Speleotherapy for asthma (Review)

Beamon S, Falkenbach A, Fainburg G, Linde K

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Speleotherapy for asthma (Review)
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Speleotherapy for asthma (Review)

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ABSTRACT

Background
Speleotherapy, the use of subterranean environments, is a therapeutic measure in the treatment of chronic obstructive airways diseases. It is virtually unknown in the UK or the US, but has considerable widespread use in some Central and Eastern European countries.

Objectives
To review evidence for the efficacy of speleotherapy in the treatment of asthma.

Search strategy
We searched electronic databases (MEDLINE, EMBASE, Cochrane Airways Specialised Register), contacted speleotherapy centres and experts in the field, handsearched proceedings, and checked bibliographies of articles obtained to identify possible relevant publications.

Selection criteria
We included controlled clinical trials (i.e., both randomized and those not reporting the method of allocation) that compared clinical effects of speleotherapy with another intervention or no intervention in patients with chronic asthma.

Data collection and analysis
Information concerning patients, interventions, results, and methodology were extracted in standardized manner by two independent reviewers and summarized descriptively.

Main results
Three trials including a total of 124 asthmatic children met the inclusion criteria, but only one trial had reasonable methodological quality. Two trials reported that speleotherapy had a beneficial short-term effect on lung function. Other outcomes could not be assessed in a reliable manner. A further search in April 2005 did not identify any new studies.

Authors’ conclusions
The available evidence does not permit a reliable conclusion as to whether speleo-therapeutic interventions are effective for the treatment of chronic asthma. Randomized controlled trials with long-term follow-up are necessary.

PLAIN LANGUAGE SUMMARY

Speleotherapy (staying in underground environments) is believed to be of some benefit to people with asthma. People spend short periods in specifically designated caves or mines, sometimes doing particular physical or breathing exercises. There are some wards for longer stays. Benefits are believed to come from air quality, underground climate, air pressure or radiation. These features differ among caves and mines (for example, there are high levels of radiation in some mines, and different types of humidity). No evidence from randomised controlled trials was found and more research is needed.
**BACKGROUND**

Speleotherapy, the use of subterranean environments, is a therapeutic measure in the treatment of chronic obstructive airways diseases. It is virtually unknown in the UK or the US, but has considerable widespread use in some Central and Eastern European countries.

The main curative factors of speleotherapy in caves and mines are thought to be air quality, underground climate and radiation. Two main kinds of air quality can be distinguished - firstly in salt and potash mines and caves, and secondly in karst caves and ore mines. Three forms of climate can be recognised (by temperature) - cold, moderate, warm and three forms of climate (by relative humidity) - low, normal, high and three forms of climate (by pressure) - low, normal, high. There are four forms of radiation - high level due to radon, moderate level - to potassium -40, normal level - to normal karst rock, and low level - to common salt rock (halite).

In practice there are: (1) cold and moderate karst caves with high humidity, normal pressure and normal radiation level (e.g., Slovak caves); (2) warm karst or granite bedrock caves with high humidity, normal pressure and high radiation level due to radon (e.g. Gasteiner Heilstollen, Badgastein-Bockstein, Austria); (3) potash mines with moderate temperature, normal humidity, high pressure and moderate radiation level (e.g. Berezniki, Russia; Soligorsk, Byelorussia); (4) warm salt mines with low humidity, high pressure and low radiation level (e.g., Solotivo, Ukraine; Tîrgu Ocna, Romania; Wieliczka, Poland); (5) salt mines and caves with moderate temperature, low humidity, low pressure and low radiation level (e.g. Chon-Tus, Kirgizia) and others.

In cold caves (temperature 6 - 10 degrees C., relative humidity 80 - 100%) the patients stay daily for about one hour during a three or four week sojourn at the health resort. In most caves, patients are advised to rest during this period. In some caves physical exercises or breathing exercises, including salt aerosols, are recommended.

The caves and mines with a moderate temperature (13 - 20 degrees C., relative humidity 45 - 70%) are used for longer treatment periods (e.g. about 8 to 10 hours 3 to 4 times per week). In Eastern European countries even some kinds of ward have been built in these caves, or mines, to allow the patients to stay in this climate for a longer period of time.

Warm caves (and former mines) (30 - 41 degrees C., relative humidity 70 - 100%) are used for treatment in Italy, France and Austria. In most of these warm caves there is an elevated concentration of radon, which is considered an important component in this form a climatic therapy. Patients stay in these caves for about one hour. Sojourn of three or four weeks at the health resort with entries every day or every other day are recommended.

