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Advising patients to increase fluid intake for treating acute respiratory infections (Review)

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[Intervention Review]

Advising patients to increase fluid intake for treating acute respiratory infections

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ABSTRACT

Background

Acute respiratory infection is a common reason for people to present for medical care. Advice to increase fluid intake is a frequent treatment recommendation. Attributed benefits of fluids include replacing increased insensible fluid losses, correcting dehydration from reduced intake and reducing the viscosity of mucus. However, there are theoretical reasons for increased fluid intake to cause harm. Anti-diuretic hormone secretion is increased in lower respiratory tract infections of various aetiologies. This systematic examination of the evidence sought to determine the benefit versus harm from increasing fluid intake.

Objectives

To answer the following questions.

1. Does recommending increased fluid intake as a treatment for acute respiratory infections improve duration and severity of symptoms?

2. Are there adverse effects from recommending increased fluids in people with acute respiratory infections?

3. Are any benefits or harms related to site of infection (upper or lower respiratory tract) or a different severity of illness?

Search methods

We searched the Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library* 2010, issue 4), which contains the Acute Respiratory Infections Group's Specialised Register, MEDLINE (1966 to November Week 3, 2010), EMBASE (1974 to December 2010), Current Contents (2000 to December 2010) and CINAHL (1982 to December 2010). We searched reference lists of articles identified and contacted experts in the relevant disciplines.

Selection criteria

Randomised controlled trials (RCTs) that examined the effect of increasing fluid intake in people with acute respiratory infections.

Data collection and analysis

Two review authors independently assessed the identified studies to determine eligibility for inclusion.

Main results

No RCTs assessing the effect of increasing fluid intake in acute respiratory infections were found.

Authors' conclusions

There is currently no evidence from RCTs for or against the recommendation to increase fluids in acute respiratory infections. The implications for fluid management of acute respiratory infections in the outpatient or primary care setting have not been studied in any RCTs to date. Some non-experimental (observational) studies report that increasing fluid intake in acute respiratory infections of the lower respiratory tract may cause harm. RCTs need to be done to determine the true effect of this very common medical advice.

PLAIN LANGUAGE SUMMARY

Advising patients to increase fluid intake for treating acute respiratory infections

Doctors commonly recommend that people with acute respiratory infections drink extra fluids. Acute infections include colds, acute sinusitis, tonsillitis, laryngitis, bronchitis, pneumonia and influenza. This review intended to find out the benefit or harm from this recommendation. Potential benefits of fluids are replacing fluid lost because of fever or rapid breathing, treating dehydration and reducing the viscosity of mucus. In infections of the lower part of the respiratory tract, possible harmful effects of fluids might be a dilution of the blood sodium concentration, leading to headache, confusion and seizures. This review found no evidence for or against the use of increased fluids in acute respiratory infections. No randomised controlled trials have been conducted to determine the benefit or harm from extra fluids. It is important that further studies be done in order to determine the true effect of this very common medical advice.

BACKGROUND

Description of the condition

Acute respiratory infections form a large proportion of disease seen in primary care settings. Some studies estimate this as the reason for presentation in up to 15% of primary care consultations (Fry 1993).

Description of the intervention

Advice to increase fluid intake is a common treatment recommendation (Evans 1998; Murtagh 2007; Rosser 1998). This advice is given across the age ranges, from infants and children through to adults and the elderly. This advice is often non-specific in terms of quantity of fluid recommended but the usual implication is to drink more than normal. However, there is debate over what is a normal healthy fluid intake (Valtin 2002). The type of fluid is not usually specified but is usually confined to oral fluids normally consumed by the patient. Sometimes specific fluids are recommended, such as fruit juice, soup, lemonade and tea (Kirkpatrick 1998; Schmitt 1999).

How the intervention might work

Benefits from fluids are attributed to: replacing increased insensible fluid loss from fever and from respiratory tract evaporation with tachypnoea (Dhawan 1992; Shann 1985); correcting dehydration from reduced intake (Gerigk 1996); reducing the viscosity of mucus (Middleton 1991; Rosser 1998); loosening nasal mucus (Saketkhoo 1978) and moistening the respiratory tract to maintain comfort (Evans 1998; Middleton 1991).

