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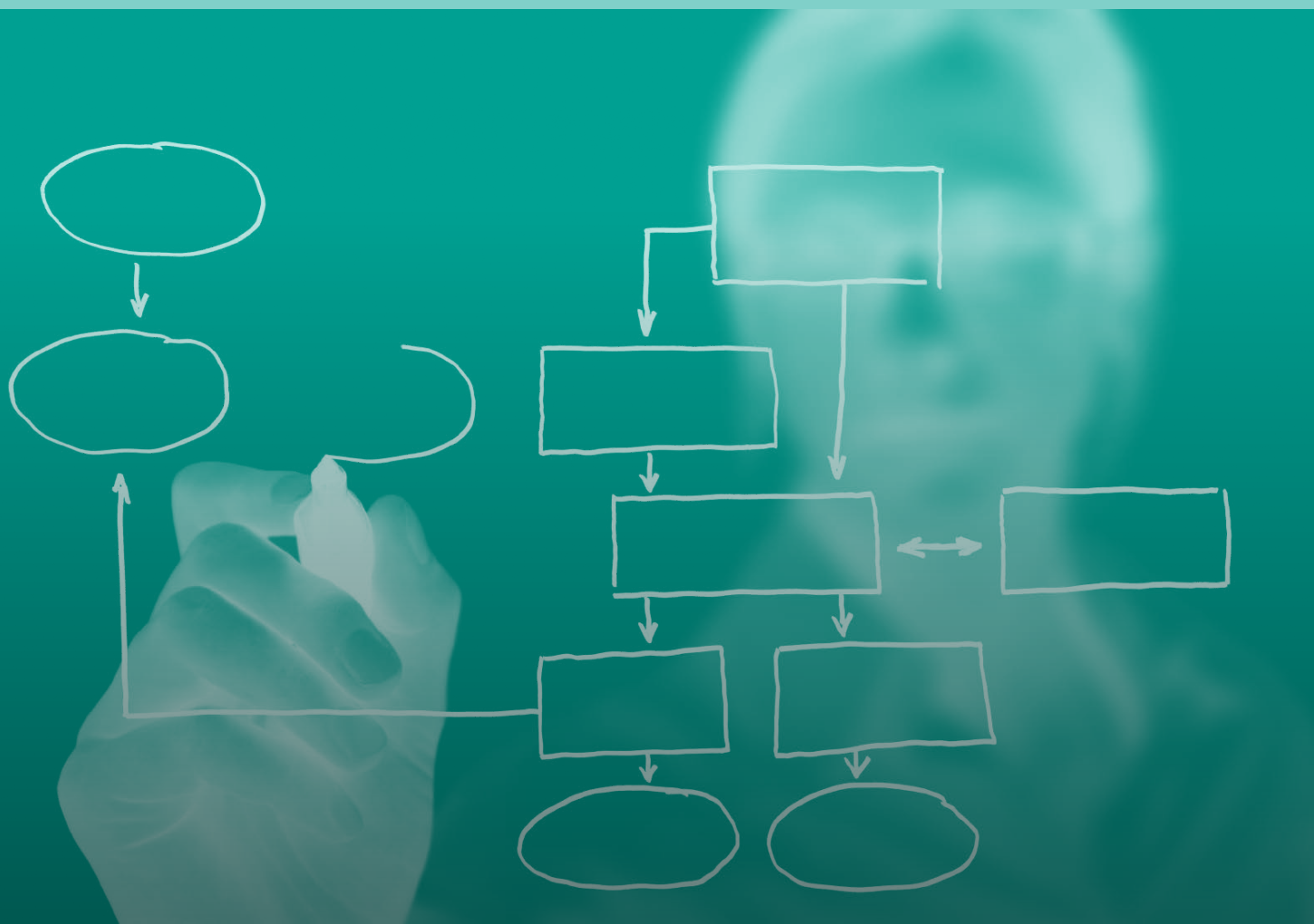
PHYSIOTHERAPY UPDATES



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Main office
C/Segle XX, 78. 08032 Barcelona
Tel. 93 207 50 29 Fax. 93 207 70 22
www.fisioterapeutes.cat
cfc@fisioterapeutes.cat

Manuscripts sent to:
Col·legi de Fisioterapeutes de Catalunya. Revista Científica.
C/Segle XX, 78. 08032 Barcelona
revistacientifica@fisioterapeutes.cat

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Col·legi de Fisioterapeutes de Catalunya

EDITORIAL

AN UPGRADED JOURNAL

Ramon Aiguadé
Treasury manager and responsible
for the Scientific Journal

In your hands you have the new issue of our Science Magazine in a format that is more complete than ever. You will find an original article on respiratory physiotherapy by Ms Inma Castillo. You will also find three translated articles published in prestigious publications like *Kinésithérapie la revue and Physical Therapy*. We continue offering translated abstracts, selected from Medline, that we believe are of great interest for all of us. We would finally like to present a new section called "Learn how to do research", where you will be offered short information capsules that all together can make up a whole book on research methodology. We hope it will stir up your interest in research.

Equally interesting is the section reviewing the SEPAR Congress and the agenda of congresses and conferences that, in the next few years, is full of really interesting events.

Quite soon we are going to publish summaries of posters done by those of you who would like to share your research studies with us and there will also be a section devoted to end-of-course papers.

In conclusion, although it takes blood, sweat, and tears to edit a high quality scientific journal, we will not give up. In order to make it more attractive to readers, we publish it in three languages: Catalan, Spanish, and English. We will continue along this path of innovation.

The present and future of physiotherapy hinges on research, on the validity of our profession and the evidence that physiotherapy is a science that can effectively help our patients and that is more economical than other drug or surgical treatments.

But we need your participation. If we want to have a periodical, we need greater participation. You do not have to be a specialist or a researcher to send an article to be translated, to suggest abstracts or, more generally, to let us know what your interests are.

We hope we can soon offer you what is our aim and objective: a high quality scientific journal that helps us improve our professional practice and care towards the patient. This is our primary purpose.

Col·legi de Fisioterapeutes de Catalunya

PHYSIOTHERAPY UPDATES

ORIGINAL ARTICLE

EFFECTIVENESS OF A CHEST PHYSIOTHERAPY PROGRAMME ON PATIENTS SUFFERING FROM PLEURAL EFFUSION: IS THE ROUTINE USE OF AN INCENTIVE SPIROMETER NECESSARY?

Inmaculada Castillo Sánchez, Julia Tárrega Camarasa*, Enric Barbeta Sánchez*

Pneumonology department. Hospital Universitario General de Granollers. Universitat Internacional de Catalunya*

Calle Santiago Rusiñol, nº 5. CP: 08553. Seva. Barcelona. Tel: 685 22 5848 icastillo@fhag.es

The authors declare that there is no conflict of interest.

We wish to acknowledge the pneumonology department in our centre.

ABSTRACT

Introduction. Chest physiotherapy (CP), early, has the primary to minimize the effects that occur in pleural effusions (PE) hematologic and infectious cause involving reduced pulmonary ventilation. The incentive spirometry (ICI) was a device used routinely in these treatments. The objective of the study is 1) quantify radiological and lung function terms, the effect of CP in reducing residual fibrothorax in patients with PE and 2) assess the additional benefit provided by the use of incentive spirometry.

Patients and methods. We included patients admitted to the respiratory medicine department of a general hospital with a diagnosis of hemothorax and pleural effusion caused by infection, including tuberculous pleurisy, which the hospital had ventilatory and / or radiological abnormalities. CP program consisted in performing techniques thoracoabdominal expansion and in a subset of patients also used the ICI. Chest radiography and spirometry was performed at baseline and after completion of the program.

Results. 33 patients with mean age 47 ± 17 years were included. PE diagnoses were: 17 (52%) parapneumonic effusions, 9 (27%) tuberculous pleurisy and the remaining 7n (21%) traumatic hemothorax. The mean baseline FVC was 64 ± 10% and all had radiographic abnormalities. The average duration of the program was 21 FR sessions. The FVC showed an absolute mean increase of 749 ± 442 ml at the end of the program. All patients showed radiographic improvement. In the 16 patients who used the ICI did not observe statistically significant differences in the final values of pulmonary function, or radiological recovery program duration or number of sessions of FR.

Conclusions. The application of early FR program in patients with pleural adhesions get a functional and radiological improvement. The ICI provides no significant benefit as additional treatment in the management of FR within DP.

KEY WORDS: Chest physiotherapy. Pleural disease. Incentive spirometry.

INTRODUCTION

Pleural effusion (PE) is defined as a pathological accumulation of fluid in the pleural space. It occurs as a result of an imbalance between production and reabsorption of pleural fluid (1). The prevalence of PE amounts to 400/100,000 people and represents 2-4% of hospital admissions in pneumology departments (2). The diagnosis begins with the classification of these PE in transudates and exudates according to biochemical criteria (3). Exudative PE evolves from an initial inflammatory phase to a more or less fibropurulent exudative phase and finally to the organisational phase and is characterised by the presence of fibroblasts on the surfaces of the two pleurae (parietal and visceral) transforming the fibrin into a thick and rigid tissue (4). Pleural effusion treatment is based on the causal treatment of the pathology. In situations of massive or submassive pleural effusions, and in the case of septation or presence of hemothorax, applying a pleural drainage will be necessary and even suggest the use of intrapleural fibrinolytics to avoid decortication through severe pachypleuritis. However, after applying these techniques there is no guarantee to achieving a complete solution neither on a functional nor on a radiologic level (5).

Chest physiotherapy is key to prevent the appearance of a restrictive ventilatory alteration. The ventilatory techniques used in expiration and/or inspiration along with position changes will increase intrapleural pressure and expand the pleural surface, thus facilitating the drainage or absorption of pleural fluid. Moreover, these ventilatory techniques initiated at an early stage allow performing a continuous mobilisation of the two pleural surfaces and prevent adhesion formation. CP also allows us to fight the pleural pain, antalgic attitude and orthopaedic problems that may affect these patients (6).

An ICI (7) is a ventilatory support technique in the CP treatment to stimulate the inspiratory capacity. In pleural disease, it is indicated as an intensive support technique in the inspiratory time in order to mobilise maximum lung volumes conducted to the area of lung collapse generated by the PE. Using an ICI the patient has visual control of the inspiratory volume and can stimulate a better maximum inspiratory technique than a manual technique would do. On the downside, the correct use of these devices requires some training. Furthermore, the patient must have a minimum inspiratory capacity (1500ml) to reach a maximum inspiratory volume and be able to facilitate ventilatory compensations and the sensation of fatigue. So far, the indications for the use of an ICI are validated for improving bronchial drainage and preventing post-operative atelectasis (8).

Valenza *et al* (9) performed the only randomised study to date comparing two groups, one control group with medical treatment and another group performing chest physiotherapy treatment. The selected group was formed by patients with pleural effusion of any aetiology. This fact could be a significant bias. We believe that further studies are needed with a group of more selected patients demonstrating the efficiency (9) and benefit of the CP treatment in patients with pleural disease although it is a usual treatment in routine clinical practice. We have found only one reference that mentions a possible benefit (10) in cases of empyema provided the treatment is started early enough (11). It has also been described that CP reduces drainage time in cases of hemothorax (12).

The goal of this study was to evaluate the effect of an early applied CP programme aimed at reducing residual fibrothorax in PE patients and analyse the additional benefit that an incentive spirometer provides in the treatment of these patients.

METHOD

Population

Included were all patients who had been admitted to our Pneumology Department from March 1999 to August 2008 with a diagnosis of pleural effusion of infectious or hemothorax aetiology evidencing a secondary restrictive ventilatory alteration (FVC <70% of the reference value) and/or a radiological alteration at the moment of hospital discharge. All patients agreed to participate in the study.

Excluded: uncooperative patients, patients diagnosed with COPD showing moderate or severe respiratory disorders (FEV1 <65%), patients with other causes of restrictive ventilatory disorders: as for example; obesity (BMI> 35 kg/m^2), ribcage pathology, neuromuscular or rheumatological diseases, patients with travel problems, and patients with severe comorbidity (e.g., heart failure, neoplasia with poor prognosis, etc. ...).

Study Design

Retrospective study to analyse the CP effect: a group of patients (group I) underwent the application of conventional ventilatory techniques. Subsequently, a subgroup of patients (group II) underwent the application of the same ventilatory techniques assisted by incentive spirometry (ICI).

Method

After the diagnosis of PE, and once the correct medical treatment had been initiated, assessment and treatment (general condition of the patient, symptoms,

respiratory auscultation and guided ventilatory techniques) were carried out by the respiratory physiotherapist during admission. The Treatment during the CP admission included 20 minutes sessions consisting of: 1) Secretion drainage techniques: on patients with clinical wet cough and expectoration techniques of guided expectoration and autogenous drainage were performed; 2) Postural changes: every hour to avoid liquid collection in areas of decline. The patient is placed in lateral position, on the side opposite to where the pleural effusion is situated (either in anterior or in posterior trunk rotation), in upright supine position, always monitoring the proper position of the spine and shoulder girdles; 3) Global passive mobilisations of the thorax, stretching of the cervical spine and shoulder girdle. Analytical muscle stretching of the latissimus dorsi of the affected side. Prior to hospital discharge a simple spirometry was performed with a JAEGER equipment (Viasys; Höchberg, Germany) assessing the FEV1, FVC, FEV1 / FVC in absolute value and percentage of the reference value of SEPAR (13), and a plain radiograph of the posterolateral chest - anterior and lateral.

During hospitalisation patients performed 20-minute sessions daily, with the recommendation to do the exercises at all times (observing meals and sleeping times).

A week after hospital discharge they attended outpatient consultations on pulmonology to continue the CP treatment on an outpatient basis. The treatment included: 1) Secretion drainage techniques: 2) Techniques of thoracoabdominal expansion: we carried out symmetric and asymmetric expansions (of the affected side) of the thorax in inspiratory time, performing an inspiratory apnea. Mobilisation of the diaphragmatic half-dome affected in inspiratory position of the hemidiaphragm affected (quadruped, sitting, contralateral or up-right supine position), performing abdominal-diaphragmatic breathing (Fig. 1). Mobilisation of the affected diaphragmatic half-dome against manual resistance: initial position of the diaphragm in expiratory position (supine position, ipsilateral lateral position) performing abdominal-diaphragmatic breathing. Lower costal expansion: localised expansion of the affected hemithorax in inspiratory time with apnea at the end of inspiration. Also associated with an inclination of trunk (concave to the same affected side). It is carried out in supine and contralateral positions (more in anterior rotation of the trunk - more in posterior rotation of the trunk (Fig. 2). Specific exercises to treat pleural adhesions: the patient performs full inspiration, closes the glottis: a located costal inspiration or a costal exhalation can be performed combined with a swelling of the abdomen and keeping the glottis always closed. Re-education of the spine and shoulder girdles: in a standing position, in position lateral to the wall bars, nearest to the unaffected side, perform an inclination of the trunk and raise the hand of the the affected side until reaching the wall bars. Additionally, in group II an AirLife® CareFusion (Yorba Linda, CA 92887 USA) volumetric incentive spirometer was used: device for a single use. The patient learned how to use the device with the physiotherapist. The air flow is indicated by a small ball. A piston going up during inspiration indicates the inspired volume. Series of 5 to 10 inspirations of large volumes were carried out keeping the small ball in the middle of the drawing. In order to avoid fatiguing the patient it is important to perform a slow and prolonged exhalation and then place the mouthpiece for the requested inspiration. The therapist monitors and evaluates the working capacity of the patient and his progression. Asymmetrical chest expansions of the affected base were performed with the patient in a sitting position. Then asymmetrical thoracic expansions in contralateral lower costal position (Fig. 3).

Outpatients performed 30-minute personalised sessions with their physiotherapist 3 days per week during the first month. Furthermore, the patients were recommended to perform five types of exercises at home,

Figure 1

Symmetrical diaphragm expansion during inhalation. Patient in half-lying position

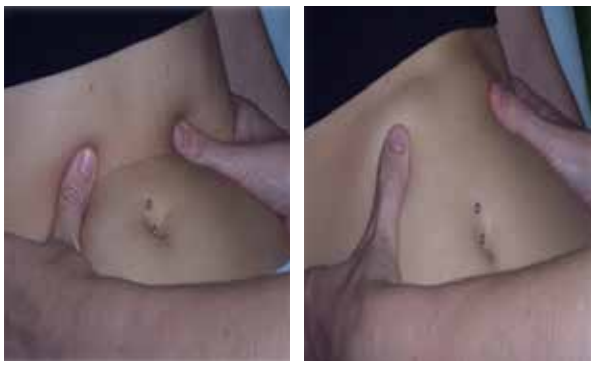


Figure 2

Inferior costal expansion of the affected side in the contralateral decubitus position, in posterior rotation.

Figure 3

Inferior costal expansion in the contra lateral decubitus position with raised arm and incentive spirometer.

10 inspirations per exercise/4 times a day, every day. Patients were advised to avoid rest and take a regular physical activity (e.g. walking). In the second month of treatment, 2 sessions of 30 minutes per week with the physiotherapist, following the same indications at home and starting from the third month one session per week until resolving the adhesions. They were advised to start a sport: swimming, cycling. The total duration of the program was 2-6 months.

The patient visited a neurologist at the end of the CP programme, the spirometry was repeated and the radiological evolution was analysed. The presence of neurological sequelae was interpreted by a combination of signs such as loss of volume, costodiaphragmatic impingement, and elevation of the affected hemidiaphragm. Four types of possible radiological changes were considered; a) worsening, b) unchanged, c) partial improvement, d) full resolution, compared to the initial radiological control.

Statistical analysis

Initially, a descriptive analysis of the collected variables was performed by calculating the average (x) and standard deviation (ST) for quantitative variables. The categorical variables were expressed in number and percentage of cases. The comparative analysis of the values of pulmonary function before and after the CR programme was carried out with the t-Student test for paired data. The chi-square test was used to analyse the radiological changes. vThe variables under study have been analysed with the statistical programme Statistical Package for Social Sciences, SPSS Inc. version 10.0 (Chicago, Illinois, USA)

A $P < 0.05$ was considered significant.

RESULTS

A total of 33 patients were included, 28 men and 5 women with an average age of 47 ± 17 years and a BMI of 25.9 kg / m2. At the time of study entry patients had a slight non-obstructive ventilatory impairment with an average FVC of 64 ± 10%, ± 66 FEV1 of 13%. No patient was excluded. All the patients were discharged from hospital with an altered chest radiograph. The pleural fluid was purulent in 14 patients (42%), showed characteristics of exudate in 12 (36%) and was macroscopically hematic in 5 (15%). In the case of 2 patients it was possible to extract pleural fluid despite making several thoracentesis. The protein level in the pleural fluid was 5 ± 0.8 g / dl and ± 5251 3176 LDH U / l. Seventeen patients (52%) were diagnosed with parapneumonic pleurisy, 9 (27%) of tuberculous pleurisy and in the remaining 7 (21%) the PE was the result of chest trauma. The most affected hemithorax was the left one (19 patients). Thirteen patients (39%) required pleural drainage. Additionally, 9 out of these patients underwent intrapleural fibrinolysis with streptokinase.

An average of 21 CP sessions (6-60) were performed and the programme lasted between 2 and 24 weeks. 12 patients (36%) required secretion drainage techniques.

When assessing pulmonary function after the chest physiotherapy programme we observed an average increase in FVC of 749 ± 442 ml (Table 1). All patients showed radiological improvement: in 18 cases (54.5%) a complete and in 15 cases (45.5%) a partial resolution, minimal pleural sequelae (Fig. 4 and Fig. 5) persisted. No patient required surgical decortication.

Figure 4

Percentual distribution of patients with radiological improvement.

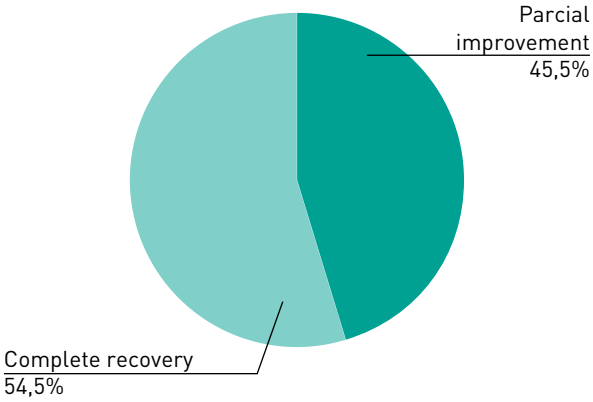


Table 1

Values of respiratory function parameters at the beginning and at the end of the respiratory physiotherapy programme.

