UNIVERSIDADE FEDERAL DO RIO GRANDE DO NORTE
CENTRO DE CIÊNCIAS DA SAÚDE
PROGRAMA DE PÓS-GRADUAÇÃO EM FISIOTERAPIA

FISIOTERAPIA RESPIRATÓRIA EM CRIANÇAS COM PNEUMONIA: REVISÃO SISTEMÁTICA

GABRIELA SUÉLLEN DA SILVA CHAVES

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Dissertação apresentada à Universidade Federal do Rio Grande do Norte - Programa de Pós-Graduação em Fisioterapia, para a obtenção do título de Mestre em Fisioterapia.

Orientadora: Profa. Dra. Karla Morganna Pereira Pinto de Mendonça

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Prof. Dr. Jamilson Simões Brasileiro

Dedicatória

A Deus, pela minha vida e por sempre me mostrar os caminhos que devo percorrer.

A minha Mãe por está sempre ao meu lado me apoiando e fortalecendo.

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Sumário

Lista de abreviaturas

TEF	Técnica de expiração forçada
CAR	Ciclo ativo da respiração
DA	Drenagem autógena
ELPr	Expiração lenta prolongada
AFE	Aumento do fluxo expiratório
ELTGOL	Expiração lenta infralateral com a glote aberta
EDIC	Exercícios com controle de fluxo inspiratório
PEP	Pressão positiva expiratória
Chi^2	Teste qui-quadrado
I^2	Índice de heterogeneidade
RevMan	Review Manager

Lista de figuras

Resumo

Introdução: A pneumonia é uma doença pulmonar inflamatória e apresenta-se como uma das maiores causas de morte em crianças menores de cinco anos de idade em todo o mundo. Um recurso que é amplamente utilizado no tratamento da pneumonia é a fisioterapia respiratória, uma vez que a aplicação de suas técnicas pode ajudar a eliminar as secreções traqueobrônquicas a fim de reduzir a resistência das vias aéreas, aumentar a troca gasosa e, assim, diminuir o trabalho respiratório. Portanto, a fisioterapia respiratória pode contribuir para a recuperação do paciente como um tratamento adjuvante ao tratamento clínico padrão. **Objetivos**: avaliar a efetividade da fisioterapia respiratória em relação melhora clínica em crianças de ambos os sexos, apresentando qualquer tipo de pneumonia. **Métodos**: nessa revisão sistemática foram pesquisadas as seguintes bases de dados: CENTRAL 2013, Issue 4 , MEDLINE (1946 a maio semana 4, 2013) , EMBASE (1974 a maio de 2013) , CINAHL (1981 a maio de 2013) , LILACS (1982 a maio de 2013); Web of Science (1950 a maio de 2013), Pedro (1950 a Maio de 2013); e o ClinicalTrials.gov e a OMS ICTRP para identificar os ensaios clínicos previstos, em andamento e inéditos . Para a busca manual foram consultadas as listas de referências de artigos relevantes encontrados pelas buscas eletrônicas. Foram incluídos ensaios clínicos randomizados (ECR) que, compararam técnicas de fisioterapia respiratória combinadas ao tratamento clínico padrão *versus* o tratamento padrão isolado. Dois revisores independentes selecionaram os estudos a serem incluídos na revisão e avaliaram a qualidade dos estudos e extraíram os dados. **Resultados:** Três ECRs envolvendo 255 crianças com pneumonia foram incluídos na revisão, as quais realizaram fisioterapia convencional, pressão expiratória positiva e pressão positiva contínua nas vias aéreas. Os principais desfechos avaliados foram: tempo de internação hospitalar, melhora clínica (observando-se os seguintes parâmetros: febre, sinais de desconforto respiratório, taquipneia, dispneia e os níveis de saturação periférica de oxigênio), redução dos ruídos adventícios, melhora na radiografia de tórax e duração da tosse em dias. Dois dos estudos incluídos encontraram uma melhora significativa na frequência respiratória e saturação de oxigênio.

Enquanto no terceiro estudo incluído, a fisioterapia respiratória convencional não se mostrou superior em relação ao tratamento clínico padrão isolado para a melhora clínica e tempo de internação hospitalar. Nenhum efeito adverso relacionado às intervenções foi descrito. Devido às características diferentes dos ensaios, tais como a duração do tratamento, os níveis de gravidade dos tipos de pneumonia e as técnicas utilizadas em crianças com pneumonia, bem como a diferenças na apresentação de análise estatística, não fomos capazes de combinar os dados em metanálise. Dois estudos incluídos tiveram um baixo risco de viés na maioria dos seus itens avaliados, enquanto que o terceiro estudo obteve um risco de viés incerto. **Conclusão:** Essa revisão não fornece evidências conclusivas que justifiquem o uso ou não de fisioterapia respiratória em crianças com pneumonia, devido à falta de dados consistentes dos estudos incluídos e baixo poder amostral.

Palavras-chave: Pneumonia; Criança; Fisioterapia; Ensaio clínico; Revisão.

Abstract

Introduction: Pneumonia is an inflammatory lung disease and it is the greatest cause of deaths in children younger than five years of age worldwide. Chest physiotherapy is widely used in the treatment of pneumonia because it can help to eliminate inflammatory exudates and tracheobronchial secretions, remove airway obstructions, reduce airway resistance, enhance gas exchange and reduce the work of breathing. Thus, chest physiotherapy may contribute to patient recovery as an adjuvant treatment even though its indication remains controversial. **Objectives:** To assess the effectiveness of chest physiotherapy in relation to time until clinical resolution in children (from birth up to 18 years old) of either gender with any type of pneumonia. M**ethods:** We searched CENTRAL 2013, Issue 4; MEDLINE (1946 to May week 4, 2013); EMBASE (1974 to May 2013); CINAHL (1981 to May 2013); LILACS (1982 to May 2013); Web of Science (1950 to May 2013); and PEDro (1950 to May 2013). We consulted the ClinicalTrials.gov and the WHO ICTRP registers to identify planned, ongoing and unpublished trials. We consulted the reference lists of relevant articles found by the electronic searches for additional studies. We included randomised controlled trials (RCTs) that compared chest physiotherapy of any type with no chest physiotherapy in children with pneumonia. Two review authors independently selected the studies to be included in the review, assessed trial quality and extracted data. **Results:** Three RCTs involving 255 inpatient children are included in the review. They addressed conventional chest physiotherapy, positive expiratory pressure and continuous positive airway pressure. The following outcomes were measured: duration of hospital stay, time to clinical resolution (observing the following parameters: fever, chest indrawing, nasal flaring, tachypnoea and peripheral oxygen saturation levels), change in adventitious sounds, change in chest X-ray and duration of cough in days. Two of the included studies found a significant improvement in respiratory rate and oxygen saturation whereas the other included study failed to show that standardised respiratory physiotherapy and positive expiratory pressure decrease the time to clinical resolution and the duration of hospital stay. No adverse effects related to the interventions were

described. Due to the different characteristics of the trials, such as the duration of treatment, levels of severity, types of pneumonia and the techniques used in children with pneumonia, as well as differences in their statistical presentation, we were not able to pool data. Two included studies had an overall low risk of bias whereas one included study had an overall unclear risk of bias. **Conclusion:** Our review does not provide conclusive evidence to justify the use of chest physiotherapy in children with pneumonia due to a lack of data. The number of included studies is small and they differed in their statistical presentation.

Key-words: Pneumonia; Child; Physiotherapy; Clinical Trial; Review

1 INTRODUÇÃO

As doenças respiratórias em crianças menores de cinco anos de idade tem sido motivo de preocupação para os profissionais de saúde devido à sua alta taxa de morbidade e mortalidade observada em todo o mundo[1]. A pneumonia é uma grande causa de morte entre crianças[2,3] e de acordo com a organização mundial de saúde é a maior causa de morte em crianças menores de cinco anos de idade em todo o mundo[1]. A pneumonia adquirida na comunidade é a mais comum entre crianças de todo o mundo, porém sua incidência e taxa de mortalidade são significativamente maiores em países em desenvolvimento do que em países industrializados[4]. A pneumonia hospitalar e a associada à ventilação mecânica são responsáveis pelas principais causas de infecções adquiridas nos hospital[5].

A pneumonia é uma inflamação pulmonar caracterizada pela presença de fluidos nos alvéolos gerando um acúmulo de secreções nas vias aéreas que leva a um aumento na resistência destas em cada movimento respiratório, contribuindo para a piora dos sintomas clínicos[2,3,6] como: febre, taquipneia, dispneia, tosse, sinais de desconforto respiratório (batimento de asa do nariz, tiragens) e saturação de oxigênio reduzida[7,8,9]. De acordo com as diretrizes clínicas o padrão-ouro para o diagnóstico da pneumonia é a presença de infiltrados pulmonares indicados pelo raio-x de tórax[10]. Os principais agentes etiológicos são *Streptococcus pneumoniae* e *Haemophilus influenzae*[11,12].

O tratamento para as crianças com pneumonia é feito com uso de antibióticos e em alguns casos estas são hospitalizadas e o uso de oxigênio suplementar é necessário, depende da gravidade da doença[7].

A fisioterapia respiratória é um importante adjuvante no tratamento de muitas doenças respiratórias[13] e é frequentemente utilizada em crianças com doença respiratória crônica ou doença neuromuscular[14]. O objetivo principal da fisioterapia respiratória pediátrica é ajudar na desobstrução traqueobrônquica, além de diminuir a resistência das vias aéreas, melhorar a troca gasosa e tornar a respiração mais fácil[14] através das suas técnicas que combinam percussão manual da caixa torácica com o posicionamento do paciente, para drenagem do muco, técnicas respiratórias e tosse[13]. No entanto, é necessário levar em consideração as peculiaridades do sistema respiratório das crianças. Mesmo que os princípios mecânicos das técnicas aplicadas em pacientes pediátricos sejam similares às aplicadas em adultos, a contínua mudança na estrutura e função respiratória que ocorrem do nascimento a idade adulta requer uma continua adaptação na aplicação das técnicas de fisioterapia respiratória em cada grupo de idade[15].

Os procedimentos de fisioterapia podem ser classificados como técnicas convencionais, modernas ou instrumentais[16,17]. Drenagem postural, vibração, percussão, *huffing* e tosse são técnicas tradicionais que objetivam facilitar a desobstrução[17,18]. As técnicas modernas são aquelas que utilizam a variação de fluxo através do controle respiratório a fim de mobilizar secreções, elas são a técnica de expiração forçada (TEF), ciclo ativo da respiração (CAR) e drenagem autógena (DA)[17,19,20]. Algumas técnicas europeias também são classificadas como modernas, tais como: expiração lenta prolongada (ELPr) e aumento do fluxo expiratório (AFE) que são usadas em pacientes pediátricos[21], bem como a expiração lenta infralateral com a glote aberta (ELTGOL) realizada

em crianças acima de 12 anos e exercícios com controle de fluxo inspiratório (EDIC) utilizada em crianças acima de 4 anos[22,23]. Finalmente, as técnicas instrumentais são: máscara de pressão positiva expiratória (PEP) e *Flutter* ® que são utilizadas na intenção de manter a limpeza das vias aéreas, bem como melhorar a ventilação mantendo as mesmas abertas durante a expiração[17]. Outro instrumento que também pode ser utilizado para aumentar a expansão pulmonar e melhorar a troca gasosa é o inspirômetro de incentivo[24].

A fisioterapia respiratória pode ser vista como a aplicação terapêutica de intervenções baseadas na fisiologia respiratória[15]. Algumas usam a posição do corpo para melhorar a *clearance*, reexpansão e ventilação pulmonar[25]. Entre as posições, a lateral é a que fornece as maiores mudanças dos volumes estáticos, ventilação local, perfusão e difusão da capacidade funcional[25-28]. Isso é consistente com as bases de fisiologia pulmonar, que mostram que as diferenças na ventilação local são os resultados da variação vertical da pressão pleural e que essas diferenças são influenciadas pela gravidade[25]. Esse posicionamento promove frequentemente *clearance* mucociliar mesmo sem aplicação de qualquer outra técnica[25].

