, 20 min apart) with β-agonist	1500 mg (3×500 mg)	1.5 ml distilled water 7.5 ml normal saline	Salbutamol 1 ml	IV hydrocortisone + salbutamol Discretion physician
Drobina	125 mg $MgSO_4$ 0.25 ml of 50% solution (3 doses, 20 min apart) with β-agonist	375 mg (3×125 mg)	0.25 ml saline solution	5 mg/ml albuterol + 2.5 ml ipratropium bromide	50 mg oral prednisolone
Kokturk	Iso-osmolar $MgSO_4$ (6.3%, 145 mg/dose) (20 min intervals) with β-agonist	1015 mg (7×145 mg)	2.5 ml isotonic saline solution	2.5 mg salbutamol	1 mg/kg MP IV
Mahajan	2.5 ml isotonic $MgSO_4$ (6.3%) solution) single dose with β-agonist	—	2.5 ml saline solution	Albuterol 2.5 mg (0.5 ml)	2 mg/kg prednisolone
Hughes	2.5 ml isotonic $MgSO_4$ (151 mg/dose) (3 doses at 30 min intervals) with β-agonist	453 mg (3×151 mg)	2.5 ml isotonic saline solution	2.5 mg salbutamol	100 mg hydrocortisone IV
Bessmertny	$MgSO_4$ 384 mg (64 mg/ml) in 6 ml sterile water (3 doses at 20 min intervals) after β-agonist	1152 mg (3×384 mg)	6 ml saline solution	Albuterol 2.5 mg/3 ml	2 mg/kg hydrocortisone IV 6 hourly
Nannini	3 ml isotonic $MgSO_4$ (7.5 g/100 ml) single dose with β-agonist	225 mg	3 ml saline solution	Salbutamol	None stated
Mangat	3 ml (95 mg) $MgSO_4$ (4 doses, 20 min apart)	380 mg (4×95 mg)	3 ml salbutamol (2.5 mg)	Part of control regimen	100 mg hydrocortisone IV
Meral	2 ml $MgSO_4$ (280 mmol/l)	—	2.5 mg/2.5 ml salbutamol	Part of control regimen	Theophylline

IV, intravenous; MP, methylprednisolone.