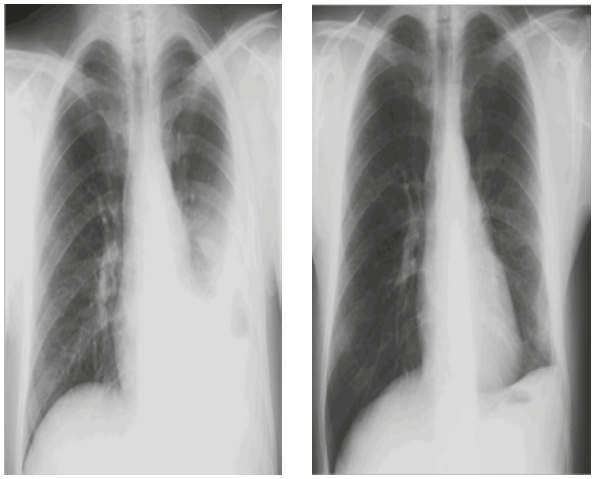
	Beginning	End
FVC (ml)	2987,5 ± 745,8	3717,22 ± 888,2
FVC (% val. ref)	64 ± 10,5	79,5 ± 9,6
FEV_1 (ml)	2310,8 ± 768,7	2879,6 ± 798,46
FEV_1 (% val. ref)	66 ± 12,79	80,3 ± 13,3

A comparative analysis of pulmonary function values was done using a paired t-test before and after the respiratory physiotherapy programme.
FVC: forced vital capacity.
FEV_1: forced expiratory volume in the first second.

In the 16 patients in whom an ICI (group II) was used we did not observe any statistically significant differences in the final lung function values compared to the patient group that received only CP (group I) (Table 2). The use of an ICI did not improve neurological sequelae after the treatment either. 41% of the patients who used an ICI had complete resolution on the chest radiograph compared to 59% of group I; the partial radiological improvement amounted to 47% and 53% respectively (p 0.517) (Fig. 6). Regarding the duration and session number of the chest physiotherapy programme there were no significant changes between the two groups. Group I had an average of 20.74 ± 14 sessions, with an average of 10 ± 6.62 weeks. Group II had an average of 21.36 ± 13.26 sessions in 11.4 ± 5.18 weeks.

Figure 5

Example of minimal pleural sequelae in the same patient at the beginning and at the end of the respiratory physiotherapy programme.



DISCUSSION

This study demonstrates the benefit of an early initiated CP programme and guided in the management of patients with pleural effusion in terms of lung function and radiographic control. In that way, incentive spirometry does not provide a significant benefit in resolving the sequelae within the physiotherapy treatment. CP has a fundamental role in the treatment for pleural disease in the fight against residual fibrothorax (14). It helps to reabsorb PE and prevents fibrous adhesions, and even its early and intensive use directed to the affected area can reverse an established fibrothorax (15). In our experience infectious hemothoraces and DP often have residual fibrothoraces caused by radiological abnormalities and restrictive ventilatory disorders. Just as shown in this study, in our group of patients, respiratory function tests measurements could be normalised even in the most severe cases, which had previously been considered tributaries to pleural decortication (16). The use of CP has been extensively studied in chronic obstructive pulmonary disease (COPD). Its benefits have been validated for inclusion in guides of clinical management of COPD (17). The result of this study is an important advance in the management of these patients because it shows that there is a conservative treatment to avoid the need for more aggressive treatments such as surgery or even the use of fibrinolytic drugs (18-19).

Incentive spirometry is described in the specialised literature as a therapy to facilitate secretion drainage and prevent post-operative atelectasis in patients. Overend *et al* (20) have demonstrated the use of this technique in post-operative monitoring of upper abdominal surgery patients, There is no sufficient evidence to reduce the incidence of pulmonary complications. According to Agostini *et al* (21), incentive spirometry does not contribute to CP alone in post-operative thoracic surgery patients. Pasquina *et al* (22), in a systematic review, state that the role of CP prevents pulmonary complications after cardiac surgery and the use of ICI does not provide any benefit and relates to a higher cost in additional time and money for the physiotherapist. Despite the hypothetical benefits of ICI in the treatment of restrictive disorders in our study and management of pleural sequelae of the PE, an ICI does not provide any significant benefit to CP so we believe that one should not generalise its use and limit its indication solely to individual cases. Given the high prevalence of pleural disease and its implications both clinical and regarding the consumption of increasingly limited financial and health resources, and appreciating the fact that none of our patients requires surgical decortication we believe that CP should be included in the regulatory treatment of pleural disease (2).

We are aware that the main limitation of the study is the absence of a control group, there is currently a study (9) but with a very heterogeneous sample. To overcome this

Table 2

Values of respiratory function parameters at the beginning and at the end of the respiratory physiotherapy programme comparing the two subgroups.

	Group II (n=14)		Group I (n=19)		
	Beginning	End	Beginning	End	*p*
FVC (ml)	2784,6	3660,7	3126,3	3755,84	NS
FVC (% val. ref)	61,4	78	65,8	80,4	NS
FEV_1 (ml)	1948,9	2648,4	2558,4	3046,6	NS
FEV_1 (% val. ref)	60,3	76,1	69,9	83,2	NS

A comparative analysis of pulmonary function values was done using a paired t-test before and after the respiratory physiotherapy programme.

Group I: group of patients using techniques for thoracic-abdominal expansion.
Group II: group of patients using an incentive spirometer.
FVC: forced vital capacity.
FEV_1: forced expiratory volume in the first second.
NS: non-significant.

limitation we can only think of a possible comparison with historical data or with data from the specialised literature regarding the persistence of consequences which have led to surgical treatment (18).

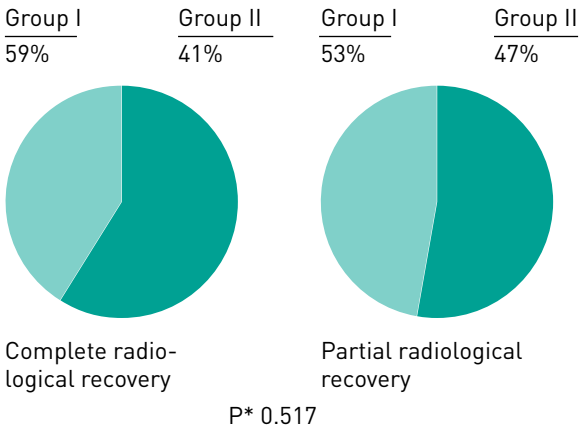
Other imaging techniques such as ultrasounds or computed chest tomographies, are routinely used in the management of pleural disease and are useful in the evolutionary monitoring of a given patient. However, a simple posteroanterior and profile chest radiograph is a completely standardised technique and of universal use in the clinical practice this study is based on, moreover it has little interobserving variability and minimises the costs of other imaging techniques.

Finally, the values of simple spirometry may be of a dimension in which statistical significance is not parallel to clinical significance but complying with the improvements obtained, we do not consider the case in our study (Table 1).

To conclude: patients with infectious PE or hemothorax included in an early intensive CP programme show a significant improvement in respiratory function and radiographic changes regarding radiological and functional impairment that persisted at the time of hospital discharge. Moreover, an ICI does not provide a significant benefit as a supportive treatment for respiratory physiotherapy in the management of pleural effusion.

Figure 6

Percentual distribution of patients with radiological improvement in both groups.



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Col·legi de Fisioterapeutes de Catalunya

PHYSIOTHERAPY UPDATES

TRANSLATED ARTICLES

ASSESSMENT OF THE EFFECTS OF MANUAL THERAPY ON SOFT TISSUE IN WOMEN WITH LOW BACK PAIN AFTER OBSTETRIC EPIDURAL ANAESTHESIA: A RANDOMISED COMPARATIVE STUDY.

Richard Abi Zeid Daou, Nisrine Abdelnour Lattouf
Institute of Physiotherapy (IPHY), Faculty of Medicine, Saint Joseph University, Rue de Damas, BP 17-5208 Mar Mikhaël, 1104-2020 Beirut, Lebanon.
Received on 3rd January 2011; revised on 31st July 2011; accepted on 29th November 2011
Corresponding author: Nisrine Abdelnour Lattouf. Institut de Physiothérapie (IPHY), Faculté de Médicine, Université Saint-Joseph, rue de Damas, BP 17-5208 Mar Mikhaël, 1104-2020 Beyrouth, Lebanon. E-mail: nisrine.lattouf@usj.edu.lb

This article has been translated from the Catalan translation of the original article in French. Original article *"Évaluation des effets de thérapie manuelle des tissus mous chez des femmes, présentant des douleurs lombaires suite à une anesthésie péridurale obstétricale: étude contrôlée randomisée"* Kinesither Rev 2012;12:52-59.

ABSTRACT

Introduction. Low back pain is common in women who have undergone epidural anesthesia during childbirth. It is instant, limited functionality of the lumbar spine and reduced amplitudes. The treatment is medical, physical agents or manual.

Methods. Twenty primiparas with low back pain, who had an average age of 31.5 ± 3.35 years, who had given vaginal birth delivery and had epidural anesthesia, participated in our experiments over a period of 4 weeks. A group of 10 women has receaved treatment under the terms of manual treatment (1 s/s) while the second group received physical agents treatment (2 m/s).

Results. Both groups had comparable improvement of their variables (except for the Slump test). An advantage in favor of manual treatment was noted with obtaining the same effect in 4 weeks by treatment of four sessions instead of eight.

Conclusion. We found a difference due to the use of both treatments. The observed results encourage us to continue to better understand the associated phenomena with neurophysiology.

Level of evidence. - III.

KEYWORDS: Epidural anesthesia in obstetrics. Fasciatherapy. Back pain. Physiotherapy.

INTRODUCTION

Through their pregnancy and postpartum period, women go through different anatomico-physiological adaptations. Low back pain, one of the problems that can affect them, begins in the last few months of pregnancy and disappears within the first weeks after childbirth. It results in an overload of the lumbar spine followed by weakness of the abdominal and dorsal muscles involved in trunk balance and in releasing tension on intervertebral articulations (1).

Several autors claim that postpartum lumbar pain is frequent (2) and can be caused by different factors, like weight gain during pregnancy (3, 4), the number of previous births (4, 5), the weight of the foetus, pregnancy at an advanced age (3, 6), low back pain before or during pregnancy (5), and epidural analgesia (7), and some authors even mention postural origin, increased motor block during labour after the administration of drugs, or contact with the periosteum. Breen *et al.*, Mac Arthur *et al.* (3, 8) claim that epidural analgesia may be a factor in the increase in back pain rates. This pain may be due to an inflammatory response of the dura mater after inserting a catheter or a syringe in the epidural space. It can lead to reduced activity of the new mother, painful limitation of articular motion of the lumbar spine and altered function.

In fact, epidural anaesthesia is indicated for those women at risk of having a difficult birth. It is a method that has proven to be effective in relieving labour pain (9). 60% of women in the United States, 48% in France, and 24% in Great Britain have epidural anaesthesia in labour (10), but its use might be the cause of several side effects that can affect both the mother and the baby. Howell *et al.* (11) have established a cause-effect relation between this technique and the aggravation of postpartum low back pain.

Some studies have examined the link between low back pain and obstetric epidural anaesthesia. Some retrospective studies (1, 11-13) have shown that the link between the use of this anaesthesia and low back pain could be caused by intramuscular haematomas or by specific nociceptors in the periosteum, which could be activated by small haematomas caused by the insertion of the epidural needle (2). These observations could explain why the pain comes after labour. Although these prospective studies (1, 8, 14, 15) have not found any increase in the risk of acute low back pain after using epidural anaesthesia.

In order to relieve this pain, which can affect her everyday life, the new mother should have a physiotherapy or manual therapy treatment that is known by its analgesic effects. This type of treatments have the advantage of being harmless during breastfeeding. In fact, the chemical substances found in medicines can be transmitted to the baby through breastfeeding, which can damage the baby's health. The assessment of risk for the baby must also include those risks related to its exposure, to chemical substances, and the advantages of breastfeeding, adding interest to the use of physiotherapy or manual treatments. Managing this risk must reduce voluntary exposure to chemical substances to a minimum (16).

Taking into account the frequency of use of epidural analgesia in births and the increase in the number of cases of postpartum low back pain, we wanted to assess the impact of two different types of treatment, physiotherapy and manual therapy, in a prospective study in order to obtain a better adaptation to the treatment for postpartum low back pain.

Table 1

Characteristics, mean and standard deviation of the women in the study.

	Physiotherapy group		Manual therapy group	
	Mean	Stand. dev.	Mean	Stand. dev.
Age (years)	30,90	2,378	32,10	4,149
Weight of baby (gr)	3345,00	423,904	3185,00	589,279
Number of children	1,30	0,483	1,70	0,675
Number of previous uses of epidural analgesia	1,30	0,483	1,30	0,483
Weight gain within this period (kg)	15,20	2,251	15,50	4,403
Date of appearance of low back pain (month)	4,10	1,370	5,50	2,953

Physiotherapy, as well as manual therapy, are some of the preferred treatments for this type of pathologies. They can act on our variables (spontaneous pain, painless articular range of motion, function). Physiotherapy can relieve the pain, relax muscles and, consequently, improve function. Manual therapy acts mainly on the fascial system.

POPULATION AND METHOD

Population

The participants in our study were twenty women who had had epidural anaesthesia and had low back pain (40) days after childbirth. The sample was randomly divided into two groups: an experimental group (treated with manual therapy) and a comparative group (treated with physiotherapy). The average specific characteristics of the two groups are presented in Table 1. The data show that both populations were comparable in the different parametres.

The participants in the study were women whose age ranged between 25 and 40 years, who had had obstetric epidural anaesthesia during labour and who had low back pain 40 days after childbirth, which could be accompanied by headaches, without any complication during their pregnancy.

We have excluded mothers of twin babies, with surgical antecendents and/or lumbar spine trauma, who had had low back pain for more than a month before or after pregnancy, who had had neurological signs of lumbar origin (paresthesia, muscle weakness, positive Lasègue's and/or Léri's signs).

Assessment protocol

All the participants were assessed on three occasions throughout the study: before the sessions started, after two weeks of treatment, and at the end of the sessions. The assessed variables were:

- pain,
- functional state and
- range of motion of the lumbar spine

The assessment of pain was done using a Visual Analogue Scale (VAS) and the Short Form Mc Gill pain questionnaire (17). Functional state was assesssed with the Oswerty low back pain disability questionnaire (18) and the Slump test in seven stages (19-21). The range of motion of the lumbar spine, in flexion, was measured with the Schöber's test (22).

The indicators for the different scales are the following:

- VAS (from 1 to 10): pain reduction corresponds to a lower number on the scale;
- Short Form Mc Gill pain questionnaire: graded on a 0 to 45 scale. Mild pain is represented by numbers between 0 and 15; moderate pain, between 15 and 30, and severe pain, between 30 and 45. The milder the pain, the lower the number.
- Oswerty low back pain disability questionnaire: funcional improvement results in a lower score.
- Schöber's test: lumbar flexion increases the measured distance between L1 and S1, which is normally 5 cm. An increase in the measure in flexion implies a bigger range of motion, whereas a decrease or invariance in the measure indicates restriction of movement in the lumbar region.
- Slump test: the different stages of this test go from 0 to 7. Patients do better in this test when they get higher scores, which reflect an improvement in the degrees of stretching of the neuromeningeal system.

Experimental treatment protocol

The experimental group received four sessions of manual therapy once a week for four weeks with the aim of selfregulating the body systems. Fasciatherapy techniques (23) excite the fascia of the sternocleidooccipitomastoid, then the visceral space in the neck, then the first diaphragm (cervical region) (Fig. 1), the second diaphragm (at the level of the solar plexus) (Fig. 2) and the third diaphragm (at the level of the pelvis) (Fig. 3), and finally the fascia at the level of the dura mater. At the end of each session, we administer the neuromeningeal treatment using the concept of the Slump test in the mobilization of the nervous system.

Comparative treatment protocol

The control group had eight physiotherapy sessions (two sessions a week for four weeks), which started with the application of thermotherapy (24) at the level of the lumbar spine for five minutes, followed by a massage (25) on this area for twelve minutes. After that, TENS currents for pain relief were delivered to this area

Figure 1

Fascia of the first diaphragm.

Figure 2

Fascia of the second diaphragm.

Figure 3

Fascia of the third diaphragm.

(frequency: 4 Hz; impulse duration: 1-3 ms; duration: 20 minutes) and the treatment was finished with continuous ultrasounds (23) at the level of the low back and upper buttocks (frequency: 1 MHz; intensity: 1.2 W/cm^2; duration: 7 minutes).

Statistical tests

The student's t-test was done once we had verified the equality of variances with the Levene's test and distribution normality with the Kolmogorov-Smirnov test in order to examine the evolution of the VAS mean score, the mean score for the Short Form Mc Gill pain questionnaire, the mean percentage for the Oswerty low back pain disability questionnaire, the mean amount of stage according to the Slump test through time, and the evolution of mobility of the lumbar spine in flexion through time based on the physiotherapy and manual therapy sessions. The significance threshold used was $p \leq 0.05$.

RESULTS

Pain

Based on the Visual Analogue Scale

In the experimental group (manual therapy), pain went from 5.4 ± 1.6 in the pre-test to 4.7 ± 1.7 in the inter-test and 3.9 ± 1.8 in the post-test (Fig. 4).

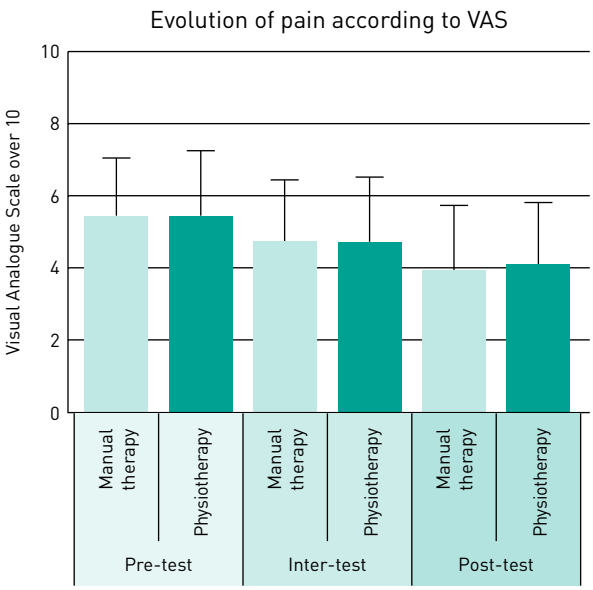
The mean decrease was 1.48 ± 0.59 and was statistically significant between the pre-test and the post-test ($p < 0.0001$). In the comparative group (physiotherapy), pain went from 5.4 ± 1.8 in the pre-test to 4.7 ± 1.8 in the inter-test and 4.1 ± 1.7 in the post-test. The mean decrease was 1.25 ± 0.55 and was statistically significant between the pre-test and the post-test ($p < 0.0001$). The mean decrease in pain in the two types of treatment was comparable ($p = 0.83$).

The Short Form Mc Gill pain questionnaire

In the experimental group (manual therapy), pain went from 19.7 ± 6.6 in the pre-test to 17.6 ± 6.9 in the inter-test and 13.7 ± 5.6 in the post-test (Fig. 5). The mean decrease was 6 ± 2.17 and was statistically significant between the pre-test and the post-test ($p < 0.001$). In the comparative group (physiotherapy), pain went from 21 ± 8 in the pre-test to 17.2 ± 7.2 in the inter-test and to 14.2 ± 6.5 in the post-test. The mean decrease was 6.8 ± 3.56 and was statistically significant between the pre-test and the post-test ($p < 0,001$). The mean decrease in pain in the two types of treatment was comparable ($p = 0.85$).

Figure 4

Mean pain assessment, at the three stages of the study, in the two groups according to the Visual Analogue Scale.



Functional state

The Oswerty low back pain disability questionnaire

In the experimental group (manual therapy), functional disability went from 36.2 ± 9 in the pre-test to 30.4 ± 8.9 in the inter-test and to 23.8 ± 7.9 in the post-test (Fig. 6). The mean decrease was 12.37 ± 4.83 and was statistically significant between the pre-test and the post-test ($p < 0.0001$). In the comparative group (physiotherapy), functional disability went from 33.3 ± 10.2 in the pre-test to 27.5 ± 9.4 in the inter-test and to 22.8 ± 9.7 in the post-test. The mean decrease was 10.49 ± 4.8 and was statistically significant between the pre-test and the post-test ($p < 0.0001$).