Why it is important to do this review

The main benefit from extra fluids may be to prevent or treat dehydration. However, there are potential reasons for increased fluid intake to cause harm. Anti-diuretic hormone (ADH) secretion is increased in lower respiratory tract infections of various aetiologies. Excessive ADH secretion has been reported in bronchitis, bronchiolitis and pneumonia (Dreyfuss 1988; Gozal 1990; Heim 1982). The mechanism of increased ADH secretion might be due to a resetting of the osmostat (Dreyfuss 1988; Hill 1990) or a response to the perception of hypovolaemia by intrathoracic receptors (Gozal 1990; Van Steensel-Moll 1990). Giving increased fluids (or even normal maintenance) might potentially lead to hy-

ponatraemia and fluid overload (Dhawan 1992). There is ongoing debate about whether tonicity of replacement fluid is the more important consideration, with some advising that replacement of water and sodium is appropriate treatment for hyponatraemia in the context of hypovolaemia (Gerigk 1996)

Given that this advice is usually generic, in that it is given to infants, children, adults and the elderly, it is likely that the physiology and fluid balance in these different groups differs markedly, particularly in different climatic environments. Therefore it is important to determine the effects of this advice across these different demographics and age ranges.

OBJECTIVES

To answer the following questions.

1. Does recommending increased fluid intake as a treatment for acute respiratory infections improve duration and severity of symptoms?

2. Are there adverse effects from recommending increased fluids in people with acute respiratory infections?

3. Are any benefits or harms related to site of infection (upper or lower respiratory tract) or a different severity of illness?

METHODS

Criteria for considering studies for this review

Types of studies

All randomised controlled parallel-group trials that examined the effect of treatment with, or recommendation for, increased oral fluid intake in people with acute respiratory infections. Comparison groups included one group receiving no treatment with, or no recommendation for, increased oral fluid intake.

Types of participants

People of all ages with an acute respiratory infection and presenting for treatment in a primary care setting. Participant age groups include infants, children, adults and geriatrics. We considered and analysed age groups separately.

We subdivided acute respiratory infection into upper and lower respiratory tract infection and included the following clinical entities, as defined by the international classification of health problems in primary care (ICHPPC) (WONCA 1983).

Upper respiratory tract infection (URTI)

This included the ICHPPC-defined conditions: acute upper respiratory tract infection (cold, nasopharyngitis, pharyngitis, rhinitis), acute sinusitis, acute tonsillitis, acute laryngitis and tracheitis. There had to be an absence of abnormal chest signs to define these conditions.

Lower respiratory tract infection (LRTI)

This included the ICHPPC-defined conditions: acute bronchitis, bronchiolitis (which includes tracheobronchitis) and pneumonia. We defined influenza according to two ICHPPC categories. We included influenza without pneumonia as an URTI. We included influenzal pneumonia in the ICHPPC category of pneumonia and considered it as a LRTI.

For the purposes of this systematic review we excluded otitis media. We excluded people with underlying medical conditions as their fluid requirements may differ from the normal population. We excluded people with central nervous system (CNS) infection as this alters their fluid management (Brown 1994). We also excluded people with diarrhoea as discussion of their fluid requirements has been covered in a previous systematic review (Hahn 2002).

Types of interventions

Treatment with, or recommendation for, increased oral fluid intake.

Types of outcome measures

Symptoms

1. Severity and duration, however measured in the studies.
2. Including but not restricted to fever, mucus production, nasal congestion, sore throat, cough, headache.

Complications

1. Symptoms of dehydration (nausea, vomiting, postural dizziness).
2. Symptoms of water overload and hyponatraemia (behavioural disturbance, headache, confusion, convulsions, coma).

Health service utilisation

1. Including requirement for hospital admission.
2. Visits to primary care facility.

Search methods for identification of studies

Electronic searches

We searched the Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library* 2010, issue 4), which contains the Acute Respiratory Infections Group's Specialised Register, MEDLINE (1966 to November Week 3, 2010), EMBASE (1974 to December 2010), Current Contents (2000 to December 2010) and CINAHL (1982 to December 2010).

Details of the original search are in Appendix 1. Updated searches were run in December 2010 for the period 2005 to December 2010. In this update we used the following search strategy to search MEDLINE and CENTRAL. The MEDLINE search was combined with the Cochrane highly sensitive search strategy for identifying randomised trials in MEDLINE: sensitivity- and precision-maximising version (2008 revision); Ovid format (Lefebvre 2009). The search strategy was adapted to search Embase.com (see Appendix 2), CINAHL (see Appendix 3) and Current Contents (Appendix 4). There were no constraints based on language or publication status when searching for trials.