Outras técnicas usam a variação do fluxo através do controle respiratório[17,20] ou usam alguns dispositivos a fim de manter a desobstrução das vias aéreas, bem como melhorar a ventilação por mantê-las abertas durante toda a expiração[17]. Promovendo, portanto, benefícios que incluem a eliminação de exudatos expiratórios e secreções traqueobrônquicas, remoção das obstruções das vias aéreas, redução da resistência das mesmas, e assim, promover a melhora da troca gasosa e redução do trabalho respiratório[14,17,19,29].

1.1 Justificativa

A maioria das mortes na infância causadas por pneumonia poderia ser evitada se intervenções efetivas fossem aplicadas entre as populações mais vulneráveis[1]. A fisioterapia respiratória é amplamente utilizada porque pode ajudar a eliminar os exudatos inflamatórios e secreções traqueobrônquicas, removendo as obstruções das vias aéreas, diminuindo sua resistência, melhorando, dessa forma, a troca gasosa e reduzindo o trabalho respiratório[14]. Logo, a fisioterapia respiratória pode contribuir como adjuvante a recuperação do paciente com diagnóstico de pneumonia[13]. Diante disso, essa revisão irá considerar as evidências científicas para avaliar a efetividade da fisioterapia respiratória em crianças com pneumonia.

1.2 Objetivos

1.2.1 Objetivo Geral

Avaliar a efetividade da fisioterapia respiratória em relação à melhora clínica em crianças e adolescentes de ambos os sexos, com qualquer tipo de pneumonia.

1.2.2 Objetivos específicos

a) identificar quais as técnicas de fisioterapia respiratória são mais efetivas em pacientes que apresentam diagnóstico de pneumonia.

b) verificar a efetividade da realização da fisioterapia respiratória para os seguintes desfechos: na ausculta pulmonar; na radiografia torácica e na saturação periférica de oxigênio; duração, em dias, do tratamento com antibiótico, tosse, produção de secreção e leucocitose.

2 MATERIAIS E MÉTODOS

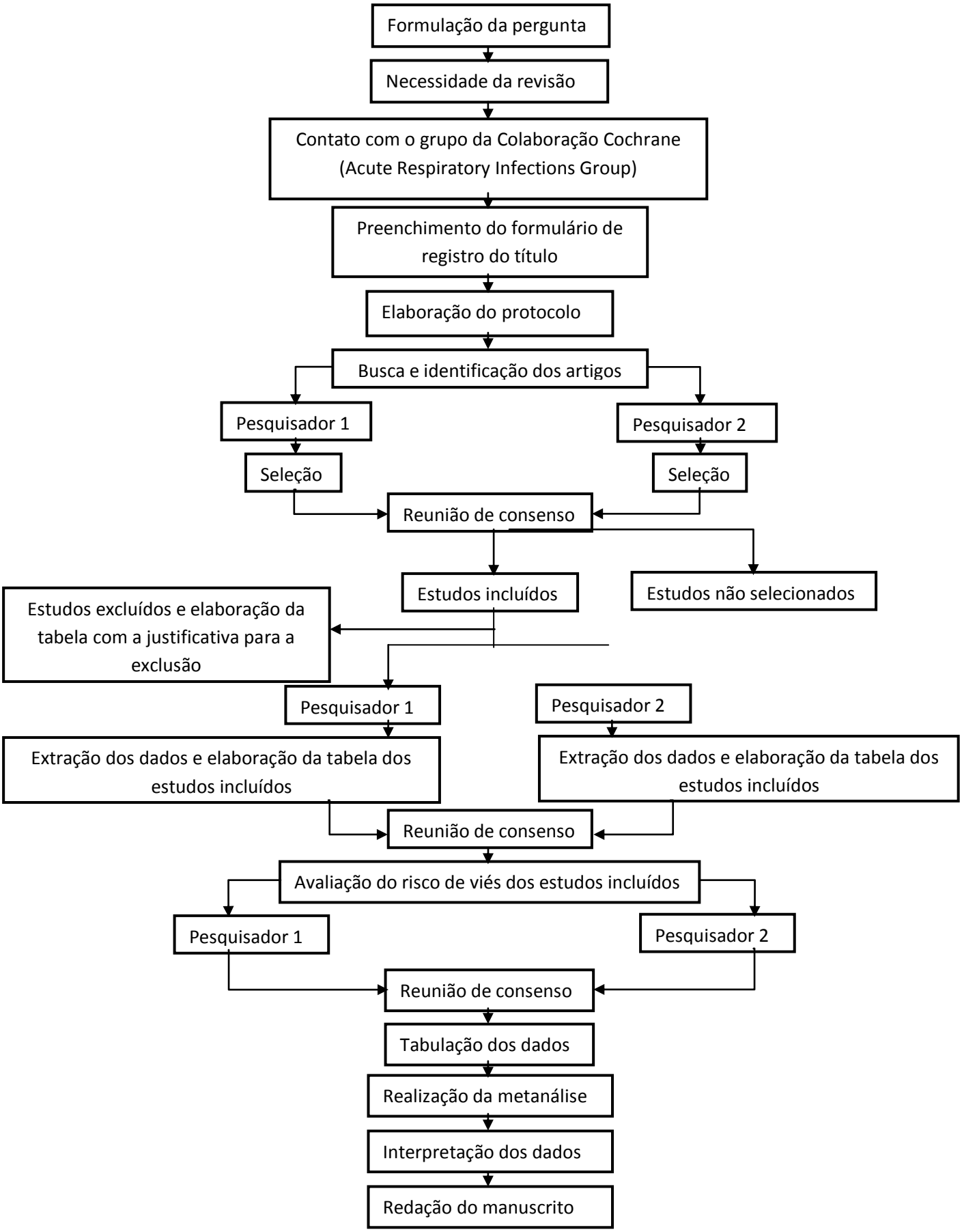
2.1. Desenho do estudo

O presente estudo caracteriza-se como uma revisão sistemática desenvolvida em parceria com a Colaboração Cochrane (The Cochrane Collaboration).

2.2. Etapas de uma revisão pela Colaboração Cochrane

A Colaboração Cochrane, fundada em 1993, trata-se de uma organização internacional sem fins lucrativos cujos objetivos são preparar, manter e assegurar o acesso a revisões sistemáticas sobre efeitos de intervenções na área de saúde. A estrutura organizacional da Colaboração Cochrane divide-se em: rede de consumidores, centros, comitê diretor, campos, grupos de metodologia e grupos de revisão. Os grupos de revisão, por sua vez, estão divididos nas diversas áreas da saúde. A presente revisão foi desenvolvida com a colaboração do “Grupo de Infecções Respiratórias Agudas” (Acute Respiratory Infecctions Group), com sede localizada na cidade Gold Coast, Queensland, Austrália.

Para iniciar uma revisão sistemática pela Colaboração Cochrane é necessário seguir alguns passos como segue no fluxograma a seguir:


Formulação da pergunta
Necessidade da revisão
Contato com o grupo da Colaboração Cochrane (Acute Respiratory Infections Group)
Preenchimento do formulário de registro do título
Elaboração do protocolo
Busca e identificação dos artigos
Pesquisador 1
Pesquisador 2
Seleção
Seleção
Reunião de consenso
Estudos incluídos
Estudos não selecionados
Estudos excluídos e elaboração da tabela com a justificativa para a exclusão
Pesquisador 1
Pesquisador 2
Extração dos dados e elaboração da tabela dos estudos incluídos
Extração dos dados e elaboração da tabela dos estudos incluídos
Reunião de consenso
Avaliação do risco de viés dos estudos incluídos
Pesquisador 1
Pesquisador 2
Reunião de consenso
Tabulação dos dados
Realização da metanálise
Interpretação dos dados
Redação do manuscrito

2.3. Local de realização

Departamento de Fisioterapia, Universidade Federal do Rio Grande do Norte.

2.4. Critérios para considerar estudos para a revisão

2.4.1. Tipos de estudos

Estudos do tipo controlados randomizados nos quais tenham sido aplicadas técnicas de fisioterapia respiratória em crianças com diagnóstico de pneumonia.

2.4.2. Tipo de participantes

Foi planejado incluir estudos que apresentassem participação de pacientes do nascimento até a idade de 18 (dezoito) anos. Foram incluídos os estudos que abordaram qualquer tipo de técnica de fisioterapia respiratória nesses pacientes independente do estágio da doença e em qualquer local de tratamento (ambulatorial ou hospitalar).

2.4.3. Tipos de intervenção

Intervenção: Pacientes com diagnóstico de pneumonia que tenham recebido qualquer tipo de fisioterapia respiratória combinado ao tratamento padrão da pneumonia.

Comparação: Pacientes com diagnóstico de pneumonia que tenham recebido apenas o tratamento padrão da pneumonia.

2.4.4. Tipos de desfecho

2.4.4.1. Desfecho primário

- Mortalidade

- Duração de permanência hospitalar (dias)

- Tempo de resolução clínica (dias) avaliando os parâmetros clínicos: febre, aumento do trabalho respiratório e os níveis de saturação periférica de oxigênio.

2.4.4.2. Desfechos secundários

- Melhora nos ruídos adventícios
- Melhora no raio-x de tórax
- Duração em dias do antibiótico, tosse e produção de secreção
- Duração em dias de leucocitose
- *Clearance* das vias aéreas
- Principais eventos adversos

2.5. Métodos de busca para identificação dos estudos

2.5.1. Busca Eletrônica

Foram utilizadas as seguintes fontes de estudos: CENTRAL 2013, Issue 4 , MEDLINE (1946 a maio de 2013), EMBASE (1974 a maio de 2013), CINAHL (1981 a maio de 2013), LILACS (1982 a maio de 2013); Web of Science (1950 a maio de 2013), Pedro (1950 a Maio de 2013). Não houve restrições de idiomas. A escolha dos descritores e a decisão dos estudos a serem incluídos são atribuições dos autores da revisão. Porém, a estratégia de

busca de artigos é realizada pela própria equipe do grupo de revisão da Colaboração Cochrane.

2.5.2. Outras fontes de pesquisa

As listas de referências dos artigos incluídos na revisão foram consultadas a fim de incluir estudos adicionais. Dois registros internacionais de ensaios clínicos (ClinicalTrials.gov e International Clinical Trials Registry Platform) também foram consultados, a fim de identificar os estudos em andamento ou aqueles finalizados e cujos dados não foram publicados.

2.6. Coleta dos dados e análise

2.6.1. Seleção dos estudos

Dois revisores (GC e DF) avaliaram de forma independente os títulos e os resumos de todos os estudos obtidos na busca eletrônica. A partir deste ponto os textos completos desses artigos foram avaliados a fim de determinar sua elegibilidade. Um terceiro (KM) autor foi consultado caso não houvesse um consenso sobre a inclusão ou não de um determinado estudo.

2.6.2. Extração dos dados

Os dados foram extraídos e inseridos de maneira independente por dois autores (GC e DF) no software Review Manager[30], disponível para download no site da Colaboração Cochrane. Os seguintes dados foram coletados, de acordo com os métodos descritos no capítulo 7 do Cochrane Handbook for Systematic Reviews of Interventions[31].

- Detalhes metodológicos (incluindo desenho do estudo, método de randomização e sigilo de alocação, ocorrência ou não de cegamento dos participantes e dos avaliadores, número de desistências e exclusões).
- Descrição dos participantes (amostra total, idade, gênero, tipo de pneumonia, severidade da pneumonia, país, ambiente da intervenção, critérios de inclusão e exclusão utilizados pelos ensaios clínicos).
- Descrição da intervenção (detalhes da fisioterapia respiratória, incluindo frequência, intensidade e tempo).
- Tipos de desfechos avaliados pelo estudo.