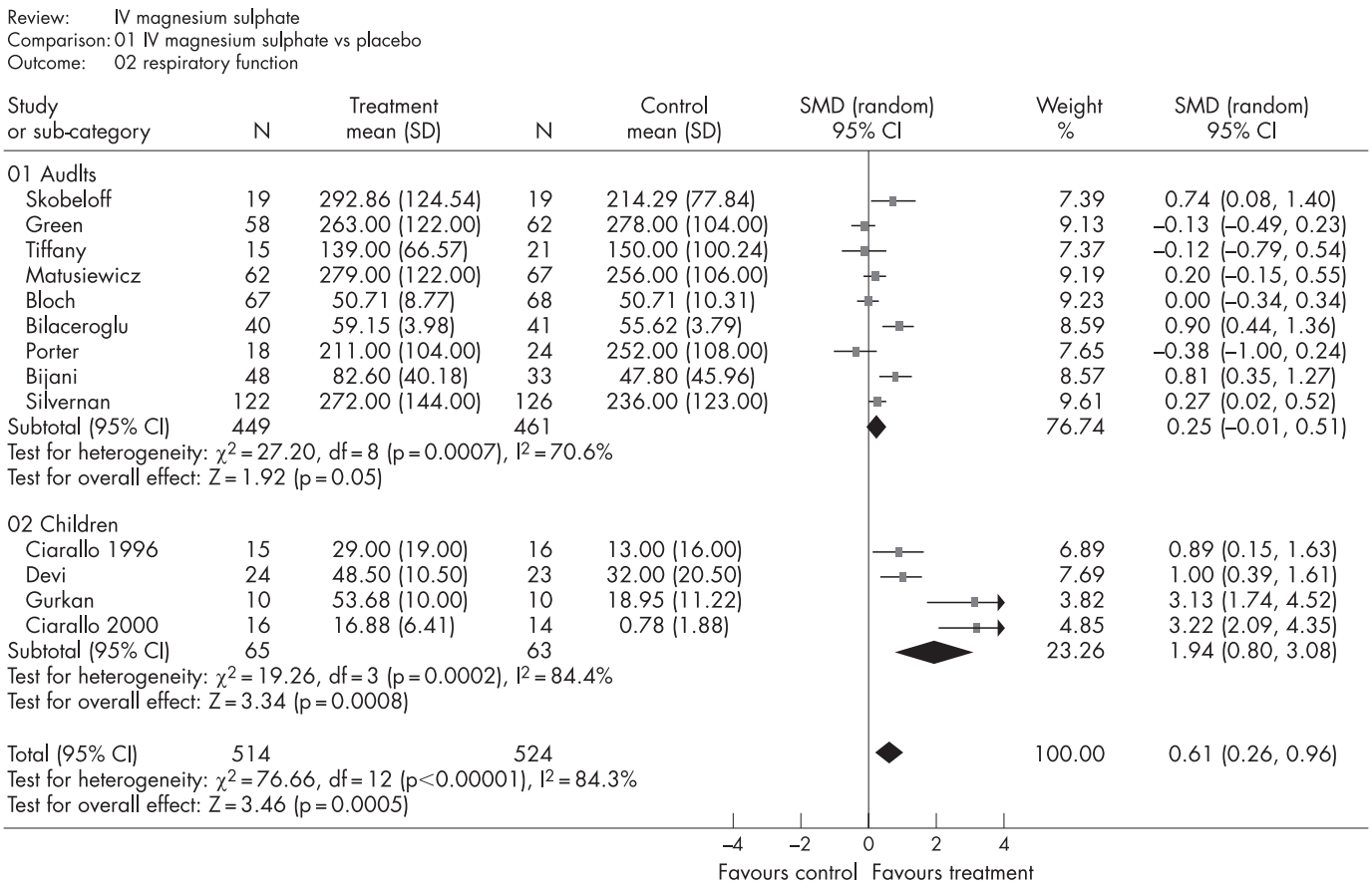

Figure 2 Effect of intravenous (IV) magnesium sulphate upon respiratory function.

Most previous meta-analyses have analysed adults and children together. Our analysis suggests that this may be inappropriate, particularly for intravenous magnesium sulphate, because there appears to be a clear difference in effectiveness between these two patient groups. It is not clear why effectiveness should differ between adults and children. Possible explanations are that children may have a greater element of reversibility to their acute asthma, or the use of weight adjusted dosing in children allows for a more appropriate dose of intravenous magnesium.

Our analysis has a number of potential limitations. Firstly, we may have failed to identify unpublished studies. We undertook a comprehensive literature search, including searches of conference abstracts, and identified three unpublished studies that were included in the review. Nevertheless we will not have identified studies that were neither presented nor published in any form. Secondly, we identified but were unable to include three potentially relevant studies because of limitations in their reporting. Thirdly, heterogeneity with respect to the exclusion criteria, treatment interventions and outcome measures may limit the appropriateness of pooling data. Of particular relevance and concern is the fact that the studies varied in whether patients with existing pulmonary pathology (such as chronic obstructive pulmonary disease) were excluded from the study. This is particularly significant as it is thought that patients with ''pure'' asthma are more likely to respond to magnesium treatment. Fourthly, most of the included studies were small and not powered to detect potentially important differences in hospital admission rates. Even after pooling these data we cannot exclude a potentially important effect from intravenous or nebulised magnesium sulphate in adults. Finally, we did not identify any studies that directly compared intravenous to nebulised magnesium sulphate.

Our analysis suggests that the revised (2007) BTS/SIGN guidelines are not entirely consistent with the current evidence. The guidelines suggest a clear role for intravenous magnesium sulphate in adults, but not children, and do not consider nebulised magnesium sulphate. In contrast, our analysis suggests that intravenous magnesium sulphate is an effective treatment for acute severe asthma in children, but has an uncertain role in adults. Nebulised and intravenous magnesium sulphate appear to be associated with similar estimates of effectiveness in adults, ranging from little or no effect to a substantial, worthwhile effect. Thus we can neither clearly state nor rule out a useful role for either nebulised of intravenous magnesium sulphate in adults.

The implications of our analysis are that intravenous magnesium sulphate should be standard treatment for children with acute severe asthma that has not responded to initial treatment, while the role of nebulised magnesium sulphate in children and the roles of both nebulised and intravenous magnesium sulphate in adults require further investigation. Given the low risk of serious side effects from magnesium sulphate it would seem reasonable to use intravenous magnesium sulphate in adults with life threatening features, in whom any potential benefit would justify the risks of treatment. Meanwhile, a large randomised trial is required to compare nebulised and intravenous magnesium sulphate to each other, and to placebo, in adults with acute severe asthma, to determine whether magnesium sulphate can improve symptoms and reduce hospital admissions. Further studies of nebulised magnesium sulphate in children are currently in progress.