MEDLINE (OVID)

1 exp Respiratory Tract Infections/
2 (respiratory adj2 infection*).tw.
3 (urti or lrti).tw.
4 exp bronchitis/ or bronchopneumonia/ or exp laryngitis/ or hoarseness/ or exp pneumonia/ or rhinitis/ or cough/ or exp respiratory tract infections/ or common cold/ or influenza, human/ or laryngitis/ or exp pharyngitis/ or exp sinusitis/ or tracheitis/ or whooping cough/ or nasopharyngitis/
5 (common cold* or acute sinusit* or tonsillit* or laryngit* or bronchit* or pneumon* or flu or influenza or bonchiolit* or nasopharyngit* or pharyngit* or sore throat* or rhinit* or tracheit* or tracheobronchit* or cough*).tw.
6 or/1-5
7 Fluid Therapy/
8 fluid therapy.tw.
9 exp Water-Electrolyte Balance/
10 water electrolyte balance.tw.
11 fluid balance.tw.
12 exp Water/
13 Drinking/
14 Drinking Behavior/
15 Thirst/
16 thirst*.tw.
17 Water Deprivation/
18 Rehydration Solutions/
19 rehydrat*.tw.
20 Beverages/
21 ((water or fluid* or liquid* or beverage*) adj3 (increas* or intake* or take* or give* or drink* or consume*)).tw.
22 exp Infusions, Parenteral/
23 parenteral infusion*.tw.
24 or/7-23
25 6 and 24

Searching other resources

We searched reference lists of articles identified and contacted experts in the relevant disciplines.

Data collection and analysis

Selection of studies

Two review authors (AR, MG) read abstracts found from the initial search to identify studies that met the inclusion criteria. Three review authors (ST, AR, MG) retrieved full-text articles and reviewed them to determine eligibility. At least two authors (AR, MG) independently assessed these studies and resolved differences of opinion by discussion.

No studies met the inclusion criteria. If any eligible studies are performed in the future we will use the following protocol.

Data extraction and management

1. Two review authors will independently extract data from the studies using a standard form.
2. Differences in extraction will be compared and resolved by discussion.

Assessment of risk of bias in included studies

We will carry out study quality assessment using the a modification of the method outlined in the *Cochrane Handbook for Systematic Reviews of Interventions* version 5.0.2 (February 2009) (Higgins 2009) (see Table 1).

Unit of analysis issues

Data analysis will be on an intention-to-treat (ITT) basis. We will use both fixed- and random-effects models. However, we only use the random-effects model if significant heterogeneity is found. We will analyse continuous data using mean differences and 95% confidence intervals. We will express dichotomous data as odds ratios with 95% confidence intervals.

If data of sufficient quality are obtained, we will perform subgroup analysis on the basis of:

1. upper and lower respiratory tract infection (as already defined);
2. age groupings with infants younger than two years old; children, as defined in the studies; adults, older than 18 years old;
3. severity of illness, as measured in the studies and also determined on the basis of health service utilisation, that is to say, requirement for admission to hospital.

RESULTS

Description of studies

Results of the search

In this 2010 update a total of 166 records were retrieved during the search. No studies met the inclusion criteria. We excluded three new studies.

Excluded studies

Of those studies that were excluded, one RCT looked at the effect of fluids in healthy volunteers (Saketkhoo 1978). A second RCT looked at the effect of fluids in chronic bronchitis (Shim 1987). The other excluded studies were observational rather than interventional (Dhawan 1992; Don 2008; Gozal 1990; Nair 2007; Shann 1985; Singhi 2005; Van Steensel-Moll 1990).

Risk of bias in included studies

No studies met the inclusion criteria.

Effects of interventions

No studies met the inclusion criteria.

DISCUSSION

Summary of main results

We came to this review expecting to find little research done on the topic and only evidence that fluids would be beneficial. We were therefore somewhat surprised by the observational studies we found. These raised the question of whether there may potentially be a problem with excess fluids, particularly in infections of the lower respiratory tract. Research has been done in the intensive care setting with respect to treatment with intravenous administration of fluids in severely ill children. However, research in the primary care setting is lacking. We concluded that further research is worth undertaking, particularly in the ambulatory primary care setting, where advice to give extra fluids is common.

Overall completeness and applicability of evidence

We found that there is much written about hyponatraemia in the inpatient hospital setting. The reported incidence of hyponatraemia in children admitted with pneumonia ranged from 27% (Singhi 1992) to 45% (Don 2008; Shann 1985) and 48% (Singhi 2005). Debate is ongoing about appropriate fluid therapy for sick, hospitalised children in order to prevent iatrogenic hyponatraemia (Hasegawa 2009; Hatherill 2004; Holliday 2003; Kaneko 2004; Moritz 2003; Taylor 2004). Recent randomised controlled trials of isotonic versus hypotonic intravenous fluids in paediatric inpatients with various conditions provide evidence that isotonic fluid administration is associated with a lower incidence of iatrogenic hyponatraemia (Alvarez Montanana 2008; Choong 2006; Yung 2009). These trials did not specifically look at children with respiratory tract infections.