The Slump test in seven stages

In the experimental group (manual therapy), the evaluation of the Slump test went from 5.9 ± 0.8 in the pre-test to 6.2 ± 0.9 in the inter-test and to 6.6 ± 0.5 in the post-test (Fig. 7). The mean increase between the pre-test and the inter-test was statistically significant ($p = 0.037$), the same as between the inter-test and the post-test ($p = 0.025$). The mean increase was 0.7 ± 0.48 between the pre-test and the post-test and was statistically significant ($p = 0.0001$).

In the comparative group (physiotherapy), the evaluation of the Slump test went from 6 ± 0.7 in the pre-test to 6 ± 0.7 in the inter-test and to 6.1 ± 0.7 in the post-test. The mean increase between the pre-test and the inter-test was not significant ($p = 1.000$), the same as between

Figure 6

Mean functional state assessment, at the three stages of the study, in the two groups according to the Oswerty low back pain questionnaire.

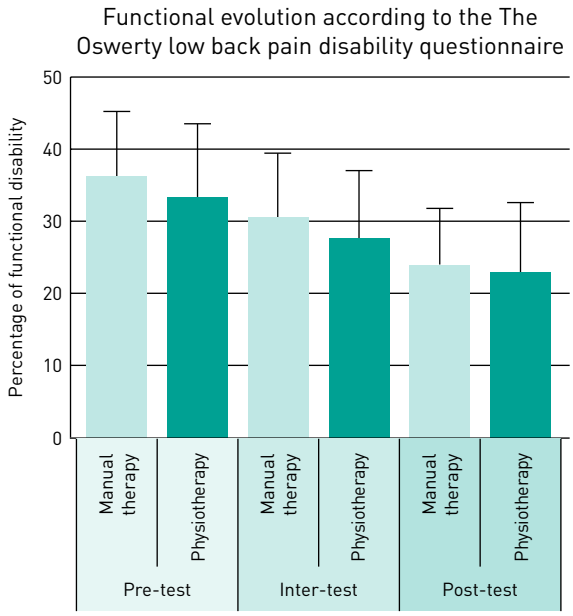


Figure 5

Mean pain assessment, at the three stages of the study, in the two groups according to the Mc Gill pain questionnaire..

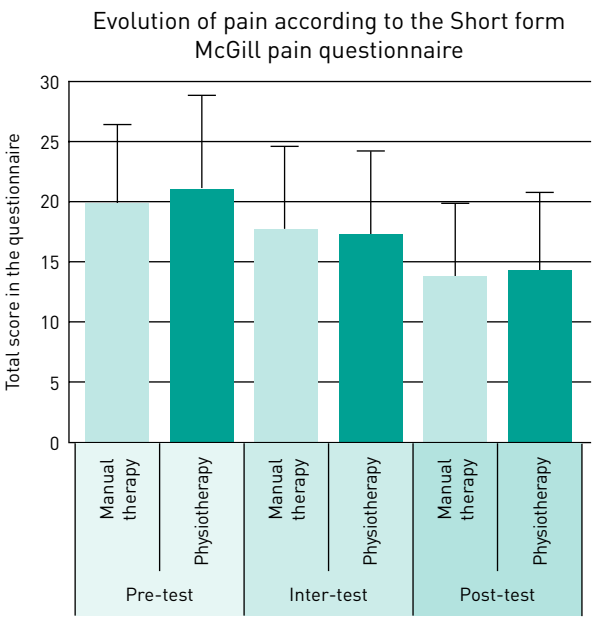
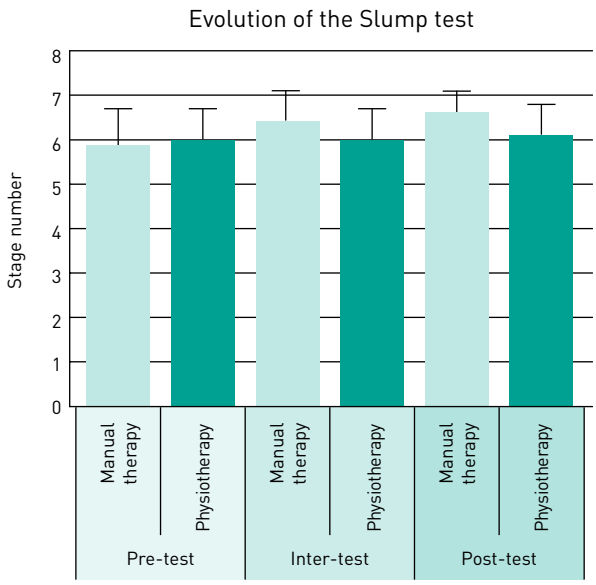


Figure 7

Mean assessment, at the three stages of the study, of the state of the neuromeningeal system in the two groups according to the Slump test.



the inter-test and the post-test (p = 1.000). The mean increase between the pre-test and the post-test was 0.1 ± 0.32 and was not significant (p = 1.000).

Range of motion of the lumbar spine

The Schöber's test

In the experimental group (manual therapy), flexion went from 3.3 ± 0.6 cm in the pre-test to 3.3 ± 0.6 cm in the inter-test and to 3.6 ± 0.5 cm in the post-test (Fig. 8). The mean increase was 0.3 ± 0.35 cm and was statistically significant between the pre-test and the post-test (p = 0.018). In the comparative group (physiotherapy), articular range of motion went from 3.2 ± 0.7 cm in the pre-test to 3.3 ± 0.5 cm in the inter-test and to 3.7 ± 0.5 cm in the post-test. The mean increase was 0.55 ± 0.28 cm and was statistically significant between the pre-test and the post-test (p < 0.0001). The mean increase in the flexion of the lumbar spine in the two groups was comparable (p = 0.05).

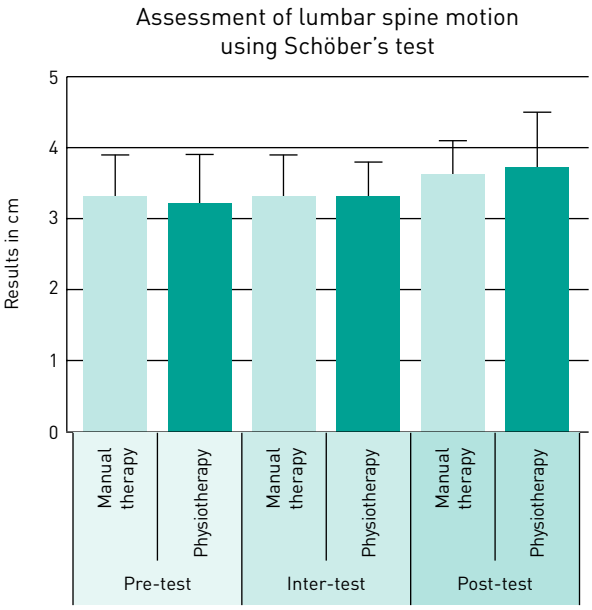
DISCUSSION

Low back pain is quite frequent and may be caused by different factors: spinal disc ailments, problems affecting the articular facets or the sacroiliac joints, spinal and pelvic fractures, lesions of the interspinous ligament and irritation of soft tissues (28). This pain can affect articular function and motion.

Pregnant women have pain in the lumbosacral region due to postural changes and the shift of the centre of gravity, which also affects the musculoskeletal system. Bone, ligament and myofascial dysfunctions, as well as pain in the lumbosacral region, are in the origin of all spinal pains (29).

Figure 8

Assessment, in the three stages of the test, of range of motion in the patients in both groups using Schöber's test.



However, regarding the participants in our study that had low back pain after receiving obstetric epidural anaesthesia, we must take into account the different theories about catheter insertion (3, 8), intramuscular haematomas or specific nociceptors in the periosteum (2) and, not to forget, the type of anaesthesia the mother had. Normally the treatment of these pains may have different surgical, pharmacological and non-pharmacological options. In our study, we have included physiotherapy and manual therapy, both non-pharmacological types of treatment.

Actually physiotherapy is recommended for those patients with musculoskeletal problems, including back pain, but the variety of applied techniques and parametres have not allowed us to elaborate a well-defined re-education protocol (30).

In our study we have applied a protocol that includes four different techniques: thermotherapy, massage, electrotherapy, and ultrasounds.

Regarding thermotherapy, it has a physiological action:

- relaxing tight muscles and reducing the pain message;
- dilating the blood vessels, which offers enhanced oxygenation to the affected tissues;
- reducing the influence of the pain message in the brain.

In fact, heat receptors block pain receptors and help the muscle fascias to change.

Applying a thirty-minute massage twice a week can help relieve pain and the symptoms of back pain. Therefore, this therapy has proven to be effective to treat and relieve low back pain (31). About TENS, there are different studies on the role of electrotherapy in the treatment of patients with chronic back pain; some studies claim it has benefits but others can't demonstrate the importance of this technique. More specifically, these studies have emphasised its effect on pain relief when applied for some time (1 hour per session). The use of TENS and pain relief can be explained because the pain originates in the specific receptors all over our skin, muscles, and viscera. These receptors transmit information to the brain through the peripheral nerves and spinal cord. Once in the brain, this information is analysed at a conscious level and is turned into an unpleasant sensation (32).

The fourth treatment option are continuous ultrasounds. In spite of all the available studies, there is little evidence of their relevance for the treatment of these patients (33).

Regarding manual treaments, the fact that there is no literature does not allow us to present any differences between the treatment we administered and other protocols.

The different evaluations of the two treatment options in terms of pain, functional disability, and articular motion have not shown any significant difference although there has been an improvement of the patients' symptoms in both groups.

Our first observation is that the duration of the treatment benefits the experimental group since the patients had to go to the health centre four times, which has a more limited impact on their social and working life.

Another observation is that the level of pain in the participants was reduced as a consequence of the treatment or the passing of time. At this point we cannot ignore a flaw in our study: the absence of a third control group.

CONCLUSION

The aim of this study was to examine the impact of two types of therapies that are used in the treatment of women aged between 25 and 40 years who had received obstetric epidural anaesthesia and had chronic low back pain.

The results demonstrated, four weeks after the beginning of the treatment, a significant progress in terms of pain and function in the two groups treated with manual therapy and physiotherapy. We also observed some improvement in the mobility of the neuromeningeal system in the group that was treated only with the second manual therapy.

According to international recommendations on postpartum care, treatment must end with global postpartum re-education including three main areas:

- perineum and sphincters,
- pelvis and spine,
- deep abdominal muscles.

Therefore, the 20 women who took part in this study improved, we must not forget though that the participants in the manual therapy group received four hours of treatment in comparision to the eight hours of treatment of the control group, which means a considerable saving of time.

It would be interesting to have further research that could include a treatment combining manual therapy and physiotherapy.

Declaration of interests

The authors declare that they have no conflict of interest regarding this article.

APPENDIX 1. APPLIED TESTS

1. Short Form McGill pain questionnaire

   It is a questionnaire based on the description of pain given by the participants.

   It consists of 15 descriptors of pain and it is an abbreviated form of the McGill questionnaire developed by Melzack.

2. Oswerty low back pain disability questionnaire

   It is a questionnaire divided into 10 sections relating to pain and its impact on the participant's life. Each section consists of six situations. The participant has to choose the option that best applies to her.

   This questionnaire is a measuring tool in which the highest score reflects the patient's disability.

3. Slump test

   The Slump test assesses the entire neural system, which means it requires monitoring its implementation and interpretation. The Slump test is useful when dealing with problems in the spinal cord, lower limbs and some problems of the upper limbs.

   The Slump test is performed in seven stages in which some active and passive movements are applied.

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Col·legi de Fisioterapeutes de Catalunya

PHYSIOTHERAPY UPDATES

TRANSLATED ARTICLES

MANUAL AIRWAY CLEARANCE TECHNIQUES IN ADULTS AND ADOLESCENTS: WHAT LEVEL OF EVIDENCE?

Michel Cabillic[1,2], Pascal Gouilly[3], Gregory Reychler[4]
[1]FMK de Rennes (IFPEK), 12, rue Jean-Louis-Bertrand, 35000 Rennes, France
[2]FMK de Nantes (IFM3R), 54, rue de la Baugerie, 44230 Saint-Sébastien-sur-Loire, France
[3]FMK de Nancy, 54000 Nancy, França, [4]UCL Saint-Luc, Brussels, Belgium
Corresponding author: M. Cabillic, L'épine, 44220 Coueron, France. E-mail: michel.cabillic@wanadoo.fr

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"Techniques manuelles de drainage bronchique des adultes et adolescents: quel niveau de preuve?"
Kinesither Rev 2014;14(155):43-64 » http://www.sciencedirect.com/science/article/pii/S1779012314003003
http://dx.doi.org/10.1016/j.kine.2014.09.009

ABSTRACT

Background. The aim of this systematic literature review was to grade the levels of evidence of the most widely used manual airway clearance techniques.

Methods. A literature search was conducted over the period 1995-2014 from the Medline, PEDro, ScienceDirect, Cochrane Library, REEDOC and kinedoc databases, with the following keywords: "postural drainage", "manual vibrations", "manual chest percussion", "directed cough", "maeesea expiratory flow", "ELTGOL, "autogenic drainage" and "active cycle of breathing technique".

Results. Two-hundred and fifty-six articles were identified. After removing duplicates and reading the titles and abstracts, 63 articles were selected, including 9 systematic reviews. This work highlights the lack of useful scientific data and the difficulty of determining levels of evidence for manual airway clearance techniques. Techniques were assessed principally with patients with sputum production (oystie fibrosis, DOS, COPD, etc.). It also shows the limited pertinence of outcome measures to quantify congestion and hence the efficacy of airway clearance techniques.

Conclusion. The 1994 consensus conference summary table classifying airway clearance techniques according to physical mechanism provides an interesting tool for assessment, grouping together techniques having identical mechanisms of action. From the findings of the present systematic review, if appears that only ELTGOL, autogenic drainage and ACBT present levels of evidence "B". All other techniques have lower levels of evidence.

Level of evidence. II.

KEYWORDS: Airway clearance. Physiotherapy manual. Pneumology.

INTRODUCTION

Bronchial congestion accompanies many lung pathologies and is defined as "an accumulation of secretions in the tracheobronchial tree as a consequence of an unbalance between the secretion state (volume and rheological properties of secretions) and the draining capacity of these secretions" (1). Combating bronchial congestion has long been one of the main aims of the treatment of these pathologies by healthcare providers (2). This combat lies, among others, on respiratory kinesiotherapy (or physiotherapy). The1st consensus conference on non-instrumental respiratory kinesiotherapy, held in Lyon in 1994 (3), concluded that "the effectiveness of kinesiotherapy in the treatment of bronchial decongestion has been recognised and accepted by all the members of the jury", without reporting any level of evidence.

The aim of this systematic literature review is to try to obtain the level of evidence of the most commonly used manual airway clearance techniques.

MATERIAL AND METHOD

Bibliographic research

The bibliographic research was done from 1995 to 2014 using the following databases: Medline, PEDro, ScienceDirect, Hooked on evidence (through the French Physiotherapy Society, SFP), Cochrane Library, REEDOC and kinedoc. The flow diagram of the techniques proposed in the consensus conference on non-instrumental bronchial drainage techniques that was held in Lyon in 1994 (3) (Fig. 1) has allowed us to get the following key words for this study: "postural drainage", "manual vibrations", "manual chest percussion", "directed cough", "forced expiratory technique", "increased expiratory flow", "autogenic drainage", "active cycle of breathing technique", "airway clearance techniques" and "slow and complete expiration in lateral posture with the glottis open".

The inclusion criteria were:

- type of studies: meta-analyses, synthesis reports, randomised or nor-randomised controlled trials, controlled studies
- articles in English and French;
- studies based on human beings.

The articles were read twice based on a reading table used to determine the level of evidence (Appendix 1). In case of disagreement, there was a discussion until a consensus was reached.

Levels of evidence

The levels of evidence developed by HAS (The French National Authority for Health) have been used (4) (Table 1).

RESULTS

A total of 256 articles have been found. After discarding duplicates and the reading of titles and abstracts, 63 articles have been included, 9 of which were systematic reviews (Fig. 2). The studies dealing with each technique are presented in nine tables (Tables II-X) with information about type of study, population, procedures applied, results, level of evidence, and PEDro score if available.

Table II presents the 14 studies on postural drainage. Table III presents the six studies on manual vibrations. Table IV presents the four studies on manual chest percussion. Table V presents the four studies on directed cough. Table VI presents the two studies on forced expiratory technique – FET. Table VII presents two studies on increased expiratory flow. Table VIII presents the six studies on slow expiration with the glottis open in lateral posture. Table IX presents the six studies on autogenic drainage. Finally, Table X presents the 17 studies on active cycle breathing technique – ACBT.

Figure 1

Manual bronchial drainage techniques and their physical mechanisms (3).

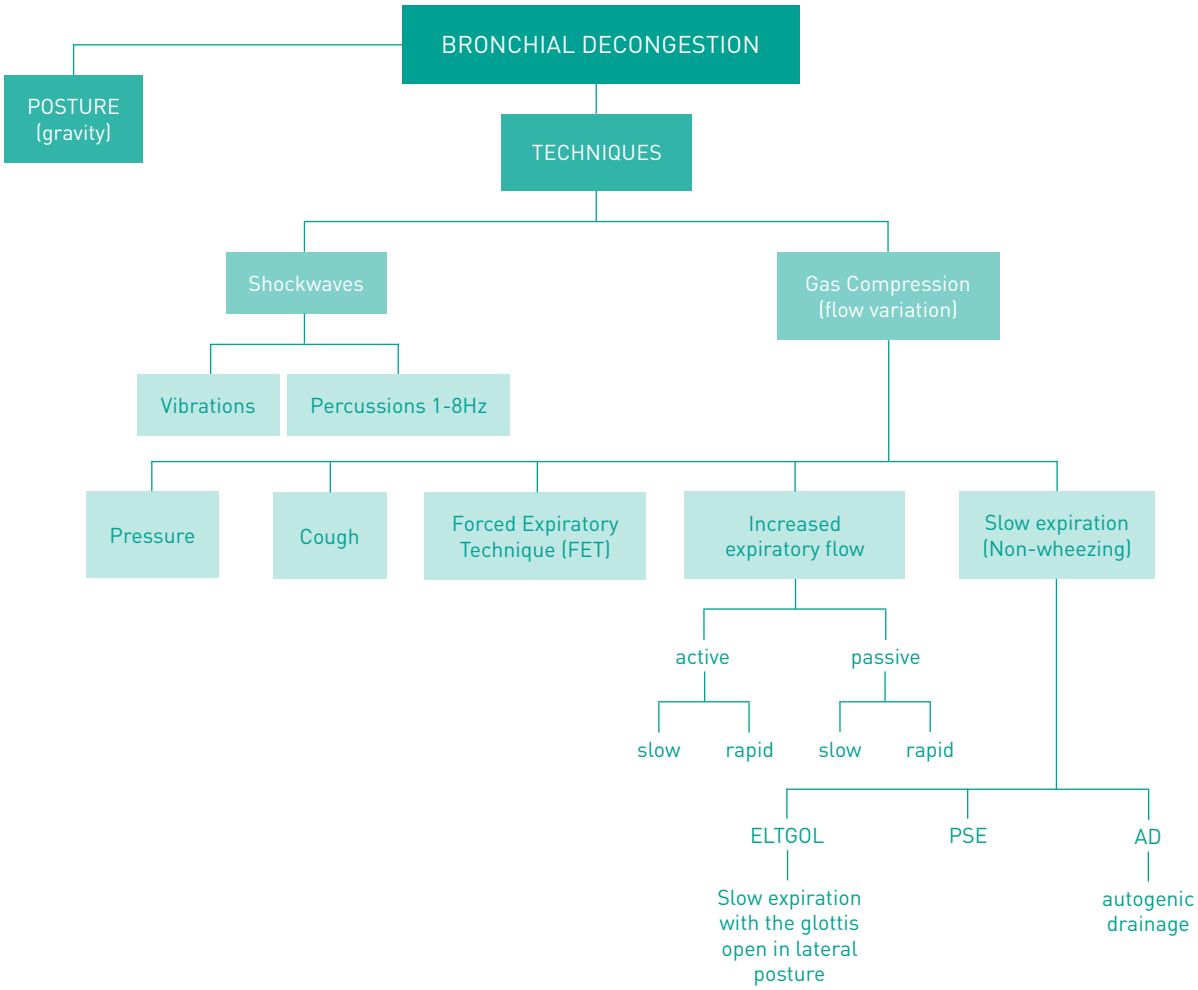

Table 1

Level of evidence according to HAS [4].