Several components of the subterranean environment, air quality and climate in the caves and mines have been thought to be relevant in the treatment of asthma. These include:

- absence of normal biotic conditions (e.g. light)
- temperature difference underground and on the Earth surface
- natural (but higher than normal) radiation level
- low mobility of air (<0.1 m/s) and big volume of underground atmosphere and large surface of its interaction with the surrounding area - presence of mineral water drops or hygroscopic minerals' aerosol
- presence of moderate or high relative humidity for the constant process of condensation and as a result contributing to the pureness of the air, scavenging dust, pollen and gases
- high rate of air ionisation (by radon or potassium-40)
- low levels of dust (0.05 mg/m3), pollen (<30/m3) and gas pollutant concentration (low level of irritation)
- low levels of bacteria and other bioaerosols contamination
- constancy of the climate
- presence of finest aerosols of vital elements (Na, K, Mg, Ca and so on)

In cold caves, the high relative humidity contributes to the purity of the air.

**OBJECTIVES**

The objective of the review was to investigate the evidence for the effectiveness of speleotherapy interventions in the treatment of asthma.

The review was planned to address the following questions:
- Compared to control interventions, does speleotherapy have a positive effect on physiological outcomes, such as peak expiratory flow rates (PEFR), forced expiratory volume (FEV1) or vital capacity in asthmatic patients?
- Compared to control interventions, does speleotherapy, have a positive influence on quality of life, subjective symptoms, medication use, immunological state, morbidity, and mortality in asthmatic patients?

**CRITERIA FOR CONSIDERING STUDIES FOR THIS REVIEW**

**Types of studies**

Controlled clinical trials (randomized trials and trials in which the method of allocation to groups was not described).

**Types of participants**

Patients with chronic stable asthma.
Types of intervention
Studies had to include at least one treatment group in which speleotherapy was applied.

Types of outcome measures
Studies had to include objective or subjective parameters related to asthma, such as lung function, subjective symptoms, quality of life, medication use.

SEARCH METHODS FOR IDENTIFICATION OF STUDIES

See: Airways Group methods used in reviews.

Eligible trials were identified by the following means:

1) The Cochrane Airways Group Specialised Register of trials was searched (the most recent search was run in April 2006 and will be updated annually). The Register is derived from systematic searches of bibliographic databases including the Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE, EMBASE and CINAHL, and handsearching of respiratory journals and meeting abstracts. All records in the Register coded as 'asthma' were searched using the following terms:
   Spelaeo* or speleo* or spelio* or cave* or microclimat* or salina* or "salt min*" or "potash min*" or subterraneotherap* or "vital air room" or halochamber* or biontron* or ionotron* or "climat* chamber*" or karst* or radon* or SaltPipe or Sopipa or BreathMaster

2) All citations identified (using the search term speleo*) in EMBASE (from 1991 onwards) and MEDLINE (from 1966 onwards) were screened by KL.

3) Institutions and subjects in Eastern Europe, Austria and Germany known to have expertise in speleotherapy were contacted for further information by SB, AF and GF.

4) Speleological and caving journals as well as proceedings and abstracts from symposia on speleotherapy were handsearched. (This strategy identified the largest number of possible relevant references)

5) References in the identified trials were checked for other possible relevant studies.

METHODS OF THE REVIEW

Literature screening and selection of eligible trials:
As speleotherapy research has rarely been published in MEDLINE- or EMBASE-listed journals the literature search had to rely primarily on contacting individuals or institutions and hand searching proceedings and abstract collections. As a first step one of the reviewers selected, from the pool of obtained material relating to the speleo-therapeutic treatment of asthma patients, those studies that were prospective, including uncontrolled case series and experiments. The studies had to include asthma patients (solely or as a separately reported subgroup) and report any clinical outcomes measures beyond "success rates". In a second step two reviewers selected from reports passing the first step those meeting the inclusion criteria. Disagreements were resolved by discussion.

Extraction of descriptive characteristics and study results were done by two reviewers using a standard form.

Regarding quality the following indicators were assessed by two reviewers independently:
- Was allocation to the compared groups described to be randomized?
- Was the concealment of randomization adequate?
- Was an attempt made to blind evaluators?
- Was there a detailed description of numbers and reasons for drop-outs and withdrawals in each group?
- Might results be biased due to drop-outs and withdrawals?