The incidence of hyponatraemia at time of hospital admission in adults with community-acquired pneumonia was found to be as high as 27.9% (Nair 2007). Observational data suggest that initial treatment of hospitalised adults with isotonic intravenous fluids is protective against the development of hyponatraemia, and that treatment with hypotonic or no fluids increases the risk of subsequent hyponatraemia (Nair 2007). These observational data need to be followed up with a randomised controlled trial.

In this review we were interested in the primary care situation, because this is where the majority of people with acute respiratory infections are treated. Given that these individuals are likely to be less sick than those hospitalised with an acute respiratory infection, do the same potential benefits and adverse effects of fluids apply? Are there similar implications for fluid management in the primary care setting?

1. Does recommending increased fluid intake as a treatment for acute respiratory infections improve duration and severity of symptoms?

No RCTs were found to answer this question definitively. Further research needs to be done to determine the true benefits from recommending increased fluids in acute respiratory infections.

The main potential benefit from fluids would be to prevent or treat dehydration (WHO 1990). We found only observational data relating to this. Singhi 1992, in a study of hospitalised children with pneumonia, found a 27% incidence of hyponatraemia, with 7% of these children being hypovolaemic. Singhi 2005 suggests that fluid retention in respiratory infections may be an appropriate response to hypoxaemia in order to improve circulating blood volume. Nair 2007, in a study of adults with pneumonia, found that nursing home residents who developed pneumonia were more likely to have hypernatraemia, possibly reflecting diminished thirst and water intake.

Another potential benefit is reducing the volume and viscosity of mucus. Saketkhoo 1978 reported that nasal mucus velocity was

increased by drinking hot liquids in a small controlled trial in healthy individuals. However, Shim 1987 reported no change in mucus production in a controlled trial of hydration versus dehydration in participants with chronic bronchitis. Neither of these studies were performed in people with acute respiratory infections so we are unable to extrapolate the results to our study question.

2. Are there adverse effects from recommending increased fluids in patients with acute respiratory infections?

No RCTs were found to answer this question definitively. Further research needs to be done to determine any true adverse effects from recommending increased fluids in acute respiratory infections.

Only observational data suggest potential adverse effects from recommending increased fluids (Breuer 1981; Dhawan 1992; Don 2008; Gozal 1990; Hanna 2003; Heim 1982; Lipsitz 1984; Lubitz 1982; Mor 1975; Nair 2007; Pollard 1975; Rivers 1981; Rosenow 1972; Singhi 2005; Van Steensel-Moll 1990). A summary of these studies is provided in Table 2, an abridged version of which has previously been published (Guppy 2003). The observational data suggest that it might be type of fluid (hypotonic), rather than quantity, that is associated with potential adverse effects (Nair 2007).

Two prospective observational studies investigated the frequency of hyponatraemia in children admitted to hospital with pneumonia. Shann 1985 reported an incidence of 45% and Dhawan 1992 reported an incidence of 31%. In an observational study of infants with bronchiolitis none were found to have hyponatraemia, despite 22 out of the 23 having elevated anti-diuretic hormone (ADH) levels (Gozal 1990). In contrast, the frequency of hyponatraemia was reported as 21% in an observational study of infants admitted to hospital with respiratory syncytial virus (RSV) infection, which included infants with bronchiolitis (Van Steensel-Moll 1990). The symptoms of hyponatraemia were not reported. These studies were in hospitalised children. In view of this potential for water overload, fluid restriction has been recommended for children with pneumonia (Shann 1995). However, one observational study suggests only restricting fluids in children with pneumonia after correction of hypoxaemia (Singhi 2005). The incidence and clinical significance of these observational data for the primary care setting and implications for fluid management need to be determined with further research.

In their study of adults with community-acquired pneumonia, Nair 2007 found an incidence of hyponatraemia on admission of 27.9%. Fluid intake prior to hospitalisation was not documented. Subsequently, an additional 10.5% of participants developed hyponatraemia during hospitalisation. Participants who developed hyponatraemia were more likely to have renal disease and to have received hypotonic intravenous fluids, or no intravenous fluids. Treatment with isotonic intravenous fluids on admission appeared to be strongly protective against the development of hyponatraemia. This apparent protective effect of isotonic fluids needs to be further delineated in a randomised controlled trial.

3. Are any benefits or harm related to site (upper or lower respiratory tract), or different severity of illness?

Site of infection

No RCTs were found to answer this question. Further research needs to be done to determine if any benefit or harm from fluids is related to site of illness.