Level of scientific evidence in the literature	Grade of recommendations
Level 1 Large randomised comparative trials Meta-analyses of randomised comparative trials Decision analysis based on well-conducted studies	A Established scientific evidence
Level 2 Randomised comparative studies with low statistical power Well-conducted non-randomised comparative trials Cohort studies	B Scientific presumption
Level 3 Case and control studies	C Low level of scientific evidence
Level 4 Comparative studies with strong bias Retrospective studies Case series studies Descriptive epidemiological studies (transversal, longitudinal)	

Figure 2

Flow diagram of article selection.

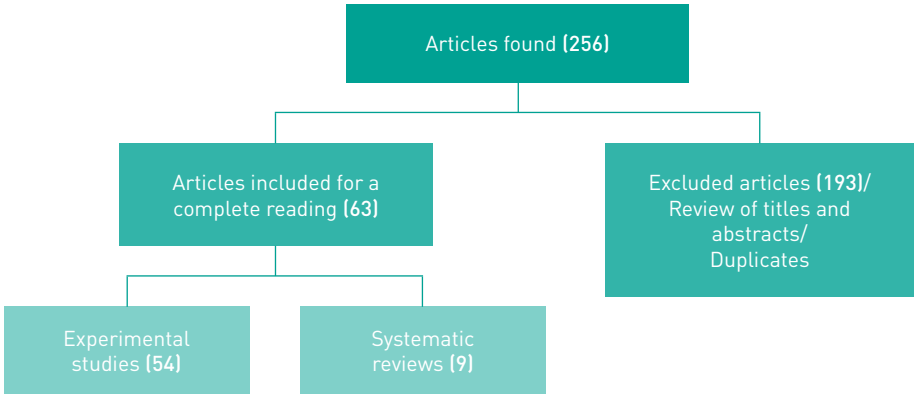

Table II

Studies on postural drainage.

Study	Type	Population (n)	Procedure and assessment criteria	Results	Level of evidence	PEDro score (/10)
Ambrosino et al. [5]	RCT	Adult patients with hypersecretion (> 25 mL/day) secretory respiratory diseases other than mucoviscidosis (28)	G1 (14): oscillatory PEP. G2 (14): postural drainage and percussion. Examination of expiratory flows, oxygen saturation, and secretion volume.	Expiratory flow and oxygen saturation are not modified. Similar secretion volume 60 minutes after the treatment. No adverse effects after the treatment.	2	5
Barnabé et al. [6]	Comparative prospective	Stable asthma (81)	CPT (PD, percussion, vibrations and FET). Group of patients (adults and children) and control group of adults (healthy participants). Session: 15 minutes. Measures: spirometry (FEV1, MEFV 25 75%, PEF) before and 5 minutes after CPT.	NS change of FEV1 or MEFV 25-75% after CPT in adults (mild, moderate, and severe asthma) and children (mild or moderate asthma). After CPT, there is no ↓ of FEV1> 20%. 32% of children and 4% of adults had a ↑ of symptoms after CPT, but none with a FEV1 ↓ of over 10%.	3	
Button et al. [7]	RCT	Mucoviscidosis (children) (20)	G1 (10): SPT; G2 (10): MPT. 12-month follow-up (8 patients in each group) for symptoms (cough, HRT) and treatment (use of physiological serum, position). 5-year follow-up (7 patients in each group). Measures: X-rays (diagnosis, 12 months, 2.5 years and 5 years). Assessed pulmonary function after 5 years (FVC, FEV1, MEFV 25-75%).	The patients with SPT had more days with symptoms affecting HRT / the MPT group (70 ± 32.8 versus 37 ± 24.9 days; $p = 0.04$) and took ATB for longer (23 ± 28.5 versus 14 ± 11.2 dies; $p = 0.05$). Lower FVC and FEV1 for 5-6 years for the SPT group compared to the MPT group ($p < 0.05$).	2	4
Clini et al. [8]	RCT	Tracheotomised adults (47)	G1 (24) : CPT (postural drainage, manual drainage) G2 (23): CPT and intrapulmonary percussive ventilation (IPV) Measures: PaO2, PaCO2 and pH.	Significatively more patients suffering from non-socomial pneumonia in G2. No significant difference between groups in terms of atelectasis, PaO2, PaCO2 or pH. Significant increase of the PaO2/FIO2 relationship and expiratory pressure in the IPV group.	3	

Table II

Studies on postural drainage (continued).

Study	Type	Population (n)	Procedure and assessment criteria	Results	Level of evidence	PEDro score (/10)
Davis et al. [9]	Randomised retrospective	ARDS, ventilated (19)	4 turning and secretion drainage regimens in randomised sequences of 6 hours each for 24 hours: (1) routine turning/2h from LLD to RLD; (2) idem + 15min of P + PD; (3) CLR with specialised bed from LLD to RLD + 2min break between each position; (4) idem + 15min of mechanical percussion. Measures: gases in blood, secretion volume, follow-up parameters.	↑ PaO_2/FiO_2 i ↓ de VD/VC during CLRT (NS). Significant ↑ of expectoration volume during CLRT. Including P and PD does not ↑ secretion volume. For 4 patients (expectoration > 4 mL/day), P + PD ↑ expectoration volume significatively.	2	5
Glies et al. [10]	Crossover randomised	Mucoviscidosis (10)	Each patient has a session of PD + P and AD on separate days, the sessions are randomly ordered. Measures: SpO_2, pulmonary function (before and 15min and 60min after the treatment), expectorations collected 1h after each treatment	SpO_2 ↓ during DP (from 93,3 ± 0,7% to 91,2 ± 0,8%: $p < 0,01$) and back to normal 15min later. SpO2 ↑ with AD and for 1 h after the treatment (94.5 ± 0.7% versus 93.3 ± 0.8% to the baseline state: $p < 0,01$)	2	4
McIlwaine [11]	RCT	Mucoviscidosis (40)	Group A: P + PD; group B: PEP mask. Follow-up for a year. Clinical state and pulmonary function (FVC, FEV1, MEFV 25-75) measured in an interval of three months.	Group B: ↑ of all pulmonary function parameters (FVC: +6.57%; FEV_1: +5.98%; MEFV 25-75%: +3.32%) statistically different from the control group (PD + P) that presents a decrease in all parameters (FVC: −2.17%; FEV_1: −2.28%; MEFV 25 75%: −0.24%)	2	6
McIlwaine et al. [12]	Crossover randomised	Mucoviscidosis (36)	Follow-up for 2 years. PD practice for at least 1 year before the study. Group A: PD for a year and AD the following year. Group B: in reverse order. Measures: clinical state and pulmonary function (FVC, FEV_1, MEFV 25-75) measured in an interval of three months.	No significant difference in pulmonary function between the 2 techniques during the 1st year. Participants preferred autogenic drainage.	2	6

Table II

Studies on postural drainage (continued).

Study	Type	Population (n)	Procedure and assessment criteria	Results	Level of evidence	PEDro score (/10)
Ntoumenopoulos et al. [13]	Prospective cohort	Adult intubated patients ventilated for 48 hours (72))	G1 (36): postural drainage, positioning, vibrations, cough 24 h/24 G2 (36): control/sham CPT Number of pneumonias, hospitalisation duration, and mortality.	CPT associated with a significant reduction in the number of pneumonias (0.16, 95% CI 0.03-0.94) No difference in terms of hospitalisation duration and mortality.	2	3
Paludo et al. [14]	RCT	Hospitalised children with pneumonia (98)	G1 (51): PD, thoracic pressure, percussion, vibration, cough stimulation and standard treatment for pneumonia. G2 (47): Standard treatment for pneumonia. Measures: problem resolution duration, hospitalisation duration, auscultation, respiratory rate, and oxygen saturation.	No significant differences between the groups in terms of problem resolution duration, hospitalisation duration, auscultation, respiratory rate, and oxygen saturation.	2	6
Paneroni et al. [15]	RCT	Bronchiectasis (44)	G1 (22): CPT: forced expiration, postural drainage, percussion, and vibration. G2 (22): intrapulmonary percussive ventilation (IPV) Respiratory and heart rate, SpO_2, dyspnoea, sputum volume or dry weight.	No significant difference between the 2 groups in terms of heart rate, SpO_2, dyspnoea, sputum volume or dry weight. Significant reduction of respiratory rate with IPV.	2	4
Stiller et al. [16]	RCT	Acute lobar atelectasis (35)	5 groups: (G1) MHI + asp.; (G2) HM + asp. + MPD + V; (G3) MHI + asp. + MPD; (G4) MHI + asp. + PD; (G5) idem G3 in a single session. Each session is run every h/6 h for a total of 24 hours. Measure: chest X-ray (ALA)	MPD is an effective tool in the resolution of ALA, combined with MHI and aspiration, every hour for 6 hours. Adding chest vibrations or conventional PD does not improve treatment response.	2	6

Table II

Studies on postural drainage (continued).

Study	Type	Population (n)	Procedure and assessment criteria	Results	Level of evidence	PEDro score (/10)
Tsang et al. [17]	RCT	BD (exacerbation) (15)	3 groups: (G1) PD + ventilation and cough (BC); (G2) Flutter + BC; (G3) only BC. 15-minute treatment every day for each group. Measures: sputum wet weight (during the treatment, after 15 minutes and 24 hours after the treatment), FVC, FEV1 and PEF. Patients assess their treatment method.	No differences in sputum production or pulmonary function among the three groups. Patients found all the techniques similar with respect to easiness of use but Flutter was seen as the most efficient in sputum elimination.	2	4
Varekojis et al. [18]	Crossover randomised	Mucoviscidosis (24)	3 groups: (G1) P + PD; (G2) IPV; (G3) HFCWC, each patient received treatment two days in a row, 3 times a day for 30 min. Expectoration during and 15 min after each treatment Measures: sputum dry and wet weight, patient preference.	Sputum wet weight differed significantly. IPV sputum wet weight > to that of HFCWC. Sputum average dry weight was not significantly different. None of the 3 methods was preferred to the other two.	2	4

ALA: acute lobar atelectasis; asp.: aspiration; ATB: antibiotics; BC: ventilation and cough; CLR: continuous lateral rotation; CPT: chest physiotherapy; FVC: forced vital capacity; AD: autogènic drainage; BD: bronchial dilatation; MEFV: maximum expiratory flow volume; PEF: peak expiratory flow; RLD: right lateral decubitus; LLD: left lateral decubitus; PD: postural drainage; MPD: postural drainage in side lying position, the lung being treated lies supralateral, with the bed flat; FET: forced expiratory technique; G: group; HFCWC: high-frequency chest wall compression; MHI: manual hyperinflation; IPV: intrapulmonary percussive ventilation; MPT: postural drainage without head down tilt; NS: non-significant; P: percussion; PEP: positive expiratory pressure; RCT: Randomised Controlled Trial; ARDS: acute respiratory distress syndrome; SPT: standard postural drainage; V: vibration; HRT: high respiratory tract; ADS: anatomical dead space; FEV1: forced expiratory volume in one second; CV: current volume.

Table III

Studies on manual vibrations.

Study	Type	Population (n)	Procedure and assessment criteria	Results	Level of evidence	PEDro score (/10)
Clinkscale et al. [19]	RCT	Hospitalised intubated and non-intubated patients requiring respiratory kinesiotherapy (*n* = 280)	Group CCPT (*n* = 146): conventional chest physical therapy (clapping, drainage posture and vibrations) Group HFCWC (*n* = 134): high-frequency chest wall compressions applied with a vibratory vest. Comfort measure measured with VAS, hospitalisation duration, time for the treatment of atelectasis (if diagnosed), occurrence of nosocomial infections and hospital mortality.	No difference between both groups with respect to hospitalisation. Better rate of comfort with HFCWC ($p = 0.009$) Shorter atelectasis treatment duration with CCPT ($p = 0.051$) No difference in the rest of indicators.	2	6
Eales et al. [20]	RCT	Cardiac post-surgery, ventilated patients (37)	Group 1 (11): asp. after 3 min of pre-oxygenation (100%) with a ventilator. Group 3 (15) idem + 6 MHI (Ambu) before asp. Group 3 (11) same as group 2 + chest vibrations during the expiratory stage of MHI. Measures: ABG, EDC	Results showed no significant difference in the ABG and EDC values among the three groups.	2	5
Elkins et al. [21]	Crossover randomised	Suspected TP (36) Other infections (23)	2 IE for 5 days (3% saline solution, maximum duration: 15 min.). On one of the days (randomly chosen) manual V, P, deep breathing and cough were used. In the other session (with no RK): the patient takes deep breaths and coughs every 5 min. Measures: severity of cough. Dispnea, wheezing, thoracic oppression (VAS). Sputum volume.	No significant difference in terms of sputum volume, sample quality or session tolerance.	2	6

Table III

Studies on manual vibrations (continued).

Study	Type	Population (n)	Procedure and assessment criteria	Results	Level of evidence	PEDro score (/10)
McCarren et al. [22]	Randomised intra-subject experimental	Healthy adults (3)	V (compression + oscillation), compression and oscillation manually applied on the chest wall of healthy participants during passive expiration and compared to passive expiration alone. Measures: chest wall circumference and force, intrapleural pressure, expiratory flow rate.	Chest wall circumference, intrapleural pressure and expiratory flow rate change in parallel with the pressure applied on the rib cage. Intrapleural pressure changes during vibrations result from the effects of recoil of the lung and the compression and oscillation components of the technique.	3	
Pattanshetty et al. [23]	RCT	Intubated, ventilated adults (101)	Control group (51): manual hyperinflation (MHI) and asp. Experimental group (50): MHI, asp. + positioning and manual V. Both groups had two sessions every day. Measure: CPIS score	The CPIS score was significantly ↓ after extubation. ↓ in mortality in the experimental group (24%) compared to the control group (49%) (p = 0,007)	2	6
Stiller et al. [16]	RCT	Acute lobar atelectasis (35)	5 groups: (G1) MHI + asp.; (G2) MHI + asp. + MPD + V; (G3) MHI + asp. + MPD; (G4) MHI + asp. + PD; (G5) same as G3 in 1 session. Each session took place each h/6 h for a total of 24h. Measure: chest X-ray (ALA)	MPD is an efficient component in the treatment of ALA, combined with MHI and asp., used every h. for 6h. Adding chest vibrations or conventional PD does not improve treatment response.	2	6

ALA: acute lobar atelectasis; asp.: aspiration; ABG: arterial blood gass; CCPT: conventional chest physiotherapy; CPIS score: Clinical Pulmonary Infection Score (temperature, leukocytes, tracheal secretions, PaO_2/FiO_2, radio...); PD: postural drainage; EDC: effective dynamic compliance; IE: induced expectoration; VAS: visual analogue scale; HFCWC: high-frequency chest wall compression; MHI: manual hyperinflation; RK: respiratory kinesiotherapy; P: percussion; RCT: Randomized Controlled Trial; TP: pulmonary tuberculosis; V: vibrations.

Table IV

Studies on manual chest percussion.

Study	Type	Population (n)	Procedure and assessment criteria	Results	Level of evidence	PEDro score (/10)
Barnabé et al. [6]	Comparative prospective	Stable asthma (81)	CTP (PD, percussion, vibrations and FET). Groups of patients (adults and children) and adult control group (healthy participants). 15-minute session. Measures: spirometry (FEV1, MEFV 25-75%, PEF) before and 5 minutes after CPT	NS change in FEV1 or MEFV 25-75% after CPT in adults (mild, moderate or severe asthma) and children (mild or moderate asthma). After CPT there is no ↓ of FEV1 > 20%. 32% of children and 4% of adults had a ↑ of symptoms after CPT, but none with FEV1 ↓ over 10%.	3	
Davis et al. [9]	Randomised prospective	ARDS, ventilated (19)	4 regimens of turning and drainage of secretions in randomised sequences of 6 hours each for 24 h: (1) routine turning / 2 h from LLD to RLD; (2) idem + 15min of P + PD; (3) CLR with specialised bed (from LLD to RLD + 2-min break in between positions; (4) idem + 15min of mechanical percussions. Measures: gas in blood, secretion volume, monitoring parameters.	↑ PaO_2/FiO_2 and ↓ of ADS/CV during CLR (NS). Significant ↑ of expectoration volume during CLR. Adding P and PD does not ↑ sputum volume. In 4 patients (expectoration > 40 mL/day), P + PD significantly ↑ sputum volume.	2	5
Raoof et al. [24]	RCT	Respiratory failure, atelectasis, with MV or SV (24)	Group 1 (17): automatic rotations + mechanical P; Group 2 (7) (control): manual rotations + manual P. Both groups received the same conventional therapy with bronchodilators and aspiration. Measure: correction of atelectasis; PaO_2/FiO_2	Partial or complete resolution of atelectasis in 14/17 patients (82.3%) in the experimental group (G1)and 1/7 patients (14.3%) in the control group (G2). A fibroscopy was performed on 3/7 patients in G2, but on no patients in G1. In G1 there was a ↑ of oxygenation at the end of the treatment, whereas in G2 there was a ↓ of it.	2	7
Wong et al. [25]	RCT	Premature babies with atelectasis (56)	Group CCC (26): between 3 and 4 continuous chest compressions for 5 minutes followed by relaxation. Performed on each hemithorax. Total session duration: 10 min followed by endotracheal asp. Group PDPV (30): PD, P, V for 10 min. Followed by asp. Sessions: 2/day for 3 days. Measures: correction of atelectasis.	CCC is more eficient in the correction of atelectasis in premature children than PD, P, V. After the 1st session, complete pulmonary re-expansion was achieved in 81% of the group CCC versus 23% in the group PD, P, V (p < 0,001)	2	8

Asp.: aspirations; CPT: chest physiotherapy; CLR: continuous lateral rotations; MEFV: maximum expiratory flow volume; PEF: peak expiratory flow; RLD: right lateral decubitust; LLD: left lateral decubitus; PD: postural drainage; FET: forced expiratory technique; CCC: continuous chest compression for 5 minutes followed by relaxation; NS: non-significant; P: percussions; RCT: Randomized Controlled Trial; ARDS: acute respiratory distress syndrome; V: vibrations; ADS: anatomical dead space; FEV1: forced expiratory volume in one second; MV: mechanical ventilation; SV: spontaneous ventilation; CV: corrent volume.

Table V

Studies on directed cough.

Study	Type	Population (n)	Procedure and assessment criteria	Results	Level of evidence	PEDro score (/10)
Fiore et al. [26]	Crossover randomised	Open heart surgery (21)	Assessment of cough within two days after surgery. The participant gives a baseline cough (maximum voluntary cough) and then, in a random order: an additional baseline cough, a supported cough (maximum voluntary cough and thoracic support) or a supported cough preceded by maximal inspiration. Measures: pulmonary function (CPEF, CEV).	TS alone does not significantly affect CPEF or CEV. With a maximal inspiration + TS, CPEF and CEV are significantly higher than in any other cough condition (p < 0,008)	2	4
Hasani et al. [27]	Crossover randomised	COBP (12) BD (7)	Group 1 "Directed cough": 6 coughs/minute (5min). Group 2 "FET": 6 FET/minute (5min). Group 3 "control": sitting. Measure: mucus movement in proximal and peripheral lung regions (radioaerosol), PEF.	↑ of mucociliary clearance in the lung while coughing (44 ± 5%) and FET (42 ± 5%).	2	5
MacKay et al. [28]	RCT	Open abdominal surgery (56)	Group A (21): mobilitzation (walk, mobilization in bed); Group B (29): mobilization + deep ventilation and cough (3 deep expansions in lateral position + cough, FET) Measures: incidence in fever, length of stay, restoration of mobility.	There was no significant difference between groups in the incidence of fever, physiotherapist time, or the number of treatments.	2	8
Placidi et al. [29]	Crossover randomised	Mucoviscidosis (17)	Control group: directed cough. Aerosol (10min) and then 4 groups (G1: NIV; G2: CPAP; G3: PEP mask; G4: control). Session: initial stage (20min) and then 3 periods of 7min, each of which followed by 3min of directed cough (total 30min), sputum collected at this stage. Directed cough = 1 or 2 FET followed by cough and sputum collection. Measures: sputum dry and wet weight, number of directed and spontaneous coughs in each session, spirometry and SpO2 before and after each session. Patient's assessment of effectiveness and tolerance of PEP mask, CPAP and NIV compared to control treament.	Significant difference in sputum wet weight, which disappears when taking into account the number of spontaneous coughs.	2	5

COBP: chronic obstructive bronchopneumopathy; CEPF: cough expiratory peak flow; CEV: cough expiratory volume; CPAP: continuous positive airway pressure; BD: bronchial dilatation; FET: forced expiratory technique; TS: thoracic support; PEP: positive expiratory pressure; RCT: randomized controlled trial; NIV: non-invasive ventilation.