2.6.3. Avaliação do risco de viés dos estudos incluídos

Na intenção de evitar a possibilidade de viés, aumentando assim a qualidade dos resultados, foi utilizada a ferramenta para avaliação do risco de viés (The Cochrane Collaboration's tool for assessing risk of bias) fornecida pela Colaboração Cochrane, a qual inclui os seguintes itens: sequência de randomização (random sequence generation), sigilo da alocação (allocation concealment), cegamento dos participantes (blinding of participants), cegamento dos avaliadores (blinding of outcome assessment), dados incompletos (incomplete outcome data), descrição seletiva do desfecho (selective reporting), e outros vieses (other bias). Cada item recebeu uma das seguintes classificações: "alto risco de viés", "baixo risco de viés" ou "risco de

viés incerto" de acordo com o Handbook for Systematic Reviews of Interventions da Colaboração Cochrane[32]. A avaliação do risco de viés foi realizada de maneira independente por dois revisores (GC e DF). Um terceiro autor (KM) foi consultado na ausência de consenso em relação à avaliação do risco de viés dos estudos incluídos.

2.6.4. Dados ausentes ou incompletos

Os autores dos estudos incluídos foram contatados para obtenção de dados ausentes ou incompletos.

2.6.5. Análise de subgrupo e avaliação

A análise de subgrupo foi planejada caso tivesse sido possível combinar os dados em metanálise. Teriam sido realizadas as seguintes análises de subgrupo:

- Idade (bebês, criança, adolescente)
- Tipos de pneumonia (adquirida na comunidade, nosocomial)
- Tipo de diagnóstico (padrão ouro e não padrão ouro)
- Ambiente de tratamento (ambulatorial, hospitalar)
- Técnicas (moderna, convencional, instrumental).

2.6.6. Análise de sensibilidade

A análise de sensibilidade foi planejada caso tivesse sido possível combinar os dados em metanálise. Teria sido realizada a fim de explorar a influência sobre os resultados dos seguintes fatores:

:

- Qualidade dos estudos (estudos controlados randomizados com pobre metodologia);
- Tamanho do estudo (estratificação pelo tamanho da amostra);
- Sigilo de alocação (alto risco de viés contra baixo risco de viés);
- Mascaramento dos participantes (alto risco de viés contra baixo risco de viés);
- Mascaramento dos avaliadores (alta risco de viés contra baixo risco de viés).

3 RESULTADOS E DISCUSSÃO

Os resultados e a discussão desta dissertação serão apresentados em língua inglesa com o formato e a sequência preconizados para sua publicação na *Cochrane Library*.

Chest physiotherapy for pneumonia in children

Review information

Review number: A185

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Abstract

Background

Pneumonia is an inflammatory lung disease and it is the greatest cause of deaths in children younger than five years of age worldwide. Chest physiotherapy is widely used in the treatment of pneumonia because it can help to eliminate inflammatory exudates and tracheobronchial secretions, remove airway obstructions, reduce airway resistance, enhance gas exchange and reduce the work of breathing. Thus, chest physiotherapy may contribute to patient recovery as an adjuvant treatment even though its indication remains controversial.

Objectives

To assess the effectiveness of chest physiotherapy in relation to time until clinical resolution in children (from birth up to 18 years old) of either gender with any type of pneumonia.

Search methods

We searched CENTRAL 2013, Issue 4; MEDLINE (1946 to May week 4, 2013); EMBASE (1974 to May 2013); CINAHL (1981 to May 2013); LILACS (1982 to May 2013); Web of Science (1950 to May 2013); and PEDro (1950 to May 2013).

We consulted the ClinicalTrials.gov and the WHO ICTRP registers to identify planned, ongoing and unpublished trials. We consulted the reference lists of relevant articles found by the electronic searches for additional studies.

Selection criteria

We included randomised controlled trials (RCTs) that compared chest physiotherapy of any type with no chest physiotherapy in children with pneumonia.

Data collection and analysis

Two review authors independently selected the studies to be included in the review, assessed trial quality and extracted data.

Results

Three RCTs involving 255 inpatient children are included in the review. They addressed conventional chest physiotherapy, positive expiratory pressure and continuous positive airway pressure. The following outcomes were measured: duration of hospital stay, time to clinical resolution (observing the following parameters: fever, chest indrawing, nasal flaring, tachypnoea and peripheral oxygen saturation levels), change in adventitious sounds, change in chest X-ray and duration of cough in days. Two of the included studies found a significant improvement in respiratory rate and oxygen saturation whereas the other included study failed to show that standardised respiratory physiotherapy and positive expiratory pressure decrease the time to clinical resolution and the duration of hospital stay. No adverse effects related to the interventions were described. Due to the different characteristics of the trials, such as the duration of treatment, levels of severity, types of pneumonia and the techniques used in children with pneumonia, as well as differences in their statistical presentation, we were not able to pool data. Two included studies had an overall low risk of bias whereas one included study had an overall unclear risk of bias.

Authors' conclusions

Our review does not provide conclusive evidence to justify the use of chest physiotherapy in children with pneumonia due to a lack of data. The number of included studies is small and they differed in their statistical presentation.

Plain language summary

Chest physiotherapy for pneumonia in children

Pneumonia is an inflammatory lung disease and it is the greatest cause of deaths in children younger than five years of age worldwide. Accumulation of secretions in the airways due to respiratory infections contributes to the worsening of clinical symptoms making it very difficult for the child to breathe. Chest physiotherapy may contribute to patient recovery as a complementary treatment because it can help to eliminate inflammatory secretions, remove airway obstructions, reduce airway resistance and the work of breathing. Chest physiotherapy techniques combine manual percussion of the chest wall and strategic positioning of the patient for mucus drainage, with cough and breathing techniques.

We looked for evidence for the effectiveness of chest physiotherapy in children with pneumonia. We found three studies involving 255 children with pneumonia aged 29 days to 12 years. In all included studies there was a group that received some type of physiotherapy and another group that did not receive physiotherapy, called a control group. Children in both groups underwent the standard medical treatment for pneumonia. Two of the included studies found a significant improvement in respiratory rate (decrease in the number of breaths per minute) and oxygen saturation (measure of how much oxygen the blood is carrying as a percentage of the maximum it could carry), whereas one included study failed to show that standardised respiratory physiotherapy and positive expiratory pressure (maintenance of a pressure in the lungs above atmospheric pressure at the end of expiration) decreased the time to clinical resolution and the duration of hospital stay. No adverse effects related to the interventions were described. This systematic review was limited by the lack of studies and the quality of the existing data. Two of the included studies had an overall low risk of bias whereas one included study had an overall unclear risk of bias. The studies differed in some of their characteristics, such as the duration of treatment, levels of severity, types of pneumonia and the techniques used in

children with pneumonia. Moreover, the included studies reported different outcomes and also had differences in their statistical presentation of data. As a result, we were not able to compare the results from these trials by meta-analysing (combining) them. There is no conclusive evidence in this review to support or refute the use of physiotherapy in children with pneumonia. The results are up to date as of May 2013.

Background

Description of the condition

Respiratory diseases in children under five years of age have been a cause of concern for health professionals because of the high morbidity and mortality observed worldwide (Chiesa 2008). Community-acquired pneumonia (CAP) is common among children all over the world but the incidence and mortality rate are significantly higher in low-income countries than in high-income countries (Principi 2011). Hospital-acquired pneumonia (HAP) and ventilator-associated pneumonia (VAP) together are the second most common hospital-acquired infection (Rotstein 2008). According to the World Health Organization (WHO), pneumonia is the single greatest cause of death in children younger than five years of age worldwide (WHO 2011).

Pneumonia is an inflammation of the lung and fluid collection in the alveoli (Oliveira 2011; Zhang 2012). The two leading causes of pneumonia in low-income countries are *Streptococcus pneumoniae* (*S. pneumoniae*) and *Haemophilus influenzae* (*H. influenzae*) (Dagan 2011; Gilani 2012). Children with pneumonia are treated with antibiotics and in some cases hospitalisation and oxygen supplementation are required, depending on the severity of the disease (Scott 2012).

Accumulation of secretions in the airways due to respiratory infection contributes to the worsening of clinical symptoms and leads to an increase in airway resistance with each breath (Durbin 2008). Signs and symptoms that are useful in diagnosing pneumonia are fever, tachypnoea, nasal flaring, cough,

breathlessness, lower chest wall indrawing and reduced oxygen saturation (Bradley 2011; Ebell 2010; Scott 2012). However, according to clinical guidelines, the gold standard for diagnosing pneumonia is the presence of lung infiltrates indicated by chest radiography (Evertsen 2010).

Description of the intervention

Chest physiotherapy is an important adjuvant in the treatment of most respiratory illnesses (Balachandran 2005) and is usually used in children with chronic respiratory or neuromuscular disease (Gajdos 2010). The central aim of paediatric chest physiotherapy is to assist the clearance of tracheobronchial secretions, thereby to decrease airway resistance, improve gas exchange and make breathing easier (Gajdos 2010). The techniques combine manual percussion of the chest wall and strategic positioning of the patient for mucus drainage with cough and breathing techniques (Balachandran 2005). However, it is necessary to take into consideration the peculiarities of the respiratory system of children. Even though the mechanical principles of the techniques applied to paediatric patients are similar to those used in adults, the continuous changes in respiratory structure and function that occur from birth to adulthood require continuous adaptation in the application of chest physiotherapy techniques in each age group (Oberwaldner 2000). The differences in the respiratory structure and function of children limit or contraindicate some of the techniques available for treatment in this age group (Oberwaldner 2000). Despite improving the patient's respiratory status and expediting recovery, in certain situations it may not be a useful intervention or may even be harmful, by increasing bronchospasm, inducing pulmonary hypertension, repositioning a foreign body or destabilising a sick infant (Wallis 1999). However, some chest physiotherapy techniques were developed in order to be used exclusively in children (Postiaux 1997).

Physiotherapy procedures can be classified as conventional, modern and instrumental techniques (Morrison 2011; Yang 2010). Postural drainage, vibration, percussion, huffing and coughing are traditional techniques the aim of

which is to facilitate mucociliary clearance (Main 2009; Yang 2010). Modern techniques use the variation of flow through breath control in order to mobilise secretions: these are the forced expiration technique, active cycle of breathing and autogenic drainage (Robinson 2010; Roqué i Figuls 2012; Yang 2010). Some European techniques are also described as modern: slow and prolonged expiration and increased expiratory flow are used in paediatric patients (Mucciollo 2008); total slow expiration with the glottis open in a lateral posture is performed in children over 12 years; and exercises with inspiratory controlled flow are used in children over four years (Postiaux 1997; Postiaux 2000). Finally, instrumental techniques such as positive expiratory pressure mask and flutter are used to maintain airway clearance, as well as to improve ventilation by keeping the airways open during expiration (Yang 2010). Another tool that can be used to increase lung expansion and improve gas exchange is incentive spirometry (Restrepo 2011). (See Appendix 1 for further description of the physiotherapy procedures).

How the intervention might work

Chest physiotherapy may be seen as the therapeutic application of mechanical interventions based on respiratory physiology (Oberwaldner 2000). Some techniques use body position to improve mucociliary clearance, re-expansion and pulmonary ventilation (Alcoforado 2011). Among these positions, the lateral position provides the biggest changes in static volumes, regional ventilation, perfusion and diffusion lung capacity (Alcoforado 2011; Gillies 2012; Krieg 2007; Manning 1999). This is consistent with the basis of pulmonary physiology, which shows that differences in regional ventilation are the result of the vertical variation of pleural pressure and that these differences are influenced by gravity (Alcoforado 2011). This positioning often promotes mucociliary clearance even without the application of any other technique (Alcoforado 2011).

Other techniques use the variation of flow through breath control (Robinson 2010; Yang 2010) or use devices to maintain airway clearance and

improve ventilation by keeping the airways open during expiration (Yang 2010). The benefits include evacuating inflammatory exudates and tracheobronchial secretions, removing airway obstructions, reducing airway resistance, enhancing gas exchange and reducing the work of breathing (Roqué i Figuls 2012; Wallis 1999; Yang 2010).