Observational data suggest hyponatraemia may be more commonly associated with infections of the lower respiratory tract. We have reported an association with pneumonia and bronchiolitis in children. Hyponatraemia has also been associated with lower respiratory tract infections in adults, including pneumonia (Breuer 1981; Nair 2007; Pollard 1975; Rosenow 1972) and bronchitis (Heim 1982).

Two cases have been reported of symptomatic hyponatraemia in infants with upper respiratory symptoms (Lipsitz 1984; Lubitz 1982). In one of these cases, the infant had been given excessive amounts of dilute oral fluids (Lipsitz 1984). However, the incidence of hyponatraemia in upper respiratory infections appears to be rare. In a study of children with RSV infection none of the infants in the upper respiratory infection group had hyponatraemia (Van Steensel-Moll 1990).

Severity of infection

No RCTs were found to answer this question definitively. Further research needs to be done to determine if any benefit or harm from fluids is related to severity of illness.

Observational data suggest that hyponatraemia may occur more frequently with increasing severity of illness. Dhawan 1992 reported that hyponatraemia was twice as common in children with severe pneumonia. Dreyfuss 1988 found that impairment of water excretion in adults with pneumonia was roughly proportional to the degree of severity of pneumonia, as seen radiographically. Hanna 2003 reported a 33% incidence of hyponatraemia in infants admitted to intensive care with bronchiolitis and a seizure rate of 4%. However, Van Steensel-Moll 1990 found in infants with RSV infection that mean sodium levels were normal and did not differ with severity of illness, despite a difference in mean ADH levels.

Singhi 1992 reported prolonged hospitalisation and increased mortality, and Singhi 2005 reported longer duration of illness in children with pneumonia and hyponatraemia, but whether this was due to the underlying disease process or the hyponatraemia is uncertain. In their study of hyponatraemia in hospitalised adults with pneumonia, Nair 2007 found that a greater proportion of hyponatraemic participants had a greater severity of pneumonia,

with hyponatraemia on admission being associated with an increased mortality, and increased length of hospitalisation.

Don 2008 studied the incidence of hyponatraemia in both hospitalised and ambulatory participants with pneumonia. They found that the presence of hyponatraemia was significantly associated with need for hospitalisation, fever and increased white blood cell count, thereby reflecting the severity of pneumonia. This study found an incidence of hyponatraemia of 42% in ambulatory outpatients with pneumonia. The hyponatraemia was generally mild, with only 5% of participants having a serum Na of < 130 mmol/l.

We did not find any studies relating to fluid management in primary care. The significance of these data in relation to both children and adults in the primary care setting needs to be determined with further research.

Quality of the evidence

The evidence that we found was based on observational data, rather than data from randomised controlled clinical trials. Additionally, the majority of the studies were of participants in the inpatient hospital setting, so extrapolation to patients in the primary care setting is problematic.

AUTHORS' CONCLUSIONS

Implications for practice

The implications for fluid management in acute respiratory infections have not been studied in any RCTs to date. There is currently inadequate evidence for or against the advice to increase fluids in acute respiratory infections. Observational data based on hospitalised participants suggest that there may be a risk of symptomatic hyponatraemia due to increased antidiuretic hormone secretion in lower respiratory tract infections. The incidence in the primary care setting, the clinical significance of these observational data, and the implications for oral fluid management need to be determined with further research, conducted as randomised controlled trials (RCTs).

Implications for research

No RCTs have been performed to determine any benefit or harm from extra fluids during acute respiratory infections. RCTs need to be done to determine the true effect of this very common medical advice.

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* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Dhawan 1992	Excluded as observational study only
Don 2008	Excluded as observational study only
Dreyfuss 1988	Excluded as it is not a randomised controlled trial
Gozal 1990	Excluded as observational study only
Nair 2007	Excluded as observational study only
Saketkhoo 1978	Excluded as did not meet inclusion criteria for acute respiratory infection. All participants were healthy
Shann 1985	Excluded as observational study only
Shim 1987	Excluded as did not meet inclusion criteria for acute respiratory infection. All participants had chronic bronchitis
Singhi 2005	Excluded as observational study only
Van Steensel-Moll 1990	Excluded as observational study only

ADDITIONAL TABLES

Table 1. Table 8.5.a: The Cochrane Collaboration's tool for assessing risk of bias

Domain	Description	Review authors' judgement
Sequence generation	Describe the method used to generate the allocation sequence in sufficient detail to allow an assessment of whether it should produce comparable groups	Was the allocation sequence adequately generated?
Allocation concealment	Describe the method used to conceal the allocation sequence in sufficient detail to determine whether intervention allocations could have been foreseen in advance of, or during, enrolment	Was allocation adequately concealed?