Table VI

Studies on Forced Expiratory Technique

Study	Type	Population (n)	Procedure and assessment criteria	Results	Level of evidence	PEDro score (/10)
Morsch et al. [30]	RCT	Asthma (16); COBP (10)	Asthma group (A) and COBP group (C): IE ± FET and OPEP. Control group: only IE. Measures: sputum weight, total cell count, and cell viability.	Final mean weight of sputum was significantly > in the asthma group (A) / in the COBP group (C) (2767.25 ± 998.08 mg versus 1689.17 ± 1189.96 mg; p = 0.03). The mean/median total cell count was higher in the A and C groups than in the control groups.	2	5
Hasani et al. [27]	Crossover randomised	COBP (12) BD (7)	Group 1 "Directed cough": 6 coughs/minute (5min). Group 2 "FET": 6 FET/minute (5min). Group 3 "control": sitting. Measures: mucus movement in proximal and peripheral lung regions (radioaerosol), PEF.	↑ of mucociliary clearance in the lung while coughing (44 ± 5%) and FET (42 ± 5%)	2	5

COBP: chronic obstructive bronchopneumopathy; BD: bronchial dilatation; IE: induced expectoration; FET: Forced Expiratory Technique; OPEP: oscillating positive expiratory pressure; RCT: randomized controlled trial.

Table VII

Study on expiratory flow increase technique.

Study	Type	Population (n)	Procedure and assessment criteria	Results	Level of evidence	PEDro score (/10)
Brito et al. [31]	RCT	Duchenne muscular distrophy (28)	Patients with NIV, with FVC CVF < 60% of the predicted value. PCF was measured at four time points: at baseline, during a spontaneous MEE, during an MEE while receiving chest compression, during an MEE after air stacking and during an MEE with air stacking and compression (combined technique) The last 3 measurements were conducted in random order.	The results obtained with the use of the combined technique were significantly better than those obtained with the use of either technique alone (p < 0,001)	2	4
Demont et al. [32]	Cohort retrospective	Newborns who developed acute or chronic lung disease requiring (362)	The EFI method is used shortly after birth, three times a day up to at least 24 hours after extubation. Measures: PEA and brain lesions. Chest X-rays taken 24h after extubation and head ultrasounds during hospitalisation.	The incidence of PEA in newborns treated with the EFI method is low and respiratory kinesiotherapy does not seem to increase the incidence of brain lesions above the % normally found in newborns with respiratory failure.	4	

EFI: expiratory flow increase; FVC: forced vital capacity; MEE: maximal expiratory effort; PCF: Peak Cough Flow; PEA: post-extubation atelectasis; RCT: randomized controlled trial; VM: mechanical ventilation; NIV: non-invasive ventilation.

Table VIII

Studies on slow and complete expiration with open glottis in lateral posture.

Study	Type	Population (n)	Procedure and assessment criteria	Results	Level of evidence	PEDro score (/10)
Bellone et al. [33]	Randomised prospective	Chronic bronchitis (exacerbation) (10)	Patients received PD, Flutter, and ELTGOL by the same respiratory therapist at about the same time of day on separate days and in random order. The total duration of treatment was 30 min. Measures: SpO_2 and pulmonary function were measured before, immediately after, and 15 min. and 1 hour after each treatment. Sputum wet weight was measured immediately after and for 1 hour after treatment.	All techniques were well tolerated and SpO_2 and FEV_1 did not change significantly during and after treatments. 30 min after the beginning of treatment, sputum production ↑ significantly with all techniques, but during the first hour after the end of treatment, it was significantly larger with Flutter ($p < 0.01$) and ELTGOL ($p < 0.02$) than with PD (NS).	2	3
Pinto et al. [34]	Prospective	HIV (132)	Patients used the spontaneous technique (ST) on days 1, 3, and 5, ELTGOL on day 2, and sputum induction with 3% hypertonic saline on day 4. Measure: secretion collection.	There is no statistically significant difference among the 3 techniques.	3	
Guimarães et al. [35]	RCT	Mucoviscidosis (14)	Group ELTGOL: Slow expiration with the glottis open in lateral posture Group Flutter Assessment of sputum weight, by plethysmography (residual volume [RV], airway resistance [Raw] and airway conductance [Gaw]).	ELTGOL produces 0.34g more of secretions than Flutter (95% IC 0.11 to 0.57), ELTGOL offers better results in terms of improvement in airway resistance (–0.51 cmH2O/L/s; 95% IC –0.88 to –0.14 and conductance (0.016 L/s/cmH2O; 95% IC 0.008 to 0.023).	2	
Guimarães et al. [36]	RCT	Bronchiectasis (10)	Group ELTGOL: Slow expiration with the glottis open in lateral posture Group Flutter Assessment of sputum weight, by plethysmography (residual volume [RV], functional residual capacity [FRC] and total lung capacity [TLC]).	There is more sputum production with ELTGOL than with Flutter ($p < 0.05$) Flutter VRP1 and ELTGOL significantly reduce residual volume (RV), funcional residual capacity (FRC) and total lung capacity ($p < 0,05$)	2	7

Table VIII

Studies on slow and complete expiration with open glottis in lateral posture (continued).

Study	Type	Population (n)	Procedure and assessment criteria	Results	Level of evidence	PEDro score (/10)
Kodric et al. [37]	RCT	Hospitalised COBP (acute exacerbation) (59)	Control group (29): standard medical therapy. Intervention group (30): standard medical therapy + ELTGOL. A subgroup was followed for 6 months to verify the effects on COBP exacerbations and need for hospitalisation. Measures: sputum volume, length of hospitalization, dyspnoea (Borg scale), quality of life (St George Respiratory Questionnaire) and incidence of exacerbations (COBP) during follow up.	At the time of hospital discharge there was no significant difference between the two groups in the outcome measures, with the exception of the Borg score, which was significantly improved in the ELTGOL group (3 ± 1.8 versus 4.3 ± 1.5 [control group]; $p = 0.004$]). During follow up, the ELTGOL group had fewer exacerbations though differences were not significant.	2	5
Martins et al. [38]	RCT	COBP (12)	ELTGOL group Control group: does nothing. Asssessment of the effects of ELTGOL on mucociliar clearance by scintigraphy.	From minute 20, there is a statistically significant difference in the increase of mucociliar clearance in the ELTGOL group. This persists up to minute 120.	2	5

COBP: chronic obstructive bronchopneumopathy; TLC: total lung capacity; FRC: functional residual capacity; PD: postural drainage; ELTGOL: slow expiration with the glottis open in lateral posture; Gaw: specific airway conductance; HIV: human immunodeficiency virus; NS: non-significant; Raw: airway resistance; RCT: randomised controlled trial; FEV1: forced expiratory volume in 1 second; RV: residual volume.

Table IX

Studies on autogenic drainage.

Study	Type	Population (n)	Procedure and assessment criteria	Results	Level of evidence	PEDro score (/10)
App et al. [39]	Crossover randomised	Mucoviscidosis (14)	2 daily AD or Flutter treatment sessions (2 groups of patients) (for 4 weeks). 1st group (1st session AD, 2nd Flutter) – 2nd group opposite order. 1-week wash-out period followed by inverted sequence in each group. Measures: at the beginning and at the end of the 4 weeks, pulmonary function was measured before and after a 30-min treatment. Sputum weight, evaluation of viscoelasticity of the sputum.	Viscoelasticity of the sputum: Flutter < AD (p < 0,01)	2	4
Giles et al. [10]	Crossover randomised	Mucoviscidosis (10)	Each patient has PD + P and AD on separate days, sessions in a random order. Measures: SpO2, pulmonary function (before, 15min and 30min after the treatment), sputum was collected during and for 1 h following each treatment.	SpO_2 ↓ during PD (from 93.3 ± 0.7% to 91.2 ± 0.8%; p < 0.01) and returned to baseline after 15min. SpO2 ↑ with AD and for 1 h after the treatment (94.5 ± 0.7% versus 93.3 ± 0.8% to baseline; p < 0,01)	2	4
McIlwaine et al. [12]	Crossover randomised	Mucoviscidosis (36)	Two-year follow-up. PD carried out at least 1 year before the study. Group A: PD for 1 year and AD the following year. Group B: inverse order. Measures: Clinical status and pulmonary function (FVC, FEV1, MEFV 25-75%) were measured at 3 monthly intervals.	No significant difference in pulmonary function between both techniques in the 1st year. Patients showed a preference for AD.	2	6
Miller et al. [40]	Crossover randomised	Mucoviscidosis (18)	Each patient was monitored for 2 days, each day a week apart. Two sessions each day (morning, afternoon). Technique A: AD; technique B: ACBT. Mucus movement was quantified by a radioaerosol technique, airway clearance (xenon-133). Expectorated sputum was collected, pulmonary function and SaO_2 were measured.	AD cleared mucus faster than ACBT. Both methods ↑ ventilation. ↑ in MEVF 25-75% with AD. ↑ FVC with ACBT. 4 points of ↓ of SpO2 with ACBT.	2	4

Table IX

Studies on autogenic drainage (continued).

Study	Type	Population (n)	Procedure and assessment criteria	Results	Level of evidence	PEDro score (/10)
Pryor et al. [41]	RCT	Mucoviscidosis (75)	Duration of study: 1 year. Assessment of ACBT, AD, PEP, OPEP. Tecnhiques randomly assigned. Getting familiar with researcher and domiciliary follow-up (number and duration of sessions depending on each patient). Measures: pulmonary function (FEV_1, FVC...), anaerobic capacity (shuttle test), quality of life.	There was no significant difference among the regimens in terms of FEV_1 (main criterion).	2	7
Savci et al. [42]	RCT	COBP (stable state) (30)	Patients were randomly assigned to 2 groups: AD and ACBT. Treatment sessions: 20min/day, 5 days/week for 20 days. Measures: pulmonary function (FEV_1, FVC, MEFV 25-75%, PEF), arterial blood gases, TD6, dyspnoea (modified Borg scale) before and after TD6.	All parametres improved with AD. FVC, PEF, PaO_2 and exercise performance improved with ACBT. PEF ↑ with AD/ACBT; PaO_2 ↓ + important of $PaCo_2$ with AD.	2	4

ACBT: active cycle breathing technique; COBP: chronic obstructive bronchopneumopathy; FVC: forced vital capacity; AD: autogenic drainage; MEFV: maximum expiratory flow volume; PEF: peak expiratory flow; PD: postural drainage; OPEP: oscillating positive expiratory pressure; PEP: positive expiratory pressure; RCT: randomized controlled trial; TD6: 6-minute walking test; FEV1: forced expiratory volume in 1 second.

Table X

Studies on the active cycle breathing technique (ACBT).

Study	Type	Population (n)	Procedure and assessment criteria	Results	Level of evidence	PEDro score (/10)
Carr et al. [43]	Same subjects Pre-post-design	Mucoviscidosis (20)	ACBT + self percussion Measures: pulmonary function (FEV1, FVC), SaO_2, TD6, sputum weight, patients' opinion	There was a statistically significant reduction in SaO_2 between the beginning of the treatment and during self-percussion (p = 0.026). The mean reduction was 2.68% (SD = 0.839).	3	
Cross et al. [44]	RCT	Exacerbation of COBP MCP group (261) Control group (266)	MCP group (manual chest physiotherapy): Active Cycle of Breathing Technique (ACBT) control group: traditional techniques Measured with the Saint Georges Respiratory Questionnaire (SGRQ), Breathlessness Cough and Sputum Scale (BCSS), EuroQol (EQ-5D) quality of life index and EuroQol (EQ-5D) quality of life index and length of hospitalisation.	There is no statistically significant difference in the Saint-Georges Respiratory Questionnaire (SGRQ), Breathlessness Cough and Sputum Scale (BCSS), EuroQol (EQ-5D) quality of life index and EuroQol (EQ-5D) quality of life index and length of hospitalisation.	1	6
Cecins et al. [45]	Crossover randomised	BD (19)	ACBT ± head-down tilt. Measures: sputum weight at the end of the sessions and 30 min afterwards, number of productive coughs during treatment and in the 30min after treatment. FVC and FEV_1 before and after treatment. SpO_2 during the sessions. VAS for dyspnoea. Patient's treatment preference.	Perception of dyspnoea (VAS) ↑ significantly after treatment with a head-down tilt (from 2.3 ± 1.6 to 3.3 ± 2 cm; p = 0.02). 18 participants preferred ACBT without a head-down tilt.	2	4
Chatham et al. [46]	Crossover randomised	Mucoviscidosis (20)	ACBT + PD/resistive inspiratory manoeuvres (RIM) at 80% Measures: Expectorated sputum was collected during and for 30 min after each treatment and weighed. Composition and weight of analysed sputum.	RIM ↑ sputum weight two-fold. The amount expectorated was greater with RIM.	2	5
Eaton et al. [47]	Crossover randomised	BD (36)	G1: Flutter; G2: ACBT; G3: ACBT + PD Measures: sputum wet weight, tolerability and acceptability, FVC, FEV1, SaO_2, dyspnoea (Borg).	Total sputum wet weight for ACBT + PD was twice that of ACBT alone or Flutter. All three techniques were well accepted and tolerated. Patient preference: 44% Flutter, 33% ACBT + PD, 22% ACBT.	2	5

Table X

Studies on the active cycle breathing technique (ACBT) (continued).

Study	Type	Population (n)	Procedure and assessment criteria	Results	Level of evidence	PEDro score (/10)
Ince et al. [48]	RCT	With NIV (respiratory failure) (34)	ACBT (hypercapnic RF. With NIV) G1: ACBT + NIV (+ vibrations in case of abundant secretions) G2: NIV (control group) Measures: length of time requiring NIV, arterial blood gas, total duration NIV, and length of stay in the intensive care unit.	↓ of $PaCO_2$ in the ACBT group (NS). Duration of time of ventilation is shorter in the ACBT group (NS). Length of time in need of NIV was significantly < in the ACBT group (5 ± 2.5 days versus 6.7 ± 2.6 days, $p = 0.03$)	2	3
Kellett et al. [49]	Crossover randomised	BD (stable state) (24)	ACBT; terbutaline + ACBT; terbutaline + IS + ACBT; terbutaline + HS + ACBT Measures: sputum wet weight and viscosity, ease of expectoration (VAS) and spirometry (FEV_1, FVC).	Sputum weight was higher after nebulised HS than IS ($p = 0.002$).Ease of expectoration lower with HS than with IS ($p = 0.0005$). ↓of sputum viscosity with HS	2	
Miller et al. [40]	Crossover randomised	Mucoviscidosis (18)	Each patient was monitored for 2 days, each day a week apart. Two sessions each day (morning, afternoon). Technique A: AD; technique B: ACBT. Mucus movement was quantified by a radioaerosol technique, airway clearance (xenon-133). Expectorated sputum was collected, pulmonary function and SaO_2 were measured.	AD cleared mucus faster than ACBT. Both methods ↑ ventilation. ↑ in MEVF 25-75% with AD. ↑ FVC with ACBT. 4 points of ↓ of SpO2 with ACBT.	2	4
Patterson et al. [50]	Crossover randomised	BD (20)	ACBT/Acapella Measures before and after treatment: spirometry, SpO_2, breathlessness, sputum weight, number of coughs and patient's preference.	No significant difference was found between weight of sputum expectorated with ACBT or Acapella. A greater proportion of patients preferred Acapella (14/20).	3	6
Patterson et al. [51]	Crossover randomised	BD (20)	G1: ACBT (+ PD, vibration) G2: RIM at 80% of MIP. Measures: sputum wet weight, pulmonary function (FVC, FEV1, PEF), SaO2, patient's preference.	Sputum weight during and 30 min post-ACBT (+ PD and vibration) was significantly greater than the sputum weight during and 30 min post-RIM treatment (mean difference : 2.44 g [CI 95% 0.43 to 4.45])	2	5

Table X

Studies on the active cycle breathing technique (ACBT) (continued).

Study	Type	Population (n)	Procedure and assessment criteria	Results	Level of evidence	PEDro score (/10)
Phillips et al. [52]	Crossover randomised	Mucoviscidosis (10)	ACBT (+ DP)/HFCC Measures: sputum wet weight for 15 min and 24 hours after treatment; pulmonary function (FVC, FEV_1); SaO_2	ACBT: sputum weight ↑ compared to HFCC (5.2 g versus 1.1 g, $p < 0.005$, in the morning; 4.1 g versus 0.7 g, $p < 0.01$, in the afternoon). Improved pulmonary function, morning (FVC, FEV_1), afternoon (FVC).	3	6
Pryor et al. [41]	RCT	Mucoviscidosis (75)	Duration of study: 1 year. Assessment of ACBT, AD, PEP, OPEP. Tecnhiques randomly assigned. Getting familiar with researcher and domiciliary follow-up (number and duration of sessions depending on each patient). Measures: pulmonary function (FEV_1, FVC...), anaerobic capacity (shuttle test), quality of life.	There was no significant difference among the regimens with respect to FEV_1 (main criterion).	2	7
Savci et al. [42]	RCT	COBP (stable state) (30)	Patients were randomly assigned to 2 groups: AD and ACBT. Treatment sessions: 20min/day, 5 days/week for 20 days. Measures: pulmonary function (FEV1, FVC, MEFV 25-75%, PEF), arterial blood gases, TD6, dyspnoea (modified Borg scale) before and after TD6	All parametres improved with AD. FVC, PEF, PaO_2 and exercise performance improved with ACBT. PEF ↑ with AD/ACBT; PaO_2 ↓ + important of $PaCo_2$ with AD.	2	4
Syed et al. [53]	Crossover randomised	BD (35)	ACBT/CPT Measures: pulmonary function, sputum wet weight and volume, and VAS for comfort of techniques.	Most patients reported comfort during ACBT (VAS). There is no difference in sputum weight and volume after the use of conventional therapies and ACBT.	2	4
Thompson et al. [54]	Crossover randomised	BD (stable stage) (17)	ACBT (+ DP)/ Flutter Measures: sputum wet weight, duration of physiotherapy treatment. PEF, FVC, FEV1, dyspnoea (Borg scale) before and after each physiotherapy session. Patients' preference with regard to the techniques.	There are no significant differences between the 2 techniques. Patients preferred Flutter (11/17) to ACBT for routine use.	2	3

Table X

Studies on the active cycle breathing technique (ACBT) (continued).

Study	Type	Population (n)	Procedure and assessment criteria	Results	Level of evidence	PEDro score (/10)
White et al. [55]	Crossover randomised	Mucoviscidosis (15)	ACBT + PD ± thoracic expansions. Measures: spirometry (FEV1; FVC, FEV_1/FVC, MEFV 25-75%), sputum wet weight, SpO_2	There was no significant difference between the treatments (with or without thoracic expansion).	3	4
Williams et al. [56]	Crossover randomised	Mucoviscidosis (15)	ACBT ± physiotherapy Measures: pulmonary function, indirect calorimetry and oximetry.	Significant improvement in pulmonary function 24 hours following the therapist-assisted ACBT. ↓ in airways obstruction following the therapist-assisted ACBT.	2	4

ACBT: active cycle breathing technique; BCSS: breathlessness cough and sputum scale; CPT: chest physiotherapy; RCT: randomized controlled trial; VC: vital capacity; FVC: forced vital capacity; AD: autogenic drainage; BD: bronchial dilatation; MEFV: maximum expiratory flow volume; PEF: peak expiratory flow; PD: postural drainage; VAS: visual analogue scale; HFCC: high-frequency chest compression; HS: hypertonic saline; RF: respiratory failure; IS: isotònic saline; MDC: manual chest physiotherapy; NS: non-significant; OPEP: oscillating positive expiratory pressure; PEP: positive expiratory presure; MIP: maximal inspiratory pressure; RCT: randomized controlled trial; RIM: resistive inspiratory manoeuvres; SGRQ: Saint-Georges Respiratory Questionnaire; TD6: 6-minute walking test; FEV1: forced expiratory volume in 1 second; NIV: non-invasive ventilation. The article by Lewis [57] cites the work by **Mine SM** *et al.* Published in South Afr J Physiother in 2004 (60: 3-6). This article has a PEDro score of 4. Having been unable to find the original text, this has not been included in the table.

DISCUSSION

This systematic literature review confirms the results of the oldest abstracts (58-60) and underlines the big heterogeneity of the protocols used, the parameters assessed and the populations in the studies. The most commonly used assessment criteria refer to respiratory function (29 studies), sputum weight (24 studies), patient's assessment of the technique (16 studies), and sputum volume (7 studies).