Why it is important to do this review

The majority of childhood deaths caused by pneumonia could be avoided if effective interventions were implemented on a broad scale and reached the most vulnerable populations (WHO 2011). Chest physiotherapy is still widely used because it can help to eliminate inflammatory exudates and tracheobronchial secretions, remove airway obstructions, reduce airway resistance, enhance gas exchange and reduce the work of breathing (Gajdos 2010). There is a systematic review involving adult patients with pneumonia (Yang 2010). This review showed that, even though physiotherapy should not be recommended as a conventional treatment for pneumonia in adults, it is still a broadly used intervention. Thus, chest physiotherapy may contribute to patient recovery as an adjuvant treatment even though its indication remains controversial (Balachandran 2005; Wallis 1999). This review considers the scientific evidence and evaluates the effects of chest physiotherapy for pneumonia in children.

Objectives

To assess the effectiveness of chest physiotherapy in relation to time until clinical resolution in children (from birth up to 18 years old) of either gender with any type of pneumonia.

Methods

Criteria for considering studies for this review

Types of studies

Randomised controlled trials (RCTs), cluster-RCTs, cross-over or quasi-RCTs.

Types of participants

Children (from birth up to 18 years old) of either gender with any type of pneumonia.

Types of interventions

Chest physiotherapy of any type compared with no chest physiotherapy.

Types of outcome measures

Primary outcomes

1. Mortality.
2. Duration of hospital stay (days).
3. Time to clinical resolution (days) of any of the following clinical parameters: fever, increase of respiratory work (chest indrawing, nasal flaring, tachypnoea) and peripheral oxygen saturation levels.

Secondary outcomes

1. Change in adventitious sounds.
2. Change in chest X-ray.
3. Duration in days of antibiotic therapy, cough and sputum production.
4. Duration in days of leukocytosis.
5. Airway clearance (measured by sputum weight or volume).
6. Number of adverse events (any undesired outcome due to the intervention).

Search methods for identification of studies

Electronic searches

We searched the Cochrane Central Register of Controlled Trials (CENTRAL) 2013, Issue 4, part of *The Cochrane Library*, www.thecochranelibrary.com (accessed 31 May 2013), which includes the Cochrane Acute Respiratory Infections Group's Specialised Register, MEDLINE (1946 to May week 4, 2013), EMBASE (1974 to May 2013), CINAHL (1981 to May 2013), LILACS (1982 to May 2013), Web of Science (1950 to May 2013) and PEDro (1950 to May 2013).

We used the following search strategy to search CENTRAL and MEDLINE. We combined the MEDLINE search with the Cochrane Highly Sensitive Search Strategy for identifying randomised trials (Lefebvre 2011) and a sensitive search strategy for identifying child studies (Boluyt 2008). We adapted the search strategy to search EMBASE (Appendix 2), CINAHL (Appendix 3), LILACS (Appendix 4), Web of Science (Appendix 5) and PEDro (Appendix 6).

MEDLINE (Ovid)

1 exp Pneumonia/
2 pneumon*.tw.
3 (bronchopneumon* or pleuropneumon*).tw.
4 (cap or hap or vap).tw.
5 ((lung* or pulmonary or pleur*) adj2 (infect* or inflam*)).tw.
6 empyema, pleural/ or pleural effusion/
7 (pleural adj3 (empyema or effusion*)).tw.
8 exp Pleurisy/
9 pleurisy.tw.
10 Respiratory Tract Infections/
11 (lower respiratory tract infection* or lower respiratory infection* or lrti).tw.
12 or/1-11
13 exp Physical Therapy Modalities/
14 (physiotherap* or physical therap* or physical treatment*).tw.
15 exp Respiratory Therapy/
16 exp Positive-Pressure Respiration/
17 Breathing Exercises/
18 Vibration/
19 (patient* adj3 (postur* or position*)).tw.
20 (body adj3 (postur* or position* or lateral)).tw.
21 (oscillat* or vibrat* or percuss* or huff*).tw.
22 ((chest or thora*) adj3 (clap* or shak* or compress*)).tw.
23 (cough* adj2 (directed or maneuver* or manoeuver* or techniqu*)).tw.

24 positive pressure ventilation*.tw.
25 positive expiratory pressure*.tw.
26 electrostimulat*.tw.
27 massag*.tw.
28 ((respirat* or ventilat*) adj2 muscle train*).tw.
29 ((postur* or autogenic) adj2 drain*).tw.
30 (breath* adj2 (control* or techni* or train* or exercis* or "active cycle")).tw.
31 ((forced or slow or prolonged or increas* or control*) adj2 (exhal* or expir*)).tw.
32 flutter.tw.
33 (incentive adj2 (inspiromet* or spiromet*)).tw.
34 eltgol.tw.
35 or/13-34
36 12 and 35

Searching other resources

We searched the trials registers ClinicalTrials.gov and the WHO ICTRP (May 2013) in order to identify planned, ongoing and unpublished trials. We consulted the reference lists of relevant articles found by the above searches for additional studies.

Data collection and analysis

Selection of studies

Two review authors (DF, GC) independently read the titles and abstracts identified from the initial search to select studies that met our inclusion criteria. We retrieved full-text articles and reviewed the results to determine eligibility. A third review author (KM) resolved differences when necessary.

Data extraction and management

Two review authors (DF, GC) independently extracted data into RevMan 5.2 (RevMan 2012) using a standard data collection form and resolved any disagreements by discussion and consensus. According to the methods described in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011a), we collected the following information:

1. Methodological details (including design, method of randomisation, total number of withdrawals and dropouts).
2. Description of participants (total sample, age, gender, type of pneumonia, diagnosis criteria, severity of pneumonia, country, setting, trial inclusion and exclusion criteria).
3. Description of intervention (details of chest physiotherapy, including type, frequency, intensity and timing).
4. Description of outcomes.

Assessment of risk of bias in included studies

We assessed the risk of bias using The Cochrane Collaboration's tool which considers the following domains:

1. Random sequence generation.
2. Allocation concealment.
3. Blinding of participants and personnel.
4. Blinding of outcome assessment.
5. Incomplete outcome data.
6. Selective reporting.
7. Other bias.

When we considered these were adequate, we judged the study as 'low risk of bias'. When these were inadequate, we classified the study as 'high risk of bias' and when these were unclear we deemed the study as 'unclear risk of bias', according to the methods described in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011b).

Measures of treatment effect

If we are able to include sufficient data in the future, we plan to analyse dichotomous outcomes as risk ratios (RR) using 95% confidence intervals (CIs) and express continuous outcomes as mean differences (MDs) with 95% CIs or

as standardised mean differences (SMDs) if different methods of measurement are used in the studies.

Unit of analysis issues

Cluster-RCTs

We had planned to include cluster-RCTs in the analysis. We would have adjusted the results when the unit of analysis in the trial is presented as the total number of individual participants instead of the number of clusters. We would have adjusted the results using the mean cluster size and intra cluster correlation coefficient (Higgins 2011c). For meta-analysis, we would have combined individually randomised trials using the generic inverse-variance method as described in Chapter 16.3 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011c).

Cross-over trials

In randomised, cross-over studies, individuals receive each intervention sequentially in a random order. A major concern in cross-over trials is the carry-over effect. It occurs if an effect (e.g. pharmacological, physiological or psychological) of the treatment in the first phase is carried over to the second phase. As a consequence, on entry to the second phase the participants can differ systematically from their initial state despite a wash-out phase. For the same reason, cross-over trials are not appropriate if the condition of interest is unstable (Elbourne 2002). However, cross-over studies usually have a wash-out period, which is a stage after the first treatment but before the second treatment, where time is given for the active effects of the first treatment to wear off before the new treatment begins (i.e. to reduce the carry-over effect). Inadequate wash-outs are seen when the carry-over effect exceeds the washout period. When including both parallel and cross-over studies with an adequate wash-out period, we will use the inverse-variance method, as recommended by Elbourne (Elbourne 2002).

Dealing with missing data

We contacted trial authors in order to request additional papers and obtain missing data.

Assessment of heterogeneity

If we are able to include sufficient data in the future, we plan to evaluate heterogeneity of study results by looking at the forest plots in order to detect non-overlapping CIs, with the application of the Chi^2 test (with a P value of 0.10 to indicate statistical significance) and by applying the I^2 statistic. According to the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011b) values up to 40% indicate that the heterogeneity may not be important, while values between 30% and 60% indicate moderate heterogeneity, between 50% and 90% substantial heterogeneity and between 75% and 100% considerable heterogeneity. We also plan to use the I^2 statistic with a value of 50% as a moderate level of heterogeneity (Higgins 2011b).

Assessment of reporting biases

If we are able to meta-analyse sufficient data in the future, we plan to use funnel plots as described in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011d) to assess reporting bias among the studies. If asymmetry is present, we also plan to explore possible causes including publication bias, poor methodological quality and true heterogeneity.

Data synthesis

If we are able to meta-analyse sufficient data in the future, we plan to use RevMan 5.2 (RevMan 2012) to combine the results when possible. If we determine the heterogeneity to be moderate, substantial or significant, as indicated by a value of the I^2 statistic greater than 30%, we will use the random-effects model to summarise results. Otherwise, we will use the fixed-effect

model. As meta-analyses could not be undertaken, we have provided a narrative synthesis of the available data.

Subgroup analysis and investigation of heterogeneity

We plan to conduct the following subgroup analyses if we are able to include sufficient data in the future and identify significant heterogeneity (a value of the I^2 statistic over 50%).

1. Age (infant, children and adolescents).
2. Type of pneumonia (community-acquired, nosocomial, etc).
3. Type of diagnosis (gold standard and non-gold standard).
4. Treatment setting (inpatient or outpatient).
5. Techniques (conventional, modern or instrumental).

Sensitivity analysis

If we are able to include sufficient data in the future, we will perform a sensitivity analysis to explore the influence on the results of the following factors.

1. Study quality (RCTs with poor methodology).
2. Study size (stratified by sample size).
3. Allocation concealment (high risk of bias versus low risk of bias).
4. Participant blinding (high risk of bias versus low risk of bias).
5. Assessor blinding (high risk of bias versus low risk of bias).

Results

Description of studies

See the Characteristics of included studies table.

Results of the search

In November 2012 we identified 623 trials with duplicates. This total was composed of 239 hits from MEDLINE, 213 from EMBASE and CENTRAL, 71 from CINAHL, 16 from LILACS, 76 from Web of Science and eight from PEDro. After duplicates were removed 446 trials remained. We also conducted an additional search and found three more references in LILACS. We did not find any ongoing studies suitable for the review in clinicaltrials.gov and the WHO ICTRP. After screening the titles and abstracts, we identified seven trials as potentially relevant. We obtained the full text for those trials with ambiguous titles and abstracts so that we could determine whether to exclude them from the review. Three trials (Lukrafka 2012; Paludo 2008; Zhao 2010) met the inclusion criteria. See Figure 1 for full details on the results of the search. In May 2013 we re-ran the literature searches. This search identified 22 trials after duplicates were removed. No further studies were included in this review.

Included studies

Two included trials were conducted in Brazil (Lukrafka 2012; Paludo 2008) and one in China (Zhao 2010). Two trials were published in English (Lukrafka 2012; Paludo 2008) and one in Chinese (Zhao 2010).

Study design

All included studies were RCTs.

Participants

In total, 255 children (aged 29 days to 12 years) were included in the three trials, with 129 in the treatment group and 126 in the control group. One study (Lukrafka 2012) stated that only previously healthy children were enrolled in their study whereas the other two studies (Paludo 2008; Zhao 2010) do not report this information. One trial (Lukrafka 2012) included only community-acquired pneumonia and two trials (Paludo 2008; Zhao 2010) did not describe the type of pneumonia. The severity of pneumonia was moderate in one trial

(Lukrafka 2012), severe in one trial (Zhao 2010) and not stated in the other trial (Paludo 2008). All studies were conducted in a hospital setting.