The primary studies were summarized descriptively because only a small number of trials were identified, the interventions were heterogeneous, and there was insufficient reporting of outcomes. The table of included studies provides a structured summary of the included studies. The following abbreviations were used in the table:
- Methods:
  A = allocation to groups,
  C = concealment of allocation,
  B = blinding,
  D = report of drop-out and withdrawals,
  S = selection bias after allocation,
  O = other information
- Patients:
  N = number,
  C = condition,
  D = demographic information,
  R = recruitment,
  S = study setting
- Interventions:
  S = speleotherapy group,
  C = control group
- Outcomes:
  L = lung functions,
  S = subjective symptoms,
  M = medication
- Notes:
  R = conclusion of the authors of the primary study,
  C = comments

DESCRIPTION OF STUDIES

Only one study fully met the inclusion criteria (Novotny 1994).
Two further studies (Agostini 1989, Makesowa 1989) did not describe how the patients were allocated to the groups, but randomization seemed unlikely in both. We decided to include these two studies given the scarce evidence available.

One study investigated the effects of speleotherapy in a cave in the Lucca region (Alps of Carrara) in Italy (Agostini 1989), one in a Karst cave in the Czech Republic (Makesowa 1989), and one in a hot tunnel with a high radon level in Austria (Novotny 1994). All three studies were performed on asthmatic children (total number = 124). No study clearly specified inclusion and exclusion criteria. An update search in April 2006 did not identify any further studies.

**METHODOLOGICAL QUALITY**

The study of Novotny 1994 seems to be of reasonable quality although a number of details (exact inclusion criteria, concealment of randomization, completeness of follow-up, con-medication, measurement of subjective symptoms) remain unclear in the available reports. The studies by Agostini 1989 and Makesowa 1989 are reported in such a manner that a reliable assessment is impossible. However, strong doubts about the adequacy of the methods seem justified. The uneven number of patients in treatment and control group in the trials by Agostini 1989 et al. and the way of reporting the methods makes it unlikely that allocation had been randomized. The comparability of the groups is completely unclear. The same applies to the study by Makesowa 1989 which also gives no information on allocation, treatment and characteristics of the control group.

**RESULTS**

In the study of Novotny 1994 a slight improvement of the lung function was observed at the end of the 3-week treatment period. There were significant differences between treatment and control group in terms of MEF25% and MEF50% although FEV1 did not differ significantly. Nine weeks after treatment no difference between the groups was observed. The authors concluded that speleotherapy had a moderate, transient therapeutic effect. Agostini 1989 reported that the children undergoing speleotherapy had better lung function parameters during and after the treatment phase while during follow-up no clear differences could be detected. The authors reported that the children in the treatment group needed less medication than those in the control group during the observation period. The reporting of Makesowa 1989 regarding lung function allows no interpretation. The need of medication at follow-up seems to have been lower in the treatment group.

**DISCUSSION**

At the moment there is insufficient evidence to assess reliably whether speleotherapy (or some forms of it) is beneficial for asthma patients. Apart from the study of Novotny 1994 we were not able to find a study which - at least in the form reported - had acceptable scientific quality.

Speleotherapy is relatively widespread in Eastern Europe and there may be relevant studies which we did not find, although we tried to contact experts in the field and asked them to provide data. The publication of this review may motivate researchers of speleotherapy to contact us and provide further studies. However, based on our contacts it does not seem likely that high-quality randomized trials of speleotherapy exist.

As the characteristics of caves and the treatment schedules vary strongly speleotherapy cannot be considered as one single treatment but rather a class of interventions. For example, the only study in our review which fully met the inclusion criteria (Novotny 1994) was performed in a site which has rather unique characteristics on a geophysical level. Positive or negative results obtained with a specific schedule in a defined cave cannot be extrapolated to speleotherapy in general.

Whether speleotherapeutic treatment has relevant risks is also unclear. We did not find any systematic investigations on that issue although the large number of treatments in Eastern Europe without reports on serious adverse effects suggests that at least short-term risks are small. The high level of radon in some caves has caused concern among some physicians and patients. For example, in an information leaflet on complementary therapies for patients the German Asthma league takes a sceptical position towards speleotherapy in radon caves.

**AUTHORS’ CONCLUSIONS**

**Implications for practice**

At present it is not possible to make any recommendations for practice which are based on evidence from rigorous randomised controlled trials.

**Implications for research**

Further research on speleotherapy seems justified. Such research should be undertaken by institutions actually practicing speleotherapy and reflect current standards of clinical research on asthma. Randomized trials in subterranean speleo hospitals are actually being planned. However, funding for these trials is still a problem.

While it seems possible that speleotherapy has short-term beneficial effects the major question is whether any of these last over a longer period and whether the treatment is cost-effective.
It may be difficult to separate specific effects due to temperature, humidity, low levels of allergen and other geophysical properties from non-specific effects such as being under the earth. Such non-specific effects might be of major importance in speleotherapy.

**Potential Conflict of Interest**

None known.