Postural drainage (PD)

We found ten studies (Table II). Most of these studies are about patients suffering from mucoviscidosis (5 studies) and BD (1 study). The protocols and length of follow-up differ greatly among studies. Two of them examine long-term results. MacIlwaine compares the use of PD and AD for two years with no method yielding better results than the other in terms of respiratory function, although patients seem to prefer AD. Button compares PD with head down tilt (SPT) and without head down tilt (MTP) and demonstrates that the latter is well tolerated. The rest of studies do not provide evidence of a positive effect of PD, some even seem to observe a negative aspect (7, 10, 11). Only 4 studies have a PEDro score over 5 (11. 12, 14, 16), which illustrates the global level of the studies. The results of the literature review confirm that postural drainage constitutes an "ocasional adjuvant therapy" to bronchial drainage (3) with a B level of recommendation.

Manual vibration

We found six studies (Table III). McCarren (22) gives evidence of the role of the lung elastic retraction as the main component in the action mechanism of vibration. Five studies have a PEDro score over 5 (16, 19-21, 23). No study highlights the iatrogenic effect of vibration by the therapist (musculoskeletal problems), in spite of this being something that needs to be taken into account. Only a study compares manual vibration to mechanical vibration, which offers more comfort to the patient (19). The reviewed studies do not allow us to recommend manual vibration.

Manual chest percussion (MCP)

We found four studies (Table IV). Three of these are unfavorable to chest percussion (6, 9, 24). Two studies have a score over 5 (24, 25). A national survey done in England in 2007, for physiotherapists that work in respiratory care services, examined the use of chest percussion, manual vibration and ACBT in patients suffering from an exacerbation of COBP. Their frequency of use was assessed (classified as "always", "often", "sometimes", "rarely" or "never"). The results of this survey indicated the great frequency of use of ACBT, always used in 54% of cases. Percussion was "often" used in 8% of cases and "sometimes" in 38% of cases, whereas manual vibration was "often" used in 23% and "sometimes" used in 41% of cases (61).

A systematic review conducted by Ides about airway clearance in COBP patients advised against the use of postural drainage and chest percussion (62). MCP can really reduce FEV_1 in patients with an acute exacerbation of COBP (63). The results of the literature review confirm the marginal situation of PTM, which cannot be recommended for airway clearance.

Directed cough

We found four studies (Table V). It is not possible to assess the efficiency of directed cough alone from the studies we found. Only Hasani's work gives evidence of the interest of directed cough in the improvement of mucociliary clearance in patients with BOBP and BD but the sample is quite small (n = 12, n = 7) respectively (27). Only one study has a PEDro score over 5 [28]. The role of directed cough is that it allows "the patient's autonomy of drainage in between kinesiotherapy sessions"(3).

Forced Expiratory Technique (FET)

The 2 studies found show an improvement in comparison to the control group (Table VI). In the 2 studies the sample is quite small. Only one study has a PEDro score equal to 5 (27). In fact most of the studies on FET have it as part of ACBT.

Increased Expiratory Flow (IEF)

The two studies we identified do not allow us to isolate the effect of this technique (Table VII). We found a randomised comparative trial that has a PEDro score below 5. Taking this result into account, we cannot recommend IEF.

ELTGOL

We found six studies (Table VIII). Two of them are about COBP patients that were hospitalised due to an exacerbation (33, 37), 1 study was about patients with mucoviscidosis (35) and patients with bronchiectasis (36). These 5 studies include 3 randomised comparative trials (PEDro: 5, 5 and 7/10). The results favour ELTGOL, with less exacerbations and hospitalisations among COBP patients (37) and an increase in sputum production regardless of the pathology (33, 35, 36). In addition, ELTGOL improves airway resistance in patients with mucoviscidosis. Special attention must be paid to Martins' study (38), which examines the effect of ELTGOL in mucociliary clearance and shows a statistically significant increase in comparison to a control group. The results of the literature review show the efficiency of ELTGOL in bronchial drainage with a good level of evidence (B level of recommendation).

Autogenic drainage

We found six studies (Table IX). Most of them are about patients with mucoviscidosis. It is associated with an improvement of gas exchanges related to AD (42) for 1 hour after treatment (10) and a faster elimination of mucus compared to ACBT (40). Only two studies have a PEDro score over 5 (12, 41). Some are based on identical physiological principles: autogenic drainage, in its stage of release of secretions, helps patients to reduce volume (expiratory reserve volume – ERV), breathing with a slow expiratory flow, which basically lies on the same physiological principle as ELTGOL, to which we add the selection of side, the slow increase of expiratory flow done at the level of ERV. The result of this literature review demonstrates the importance of autogenic drainage in bronchial drainage with a good level of evidence (B level of recommendation).

ACBT

It was not examined in the 1994 consensus conference, ACBT is really made up of several techniques: abdominal ventilation, chest expansion (high lung volume) and FET (rapid increase of expiratory flow) (Table X). It is the most commonly studied technique. We found 17 studies on patients that have mucoviscidosis (7 studies), BD (7 studies) and COBP (2 studies). More patients have a better VC in comparison to AD but there was a reduction in SpO2 in 4 of the 18 patients during the session [40]. When compared to CPT, ACBT is more valued by patients (53). Two studies that compare ACBT and Acapella and Flutter are not favorable to ACBT (50, 54). ACBT effectiveness is higher when it is taught by a physiotherapist (56). Four of the 17 studies have a PEDro score above 5 (41, 44, 50, 52).

A systematic review by Lewis *et al.* in 2011 considered the issue of the best available evidence (volume, quality, consistency...) regarding ACBT. Twenty-four studies were included, thirteen of them had been published before 1994. The most commonly assessed data were sputum wet weight (n = 17), VC (n = 12) and FEV_1 (n = 12). There was an increase in sputum wet weight for 1 hour post-ACBT in comparison to conventional respiratory kinesiotherapy (SMD 0.32, CI 95% 0.05-0.59), with systems that generate external oscillations (0.75, 0.48-1.02) and with a control group (0.24, 0.02-0.46) with a good level of evidence (57). A Cochrane systematic review relating to muscoviscidosis examined the studies that compared ACBT to autogenic drainage, airway oscillating systems, high frequency chest compression devices, and conventional chest physiotherapy. Seventeen studies were included, four of which were randomised controlled studies. The authors concluded that there was insufficient evidence to support or reject the use of ACBT over any other airway clearance therapy. Four studies, with four different comparators, found that ACBT was comparable to other therapies in outcomes such as lung function, sputum weight, oxygen saturation, and number of pulmonary exacerbations. The authors recommended longer-term studies on outcomes such as quality of life and patient preference (64). McKoy *et al.* (65), in a Cochrane Library review published in 2012 reached the same conclusion. The authors included five studies, with five different comparators (patient preference, lung function, sputum weight, oxygen saturation, and number of pulmonary exacerbations) and found that ACBT was comparable to other therapies.

The aim of the Cochrane Library review by Warnock in 2013 (66) was to determine the effectiveness of chest physiotherapy compared to no treatment or spontaneous cough alone to improve mucus clearance in mucoviscidosis. The results of this review show that airway clearance techniques have short-term effects in terms of increasing mucus transport. No evidence was found on which to draw conclusions concerning the long-term effects. The importance of ACBT seems to be irrefutable in bronchial drainage, with a good level of evidence (B level of recommendation).

Summary of the recommendations

Table XI shows a summary of the latest recommendations based on the flow diagram of the techniques examined in the consensus conference of 1994 on physical mechanisms.

CONCLUSION – PERSPECTIVES

This review highlights the fact that there is insufficient valid scientific evidence and the difficulty in determining the level of evidence of manual airway clearance techniques. The techniques have been assessed mainly with patients suffering from secretory diseases (mucoviscidosis, BD, COBP...). It also shows the limits of the assessment criteria that help measure the presence of congestion and, therefore, the effectiveness of decongestion.

The flow diagram with the classification of bronchial decongestion techniques based on their physical mechanism, drawn during the consensus conference of 1994, seems to be an interesting tool for this assessment since it allows to group those techniques that have identical action mechanisms.

The assessment of the effectiveness of the techniques used was one the concerns and research topics of a pioneer in respiratory kinesiotherapy, Henri Fauré (67).

In view of the results of this systematic review, it seems that only ELTGOL, autogenic drainage and ACBT (PD?) have a B level of evidence. The rest of techniques have a lower level of evidence. In addition to this, most studies use small samples and have methodological limitations.

Table XI

Different techniques classified according to evidence based medicine.

	Name of the technique	Proposals 2014
Controlled expiratory flow	Tos dirigida Augment del flux expiratori Acceleració del flux expiratori Tècnica d'expiració forçada (TEF) ELTGOL Drenatge autogen Pressió toràcica ACBT	Yes (C lev.) Yes (C lev.) Yes (C lev.) Yes (B lev.) Yes (B lev.) Not assessed in this reviewl Yes (B lev.)
Shockwaves	Manual vibration Percussion (*clapping*)	Randomised effectiveness (C lev.) No (B lev.)
Gravity	Position with head-down tilt Drainage position	No (C lev.) Yes (B lev.)

Declaration of interests

The authors declare that there is no conflict of interest regarding this article.

APPENDIX 1 SYNOPTIC TABLE	
Title of study	
Author/Publication/Year/ Volume/Pages	
Aim of study	Type of study Population
Methodology	Statistical analysis / Clinical significance Variables used Development of study Value criteria
Results	
Level of evidence/ PEDro score	
Conclusion	

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PHYSIOTHERAPY UPDATES

WHAT WORKS TO PREVENT FALLS IN COMMUNITY-DWELLING OLDER ADULTS? UMBRELLA REVIEW OF META-ANALYSES OF RANDOMIZED CONTROLLED TRIALS

Brendon Stubbs, Simone Brefka, Michael D. Denkinger

B. Stubbs, PT, MSc, MCSP, Faculty of Education and Health, University of Greenwich, Southwood Site, Avery Hill Road, Eltham, London, United Kingdom SE9 2UG. Address all correspondence to Mr Stubbs at: brendonstubbs@hotmail.com

S. Brefka, MD, AGAPLESION Bethesda Clinic, Department of Geriatrics, Ulm University, Ulm, Germany

M.D. Denkinger, MD, Competence Centre of Geriatrics and Aging Research Ulm/Alb-Donau, Ulm, Germany.

Address all correspondence to Mr Stubbs at: brendonstubbs@hotmail.com

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All authors designed the study, which was prospectively registered, and helped acquire the data. Mr Stubbs and Dr Denkinger wrote the manuscript. Dr Brefka provided input. All authors approved the final version.

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ABSTRACT

Background. Preventing falls is an international priority. There is a need to synthesize the highest-quality falls prevention evidence in one place for clinicians.

Purpose. The aim of this study was to conduct an umbrella review of meta-analyses of randomized controlled trials (RCTs) of falls prevention interventions in community-dwelling older adults.

Data Sources. The MEDLINE, EMBASE, CINAHL, AMED, BNI, PsycINFO, Cochrane Library, PubMed, and PEDro databases were searched.

Study Selection. Meta-analyses with one pooled analysis containing ≥3 RCTs that investigated any intervention to prevent falls in community-dwelling older adults aged ≥60 years were eligible. Sixteen meta-analyses, representing 47 pooled analyses, were included.

Data Extraction. Two authors independently extracted data.

Data Synthesis. Data were narratively synthesized. The methodological quality of the meta-analyses was moderate. Three meta-analyses defined a fall, and 3 reported adverse events (although minor). There is consistent evidence that exercise reduces falls (including the rate, risk, and odds of falling), with 13/14 pooled analyses (93%) from 7 meta-analyses demonstrating a significant reduction. The methodological quality of meta-analyses investigating exercise were medium/high, and effect sizes ranged from 0.87 (relative risk 95% confidence interval=0.81, 0.94; number of studies=18; number of participants=3,568) to 0.39 (rate ratio 95% confidence interval= 0.23, 0.66; number of meta-analyses=6). There is consistent evidence that multifactorial interventions reduce falls (5/6, 83% reported significant reduction). There is conflicting evidence regarding the influence of vitamin D supplementation (7/12, 58.3% reported significant reduction).

Limitations. Meta-analyses often used different methods of analysis, and reporting of key characteristics (eg, participants, heterogeneity, publication bias) was often lacking. There may be some overlap among included meta-analyses.

Conclusions. There is consistent evidence that exercise and individually tailored multifactorial interventions are effective in reducing falls in community-dwelling older adults.

Falls represent a substantial threat to the aging global population's quality of life and remain a leading cause of morbidity and mortality (1-3). Falls are common and affect around 30% of those aged over 65 years of age living in the community, and the risk increases with age (2, 4, 5). The financial costs of falls also are profound. For instance, after accounting for inflation, the direct cost of health care provision following a fall in the United States was estimated at $30 billion in 2010 (6). Not surprisingly, numerous national and international guidelines have been developed that seek to prevent falls (1, 7, 8).

A diverse range of interventions have been developed and tested through robust randomized controlled trials (RCTs) and subsequently summarized in systematic reviews and meta-analyses. Conclusions based on systematic reviews of RCTs are considered the top of the hierarchy of evidence (9). Although there are some criticisms of systematic reviews as an entity (eg, prone to bias in original studies, publication bias, and may miss landmark well-powered primary studies (10), a well-conducted systematic review does have the ability to make robust, generalizable conclusions over and above those from a single study. In addition, meta-analyses have the potential to provide the closest effect size of an intervention (11). Although meta-analyses based on systematic reviews are considered the "gold standard," there is increasing recognition that even a perfect meta-analysis with perfect data can provide only a partial overview of the interventions available to clinicians (12). This finding is particularly true in complex interventions such as falls prevention, where many different options are available to clinicians. With this realization, the popularity of umbrella reviews, or systematic reviews of systematic reviews, has increased to provide clinicians, policy makers, and researchers with the highest-quality information in one place regarding any particular intervention.

Concerning the prevention of falls, a range of interventions has been considered with systematic reviews and meta-analyses, including single interventions such as exercise (13) and vitamin D supplementation (14) or more complex multifactorial interventions (4). Physical therapists have an integral role in the prevention of falls, and it is essential they have knowledge of the highest-quality evidence of interventions that reduce falls. Because of this proliferation in high-quality falls prevention research, we sought to conduct a comprehensive umbrella review of all systematic reviews containing meta-analyses of RCTs on the prevention of falls in community-dwelling older adults.

METHOD

This umbrella review followed a predetermined published protocol (PROSPERO registration: CRD42014010715).

Eligibility Criteria

Meta-analyses of RCTs that investigated any intervention that sought to reduce falls in community-dwelling older adults were included. More specifically, meta-analyses had to meet the following criteria:

Population

The study population comprised community-dwelling older adults (ie, living in the community and not in a long-term care facility, with a mean age of ≥60 years). We did not include studies conducted in hospitals or long-term care facilities. We excluded reviews in specialist populations (eg, stroke, Parkinson disease).

Interventions

Any intervention that sought to prevent falls was included.

Outcome measures

Our primary outcome measure was the effect of interventions on the rate of falls or the number of fallers. In this study, a fall was defined as "an unexpected event in which the participants come to rest on the ground, floor, or lower level." (15[p1619]). We considered any type of falls, including recurrent (2 or more falls over the study period) and injurious falls.

We did not place any language restriction upon our searches. If we encountered manuscripts published in languages other than English, German, French, or Spanish, we planned to contact the authors to acquire the data of interest. Meta-analyses not informed by a systematic review were excluded. Meta-analyses must contain at least one pooled analysis with ≥3 RCTs. Because some meta-analyses conducted multiple subgroup and sensitivity analyses, we report the primary analysis (effect size) for each intervention they investigated. If we encountered meta-analyses that were updates from previous reviews (eg, updated Cochrane review), we included only the most recent meta-analysis. If we encountered reviews on similar topics with different methods of analysis, inclusion criteria, and results, we included both reviews (decided by 3 authors). Meta-analyses including some controlled trials were included if ≥80% of the included studies within the pooled analysis were RCTs.

Search Procedure

Two independent authors (B.S., S.B.) conducted a systematic search of the MEDLINE, EMBASE, CINAHL, AMED, BNI, PsycINFO, Cochrane Library, PubMed, and PEDro databases from inception to August 2014. A third author (M.D.D.) was available as a mediator. The key words used in the searches were "falls" or "fall*" or "recurrent falls" or "injurious fall" or "fall prevention" AND "randomised

control trial" or "RCT" or "systematic review" or "meta-analysis" AND "older adult" or "elderly" or "age" AND "intervention" AND "exercise" AND "vitamin D supplementation" and "multifactorial." The reference lists of all potentially eligible articles were reviewed.

Data Extraction and Synthesis

Two authors (B.S., S.B.) independently extracted data, and a third reviewer (M.D.D.) was available. Data extracted included: first author, year of publication, country, setting, aim, search strategy, eligibility criteria, type of fall investigating, falls definition used, details of falls intervention, number of studies and number of participants, participant demographics, main results (effect size with 95% confidence intervals [95% CIs]), adverse events, heterogeneity, publication bias, and conclusions. In the literature, a range of statistical methods has been used to assess the effect of interventions on falls, including rate ratios (RaR=rate of falls), risk ratios/relative risk (RR=number of people who have fallen/risk of falls), and odds ratios (OR=odds of having a fall during the trial). The RaR provides a summary of the rate of falls between the intervention and control groups (4). The RR, on the other hand, compares the number of people who have fallen between the intervention and control groups (4), and the OR is the ratio of the odds of a fall happening in each group (16). Collectively, we refer to the effect of the interventions on falls. However, when we refer to individual meta-analyses, we refer to the actual measurement used in each study. Where possible, we extracted data on heterogeneity from each pooled analysis and, in accordance with the Cochrane collaboration, report the I^2 statistic, which refers to the percentage of total variation across studies that is due to heterogeneity rather than chance (16, 17). Low, moderate, and high I^2 values of 25%, 50%, and 75%, respectively, are commonly accepted (17). Due to the heterogeneity in the populations, interventions, and other key characteristics, the results are presented in a narrative synthesis (12).

Methodological Quality Assessment

Two authors (B.S., S.B.) independently completed the Assessment of Multiple Systematic Reviews (AMSTAR).18 A third reviewer (M.D.D.) was available. The AMSTAR is a reliable and valid way to assess the methodological quality of systematic reviews and meta-analyses (19). The AMSTAR tool consists of 11 items that are rated as "met," "unclear," or "unmet," and scores are given ranging from 0 (low quality) to 11 (highest quality) (18, 19). The AMSTAR scores are graded as high (8–11), medium (4–7), or low (0–3) quality (18-20).

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eAppendix: Articles excluded from communiy-dwelling umbrella review: Reasons for exclusion.

RESULTS

Description of Search Results

Using the search strategy, 112 full texts were considered, and 96 articles were excluded (see eAppendix for list of excluded articles). Within the final sample, 16 separate meta-analyses reporting 47 pooled analyses were represented (4, 14, 21-34). Full details of the search results are presented in the Figure.

Description of Included Meta-analyses

Details of the included meta-analyses are summarized in Table 1. In brief, the meta-analyses included between 3 and 22 (23) individual RCTs and between 348 (23) (education and exercise analysis, number of studies=3) and 27,522 (21) participants across the pooled analyses. Only 3 meta-analyses provided a definition for a fall (4, 24, 26). Three meta-analyses provided details of adverse events of the RCT interventions (4, 24, 29), which were all minor. Overall, the quality of the meta-analyses was medium to high. Specifically, 8 meta-analyses were graded as high quality, (4, 14, 22, 24-26, 29, 32) 7 were graded as medium quality, (21, 23, 27, 28, 30, 31, 33) and 1 was considered as low quality (34) (see Tab. 1 for AMSTAR scores).

Single Interventions

Exercise

Seven meta-analyses investigated a range of exercise interventions, (4, 23, 24, 27, 29, 30, 34) and from these meta-analyses, 13 out of 14 pooled analyses demonstrated that exercise significantly reduced falls (including the rate and risk of falling). Exercise was responsible for reductions in falls, ranging from a 13% reduced risk (29) (RR=0.87; 95% CI=0.81, 0.94); number of trials=18; number of participants=3,568) and a 61% reduction in the rate of falls24 (RaR=0.39; 95% CI=0.23, 0.66; number of trials=6) and rate of falls causing fracture (number of trials=6). Only one study (34) demonstrated a nonsignificant reduction in falls, although it was rated as low quality. Overall, the methodological quality of exercise MAs was moderate to high.