Table 1. Table 8.5.a: The Cochrane Collaboration's tool for assessing risk of bias (*Continued*)

Blinding of participants, personnel and outcome assessors *Assessments should be made for each main outcome (or class of outcomes).*	Describe all measures used, if any, to blind study participants and personnel from knowledge of which intervention a participant received. Provide any information relating to whether the intended blinding was effective	Was knowledge of the allocated intervention adequately prevented during the study?
Incomplete outcome data *Assessments should be made for each main outcome (or class of outcomes).*	Describe the completeness of outcome data for each main outcome, including attrition and exclusions from the analysis. State whether attrition and exclusions were reported, the numbers in each intervention group (compared with total randomised participants), reasons for attrition/exclusions where reported, and any re-inclusions in analyses performed by the review authors	Were incomplete outcome data adequately addressed?
Selective outcome reporting	State how the possibility of selective outcome reporting was examined by the review authors, and what was found	Are reports of the study free of suggestion of selective outcome reporting?
Other sources of bias	State any important concerns about bias not addressed in the other domains in the tool If particular questions/entries were prespecified in the review's protocol, responses should be provided for each question/entry	Was the study apparently free of other problems that could put it at a high risk of bias?

Table 2. Hyponatraemia in patients with respiratory infections

Author	Number of participants	Characteristics	Diagnosis	Exclusions	Serum Na (mmol/l)	Anti-diuretic hormone	Serum/ urine conc.	Symptoms of low Na
Nair 2007	342	All participants with the diagnosis of CAP	Community-acquired pneumonia	Respiratory failure, immunosuppression medication, no antibiotics in first 24 hours	95 (27.9 %) participants on admission (< 135 mm/l). 36 (10.5%) participants during hospital stay			Longer duration in hospital
Don 2008	108	Children 16 to 94 months	Community-acquired	Newborns, wheezing, chronic	Na < 135 mmol/l 49 (45.4%) on	Not measured	Not measured	

Table 2. Hyponatraemia in patients with respiratory infections (*Continued*)

			pneumonia	illness, renal disease, endocrine disease, medications interfering with fluid balance	admission			
Dhawan 1992	100	Children 1 month to 12 years	Pneumonia	Clinical dehydration	31 had Na < 130, + 18 < 135 (49%)		29 dilute serum, 2 concentrated - probable dehydration	4 died - Na < 125 mmol/l, hyponatraemia 2 to 3 times more frequent with severe pneumonia
Hanna 2003	91	Infants	RSV bronchiolitis requiring intensive care admission	Diuretic therapy, cardiac or renal disease	30 had Na < 136 (33%)		No signs of dehydration	4 infants had seizures
Shann 1985	73	Children 1 month to 24 + months	Pneumonia	Clinical dehydration	33 had Na < 134 (45%)			Not reported
Singhi 2005	50	Children aged 2 to 59 months	Community-acquired pneumonia	Fever > 7 days, i.v. fluids or diuretics in past 6 hours, dehydration in past 24 hours, measles, pertussis, heart disease, asthma, shock, primary liver or renal disease, malnutrition, encephalitis	24 children had Na < 135 (48%) on admission, 21 during recovery		Dilute serum, concentrated urine on admission, compared to recovery	Longer duration of illness
Van Steensel-Moll 1990	48	Median age 104 days, 79% <	Non-pulmonary	Clinical dehydration	10 had Na < 135 on ad-	27 had elevated		Not reported

Table 2. Hyponatraemia in patients with respiratory infections (*Continued*)

		1 year	RSV, pulmonary RSV, ventilated		mission (20%)	ADH on admission		
Gozal 1990	23	Children < 1 year, mean age 5. 5 months	Bronchiolitis		Normal	22 had elevated ADH	22 dilute serum, concentrated urine	
Rivers 1981	4	6 to 8 weeks and 6 months	3 bronchiolitis, 1 pneumonia		3 participants 114 to 124		Concentrated urine, or not maximally dilute urine	Seizures in 1 participant with bronchiolitis
Rosenow 1972	3	40-year old woman, 24 and 28-year old pregnant women	Pneumonia		118 to 135		Dilute serum, concentrated urine	40-year old woman lost consciousness
Lipsitz 1984	1	10-week old girl	Mild coryza - had been given large amounts of oral fluids		112			Seizures
Heim 1982	1	58-year old male	3 episodes of acute bronchitis		118 at 2nd episode			Disorientation, nausea, vomiting
Lubitz 1982	1	5-week old girl	Initially upper respiratory symptoms only, subsequent bronchiolitis		117		Dilute serum, concentrated urine	Seizures
Breuer 1981	1	68-year old woman, chronic bronchitis but no right-sided heart failure	Mycoplasma pneumonia		Initially 137, 111 after receiving 2.8 L i.v. fluids over 18 hours		Dilute serum, concentrated urine	Seizures, stuporous