**Acknowledgements**

We would like to thank Steve Milan for his help at all steps of the review.

**Sources of Support**

**External sources of support**

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- Askim Insurance Consultants, Histon, Cambridge (supporting SB) UK

**Internal sources of support**

- NHS Research and Development UK

**References**

**References to studies included in this review**

Agostini 1989 *(published data only)*


Makesowa 1989 *(published data only)*


Novotny 1994 *(published and unpublished data)*


**References to studies excluded from this review**

Bernatzky 1994


Homolka 1989


Khamzamylin 1990


Lemko 1994

Lemko I, Lemko O. Influence of speleotherapy upon the lung function of patients with bronchial asthma [Einfluss der Speläotherapie...

**Sokolov 1994**

**Timová 1989**

**References to studies awaiting assessment**

**Leichsenring 2002**

**Additional references**

**Fodor 1973**

**Fodor 1977**

**Hille 1975**
Hille H. Speleotherapy in the Münstertal cave [Spelaotherapie in der “Münstertalhöhle” (Schwarzwald, Bundesrepublik Deutschland)]. *Die Höhle* 1975;26:81–8.

**Jadad 1996**

**Kessler 1975**

**Maximovich 1972**

**Roda 1973**

**Roda 1980**

**Roda 1982**

**Ronaki 1973**

**Symposium 1986**

**Symposium 1992**

**Trombe 1952**

---

### TABLES

#### Characteristics of included studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Agostini 1989</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methods</td>
<td>A: unclear</td>
</tr>
<tr>
<td></td>
<td>C: unclear</td>
</tr>
<tr>
<td></td>
<td>B: unclear (probably no blinding)</td>
</tr>
<tr>
<td></td>
<td>D: partly described</td>
</tr>
<tr>
<td></td>
<td>S: major bias unlikely</td>
</tr>
<tr>
<td></td>
<td>O: follow-up 12 months</td>
</tr>
<tr>
<td>Participants</td>
<td>N: 26 included, 23 analyzed (16 in the treatment and 7 in the control group)</td>
</tr>
<tr>
<td></td>
<td>C: atopic asthma</td>
</tr>
<tr>
<td></td>
<td>D: children (no further information)</td>
</tr>
<tr>
<td></td>
<td>R: unclear</td>
</tr>
</tbody>
</table>

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*Spleleotherapy for asthma (Review)*

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**Characteristics of included studies (Continued)**

<table>
<thead>
<tr>
<th>Interventions</th>
<th>S: four Italian clinics and institutes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I: 78 to 110 hours in a cave (dolomite limestone and rock, 11°C, 98-100% humidity) during a 3 week period</td>
</tr>
<tr>
<td></td>
<td>C: no speleotherapy</td>
</tr>
<tr>
<td></td>
<td>No information on other therapies</td>
</tr>
<tr>
<td>Outcomes</td>
<td>L: improvement of lung function during the treatment phase in the speleotherapy groups, follow-up results do not seem to show a clear effect (insufficient data given)</td>
</tr>
<tr>
<td></td>
<td>S: not mentioned</td>
</tr>
<tr>
<td></td>
<td>M: seem to have been lower in the speleotherapy group</td>
</tr>
<tr>
<td>Notes</td>
<td>A: no conclusions presented</td>
</tr>
<tr>
<td></td>
<td>C: insufficient presentation, study hardly assessable</td>
</tr>
<tr>
<td>Allocation concealment</td>
<td>B – Unclear</td>
</tr>
</tbody>
</table>

**Study**

**Makesowa 1989**

<table>
<thead>
<tr>
<th>Methods</th>
<th>A: unclear (randomization unlikely)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C: unclear (probably inadequate)</td>
</tr>
<tr>
<td></td>
<td>B: probably none</td>
</tr>
<tr>
<td></td>
<td>D: not described</td>
</tr>
<tr>
<td></td>
<td>S: unclear</td>
</tr>
<tr>
<td></td>
<td>O: possibly case-control design, follow-up between 1 and 5 years</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Participants</th>
<th>N: included ?, analyzed 37/28</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D: asthma (47 also had pollinosis)</td>
</tr>
<tr>
<td></td>
<td>D: age 7 - 13 years, 47 boys, 18 girls</td>
</tr>
<tr>
<td></td>
<td>R: unclear</td>
</tr>
<tr>
<td></td>
<td>S: allergology department of National Health Institutes in Brno (Czech Rep.)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interventions</th>
<th>I: speleotherapy in a local Karst cave (no further details)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C: no speleotherapy (no further details)</td>
</tr>
<tr>
<td></td>
<td>Both groups seem to have received anti-asthmatic drugs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>L: no interpretable results presented</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S: no data presented</td>
</tr>
<tr>
<td></td>
<td>M: drug use seems to be lower in speleotherapy group (presented results hardly interpretable)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Notes</th>
<th>A: positive</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C: insufficient presentation, therefore study not reliably assessible and interpretable</td>
</tr>
</tbody>
</table>