Guo *et al* (23) pooled 22 studies (number of participants=4,912) investigating a range of exercise interventions and found that exercise significantly reduced the odds of falling (OR=0.78; 95% CI=0.65, 0.93). El-Khoury *et al* (24) found that exercise significantly reduced the rate of injurious falls (RaR=0.63; 95% CI=0.51, 0.77; number of trials=10; I2=50%), the rate of falls resulting in medical care (RaR=0.70; 95% CI=0.54, 0.92; number of trials=8; I2=20%), the rate of falls causing serious injury (RaR=0.57; 95% CI=0.36, 0.90; number of trials=7; I2=46%), and the rate of falls causing a fracture (RaR=0.39; 95% CI=0.23, 0.66; number of trials=6; I2=0%). Petridou *et al* (27) reported that exercise significantly reduced risk of falls (RR=0.67; 95% CI=0.52, 0.85).

Gillespie *et al* (4) demonstrated that exercise reduced the rate of falls regardless of whether it was conducted in a group setting (RaR=0.71; 95% CI=0.63, 0.82; number of trials=16; number of participants=3,622; I^2=48%) or at home (RaR=0.68; 95% CI=0.58, 0.80; number of trials=7; number of participants=951; I^2=0%). They also established that exercise focused on gait, balance, or functional training reduces the rate of falls (RaR=0.72; 95% CI=0.55, 0.94; number of trials=4; number of participants=519; I^2=0), whereas tai chi, although significant, was borderline and heterogeneous (RaR=0.72; 95% CI=0.52, 1.00; number of trials=5; number of participants=1,563; I^2=72%). Michael *et al* (29) reported that physical therapy–based exercises resulted in a reduction in risk of falls (RR=0.87; 95% CI=0.81, 0.94; number of trials=18; number of participants=3,986; I^2=4%). Thomas *et al* (30) reported the Otago exercise program significantly reduced the rate of falls across 6 studies involving 1,466 people (RaR=0.68; 95% CI=0.56, 0.79; I^2=0%).

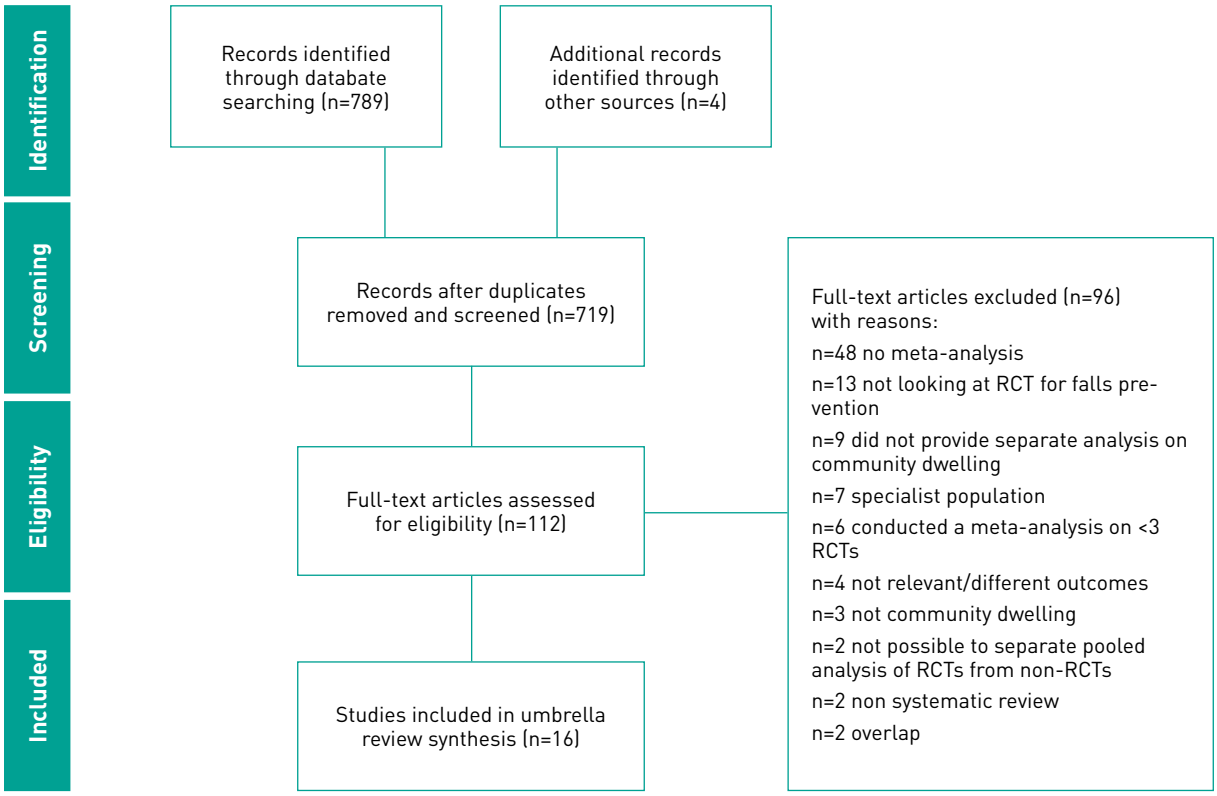
In conclusion, there is consistent evidence (93% or 13/14 pooled analyses) to support the effectiveness of exercise as a single intervention to prevent falls (including the risk, odds, and rate of falls). This finding is primarily based on medium-high quality evidence.

Vitamin D supplementation. Seven meta-analyses investigated the influence of vitamin D supplementation on falls, (4, 14, 21, 23, 26, 29, 33) and from 12 pooled analyses, 7 established that vitamin D supplementation significantly reduced falls. The effect size ranged from a 22% reduced odds of falling when vitamin D supplementation was combined with calcium (23) (OR=0.78; 95% CI=0.63, 0.98; number of trials=6; number of participants=4,326) to a 12% reduced risk of falls without calcium (26) (RR=0.88; 95% CI=0.81, 0.96; number of trials=10; number of participants=12,701).

Guo *et al* (23) pooled 11 RCTs (6 with vitamin D supplementation and calcium and 5 with vitamin D supplementation alone) and found there was no significant effect on the odds of falling. In a subgroup analysis, the authors established that vitamin D supplementation when combined with calcium reduced the odds of falling (OR=0.78; 95% CI=0.63, 0.98) but vitamin D supplementation alone did not (OR=1.02; 95% CI=0.82, 1.28). Kalyani *et al* (26) pooled 10 studies and reported that vitamin D supplementation significantly reduced the risk of falls (RR=0.88; 95% CI=0.81, 0.96; number of participants=12,701; I^2=34%). Gillespie *et al* (4) pooled the data from 7 RCTs (number of participants=9,324)

Figure

Flow diagram of search strategy. RCT=randomized controlled trial.



and reported that vitamin D supplementation had no significant effect on falls rate (RaR=1.00; 95% CI=0.90, 1.11; I2=69%). Murad *et al* (14) and Michael *et al* (29) pooled the data on RCTs of vitamin D supplementation with and without calcium and found that the risk and odds of falls were respectively reduced (Michael *et al* (29): RR=0.83; 95% CI=0.77, 0.89; number of trials=9; number of participants=5,809; I^2=3%; Murad *et al* (14): OR=0.80; 95% CI=0.69, 0.93; number of trials=16; number of participants=unclear). Bolland *et al* (21) reported that vitamin D supplementation had no significant effect on the risk of falls (RR=0.96; 95% CI=0.90, 1.02; number of trials=14; number of participants=27,522); this finding remained true in subgroup analyses for vitamin D supplementation alone (RR=0.96; 95% CI=0.88, 1.04; number of trials=11; number of participants=20,861) and when combined with calcium (RR=0.93; 95% CI=0.85, 1.02; number of trials=5; number of participants=9,336).

In summary, there is conflicting evidence (58.3% or 7/12 pooled analyses) regarding the effectiveness of vitamin D supplementation to reduce falls (including the rate, odds, and risk), although the influence of vitamin D supplementation appears more effective when combined with calcium.

Environmental interventions. In total, 3 meta-analyses considered environmental interventions to reduce falls, and 7 different pooled analyses were available (4, 23, 31). All 3 meta-analyses reported one analysis that demonstrated environmental interventions reduced falls; overall, 4 out of the 7 pooled analyses demonstrated a statistically significant reduction in falls.

Guo *et al* (23) reported in the pooled environmental and assistive technology analysis that the odds of falling were not significantly reduced (OR=0.83; 95% CI=0.68, 1.01; number of trials=13; number of participants=6,353). However, when they conducted a subgroup analysis of these results, they demonstrated that home visit and modification did significantly reduce the odds of falling (OR=0.75; 95% CI=0.56, 0.99; number of trials=7; number of participants=3,531), whereas assessment and modification alone did not (OR=1.11; 95% CI=0.83, 1.48; number of trials=3; number of participants=1,956). In their Cochrane review, Gillespie *et al* (4) demonstrated that home safety and modification reduces the rate of falls (RaR=0.81; 95% CI=0.68, 0.97; number of trials=6; number of participants=4,208; I^2=64%). They then demonstrated that home safety interventions were significantly effective when delivered by an occupational therapist (RaR=0.69; 95% CI=0.55, 0.86; number of trials=4; number of participants=1,443) but not when delivered by a non-occupational therapist (RaR=0.91; 95% CI=0.75, 1.11; number of trials=4; number of participants=3,075; I^2=42%). Finally, Clemson *et al* (31) conducted a review focusing solely on environmental interventions and found that interventions that adapted and modified the environment resulted in a reduction in the risk of falls (RR=0.79; 95% CI=0.65, 0.97; number of trials=6; number of participants=3,298; I^2=69%).

Overall, there is conflicting evidence (57%, 4/7 pooled analysis) to suggest that environmental interventions may reduce falls in community-dwelling older adults. This finding was based on moderate-quality meta-analyses.

Surgery. Two meta-analyses (4, 23) reported a pooled analysis investigating the influence of surgery on falls. Gillespie *et al* (4) pooled data from 3 RCTs investigating cardiac pacing surgery and found that it significantly reduced the rate of falls in older adults with carotid sinus hypersensitivity, a condition that causes sudden changes in heart rate and blood pressure (RaR=0.73; 95% CI=0.57, 0.93; number of participants=349; I^2=51%). Guo *et al* (23) pooled 2 studies investigating cardiac pacing and 1 study investigating cataract surgery and found there was a nonsignificant reduction in the odds of falling (OR=0.87; 95% CI=0.45, 1.66; number of participants=704). Overall, there is limited evidence to suggest that surgical interventions can reduce falls.

Other Single Interventions

Guo *et al* (23) reported that education did not significantly reduce the odds of falling (OR=0.75; 95% CI=0.51, 1.10; number of trials=4; number of participants=810). Campbell and Robertson (28) pooled a range of single interventions and reported a statistical reduction in the rate of falls (RaR=0.77; 95% CI=0.67, 0.89; number of trials=10; number of participants=unclear).

Multifactorial Interventions

Six meta-analyses investigated the efficacy of individually tailored multifactorial interventions (4, 25, 27-29, 34). Of these meta-analyses, 5 reported that falls were significantly reduced, (4, 25, 27, 28, 34) and 1 showed a nonsignificant trend toward reducing falls (29). Multifactorial falls preventions reduced falls by between 10% (25, 27) and 35% (34), although the study by Weatherall *et al* (34) scored low (2) on the AMSTAR tool.

Choi and Hector (25) pooled 12 RCTs (number of participants=unclear) and found that multifactorial interventions reduced the risk of falls (RR=0.90; 95% CI=0.85, 0.96; Q=1.757; P=.185), which is comparable to the effect found in the meta-analysis by Petridou *et al* (27) (RR=0.90; 95% CI=0.82, 1.00; number of trials=5; number of participants=1,952; Q=6.9; P=.1). Gillespie *et al* (4) pooled data from 19 RCTs investigating multifactorial interventions and found that the rate of falls was significantly reduced (RaR=0.76; 95% CI=0.67, 0.86; number of participants=9,503; I^2=85%). Campbell and Robertson (28) pooled data from 6 RCTs and established that the rate of falls was reduced (RaR=0.78; 95% CI=0.68, 0.89; number of participants=unclear; I^2=38%).

Overall, there is consistent evidence (83%, 5/6 pooled analyses) that multifactorial interventions reduce falls

(including the rate and risk of falling) in community-dwelling older adults. This finding was based on moderate- to high-quality meta-analyses.

Other Combined and Multicomponent Interventions

Goodwin *et al* (22) pooled the data from 15 RCTs investigating "multicomponent" interventions, where the interventions were not individually tailored. They found that multicomponent interventions significantly reduced the risk of falls (RR=0.86; 95% CI=0.80, 0.92; number of participants=unclear; I2=0%). Another meta-analysis (32) pooled data from 4 nurse-led RCTs and found that the intervention had no significant effect on the odds of falling (OR=0.51; 95% CI=0.19, 1.36; number of participants=1,392; I^2=89%).

Overall, there is limited evidence from one meta-analysis that multicomponent interventions reduce falls, and there is no evidence that nurse-led interventions reduce falls. Summaries of the interventions are presented in Table 2.

DISCUSSION

Within this umbrella review, we have demonstrated that there is consistent moderate- to high-quality evidence (13/14 pooled analyses or 6/7 meta-analyses) that exercise can significantly reduce falls (including the rate, risk, and odds of falling). There is conflicting evidence that environmental and vitamin D supplementation interventions can reduce falls. There is evidence from moderate- and high-quality meta-analyses that multifactorial interventions can reduce falls among older adults (5/6 pooled analyses reported significant reduction). Surprisingly, there is a dearth of information on the harms from fall prevention interventions reported in the meta-analyses included in our umbrella review. However, in those meta-analyses that did report such information, the reported harms were all relatively minor, and this dearth of information may be a reflection of the lack of reporting in the original studies.

The results of this review support the notion that exercise should be provided to community-dwelling older adults to prevent falls. Our findings echo those of individual meta-analyses (13) showing strong evidence that exercise is effective in preventing falls (albeit pooled analyses across mixed settings). The exact type (eg, balance, strengthening, tai chi), duration, frequency, and setting of such interventions do show some variations in the effect of the results, but describing these variations in greater detail is beyond the scope of this review. Still, with regard to the optimal nature of exercise, a balanced program including endurance, balance, and strength exercises could be recommended (35). Perhaps the most robust included meta-analysis investigating exercise was the Cochrane review by Gillespie *et al* (4). All 4 pooled analyses that we included demonstrated a similar significant reduction in falls, regardless of whether it was in a group (RaR=0.71), was at home (RaR=0.68), involved balance training (RaR=0.72), or was tai chi-based (RaR=0.72). In an innovative review, El-Khoury *et al* (24) found that exercise had profound effects on reducing a range of different types of injurious falls (including fractures); thus, exercise has an integral role in the management of falls in the community. Overall, about half of the pooled analyses investigating exercise (5/11 pooled analyses) had low to moderate heterogeneity (I^2<50% or nonsignificant Cochran Q). Therefore, together with the moderate- and high-quality nature of these meta-analyses, we can be confident that exercise helps to prevent falls.

Ultimately, outside evidence on the frequency, intensity, and type (FIT) principles, the patients' preference also should be considered, as it can influence adherence to exercise programs. In addition, some older adults may have specific physical comorbidities (eg, musculoskeletal pain3), meaning that they may need a physical therapist to provide an assessment and deliver appropriate adaptive interventions. Specifically, the effectiveness of physical therapy–based exercise interventions was established in the US Preventive Services Task Force meta-analysis (29). The results of the current umbrella review affirm the central role of physical therapists in the prevention of falls in community-dwelling older adults. When one considers that exercise has a range of wider health benefits, such as comparable effects of medication interventions on preventing mortality (36), the standout benefits of exercise on falls prevention are encouraging. We recommend, therefore, that all older people at risk for falling or known to fall should be encouraged to exercise, and for those who are particularly high risk and have a range of limitations, physical therapists should oversee this process.

The evidence regarding vitamin D supplementation is conflicting, although this intervention does appear more promising when combined with calcium supplementation. In their recent sequential meta-analysis, Bolland *et al* (21) demonstrated that vitamin D supplementation did not reduce falls or alter the relative risk by 15% or more. They recently compared the results of their meta-analysis (21) and an earlier one (14), which arrived at opposite conclusions, and stated that the different conclusions were due to methodological differences and different statistical approaches (37). Other groups have criticized these findings because of the inclusion of low-quality RCTs and the importance of appropriate doses (38, 39). Although even small effects of vitamin D supplementation could still result in public health recommendations because of overall low serum levels in older adults, little adverse effects, and low price, calcium has to be considered separately. Calcium supplementation has been associated with an increased risk of cardiovascular events (40), and in a recent review by the same group, the authors concluded that any benefit of calcium supplements on preventing fracture is outweighed by increased cardiovascular events (41). So far, weighing current evidence and balancing risks (few) and benefits (fair) beyond the outcome falls (in the pre-

ceding sentences, we discuss the wider implications of vitamin D; here, we are saying vitamin D may have other benefits outside of falls prevention), we support current recommendations of most guidelines: sufficient vitamin D supplementation of at least 1,000 IE daily or serum 25-hydroxy-vitamin D supplementation concentrations of 30 ng/mL (75 nmol/L) and higher, especially with respect to frail older adults and those with very low vitamin D supplementation levels (42).

Regarding environmental falls prevention strategies, the interventions were generally not well defined and appear heterogeneous, although they may be effective in reducing falls, particularly when conducted by an occupational therapist (4). Multifactorial interventions, in which particular risk factors are identified and then interventions are individually tailored, have become popular in the medical literature and clinical practice. The results from our umbrella review support the use of this approach, although delivering multifactorial interventions and identifying individual risk factors can be time-consuming. Therefore, the finding from the recent meta-analysis that multicomponent interventions (in which the intervention is not specifically tailored to the individual) also can reduce falls is of great interest (22). This finding again seems to account particularly for programs where exercise is part of the intervention. However, effect sizes do not differ very much from those that build on exercise alone.

Limitations and Strengths

Our umbrella review has a number of strengths. We conducted a comprehensive search, including only the highest-quality evidence (meta-analyses of RCTs), and condensed this evidence in one place to make it readily accessible for physical therapists and other clinicians. The overall methodological quality of the included meta-analyses was moderate. Although this is the first umbrella review, a number of limitations should be acknowledged, which are largely reflected by limitations in the original studies. First, not all of the studies assessed heterogeneity, and as shown in Table 1, only studies of 10 meta-analyses reported a heterogeneity statistic. Often, the studies analyzed the effect of the intervention using different summary measures (eg, RaR, RR, OR), making it more challenging for the reader to interpret. Second, the meta-analyses often did not publish specific details regarding the included studies. Thus, it was not always possible to determine clinical homogeneity. Third, several meta-analyses may have included similar studies in their analyses. Also, it is unclear if the lack of adverse events reported in the included meta-analyses is due to the absence of these in the original studies. In addition, relying upon systematic reviews may mean that landmark primary studies are not highlighted. Finally, we could not include several reviews that investigated falls prevention interventions with meta-analysis in mixed settings that did not provide subgroup analysis for community-dwelling older adults.

Nevertheless, allowing for these caveats, our umbrella review is the first such review and provides key evidence to position physical therapists to be well equipped to manage falls in community-dwelling older adults. In essence, the available evidence suggests that exercise interventions are the most consistently effective and robust interventions to tackle falls in older adults, and it could be hypothesized that exercise also largely accounts for the effect seen in multifactorial/multicomponent programs. However, future research should investigate the frequency, intensity, and type of intervention and setting and test their effectiveness in clinical practice. Very few meta-analyses reported on the harms associated with falls prevention interventions—an important outcome that was likely limited by the primary studies. Regardless, policies are often made based on systematic reviews of interventions. Therefore, it is important that authors of studies of interventions adequately report any harmful side effects and clearly define their outcome measures in advance.

In conclusion, we found consistent evidence to suggest that exercise is associated with a reduction in the rate, risk, and odds of falling (including falls resulting in injury), thus affirming physical therapists' central position to lead in international efforts to prevent falls. There also is consistent evidence regarding the effectiveness of multifactorial interventions.

Table 1

Summary and Results of Induded Studies[a].