Table 2. Hyponatraemia in patients with respiratory infections (*Continued*)

Pollard 1975	1	17-year old male	Adenovirus pneumonia		123		Dilute serum, concentrated urine	Confusion
Mor 1975	1	6-week old boy	Pneumonia		107			Seizures, resolved with fluid restriction

Na = sodium
CAP = community-acquired pneumonia
RSV = respiratory syncytial virus
i.v. = intravenous
ADH = anti-diuretic hormone

APPENDICES

Appendix 1. Previous search

We searched the Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library* 2005, Issue 2) which contains the Acute Respiratory Infections Group's Specialised Register, MEDLINE (1966 to July Week 1, 2005), EMBASE (1974 to Week 29, 2005), Current Contents (current five years) and CINAHL (1982 to July week 3, 2005).
We combined the following search strategy with the Cochrane highly sensitive search strategy phases one and two as published in appendix 5c of the Cochrane Reviewers' Handbook (Clarke 2003). There were no constraints based on language or publication status when searching for trials. The following terms were also searched on CENTRAL and adapted for EMBASE, Current Contents and CINAHL as necessary.
MEDLINE (OVID)
1 exp Respiratory Tract Infections/
2 respiratory infection*
3 upper respiratory tract infection*
4 URTI
5 1-4 OR
6 exp Fluid Therapy/
7 fluid therapy
8 exp Water-Electrolyte Balance/
9 water electrolyte balance
10 fluid balance
11 exp water/
12 exp drinking/
13 exp drinking behaviour/
14 drink* adj (fluid* or water)
15 exp Infusions, Parenteral/
16 parenteral infusion*
17 exp thirst/

18 thirst*
19 exp water deprivation/
20 water intake
21 fluid intake
22 rehydration
23 exp Rehydration Solutions/
24 rehydration solution*
25 oral rehydration therapy
26 (give fluid*)
27 (give NEAR fluid*)
28 6-27
29 5 AND 28

Appendix 2. Embase.com search strategy

18. #14 AND #17
17. #15 OR #16
16. random*:ab,ti OR placebo*:ab,ti OR factorial*:ab,ti OR crossover*:ab,ti OR 'cross over':ab,ti OR 'cross-over':ab,ti OR assign*:ab,ti OR allocat*:ab,ti OR volunteer*:ab,ti OR ((singl* OR doubl*) NEAR/2 (blind* OR mask*)):ab,ti
15. 'randomized controlled trial'/exp OR 'single 209,300 27 Jan 2010
blind procedure'/exp OR 'double blind
procedure'/exp OR 'crossover procedure'/exp AND
[embase]/lim
14. #5 AND #13
13. #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12
12. 'parenteral infusion':ab,ti OR 'parenteral infusions':ab,ti
11. 'infusion'/de
10. 'water'/de OR 'drinking'/de OR 'thirst'/de OR 'water deprivation'/de OR 'oral rehydration therapy'/de OR 'oral rehydration solution'/de OR 'rehydration'/de OR 'beverage'/de
9. ((water OR fluid* OR liquid* OR beverage*) NEAR/3 (increas* OR intake* OR take* OR give* OR drink* OR consume*)):ab,ti
8. (fluid NEAR/2 (balance OR therap*)):ab,ti OR 'electrolyte balance':ab,ti
7. 'electrolyte balance'/exp
6. 'fluid therapy'/de
5. #1 OR #2 OR #3 OR #4 242,017 27 Jan 2010
4. 'common cold':ab,ti OR 'common colds':ab,ti OR 'acute sinusitis':ab,ti OR tonsillit*:ab,ti OR laryngit*:ab,ti OR bronchit*:ab,ti OR pneumon*:ab,ti OR flu:ab,ti OR influenza:ab,ti OR bronchiolit*:ab,ti OR nasopharyngit*:ab,ti OR
rhinopharyngit*:ab,ti OR pharyngit*:ab,ti OR 'sore throat':ab,ti OR rhinit*:ab,ti OR tracheit*:ab,ti OR tracheobronchit*:ab,ti OR cough*:ab,ti
3. 'bronchitis'/exp OR 'pneumonia'/exp OR 'laryngitis'/exp OR 'common cold'/de OR 'sinusitis'/exp OR 'pharyngitis'/exp OR 'tracheitis'/exp OR 'tonsillitis'/de OR 'rhinitis'/de OR 'coughing'/de OR 'hoarseness'/de OR 'sore throat'/de OR 'influenza'/exp
2. (respiratory NEAR/2 infection*):ab,ti urti:ab,ti OR lrti:ab,ti
1. 'respiratory tract infection'/de OR 'upper respiratory tract infection'/de OR 'lower respiratory tract infection'/de