Interventions

One trial (Lukrafka 2012) compared chest physiotherapy with a non-mandatory request to maintain lateral positioning to improve air exchange, to cough in order to clear secretions and to perform diaphragmatic and deep breathing, for five minutes, once a day, during the whole hospital stay. However, this recommendation has not been evaluated. One trial (Paludo 2008) compared chest physiotherapy plus standard treatment for pneumonia with standard treatment for pneumonia alone. One trial (Zhao 2010) compared continuous positive airway pressure plus standard treatment for pneumonia with standard treatment for pneumonia alone. These trials used different types of chest physiotherapy, including conventional chest physiotherapy, breathing exercises and positive expiratory pressure. In the three trials all patients received antibiotic treatment and oxygen support if clinically indicated (Lukrafka 2012; Paludo 2008; Zhao 2010).

Outcome measures

The included studies did not address one of the primary outcomes of this review (mortality). The other two primary outcomes (duration of hospital stay and time to clinical resolution) were assessed in two trials (Lukrafka 2012; Paludo 2008). However, in both trials, the outcome duration of hospital stay was a secondary outcome, whereas the outcome time to clinical resolution was the primary outcome. One trial (Zhao 2010) assessed only one outcome proposed by the review (peripheral oxygen saturation levels).

Excluded studies

We excluded four trials from the review. See Characteristics of excluded studies table.

Risk of bias in included studies

The detailed 'Risk of bias' judgements and quality of each study can be found in the Characteristics of included studies table and are summarised in Figure 2.

Allocation (selection bias)

Two studies (Lukrafka 2012; Paludo 2008) described adequate sequence generation and we judged them to be of low risk of bias. We judged one trial (Zhao 2010) as unclear risk of bias due to insufficient information to permit a judgement of low risk or high risk. Only one study clearly reported the method of allocation concealment (Lukrafka 2012) and we judged it to be of low risk of bias. We classified the other two trials (Paludo 2008; Zhao 2010) as unclear risk of bias because there was insufficient information to permit a judgement of low risk or high risk.

Blinding (performance bias and detection bias)

Two trials stated that the blinding of participants and personnel was not possible and we judged them to have a high risk of bias as the outcomes may be influenced by the lack of blinding (Lukrafka 2012; Paludo 2008). We judged one trial (Zhao 2010) as unclear risk of bias because there was insufficient information to permit a judgement of low risk or high risk.

Two studies described blinding of outcome assessors (Lukrafka 2012; Paludo 2008) and we classified them as low risk of bias. We judged one trial (Zhao 2010) as unclear risk of bias because there was insufficient information to permit a judgement of low risk or high risk.

Incomplete outcome data (attrition bias)

Two trials described the occurrence of withdrawals and dropouts and we judged them to be low risk of bias because the missing outcome data were balanced numerically across the intervention groups (Lukrafka 2012; Paludo 2008). We judged one trial (Zhao 2010) to be of low risk of bias because there

were no withdrawals or dropouts. In Lukrafka 2012, from the 79 patients who were randomised, four underwent chest drainage (three in the intervention group) and three patients had atelectasis detected by chest X-ray (all in the control group). Therefore, 72 patients (n = 35 in the intervention and n = 37 in the control) remained in the study and follow-up (Lukrafka 2012). In Paludo 2008, from 98 patients who were randomised, four patients withdrew (in the intervention group) because two were discharged/transferred before the second assessment and two met an exclusion criterion; and five patients withdrew (in the control group) because two were discharged before the second assessment and three met an exclusion criterion. Therefore, 89 patients (n = 47 in the intervention and n = 42 in the control) remained in the study and follow-up (Paludo 2008). In Zhao 2010, of 94 patients who were randomised (n = 47 in the intervention and n = 47 in the control) all of them completed the treatment.

Selective reporting (reporting bias)

One study (Lukrafka 2012) was registered in clinicaltrials.gov but there is no information regarding the outcomes. Thus, we judged this trial to be of high risk of bias. Two studies (Paludo 2008; Zhao 2010) are not available in trials registers. However, Zhao 2010 adequately reported all outcome data and we judged this study to be of low risk of bias. We judged the study of Paludo 2008 to be of high risk of bias because one or more outcomes of interest in the review were reported incompletely.

Other potential sources of bias

We judged all three included studies to be at unclear risk of other sources of bias as they did not provide sufficient information to assess whether an important risk of bias exists (Lukrafka 2012; Paludo 2008; Zhao 2010).

Effects of interventions

Primary outcomes

Mortality

This outcome was not reported in the included studies. However, Lukrafka 2012 reported that there were no deaths.

Duration of hospital stay

Two studies reported this outcome (Lukrafka 2012; Paludo 2008) but in both this was considered as a secondary outcome. There was no significant difference in duration of hospitalisation between the control and intervention groups (P = 0.11 and P = 0.79) in Lukrafka 2012 and Paludo 2008, respectively.

Time to clinical resolution

This outcome was considered in three trials (Lukrafka 2012; Paludo 2008; Zhao 2010). In Lukrafka 2012 this outcome was classified as a severity score including tachypnoea, recession, fever, oxygen saturation and X-ray. There were differences between baseline versus discharge within each group in severity score and respiratory rate (P < 0.001) favouring the intervention group. In Paludo 2008 there were no significant differences between the two groups in these parameters of clinical evolution. The study Zhao 2010 considered only peripheral oxygen saturation levels. This study reported that the intervention group had improved peripheral oxygen saturation levels after application of continuous positive airway pressure (CPAP) compared with the control group (P < 0.001).

Secondary outcomes

Change in adventitious sounds

Only one trial described this outcome (Paludo 2008). This study reported that the intervention group had a longer median duration of rhonchi on lung auscultation (P = 0.03) than the control group.

Change in chest X-ray

Only one trial described this outcome (Lukrafka 2012). This outcome was included in severity scores and there were no differences between the intervention and control group.

Duration in days of antibiotic therapy, cough and sputum production

Only one trial described this outcome (Paludo 2008). This study reported that the intervention group had a longer median duration of coughing (P = 0.04) than the control group.

Duration in days of leukocytosis

This outcome was not reported in the included studies.

Airway clearance (measured by sputum weight or volume)

This outcome was not reported in the included studies.

Number of adverse events (any undesired outcome due to the intervention)

This outcome was not reported in the included studies.

Discussion

Summary of main results

This systematic review assessed the effectiveness of chest physiotherapy in relation to time until clinical resolution in children with pneumonia. Three randomised controlled trials (RCTs) involving 255 participants were included in this review, which appraised three types of chest physiotherapy (standardised respiratory physiotherapy, positive expiratory pressure and continuous positive airway pressure). None of the included studies assessed the outcome mortality. Standardised respiratory physiotherapy and positive expiratory pressure as an adjunct therapy were not shown to decrease the time to clinical resolution and the duration of hospital

stay in children with pneumonia. However, the application of these techniques improved some clinical parameters used to determine the time to clinical resolution, such as respiratory rate. Continuous positive airway pressure appears to improve oxygen saturation.

Overall completeness and applicability of evidence

The three included studies did not address all of our selected objectives. None assessed one of the primary outcomes of the review (mortality), however two studies (Lukrafka 2012; Paludo 2008) addressed the other two primary outcomes and some of the secondary outcomes. The study by Zhao 2010 addressed only one of our primary outcomes (oxygen saturation).

Lukrafka 2012 evaluated some parameters such as fever, tachypnoea and peripheral oxygen saturation levels but they were reported as a severity score. In Paludo 2008 the trial authors expressed the baseline values as mean deviations (MDs) and standard deviations (SDs) and the post-intervention values as number of days. In Zhao 2010 the baseline and post-intervention values were reported as MDs and SDs. It was not possible to pool data by meta-analysis because of differences in the statistical presentation of data.

The ages of the participants differed between these studies and did not include our proposed age ranges. The different age ranges in the studies may have affected the results.

The chest physiotherapy techniques used in the included studies did not cover all of the existing techniques. Moreover, the differences between physiotherapy techniques and methods used in the three included trials were also factors that prevented data pooling and analysis. In Lukrafka 2012, the intervention group received a standardised respiratory physiotherapy (positioning, thoracic vibration, thoracic compression, positive expiratory pressure, breathing exercises and forced exhalation with the glottis open or 'huffing'). However, this trial considered positive expiratory pressure as a conventional physiotherapy and this is an instrumental technique (Yang 2010).

In Paludo 2008 the intervention group only received conventional physiotherapy and aspiration of secretions if necessary. In Zhao 2010 the intervention group only received continuous positive airway pressure (CPAP). Thus, it was not possible to pool and analyse data from these studies because of the different chest physiotherapy techniques.

Moreover, the different levels of severity, types of pneumonia and medications used may have affected the practice of physiotherapy and also the duration of hospital stay. While the application of therapy led to improvement of some clinical aspects it also led to a worsening of other factors such as cough and rhonchi on lung auscultation (Paludo 2008). This can be explained because some of the techniques applied in children in these trials are used in adults and may not be appropriate for children, considering the anatomical and physiological differences between these age groups (Oberwaldner 2000).

Quality of the evidence

This systematic review was limited by the lack of studies and the quality of the existing data. Some points must be taken into consideration when analysing the review results: the small number of included studies and differences in the duration of treatment, levels of severity, types of pneumonia and techniques used in children with pneumonia. Moreover, poor reporting of methodological aspects of most of the included studies led to risk of bias.

Two studies (Lukrafka 2012; Paludo 2008) explain how randomisation was conducted and we classified them as low risk of bias. Only one described allocation concealment and we judged this trial as low risk of bias (Lukrafka 2012). According to Moher 2001, inadequately reported randomisation has been associated with bias in estimating the effectiveness of interventions. Savović 2012 showed that inadequate reporting of trial methods can severely impede the assessment of trial quality and the risk of bias in trial results and this is a particular problem for the assessment of sequence generation and allocation concealment, which are often not described in trial publications. Two

studies reported adequate blinding of outcome assessment and we judged them as low risk of bias (Lukrafka 2012; Paludo 2008). Two included trials described chest physiotherapy as being performed by a physiotherapist, so it might be difficult to blind the practitioners (Lukrafka 2012; Paludo 2008). In a RCT, at least three distinct groups (trial participants, trial personnel and outcome assessors) can potentially be blinded (Savović 2012). The description of these methodological items is recommended by the CONSORT 2010 statement. Moreover, there are challenges in obtaining high-quality evidence for physiotherapy interventions because of the difficulties in blinding the intervention, standardising the method of chest physiotherapy and defining clinically meaningful outcomes (Yang 2010). Only one protocol for an included study was found in trials registers (Lukrafka 2012) but there was no information regarding the outcomes. This aspect is covered in the CONSORT 2010 checklist of information to include when reporting a randomised trial. A study's protocol registration provides information such as the main objective of the study, inclusion and exclusion criteria, primary and secondary outcomes and other methodological aspects. Clinical trial registration minimises or avoids the consequences of non-publication of entire trials and selective reporting of outcomes within trials (CONSORT 2010).

Potential biases in the review process

The included studies reported different data, therefore they could not be pooled in meta-analysis and this may be considered a potential source of bias in this review. Besides the bias found by using the 'Risk of bias' tool provided by The Cochrane Collaboration, other factors may be considered as potential biases. Differences in statistical presentation of data was one of the main factors that prevented meta-analysis of data in this review. Another factor to consider was the inability to conduct a subgroup analysis by age.

In trying to resolve these problems we contacted trial authors when possible to obtain additional information about unpublished data. However, we were not able to obtain further data from all three of the included trials. The time

of application of the techniques, the different techniques applied and follow-up can also be considered a potential source of bias. All of these factors varied between studies or were not reported.

Agreements and disagreements with other studies or reviews

Chest physiotherapy has been widely used for pneumonia but there is weak evidence regarding its benefits (Guessous 2008). Furthermore, few RCTs have been conducted because developing research on this topic is difficult due to costs, the need for equipment and the requirement of experienced respiratory therapists, physiotherapists or clinicians to perform the techniques (Guessous 2008).

There is one previously published systematic review on this topic (Yang 2010) but it focused on adults with pneumonia. However, the results of the review support our findings because it did not show evidence of the effectiveness of the application of physiotherapy in patients with pneumonia. In the Yang 2010 review, all included studies were of poor to moderate methodological quality. To our knowledge, this is the first systematic review to assess the effectiveness of chest physiotherapy in children with pneumonia.