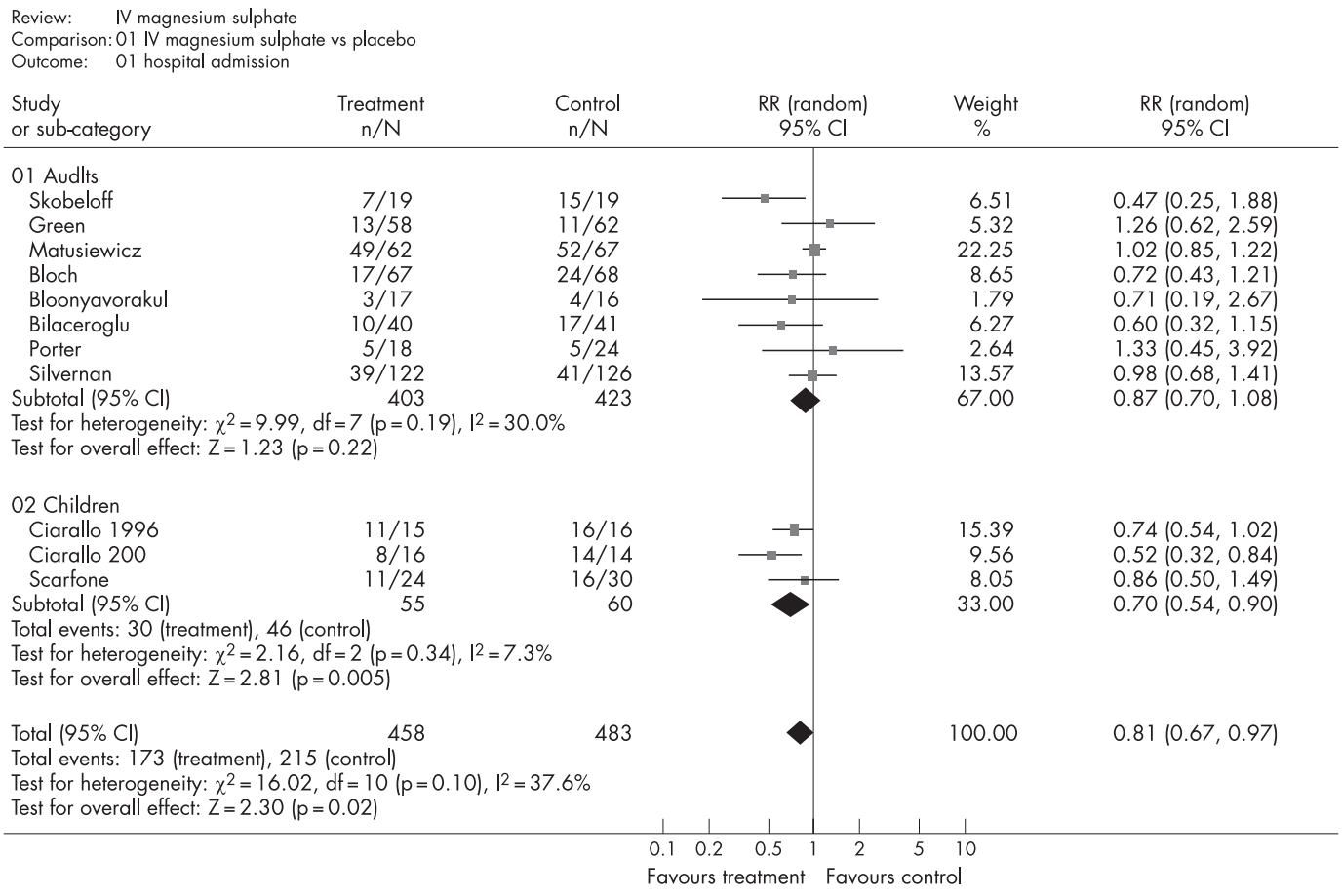

Figure 3 Effect of intravenous (IV) magnesium sulphate upon hospital admission.