Appendix 3. CINAHL search strategy

S23 S19 and S22
S22 S20 or S21
S21 TI (random* or placebo* or single blind* or double blind* or crossover* or assign* or allocat* or volunteer* or factorial*) or AB (random* or placebo* or single blind* or double blind* or crossover* or assign* or allocat* or volunteer* or factorial*)
S20 (MH "Clinical Trials+")
S19 S5 and S18
S18 S6 or S7 or S8 or S9 or S10 or S11 or S12 or S13 or S14 or S15 or S16 or S17
S17 TI (rehydrat* or parenteral infusion*) or AB (rehydrat* or parenteral infusion*)
S16 TI ((water or fluid* or liquid* or beverage*) AND (increas* or intake* or take* or give* or drink* or consume*)) or AB ((water or fluid* or liquid* or beverage*) AND (increas* or intake* or take* or give* or drink* or consume*))
S15 (MH "Infusions, Parenteral+")
S14 (MH "Beverages")
S13 (MH "Rehydration Solutions+")
S12 TI thirst* or AB thirst*
S11 (MH "Thirst")
S10 (MH "Drinking Behavior")
S9 (MH "Water")
S8 TI (fluid therap* or fluid balance or fluid-electrolyte balance or fluid electrolyte balance or water-electrolyte balance or water electrolyte balance) or AB (fluid therap* or fluid balance or fluid-electrolyte balance or fluid electrolyte balance or water-electrolyte balance or water electrolyte balance)
S7 (MH "Fluid-Electrolyte Balance+")
S6 (MH "Fluid Therapy")
S5 S1 or S2 or S3 or S4
S4 TI (common cold* or acute sinusit* or tonsillit* or laryngit* or bronchit* or pneumon* or flu or influenza or bronchiolit* or nasopharyngit* or pharyngit* or sore throat* or rhinit* or tracheit* or tracheobronchit* or cough*) or AB (common cold* or acute sinusit* or tonsillit* or laryngit* or bronchit* or pneumon* or flu or influenza or bronchiolit* or nasopharyngit* or pharyngit* or sore throat* or rhinit* or tracheit* or tracheobronchit* or cough*)
S3 TI (urti or lrti) or AB (urti or lrti)
S2 TI (respiratory tract infection* or respiratory infection*) or AB (respiratory tract infection* or respiratory infection*)
S1 (MH "Respiratory Tract Infections+")

Appendix 4. Current Contents search strategy

Topic=("respiratory tract infection*" or "respiratory infection*" or "upper respiratory tract infection*" or urti) AND Topic=("fluid therapy" or "water electrolyte balance" or "fluid balance" or "drink* water" or "drink* fluid*" or "drinking behaviour" or "drinking behavior" or "parenteral infusion*" or "water intake" or "fluid intake" or rehydration or "give fluid*") AND
Topic=(random* or placebo* or blind* or trial* or rct)

WHAT'S NEW

Date	Event	Description
16 December 2010	New search has been performed	Searches conducted.
28 January 2010	New citation required but conclusions have not changed	Two new review authors joined the review team. We excluded three new studies. The conclusions of the updated review remained unchanged

HISTORY

Protocol first published: Issue 4, 2003

Review first published: Issue 4, 2005

Date	Event	Description
21 January 2010	Amended	Contact details updated.
15 July 2008	Amended	Converted to new review format.
11 August 2005	New search has been performed	Review first published issue 4, 2005.

CONTRIBUTIONS OF AUTHORS

The initial idea was conceived by Chris Del Mar (CDM).

The original review was written by Michelle Guppy (MG), and updated review written by MG and Alexander Rack (AR).

Formulating the question and editing the review was carried out by CDM and Sharon Mickan (SM).

Sarah Thorning (ST) updated the search strategy, performed all searches and procured relevant studies.

AR and MG critically appraised new studies from the updated search.

DECLARATIONS OF INTEREST

None known.

INDEX TERMS

Medical Subject Headings (MeSH)

*Drinking; Acute Disease; Dehydration [etiology; therapy]; Fluid Therapy [*adverse effects]; Respiratory Tract Infections [complications; *therapy]

MeSH check words

Humans