Authors' conclusions

Implications for practice

Although some outcomes evaluated in the included trials led to improvement in the group of children with pneumonia who underwent chest physiotherapy, it was not possible to perform a meta-analysis. Therefore, due to a lack of information, this systematic review provides insufficient evidence to justify the application of chest physiotherapy in children with pneumonia.

Implications for research

It is clear that there is a need for more randomised controlled trials of high methodological quality addressing the use of chest physiotherapy in children with pneumonia. Future studies should report methodological aspects such as adequate random sequence generation and allocation concealment, and blinding of outcome assessors, and consider key points such as appropriate sample size with the power to detect expected differences, standardisation of chest physiotherapy, appropriate outcomes and adverse effects. Moreover, randomised trials should be reported following the CONSORT statement (CONSORT 2010).

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Contributions of authors

Gabriela Chaves (GC): selected the studies, extracted data and drafted the final review.
Guilherme Fregonezi (GF): contributed with clinical expertise and drafted the final review.
Fernando Dias (FD): drafted the final review.
Cibele Ribeiro (CR): drafted the final review.
Ricardo Guerra (RG): contributed with methodological expertise and drafted the final review.
Diana Freitas (DF): selected the studies, extracted data and drafted the final review.

Verônica Parreira (VP): contributed with clinical expertise and drafted the final review.
Karla Mendonça (KM): co-ordinated the review, made an intellectual contribution and drafted the final review.

Declarations of interest

None known.

Characteristics of studies

Characteristics of included studies

Lukrafka 2012

Methods	Design: randomised controlled trial. Method of randomisation: assigned to 2 groups. The randomisation was performed by an epidemiologist using a computerised random number generator to select blocks of 3 and 4. A separate randomisation procedure was performed in each of 2 age group subsets (12 to 59 months and 5 to 12 years). Method of allocation concealment: randomisation was concealed using sequentially numbered opaque envelopes by the senior investigator. Outcome assessor blinding: the study radiologist, statistician and epidemiologist involved in evaluating the outcomes of this RCT did not take part in the clinical attendance and therapeutic decisions. Withdrawal/dropouts: after the randomisation, 4 participants underwent chest drainage (3 in the intervention group) and 3 participants had atelectasis detected by chest X-ray (all in the control group); therefore, 72 participants (n = 35 in the intervention and n = 37 in the control) remained in the study and follow-up
Participants	Country: Brazil Setting: hospital Healthy status: children hospitalised with a clinically and radiologically confirmed diagnosis of acute community-acquired pneumonia Total sample: 72 participants (n = 35 in the intervention and n = 37 in the control)

	Age ranged: 1 to 12 years Exclusion criteria: participants who were severely ill, such as ¬those hospitalised in intensive care units, with pleural effusion treated with chest drainage, atelectasis detected by X-ray, history of pneumonia or pleural effusion in the previous 6 months, or other pulmonary underlying diseases, heart diseases, cerebral palsy or immune deficiency
Interventions	Duration: active treatment: 3 times daily Intervention group: standardised respiratory physiotherapy (positioning, thoracic vibration, thoracic compression, positive expiratory pressure, breathing exercises and forced exhalation with the glottis open or 'huffing') Control group received a non-mandatory request to breathe deeply, expectorate the sputum and maintain a lateral body position once a day Re-evaluated at discharge
Outcomes	Respiratory rate Temperature Tachypnoea Nasal flaring Suprasternal, intercostal and subcostal recession Oxygen saturation X-ray Duration of hospitalisation
Notes	The trial author has responded to our enquiries but informed us that was not possible for her to send data as means and standard deviations

Risk of bias table

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	The randomisation was performed by an epidemiologist using a computerised random number generator to select blocks of 3 and 4
Allocation concealment (selection bias)	Low risk	Randomisation was concealed by the senior investigator using sequentially numbered opaque envelopes

Blinding of participants and personnel (performance bias)	High risk	No blinding and the outcome is likely to be influenced by lack of blinding
Blinding of outcome assessment (detection bias)	Low risk	Blinding of outcome assessment ensured
Incomplete outcome data (attrition bias)	Low risk	Missing outcome data balanced in numbers across intervention groups, with similar reasons for missing data across groups
Selective reporting (reporting bias)	High risk	The study protocol is available, but there is no information regarding the outcomes
Other bias	Unclear risk	Insufficient information to assess whether an important risk of bias exists

Paludo 2008

Methods	Design: randomised controlled trial Method of randomisation: simple randomisation was performed from a table of random numbers Method of allocation concealment: not described Outcome assessor blinding: all attending paediatricians were blinded to group assignment and study protocol Withdrawal/dropouts: 9 participants withdrew from the study
Participants	Country: Brazil Setting: hospital Healthy status: participants hospitalised with a diagnosis of acute pneumonia (did not specify the acquisition form) Total sample: 89 participants Age range: children aged 29 days to 12 years Exclusion criteria: participants who needed a chest drain, had haemodynamic instability, bone fragility or rib fractures and any other contraindication to chest physical therapy were excluded
Interventions	Duration: active treatment: twice daily Intervention group: each session of chest physical therapy took about 30 min and consisted of postural drainage, thoracic squeezing, chest percussion, vibration, cough stimulation and aspiration of secretions (if necessary)

	Control group received standard treatment for pneumonia alone Re-evaluated at discharge
Outcomes	Time to clinical resolution: afebrile, absence of severe signs (chest indrawing, nasal flaring), normal respiratory rate and arterial oxygen saturation > 95% Length hospital stay and persistence of respiratory symptoms and signs (fever, cough, wheezing, tachypnoea, chest indrawing, adventitious sounds on lung auscultation and arterial oxygen saturation)
Notes	The author has responded to our enquiries with further details

Risk of bias table

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Simple randomisation was performed from a table of random numbers
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement of 'low risk' or 'high risk'
Blinding of participants and personnel (performance bias)	High risk	No blinding and the outcome is likely to be influenced by lack of blinding
Blinding of outcome assessment (detection bias)	Low risk	Blinding of outcome assessment ensured
Incomplete outcome data (attrition bias)	Low risk	Missing outcome data balanced in numbers across intervention groups, with similar reasons for missing data across groups
Selective reporting (reporting bias)	High risk	The study protocol is not available and one or more outcomes of interest in the review are reported incompletely so that they cannot be entered in a meta-analysis
Other bias	Unclear risk	Insufficient information to assess whether an important risk of bias exists

Zhao 2010

Methods	Design: randomised controlled trial Method of randomisation: not described Method of allocation concealment: not described Outcome assessor blinding: not described Withdrawal/dropouts: not described
Participants	Country: China Setting: hospital Healthy status: severe pneumonia Total sample: 94 children (47 in each group) Mean age: 10.79 ± 4.75 months Age range: children aged 2 months to 2 years Exclusion criteria: not described
Interventions	Duration: active treatment: until the stabilisation of the patient based on oxygen saturation Intervention group: continuous positive airway pressure Control group received standard treatment for pneumonia with oxygen support Re-evaluated 4 hours and 12 hours after treatment
Outcomes	Arterial oxygen saturation; arterial oxygen pressure; arterial carbon dioxide pressure
Notes	This paper was translated from Chinese

Risk of bias table

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Insufficient information about the sequence generation process
Allocation concealment (selection bias)	Unclear risk	Insufficient information about the allocation concealment
Blinding of participants and personnel (performance bias)	Unclear risk	Insufficient information to permit judgement of 'low risk' or 'high risk'
Blinding of outcome assessment (detection bias)	Unclear risk	Insufficient information to permit judgement of 'low risk' or 'high risk'
Incomplete outcome data (attrition bias)	Low risk	No missing outcome data
Selective reporting	Low risk	The study protocol is not available but the published

(reporting bias)		reports include all expected outcomes, including those that were pre-specified
Other bias	Unclear risk	Insufficient information to assess whether an important risk of bias exists

Characteristics of excluded studies

Brunetto 2002

Reason for exclusion	There is no control group

Campos 2007

Reason for exclusion	There is no control group

Lanza 2009

Reason for exclusion	The control group received some intervention

Santos 2009

Reason for exclusion	There is no control group

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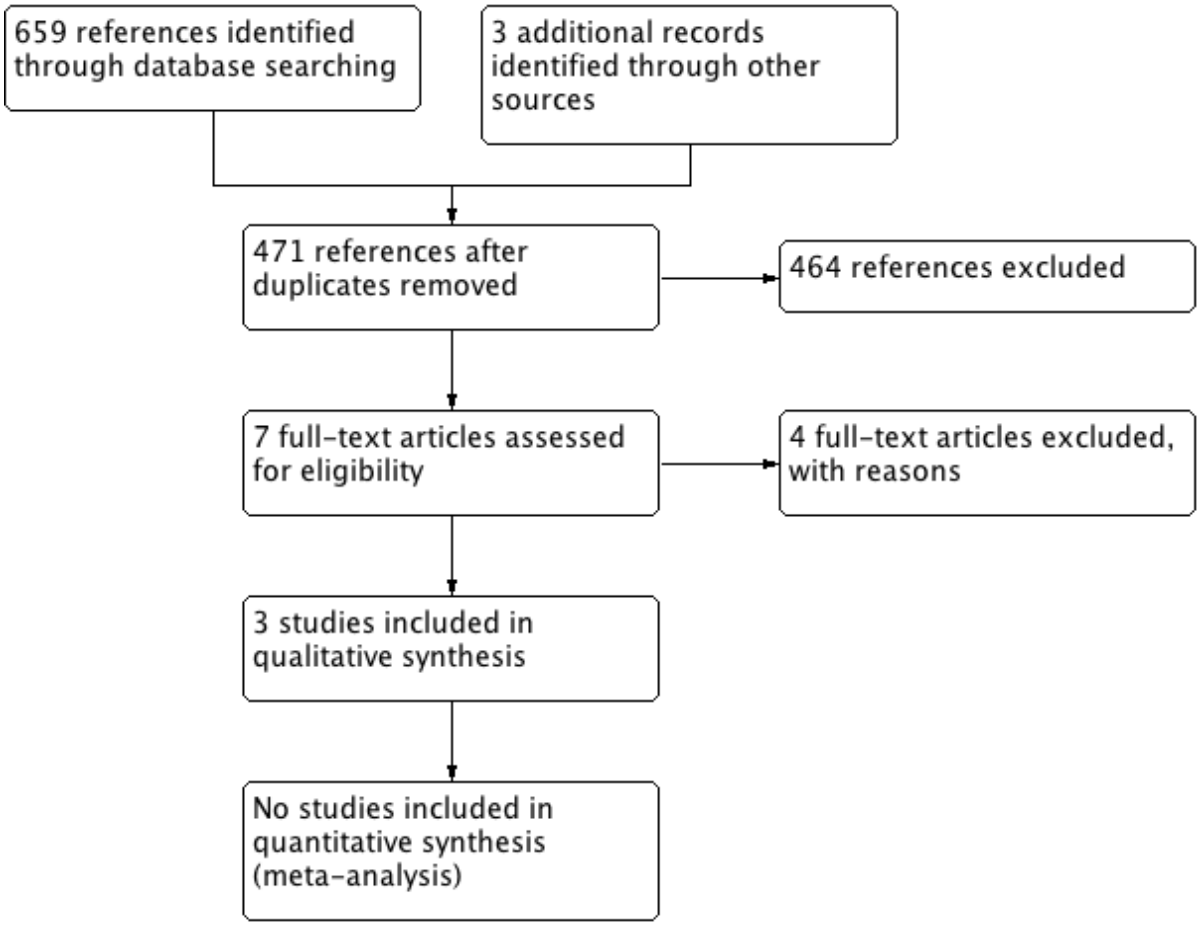
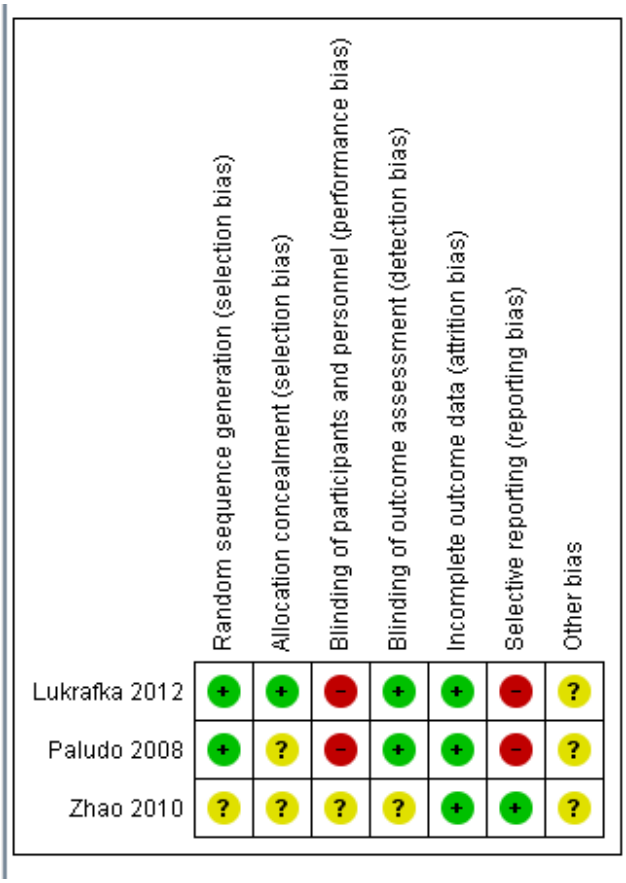
Figure 1



Study flow diagram

Figure 2



'Risk of bias' summary: review authors' judgements about each risk of bias item for each included study.