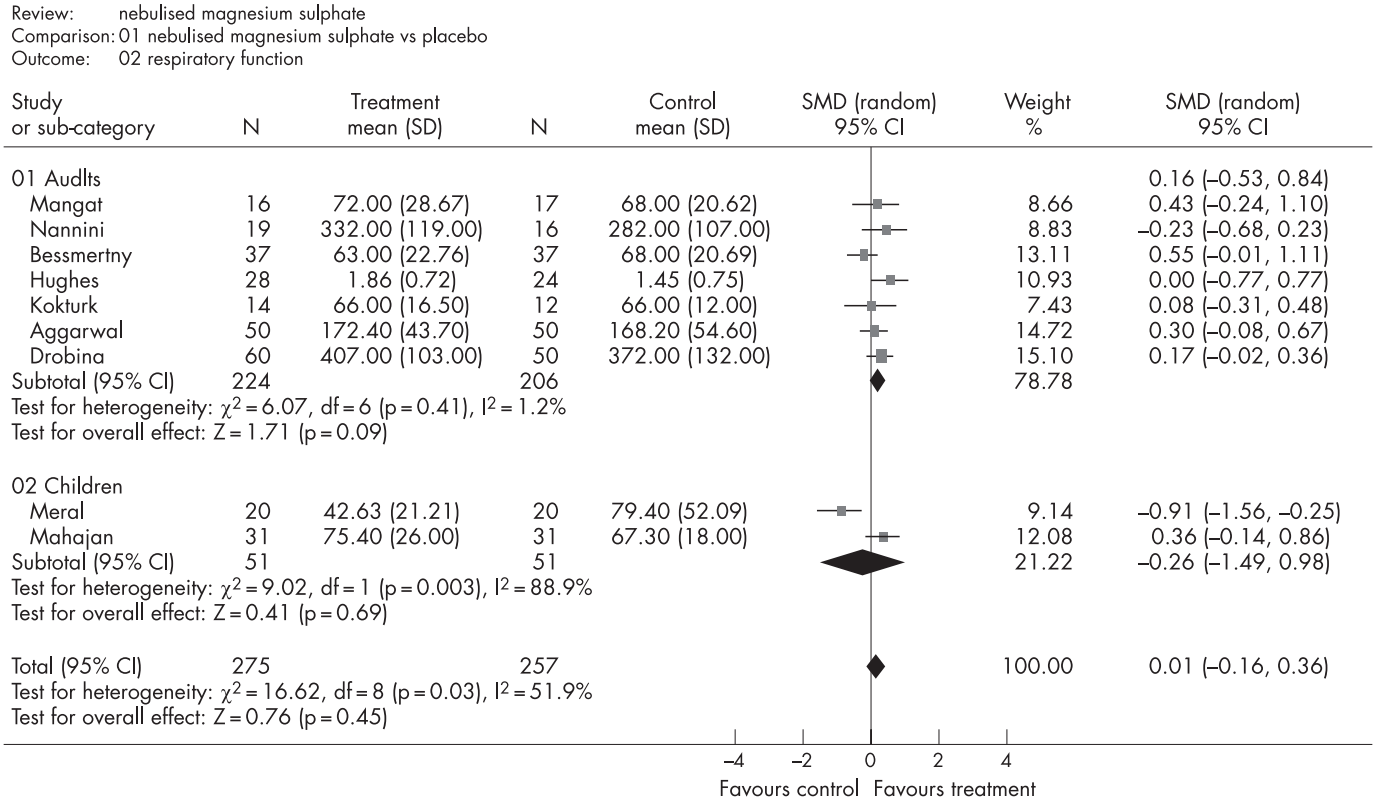

Figure 4 Effect of nebulised magnesium sulphate upon respiratory function.