**Allocation concealment** | B – Unclear

**Study**

**Novotny 1994**

<table>
<thead>
<tr>
<th>Methods</th>
<th>A: children were matched into pairs (based on clinical symptoms, allergological status, lung function) and then randomized</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C: unclear</td>
</tr>
<tr>
<td></td>
<td>D: not mentioned</td>
</tr>
<tr>
<td></td>
<td>S: unclear (but not likely)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Participants</th>
<th>N: 30 included, 30 analyzed (?)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C: asthma (mean FEV1 before therapy slightly below 80% of the predicted value)</td>
</tr>
<tr>
<td></td>
<td>D: age 7 to 15 years, 20 boys and 10 girls</td>
</tr>
<tr>
<td></td>
<td>R &amp; S: children were invited to a cost-free 3 week holiday in a health resort in Badgastein, Austria</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interventions</th>
<th>S: 10 times 1 hour stay in the radon-thermal climate (granite, 38-41.5°C, humidity 75-90%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C: no speleotherapy</td>
</tr>
<tr>
<td></td>
<td>In addition both group participated to the same activity and free time programme in the resort. No information on medication</td>
</tr>
</tbody>
</table>
Characteristics of included studies (Continued)

Outcomes

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Outcome measurement 3 weeks before admission, at admission, at discharge and 9 weeks after discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td>L: slight improvement in the speleotherapy group compared to control group (significant differences for MEF50% and MEF25% but not for FEV1), worsening in both groups after discharge (interpreted as a seasonal effect)</td>
<td></td>
</tr>
<tr>
<td>S: no information</td>
<td></td>
</tr>
<tr>
<td>M: no information</td>
<td></td>
</tr>
</tbody>
</table>

Notes

<table>
<thead>
<tr>
<th>Notes</th>
<th>A: speleotherapy in the investigated cave has a moderate and transient therapeutic effect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C: study seems to be quite reliable. Reporting not fully satisfactory; only minor additional information could be obtained</td>
</tr>
</tbody>
</table>

Allocation concealment

| Allocation concealment | D – Not used |

Characteristics of excluded studies

<table>
<thead>
<tr>
<th>Characteristics of excluded studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bernatzky 1994 uncontrolled observational study</td>
</tr>
<tr>
<td>Homolka 1989 uncontrolled observational study</td>
</tr>
<tr>
<td>Khamzamylin 1990</td>
</tr>
<tr>
<td>Lemko 1994 uncontrolled case series</td>
</tr>
<tr>
<td>Sokolov 1994 uncontrolled case series</td>
</tr>
<tr>
<td>Timová 1989 controlled study on recurrent obstructive bronchitis</td>
</tr>
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</table>

GRAPHS AND OTHER TABLES

This review has no analyses.

INDEX TERMS

Medical Subject Headings (MeSH)

Air Ionization; Asthma [*therapy]; Chronic Disease; Climate; Environment; Humidity; Naturopathy [*methods]

MeSH check words

Humans

COVER SHEET

<table>
<thead>
<tr>
<th>Title</th>
<th>Speleotherapy for asthma</th>
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<tr>
<td>Authors</td>
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</tr>
<tr>
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<td>Information not supplied by author</td>
</tr>
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<td>Issue protocol first published</td>
<td>1997/1</td>
</tr>
<tr>
<td>Review first published</td>
<td>1999/2</td>
</tr>
<tr>
<td>Date of most recent amendment</td>
<td>03 April 2006</td>
</tr>
<tr>
<td>Date of most recent SUBSTANTIVE amendment</td>
<td>09 January 2001</td>
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<td>What's New</td>
<td>Information not supplied by author</td>
</tr>
<tr>
<td><strong>Date new studies sought but none found</strong></td>
<td>03 April 2006</td>
</tr>
<tr>
<td><strong>Date new studies found but not yet included/excluded</strong></td>
<td>Information not supplied by author</td>
</tr>
<tr>
<td><strong>Date new studies found and included/excluded</strong></td>
<td>Information not supplied by author</td>
</tr>
<tr>
<td><strong>Date authors' conclusions section amended</strong></td>
<td>Information not supplied by author</td>
</tr>
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| **Editorial group** | Cochrane Airways Group |
| **Editorial group code** | HM-AIRWAYS |