Appendices

1 Description of the techniques used for chest physiotherapy

Conventional physiotherapy

- Postural drainage - postural drainage is the positioning of the child with the assistance of gravity to mobilise the secretions towards the main bronchus (Britto 2009).
- Vibration - in this technique a rapid vibratory impulse is transmitted through the chest wall from the flattened hands of the therapist by isometric alternate contraction of forearm flexor and extensor muscles, to loosen and dislodge the airway secretions (Britto 2009).
- Percussion – the therapist can use single or both cupped hands or three fingers with the middle finger tented, or a facemask with the port either covered or occluded by a finger, and strike repeatedly at a rate of three per second over the part of the bronchopulmonary segment which needs to be drained (Britto 2009).
- Huffing – fast expiration at high volume performed by the patient (Britto 2009).
- Coughing - child can be requested to cough. In unco-operative or small children tracheal stimulation or tickling can be done by placing index finger or thumb on the anterior side of the neck against trachea just above sternal notch with gentle but firm inward pressure in a circular pattern as the child begins to exhale (Britto 2009).

Modern techniques

- Forced expiration technique - patient should undertake a diaphragmatic inspiration to medium volume, with relaxation of the scapulohumeral region and with the mouth and glottis open (Britto 2009).
- Active cycle of breathing - the patient can be positioned supine, prone, lateral or sitting and can be helped by the physiotherapist or perform this independently. This technique consists of the following phases (Alexander 2011; Britto 2009).

    - Control of breathing: the patient must perform inhalations and exhalations at current volume level, relaxing the upper thoracic region and breathing quietly using the lower chest.
    - Exercise chest expansion: this consists of deep breathing exercises performed as follows: slow nasal breathing at inspiratory reserve volume level, followed by a two to three-second post-inspiratory pause and ending with oral expiration at functional residual capacity level.
    - Forced expiration technique: patient should undertake a diaphragmatic inspiration to medium volume, with relaxation of the scapulohumeral region and with the mouth and glottis open.

- Autogenic drainage - a three-phase breathing regimen utilising high expiratory flow rates and variable lung volumes to unstick, collect and evacuate secretions. The patient is placed sitting, back straight and head slightly hyperextended, hands resting on the upper left and right chest (Alexander 2011; Britto 2009). The three phases are described as follows:

  - Displacement: starts with a slow and forced oral expiration, recruiting a percentage of expiratory reserve volume, and then carrying inspiration to low volume, recruiting percentages of tidal volume followed by a two to three-second post-inspiratory pause. Finally, there is a slow oral exhalation recruiting a percentage of expiratory reserve volume.
  - Collection: nasal inspiration to medium volume, recruiting a larger percentage of tidal volume, followed by a two to three-second post-inspiratory pause. Finally, there is a slow oral exhalation recruiting percentage of expiratory reserve volume.
  - Elimination: nasal inspiration to high volume recruiting the tidal volume and a percentage of inspiratory reserve volume, followed by a two to three-second post-inspiratory pause. Then, there is oral expiration at the level of tidal volume. Finally, the forced expiration technique is performed to high volumes.

- Slow and prolonged expiration - this is an entirely passive technique given the age and the inability of a small patient to co-operate. The child is positioned supine. The therapist places a hand on the patient's chest and the other one on the abdomen. At the end of a spontaneous expiration, pressure is applied to the chest caudally and on the abdomen cephalically. The pressure is maintained for two to three respiratory cycles. No pressure is exerted during the first part of expiration (Postiaux 1997).
- Increased expiratory flow - this technique should be performed during the expiratory time using pressure exerted by the physiotherapist's hands on the child's chest, lying supine. The other hand of the professional remains static over the abdomen to prevent the dissipation of pressure to the abdominal compartment. The physical therapist will perform the movement on the chest with the goal of deflation, the speed of which should be more than a spontaneous expiration (Postiaux 1992).
- Total slow expiration with the glottis open in a lateral posture - the patient is placed in lateral decumbency. The patient can be helped by the physiotherapist or can also perform this independently, without the help of the therapist. The patient starts by performing a nasal inspiration at tidal volume level. Then, the patient performs an oral slow expiration with the open glottis at residual volume level (Postiaux 1997).
- Exercises of controlled inspiratory flow - this technique can be performed in two positions: the posterolateral and anterolateral. In the first position, patient is positioned in lateral decumbency with the trunk and pelvis tilted slightly above perpendicular to the plane of support. In the second position, the patient is positioned in lateral decumbency with the limb flexed and the upper hand on the occipital region to promote the elongation of the pectoral musculature. In both placements, the patient must perform a slow, deep inspiration recruiting the inspiratory reserve volume, then a two to three-second post-inspiratory pause, and then an oral expiration at functional residual capacity level (Postiaux 2000).

Instrumental techniques

- Positive expiratory pressure mask - provides resistance to expiration through a mouthpiece or facemask, followed by forced expirations. This treatment must be carried out in a sitting position: the patient inhales and exhales through the mask 15 times (approximately two minutes). The inhalation is at tidal volume and the expiration is slightly active against the mask. The patient then removes

the mask and performs two or three forced expirations follow by a cough to clear secretions that are mobilised to the central airways. This procedure is followed by a one to two-minute period of relaxed, controlled breathing (Alexander 2011; Britto 2009).

- Flutter - pipe-shaped device that creates oscillation and positive pressure on expiration used in conjunction with forced expirations. They perform a nasal inhalation, followed by an inspiratory pause lasting two to three seconds. Oral exhalation must be fast enough to move the ball. The sequence should be repeated for 10 to 15 breaths (Alexander 2011; Britto 2009).
- Incentive spirometer - referred to as sustained maximal inspiration. It is accomplished by using a device that provides feedback when patient inhales at a predetermined flow or volume and sustains the inflation for at least five seconds (Restrepo 2011).

2 EMBASE (Elsevier) search strategy

#36 #11 AND #35 15056
#35 #12 OR #13 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 OR #32 OR #33 OR #34 250196
#34 eltgol:ab,ti 4
#33 (incentive NEAR/2 (inspiromet* OR spiromet*)):ab,ti 209
#32 flutter:ab,ti 6494
#31 ((forced OR slow OR prolonged OR increas* OR control*) NEAR/2 (exhal* OR inhal*)):ab,ti 2516
#30 (breath* NEAR/2 (control* OR techni* OR train* OR exercis* OR 'active cycle')):ab,ti 4591
#29 ((postur* OR autogenic) NEAR/2 drain*):ab,ti 309
#28 ((respirat* OR ventilat*) NEAR/2 ('muscle train' OR 'muscle training')):ab,ti 222
#27 massag*:ab,ti 5850
#26 electrostimulat*:ab,ti 2042
#25 'positive pressure ventilation':ab,ti OR 'postive expiratory pressure':ab,ti 4009
#24 (cough* NEAR/2 (directed OR maneuver* OR manoeuver* OR techniqu*)):ab,ti169
#23 ((chest OR thora*) NEAR/3 (clap* OR shak* OR compress*)):ab,ti 3291
#22 oscillat*:ab,ti OR vibrat*:ab,ti OR percuss*:ab,ti OR huff*:ab,ti 69253
#21 (body NEAR/3 (postur* OR positon* OR lateral)):ab,ti 2919
#20 (patient* NEAR/3 (postur* OR position*)):ab,ti 11130
#19 'vibration'/de 11265
#18 'breathing exercise'/de 2748
#17 'artificial ventilation'/exp 85889
#16 'oxygen therapy'/de 13072
#15 'extracorporeal oxygenation'/de 6897
#14 'postural drainage'/de 474
#13 physiotherap*:ab,ti OR 'physical therapy':ab,ti OR 'physical therapies':ab,ti OR 'physical treatment':ab,ti OR 'physical treatments':ab,ti 26544
#12 'physiotherapy'/exp 34808
#11 #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 261137
#10 'lower respiratory tract infection':ab,ti OR 'lower respiratory tract infections':ab,ti OR 'lower respiratory infection':ab,ti OR 'lower respiratory infections':ab,ti OR lrti:ab,ti 5195
#9 'lower respiratory tract infection'/de 5969
#8 pleurisy:ab,ti 2255
#7 'pleurisy'/de OR 'exudative pleurisy'/de 4261
#6 'pleura effusion'/de OR 'pleura empyema'/de 25867
#5 ((lung* OR pulmonary OR pleur*) NEAR/2 (infect* OR inflam*)):ab,ti 25127
#4 cap:ab,ti OR hap:ab,ti OR vap:ab,ti 30610
#3 bronchopneumon*:ab,ti OR pleuropneumon*:ab,ti 3654
#2 pneumon*:ab,ti 119018
#1 'pneumonia'/exp 138579

3 CINAHL (Ebsco) search strategy

S58 S35 AND S48 AND S57 71
S57 S49 OR S50 OR S51 OR S52 OR S53 OR S54 OR S55 OR S56 178,200
S56 (MH "Quantitative Studies") 8,230
S55 (MH "Placebos") 6,531
S54 TI placebo* OR AB placebo* 19,643
S53 TI random* OR AB random* 97,503
S52 TI ((singl* or doubl* or trebl* or tripl*) W1 (blind* or mask*)) OR AB ((singl* or doubl* or trebl* or tripl*) W1 (blind* or mask*)) 14,307