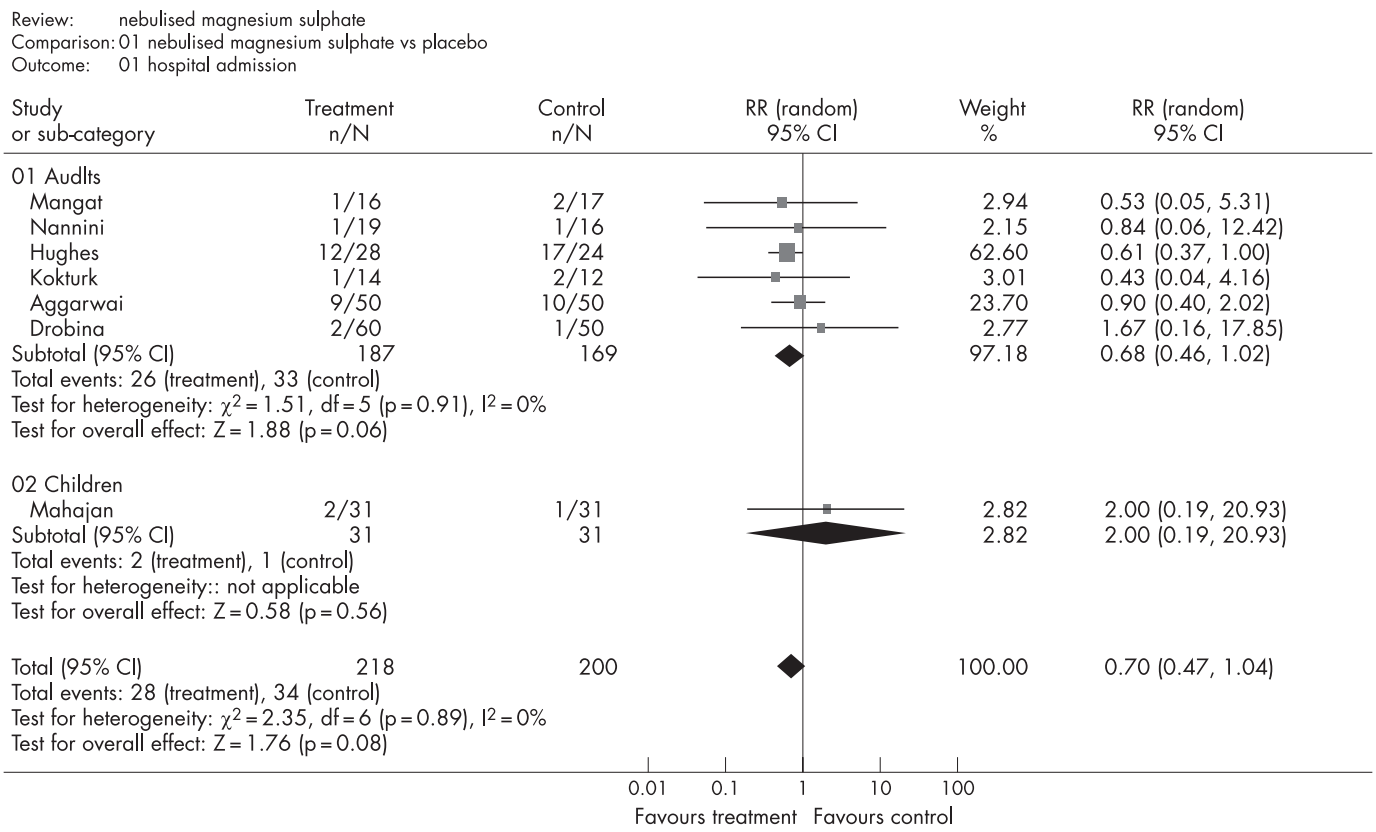

Figure 5 Effect of nebulised magnesium sulphate upon hospital admission.

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Competing interests: SG is principal investigator for the 3Mg Trial, a multicentre trial of intravenous and nebulised magnesium sulphate in acute severe asthma.

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IMAGES IN EMERGENCY MEDICINE

Faecal mediastinitis following decompression of suspected tension pneumothorax

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A 28-year-old caucasian man presented to the accident and emergency department with left sided abdominal pain. Shortly after admission he complained of difficulty in breathing and left sided chest pain and appeared in distress. Six months before this admission the patient was involved in a road traffic accident and sustained fractures of the left fourth and fifth ribs and clavicle with bilateral lung contusion.

Clinical examination revealed decreased air entry with hyperresonance on the left side. Urgent needle decompression resulted in release of air and faecal fluid. This was followed by tube thoracostomy which drained feculent material. Chest *x* ray performed after tube thoracostomy showed a dilated loop of bowel with the chest drain in the left hemithorax (fig 1). A subsequent computed tomographic scan (fig 2) revealed diaphragmatic rupture with dilated loops of colon in the left hemithorax and the tip of the chest drain was seen to be penetrating the colon. The pleural cavity was soiled with faecal material.

This case highlights the pitfalls in the diagnosis of diaphragmatic injury and the potential dangers of inserting an intercostal drain into any intrathoracic gas collection, presuming it to be a pneumothorax.

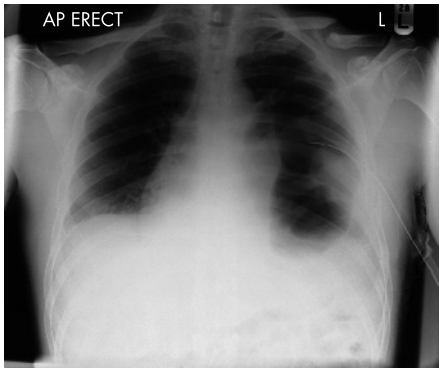

Figure 1 Anteroposterior chest *x* ray shows dilated loop of bowel with the chest drain penetrating it.

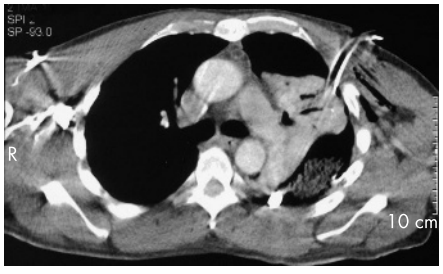

Figure 2 Computed tomographic scan shows loops of colon in the left hemithorax with the chest drain and collection of faecal material.

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