S51 TI clinic* W1 trial* OR AB clinic* W1 trial* 27,056
S50 PT clinical trial 51,858
S49 (MH "Clinical Trials+") 109,939
S48 S36 OR S37 OR S38 OR S39 OR S40 OR S41 OR S42 OR S43 OR S44 OR S45 OR S46 OR S47 490,359
S47 TI (nursery school* or kindergar* or primary school* or secondary school* or elementary school* or high school* or highschool*) OR AB (nursery school* or kindergar* or primary school* or secondary school* or elementary school* or high school* or highschool*) 12,361
S46 (MH "Schools+") 30,483
S45 TI (pediatric* or paediatric*) OR AB (pediatric* or paediatric*) 40,374
S44 (MH "Pediatrics+") 6,021
S43 TI (minor* or juvenile* or pubert* or pubescen*) OR AB (minor* or juvenile* or pubert* or pubescen*) 24,422
S42 (MH "Puberty") 974
S41 TI (adoles* or teen* or boy* or girl*) OR AB (adoles* or teen* or boy* or girl*) 57,128
S40 (MH "Adolescence+") 179,705
S39 (child* or schoolchild* or school age* or preschool* or kid or kids or toddler*) OR (child* or schoolchild* or school age* or preschool* or kid or kids or toddler*) 305,552
S38 (MH "Child+") 266,981
S37 TI (infant* or infancy or newborn* or baby* or babies or neonat* or preterm* or prematur* or postmatur*) OR AB (infant* or infancy or newborn* or baby* or babies or neonat* or preterm* or prematur* or
postmatur*) 72,042
S36 (MH "Infant+") 107,884
S35 S11 AND S34 1,729
S34 S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22 OR S23 OR S24 OR S25 OR S26 OR S27 OR S28 OR S29 OR S30 OR S31 OR S32 OR S33 100,769
S33 TI eltgol OR AB eltgol 2
S32 TI (incentive N2 (inspiromet* or spiromet*)) OR AB (incentive N2 (inspiromet* or spiromet*)) 98
S31 TI flutter OR AB flutter 1,055
S30 TI ((forced or slow or prolonged or increas* or control*) N2 (exhal or expir*)) OR AB ((forced or slow or prolonged or increas* or control*) N2 (exhal or expir*)) 1,533
S29 TI (breath* N2 (control* or techni* or train* or exercis* or "active cycle")) OR AB (breath* N2 (control* or techni* or train* or exercis* or "active cycle")) 845
S28 TI ((postur* or autogenic) N2 drain*) OR AB ((postur* or autogenic) N2 drain*) 85
S27 TI ((respirat* or ventilat*) N2 muscle train*) OR AB ((respirat* or ventilat*) N2 muscle train*) 117
S26 TI massag* OR AB massag* 3,972
S25 TI electrostimulat* OR AB electrostimulat* 157
S24 TI positive expiratory pressur* OR AB positive expiratory pressur*712
S23 TI positive pressure ventilation* OR AB positive pressure ventilation* 954
S22 TI (cough* N2 (directed or maneuver* or manoeuver* or techniqu*)) OR AB (cough* N2 (directed or maneuver* or manoeuver* or techniqu*)) 57
S21 TI ((chest or thora*) N3 (clap* or shak* or compress*)) OR AB ((chest or thora*) N3 (clap* or shak* or compress*)) 533
S20 TI (oscillat* or vibrat* or percuss* or huff*) OR AB (oscillat* or vibrat* or percuss* or huff*) 3,324
S19 TI (body N3 (postur* or position* or lateral)) OR AB (body N3 (postur* or position* or lateral)) 904
S18 TI (patient* N3 (postur* or position*)) OR AB (patient* N3 (postur* or position*)) 2,168
S17 (MH "Vibration") 1,386
S16 (MH "Breathing Exercises+") 971
S15 (MH "Positive Pressure Ventilation+") 4,266
S14 (MH "Respiratory Therapy+") 19,474
S13 TI (physiotherap* or physical therap* or physical treatment*) OR AB (physiotherap* or physical therap* or physical treatment*) 20,748

S12 (MH "Physical Therapy+") 61,365
S11 S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 19,864
S10 TI (lower respiratory tract infection* or lower respiratory infection* or lrti) OR AB (lower respiratory tract infection* or lower respiratory infection* or lrti) 597
S9 (MH "Respiratory Tract Infections") 3,194
S8 TI (pleural N3 (empyema or effusion*)) OR AB (pleural N3 (empyema or effusion*)) 929
S7 TI pleurisy OR AB pleurisy 65
S6 (MH "Pleurisy") 81
S5 (MH "Empyema") OR (MH "Pleural Effusion") 1,091
S4 TI ((lung* or pulmonary or pleur*) N2 (infect* or inflam*)) OR AB ((lung* or pulmonary or pleur*) N2 (infect* or inflam*)) 1,577
S3 TI (cap or hap or vap) OR AB (cap or hap or vap) 2,251
S2 TI (pneumon* or bronchopneumon* or pleuropneumon*) OR AB (pneumon* or bronchopneumon* or pleuropneumon*) 9,935

S1 (MH "Pneumonia+") 8,6664 LILACS (BIREME) search strategy

(MH:pneumonia OR pneumon$ OR Neumonía OR MH:C08.381.677$ OR MH:C08.730.610$ OR "Inflamación Experimental del Pulmón" OR "Inflamación del Pulmón" OR "Neumonía Lobar" OR Neumonitis OR "Inflamación Pulmonar" OR Pneumonía OR Pulmonía OR "Inflamação Experimental dos Pulmões" OR "Inflamação do Pulmão" OR "Pneumonia Lobar" OR Pneumonite OR "Inflamação Pulmonar" OR Pulmonia OR Bronchopneumonia OR Bronconeumonía OR Pleuropneumonia OR Pleuroneumonía OR MH:"Empyema, Pleural" OR "Empiema Pleural" OR "Pleural Effusion" OR "Derrame Pleural" OR MH:Pleurisy OR Pleuresia OR Pleurisia OR pleurisy OR "pleural effusion" OR MH:"Respiratory Tract Infections" OR "Infecciones del Sistema Respiratorio" OR "Infecções Respiratórias" OR " lower respiratory tract infection" OR "lower respiratory tract infections" OR "lower respiratory infection" OR "lower respiratory infections" or lrti OR "Infecciones de las Vías Respiratorias" OR "Infecciones del Aparato Respiratorio" OR "Infecciones del Tracto Respiratorio" OR "Infecciones Respiratorias" OR "Infecções das Vias Respiratórias" OR "Infecções do Aparelho Respiratório" OR "Infecções do Sistema Respiratório" OR "Infecções do Trato Respiratório") AND (MH:"Physical Therapy Modalities" OR MH:E02.779$ OR "Modalidades de Fisioterapia" OR "Modalidades de Fisioterapia" OR physiotherap$ OR "physical therapy" OR "physical therapies" OR "physical treatment" OR "physical treatments" OR "Modalidades de Terapia Física" OR Fisioterapia OR "Técnicas Fisioterápicas" OR MH:"Respiratory Therapy" OR MH:E02.880$ OR "Terapia Respiratoria" OR "inhalation therapy" OR "Terapia de Inhalación" OR "Terapia por Inalação" OR MH:"Positive-Pressure Respiration" OR MH:E02.041.625.790$ OR MH:E02.880.820.790$ OR "Respiración con Presión Positiva" OR "Respiração com Pressão Positiva" OR MH:"Breathing Exercises" OR "Ejercicios Respiratorios" OR "Exercícios Respiratórios" OR "Respiratory Muscle Training" OR "Entrenamiento del Musculo Respiratorio" OR "Exercícios para os Músculos Respiratórios" OR MH:Vibration OR Vibración OR Vibração OR oscillat$ OR vibrat$ OR percuss$ OR huff$ OR coughing Or "directed cough" OR "cough technique" OR "patient posture" OR "body posture" OR "patient position" OR "patient positioning" OR "body position" OR "lateral position" OR "lateral posture" OR ELTGOL OR "forced expiration technique" OR "active cycle of breathing" OR "slow expiration" OR "prolonged expiration" OR ELPr OR "increased expiratory flow" OR AFE OR "inspiratory controlled flow" OR EDIC OR "positive expiratory pressure" OR PEP OR flutter OR electrostimulat$ OR massag* OR "postural drainage")

5 Web of Science (Thomson Reuters) search strategy

#7	76	#6 AND #5 *Databases=SCI-EXPANDED, CPCI-S Timespan=All Years* *Lemmatization=On*
#6	1,306,314	Topic=(random* or placebo* or crossover* or "cross over" or allocat* or ((singl* or doubl*) NEAR/1 (blind* or mask*))) OR Title=(trial) *Databases=SCI-EXPANDED, CPCI-S Timespan=All Years* *Lemmatization=On*
#5	347	#4 AND #3 *Databases=SCI-EXPANDED, CPCI-S Timespan=All Years* *Lemmatization=On*
#4	1,748,376	Topic=(infant* or infancy or newborn* or baby* or babies or neonat* or preterm* or prematur* or postmatur* or child* or schoolchild* or "school age*" or preschool* or kid or kids or toddler* or adoles* or teen* or boy* or girl* or minor* or juvenile* or pubert* or pubescen* or pediatric* or paediatric* or kindergar* or highschool* or (school* NEAR/1 (nursery or primary or secondary or elementary or high))) *Databases=SCI-EXPANDED, CPCI-S Timespan=All Years* *Lemmatization=On*
#3	1,590	#2 AND #1 *Databases=SCI-EXPANDED, CPCI-S Timespan=All Years* *Lemmatization=On*
#2	422,588	Topic=(physiotherap* or (physical NEAR/1 (treatment* or therap*)) or "respiratory therapy" or "positive pressure respiration" or "positive pressure ventilation" or (patient* NEAR/3 (posture or position*)) or (body NEAR/3 (postur* or position* or lateral)) or oscillat* or vibrar* or percuss* or huff* or (cough* NEAR/2 (directed or maneuver* or manoeuver* or techni*)) or "positive expiratory pressure" or electrostimulat* or massag* or ((respirat* or ventilat*) NEAR/2 "muscle training") or ((postur* or autogenic) NEAR/2 drain*) or (breath* NEAR/2 (control* or techni* or train* or exercis* or "active cycle")) or ((forced or slow or prolonged or increas* or control*) NEAR/2 (exhal* or expir)) or flutter or (incentive NEAR/2 (inspiromet* or spiromet*)) or eltgol) *Databases=SCI-EXPANDED, CPCI-S Timespan=All Years* *Lemmatization=On*
#1	163,229	Topic=(pneumon* or bronchopneumon* or pleuropneumon* or pleurisy or ((lung* or pulmonary or pleur*) NEAR/2 (infect* or inflam*)) or (pleural NEAR/2 (empyema or effusion*)) or "lower respiratory tract infection" or "lower respiratory tract infections" or "lower respiratory infection" or "lower respiratory infections" or lrti)

		Databases=SCI-EXPANDED, CPCI-S Timespan=All Years *Lemmatization=On*

6 PEDro (Physiotherapy Evidence Database) search strategy

Pneumonia in title abstract field
Paediatrics in subdivision field
Clinical trials in methods field

4 CONSIDERAÇÕES FINAIS

A presente revisão sistemática, realizada em parceria com a Colaboração Cochrane, incluiu três estudos envolvendo 255 crianças com idade de 29 dias a 12 anos, apresentando diagnóstico de pneumonia, assistidos em ambiente hospitalar. Embora alguns desfechos avaliados nos estudos tenham demonstrado melhora através da realização da fisioterapia respiratória, a evidência existente em relação aos benefícios da mesma, no tratamento de crianças com pneumonia, ainda não é suficiente para comprovar ou refutar os efeitos benéficos deste tipo de tratamento como terapia adjunta de pacientes com pneumonia.

De uma maneira geral, os estudos revisados possuem baixa qualidade metodológica apresentando ausência ou descrição superficial dos pontos metodológicos de grande importância, como sigilo de alocação e cegamento dos avaliadores. Porém, o cegamento é difícil de ser realizado devido à natureza do estudo.

Dos nove desfechos propostos pelo protocolo da revisão, quatro não foram avaliados pelos estudos incluídos (mortalidade, duração em dias da leucocitose, a *clearance* das vias aéreas e o número de efeitos adversos).

O baixo número de estudos encontrados e a baixa qualidade metodológica, bem como a ausência dos dados finais completos para que seja realizada a metanálise, deixa clara a necessidade da realização de ensaios clínicos que descrevam a metodologia seguindo as normas do CONSORT.

Futuros estudos são necessários com o objetivo de avaliar os efeitos da fisioterapia respiratória em crianças com pneumonia. Um cálculo amostral antes do início do estudo deve ser realizado, para que se possa obter um

número adequado de pacientes, realizar e descrever o método de randomização, de sigilo da alocação e cegamento.

Apesar de não apresentar evidência suficiente para comprovar os efeitos benéficos da fisioterapia no tratamento de crianças com pneumonia, a fisioterapia respiratória parece ser bem tolerada pelos pacientes, oferecendo baixos riscos e baixos custos para aqueles que a realizam.

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6 ANEXOS