Study	Country	Intervention	RCTs Included (nNumber of Participants)	Participants' Details	Define a Fall?	Main Results (95% CI)	Heterogeneity	Adverse Events	AMSTAR	Conclusion
Bolland et al, (21) 2014	New Zealand	Vitamin D with or without calcium	14 (n=27.522)	Mean age=67–81 y in RCTs, 24%–100% female participants in RCTs	No	RR=0,96 (0,90, 1,02)	NR	NR	5	Vitamin D supplementation with or without calcium does not reduce the risk of falling in community-dwelling older adults
		Vitamin D without calcium	11 (n=20.861)			RR=0,96 (0,88, 1,04)	NR			
		Vitamin D with calcium	5 (n=9.336)			RR=0,93 (0,85, 1,02)	NR			
Goodwin et al, (22) 2014	United Kingdom	Multicomponent interventions (2 or more interventions not individually tailored)	15 (n=?, 5.034 in total)	Mean age= 69–86.4 y, 38%–100% female	No	**RR=0,86 (0,80, 0,92)**	I^2 = 0%	NR	9	Multicomponent interventions not specifically tailored to an individual's risk factors reduce the number of fallers and rate of falls
						RaR=0,78 (0,71, 0,85)	I^2 =20%			
Gou et al, (23) 2014	Taiwan	Exercise vs control:	22 (n=4.912)	Older adults without cognitive impairment Mean age= 64.5–89.0 y	No	**OR=0,78 (0,65, 0,93)**	NR	NR	4	Exercise reduces falls in older adults

Table 1

Summary and Results of Induded Studies[a] (continued).

Study	Country	Intervention	RCTs Included (nNumber of Participants)	Participants' Details	Define a Fall?	Main Results (95% CI)	Heterogeneity	Adverse Events	AMSTAR	Conclusion
		Non tai chi exercise	20 (n=4.150)			**OR=0,78 (0,64, 0,95)**				
		Nutritional supplement	11 (n=9.750)			OR=0,89 (0,75, 1,04)				Vitamin D supplementation with calcium reduces falls, but vitamin D alone does not
		Vitamin D alone	5 (n=5.424)			OR=1,02 (0,82, 1,28)				
		Vitamin D + calcium	6 (n=4.326)			**OR=0,78 (0,63, 1,01)**				
		Environment/ assistive technology	13 (n=6.353)			OR=0,83 (0,68, 1,01)				
		Home visit and modification	7 (n=3.531)			**OR=0,75 (0,56, 0,99)**				Home visits and modification reduce falls
		Assess and modification	3 (n=1.956)			OR=1,11 (0,83, 1,48)				
		Education intervention	4 (n=810)			OR=0,75 (0,51, 1,10)				Education alone or when combined with exercise has no effect on falls
		Education and exercise	3 (n=348)			OR=1,16 (0,40, 3,32)				

Table 1

Summary and Results of Induded Studies[a] (continued).

Study	Country	Intervention	RCTs Included (nNumber of Participants)	Participants' Details	Define a Fall?	Main Results (95% CI)	Heterogeneity	Adverse Events	AMSTAR	Conclusion
		Surgery (2x cataract and 1x cardiac pacing)	3 (n=704)			OR=0,87 (0,45, 1,66)				Surgery does not reduce falls
El-Khoury *et al*, (24) 2013	France	Exercise	17 (n=4.305)	Mean age=76.7 y, 77% female	Sí	**RaR for injurious falls=0.63 (0.51, 0.77, number of trials=10)**	Injurious falls I^2=50%	Yes, 6 RCTs reported, a total of 8 participants had minor injuries. No major adverse events	9	Exercise significantly reduces all types of injurious falls, including falls requiring medical care or resulting in severe injury or fractures
						RaR for falls requiring medical care=0.70 (0.54, 0.92, number of trials=8)	Falls requiring medical care I^2 = 20%			
						RaR for serious injury=0.57 (0.36, 0.90, number of trials=7)	Serious injury I^2 = 46%			
						RaR for falls causing fracture=0.39 (0.23, 0.66, number of trials=6)	Falls causing fracture I^2 = 0%			

Table 1

Summary and Results of Induded Studies[a] (continued).

Study	Country	Intervention	RCTs Included (nNumber of Participants)	Participants' Details	Define a Fall?	Main Results (95% CI)	Heterogeneity	Adverse Events	AMSTAR	Conclusion
Choi and Hector, (25) 2012	United States	Multifactorial interventions (n=15) or single interventions n=2)	12/17 communi-ty-dwelling (n=, total=5,501)	NR	No	**Multifactorial interventions, community only RR=0.90 (0.85, 0.96, N=12)**	Q=1,757, *P*= ,185	NR	8	Multifactorial interven-tions reduce falls
Kalyani et al, (26) 2010	United States	Vitamin D supplementation	10 (n=12.701)	Age range= 71–92 y	Yes	**RR=0,88 (0,81, 0,96)**	I^2 = 34%	NR	9	Vitamin D therapy reduces falls in community-dwelling olderadults younger than 80 y regardless if a fall was defined or not
			5 (n=1.504)			**RR=0,79 (0,69, 0,92)** for par-ticipants < 80 years of age who defined a fall	I^2 = 29%			
Petridou et al, (27) 2009	Greece	Exercise and multifactorial interventions	10 (n=2.549)	All ≥ 65 years of age	No	**RR=0,67 (0,52, 0,85)**	Q=51,4 (*P*<,001)	NR	5	Exercise and multifac-torial interventions both reduce falls
		Exercise only	5 (n=597)			**RR=0,45 (0,29, 0,71)**	Q=18,5 (*P*<,001)			
		Multifactorial interventions only	5 (n=1.952)			**RR=0,90 (0,82, 1,00)**	Q=6,9 (*P* = ,14)			

Table 1

Summary and Results of Induded Studies[a] (continued).

Study	Country	Intervention	RCTs Included (nNumber of Participants)	Participants' Details	Define a Fall?	Main Results (95% CI)	Heterogeneity	Adverse Events	AMSTAR	Conclusion
Gillespie et al, (4) 2012	United Kingdom	**Exercise single interventions**		70% female All ≥ 60 years of age	Yes			Yes Resistance, 2 trials reported musculoskeletal injuries	10	Exercise as a single intervention reduces falls (including multiple components and balance)
		Group exercise: multiple categories vs control	16 (n=3.622)			**RaR=0,71 (0,63, 0,82)**	I^2 = 48%			
		Home-based exercises containing multiple components vs control	7 (n=951)			**RaR=0,68 (0,58, 0,80)**	I^2 = 0%			
		Tai chi	5 (n=1.563)			**RaR=0,72 (0,52, 1,00)**	I^2 = 72%			Tai chi has marginal effect on falls
		Gait, balance, or functional training	4 (n=519)			**RaR=0,72 (0,55, 0,94)**	I^2 = 0%	Minor adverse events Vitamin D		
		Vitamin D:	7 (n=9.324)			RaR=1,00 (0,90, 1,11)	I^2 = 69%			Vitamin D does not reduce falls
		Surgery: cardiac pacing	3 (n=349)							Fitting cardiac pacing device reduces falls

Table 1

Summary and Results of Induded Studies[a] (continued).

Study	Country	Intervention	RCTs Included (nNumber of Participants)	Participants' Details	Define a Fall?	Main Results (95% CI)	Heterogeneity	Adverse Events	AMSTAR	Conclusion
		Environment:				**RaR=0,73 (0,57, 0,93)**	I^2 = 51%			Environmental interventions and modifications reduce falls when delivered by an OT to individuals at high risk of falling
		Home safety and modification	6 (n=4.208)			**RaR=0,81 (0,68, 0,97)**	I^2 = 64%			Home safety and modification are effective in reducing falls
		Home safety by OT	4 (n=1.443)			**RaR=0,69 (0,55, 0,86)**	I^2 = 58%			
		Home safety not by OT	4 (n=3.075)			RaR=0,91 (0,75, 1,11)				
		Multifactorial interventions	19 (n=9.503)			**RaR=0,76 (0,67, 0,86)**				Multifactorial interventions reduce falls
Campbell and Robertson, (28) 2007	New Zealand	Multifactorial interventions	14 (n=5.968)	67% female All > 65 years of age	No	**RaR=0,78 (0,68, 0,89, number of trials = 6)**	I^2 = 38%	NR	7	Both multifactorial and single interventions reduce falls and are equally effective
		Single intervention				**RaR=0,77 (0,67, 0,89, number of trials = 10)**	I^2 = 54%			

Table 1

Summary and Results of Induded Studies[a] (continued).

Study	Country	Intervention	RCTs Included (nNumber of Participants)	Participants' Details	Define a Fall?	Main Results (95% CI)	Heterogeneity	Adverse Events	AMSTAR	Conclusion
Michael et al, (29) 2010	United States	Multifactorial interventions	19 (n=7.099)	All studies included people > 65 years of age	No	**RR=0,94 (0,87, 1,02)**	I^2 = 73%	5/19 reported harms, all minor	8	Physical therapy / exercise and vitamin D significantly reduces falls, but it is unclear if multifactorial assessment and interventions reduce falls
		Exercise / physical therapy	18 (n=3.568)			**RR=0,87 (0,81, 0,94)**	I^2 = 4%	No evidence of increased falls in physical therapy studies		
		Vitamin D (with or without calcium)	9 (n=5.809)			**RR=0,83 (0,77, 0,89)**	I^2 = 3%	No evidence vitamin D increases falls, no reported harms		
Thomas et al, (30) 2010	Australia	Otago exercise program	6 (n=1.466), 1 study was CCT	Mean age=81.6 y	No	**RaR=0,68 (0,56, 0,79)**	I^2 = 0%	4 studies reported minor adverse events	7	The Otago exercise program significantly reduces falls
Murad et al, (14) 2011	United States	Vitamin D	16 (n=?, overall sample)	Mean age=76 y, 78% female	No	**OR=080 (0.69, 0.93)**	NR	NR	8	Vitamin D combined with calcium reduces falls and number of fallers among community-dwelling older adults
Clemson et al, (31) 2008	Australia	Environmental interventions (adaptations and modifications to environment)	6 (n=3,298)	Mean age=79.6 y	No	**RR=0.79 (0.65, 0.97)**	I^2 = 69%	NR	7	Focused home assessment interventions reduce falls, particularly in high risk groups

Table 1

Summary and Results of Induded Studies[a] (continued).

Study	Country	Intervention	RCTs Included (nNumber of Participants)	Participants' Details	Define a Fall?	Main Results (95% CI)	Heterogeneity	Adverse Events	AMSTAR	Conclusion
Tappenden et al, (32) 2012	United Kingdom	Nurse-based health promotion interventions	4 (n=1.392)	Age range= 71.9–83 y	No	OR=0,51 (0,19, 1,36)	I^2 = 89%	NR	8	Nurse-based health promotion interventions do not appear to significantly reduce falls
Jackson et al, (33) 2007	United Kingdom	Vitamin D	3 (n=784)	>60 years of age	No	RR=0,92 (0,75, 1,12)	I^2 = 44%	NR	6	Vitamin D does not reduce falls
Weatherall, (34) 2004	New Zealand	Exercise	5 (n=860)	NR	No	OR=0,79 (0,58, 1,08)	NR	NR	2	Exercise does not significantly reduce falls, but multifactorial interventions do
		Multifactorial interventions	11 (n=3.350)			**OR=0,65 (0,52, 0,81)**				Note: very lowquality metaanalysis

[a]NR=not reported, OR=odds ratio, CI=confidence interval, AMSTAR=Assessment of Multiple Systematic Reviews, RR=risk ratio (number of people who fall) or relative risk, RaR=rate ratio (fall rate), ?=unclear how many participants were included in the analysis, OT=occupational therapist, CCT=controlled clinical trial. Bolded results are statistically significant.

Table 2

Overview of Findings of the Meta-Analyses (MAs) Included in the Umbrella Review.

Intervention	Number of MAs	Number of Pooled Analyses	Number of MAs (Number of Pooled Analyses)			% of Overall Effect Reduces Falls (Pooled)[a]	Comment
			Reduces Falls	Increases Falls	Nonsignificant Effect		
Single interventions							
Exercise	7	14	6 (13) (4, 23, 24, 27, 29, 30)	0	1 (1) (14)	+93% (13/14)	There is consistent evidence that exercise significantly reduces falls (rate, risk, and odds), including those that cause injury. Only one MA of low methodological quality demonstrated a nonsignificant reduction in falls.
Vitamin D	7	12	5 (7) (14, 21, 23, 26, 29)	0	3 (5) (4, 23, 33)	+58,3% (7/12)	There is conflicting evidence that vitamin D supplementation prevents falls. Best evidence exists for combination with calcium.
Environmental	3	7	3 (4) (4, 23, 31)	0	2 (3) (4, 23)	+57% (4/7)	There is conflicting evidence that environmental interventions can reduce falls. Home assessment and modification are effective, particularly when delivered by an occupational therapist.
Surgery	2	2	1 (1) (4)	0	1 (1) (23)	Limited	There is limited and inconsistent evidence that surgery reduces falls, although one MA suggests that cardiac pacing surgery does reduce falls.
Education	1	1	0	0	1 (1) (23)	No evidence	1 MA demonstrated that education does not reduce falls
Single interventions combined	1	1	1 (1) (28)	0	0	Limited	1 MA pooled various single interventions and did not differentiate the type of intervention but found it reduced falls
Multifactorial, combined, and multicomponent interventions							
Individually tailored multifactorial interventions	6	6	5 (5) (4, 25, 27, 28, 34)	0	1 (1) (29)	+ 83% (5/6)	5 out of 6 MAs demonstrated that multifactorial interventions reduce falls, whereas 1 MA showed a trend toward reduction of falls. One MA demonstrating positive results had low methodological quality.
Nurse-led falls prevention	1	1	0	0	1 (1) (32)	No evidence	One MA found that nurse-led combined interventions do not reduce falls

Table 2

Overview of Findings of the Meta-Analyses (MAs) Included in the Umbrella Review (continued).

Intervention	Number of MAs	Number of Pooled Analyses	Number of MAs (Number of Pooled Analyses)			% of Overall Effect Reduces Falls (Pooled)[a]	Comment
			Reduces Falls	Increases Falls	Nonsignificant Effect		
Intervencions multifactorials, combinades i multicomponent							
Education and exercise combined	1	1	0	0	1 (1) (23)	No evidence	Education and exercise had no significant effect on falls
Multicomponent interventions (not individually tailored)	1	2	1 (2) (22)	0	0	Limited	One MA established that multicomponent interventions not tailored to the individual reduce falls

[a] Overall effect=number of supporting associations versus overall number (pooled), limited=only 1 MA investigating an intervention.

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PHYSIOTHERAPY AND NEUROGENIC LOWER URINARY TRACT DYSFUNCTION IN MULTIPLE SCLEROSIS PATIENTS: A RANDOMIZED CONTROLLED TRIAL

Randomized controlled trial
Gaspard L, et al. Prog Urol. 2014.
Prog Urol. 2014 Sep;24(11):697-707. doi: 10.1016/j.purol.2014.05.003. Epub 2014 Jun 19.

ABSTRACT

Aim

This randomized controlled trial compare the efficacy of pelvic floor muscle training vs. transcutaneous posterior tibial nerve stimulation.

Patients and methods

Inclusion criteria were EDSS score←7 and presence of lower urinary tract symptoms. Exclusion criteria were multiple sclerosis relapse during the study, active urinary tract infection and pregnancy. The primary outcome was quality of life (SF-Qualiveen questionnaire). Secondary outcomes included overactive bladder (USP questionnaire) score and frequency of urgency episodes (3-day bladder diary). Sample size was calculated after 18 patients were included. Data analysis was blinded. Each patient received 9 sessions of 30 minutes weekly. Patients were randomized in pelvic floor muscles exercises with biofeedback group (muscle endurance and relaxation) or transcutaneous posterior tibial nerve stimulation group (rectangular alternative biphasic current with low frequency).

Results

A total of 31 patients were included. No difference appeared between groups for quality of life, overactive bladder and frequency of urgency episodes (respectively P=0.197, P=0.532 et P=0.788). These parameters were significantly improved in pelvic floor muscle training group (n=16) (respectively P=0.004, P=0.002 et P=0.006) and in transcutaneous posterior tibial nerve stimulation group (n=15) (respectively P=0.001, P=0.001 et P=0.031).

Conclusions

Pelvic floor muscle training and transcutaneous posterior tibial nerve stimulation improved in the same way symptoms related to urgency in MS patients with mild disability.

Level of evidence: - II.

PMID: 25214451 [PubMed - indexed for MEDLINE]

Available at: www.ncbi.nlm.nih.gov/m/pubmed/25214451/

PREVALENCE AND "RED FLAGS" REGARDING SPECIFIED CAUSES OF BACK PAIN IN OLDER ADULTS PRESENTING IN GENERAL PRACTICE

Wendy T.M. Enthoven, Judith Geuze, Jantine Scheele, Sita M.A. Bierma-Zeinstra, Herman J. Bueving, Arthur M. Bohnen, Wilco C. Peul, Maurits W. van Tulder, Marjolein Y. Berger, Bart W. Koes, Pim A.J. Luijsterburg

DOI: 10.2522/ptj.20140525 Publicat Març 2016

ABSTRACT

Background

In a small proportion of patients experiencing unspecified back pain, a specified underlying pathology is present.

Objective

The purposes of this study were: (1) to identify the prevalence of physician-specified causes of back pain and (2) to assess associations between "red flags" and vertebral fractures, as diagnosed by the patients' general practitioner (GP), in older adults with back pain.

Methods

The Back Complaints in the Elders (BACE) study is a prospective cohort study. Patients (aged >55 years) with back pain were included when consulting their GP. A questionnaire was administered and a physical examination and heel bone densitometry were performed, and the results determined back pain and patient characteristics, including red flags. Participants received a radiograph, and reports were sent to their GP. The final diagnoses established at 1 year were collected from the GP's patient registry.

Results

Of the 669 participants included, 6% were diagnosed with a serious underlying pathology during the 1-year follow-up. Most of these participants (n=33, 5%) were diagnosed with a vertebral fracture. Multivariable regression analysis showed that age of ≥75 years, trauma, osteoporosis, a back pain intensity score of ≥7, and thoracic pain were associated with a higher chance of getting the diagnosis of a vertebral fracture. Of these variables, trauma showed the highest positive predictive value for vertebral fracture of 0.25 (95% confidence interval=0.09, 0.41) and a positive likelihood ratio of 6.2 (95% confidence interval=2.8, 13.5). A diagnostic prediction model including the 5 red flags did not increase these values.

Limitations

Low prevalence of vertebral fractures could have led to findings by chance.

Conclusions

In these older adults with back pain presenting in general practice, 6% were diagnosed with serious pathology, mainly a vertebral fracture (5%). Four red flags were associated with the presence of vertebral fracture.

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EFFECTS OF EXERCISE THERAPY ON POSTURAL INSTABILITY IN PARKINSON DISEASE: A META-ANALYSIS

Klamroth, Sarah BSc Physiotherapy; Steib, Simon Dr. phil; Devan, Surendar MA; Pfeifer, Klaus Dr. phil

Journal of Neurologic Physical Therapy
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ABSTRACT

Background and Purpose

Exercise therapy is a common intervention for improving postural stability. The purpose of this meta-analysis was to assess the effect of exercise therapy on postural instability in persons with Parkinson disease (PD) based on the available literature, and to evaluate the efficacy across various types of exercise interventions.

Data Sources and Study Selection

In January 2015, electronic databases (PubMed, Scopus, PEDro) and study reference lists were searched for randomized controlled trials with moderate or high methodological quality (PEDro score ≥ 5), investigating the effect of exercise on postural instability in persons with PD.

Data Extraction and Synthesis

Three reviewers extracted data and assessed quality.

Main Outcome and Measure

Postural stability as measured using the Berg Balance Scale, postural sway, Timed Up and Go, or Functional Reach test. Standardized mean differences (SMDs) with 95% confidence intervals (CIs) were calculated.

Results

Twenty-two trials, with a total of 1072 participants, were eligible for inclusion. The pooled estimates of effects showed significantly improved postural instability (SMD, 0.23; 95% CI, 0.10-0.36; $P < 0.001$) after exercise therapy, in comparison with no exercise or sham treatment. Exercise interventions specifically addressing components of balance dysfunction demonstrated the largest efficacy, with moderate to high effect sizes (SMD, 0.43; 95% CI, 0.21-0.66; $P < 0.001$). Little or no beneficial effects were observed for interventions not specifically targeted at postural stability (SMD, 0.20; 95% CI −0.04 to 0.44; $P = 0.11$) or for home-based, multicomponent exercise programs (SMD, 0.02; 95% CI −0.20 to 0.25; $P = 0.86$).

Discussion and Conclusions

Exercise therapies specifically addressing balance dysfunction are an important treatment option for improving postural stability in persons with PD. Future studies should investigate sustainability of the short-term effects and establish the dose-response relationship of balance training in persons with PD.

Video abstract available for additional insights from the authors (see Video, Supplemental Digital Content 1): http://links.lww.com/JNPT/A121

USE OF ULTRASOUND TO MONITOR BICEPS FEMORIS MECHANICAL ADAPTATIONS AFTER INJURY IN A PROFESSIONAL SOCCER PLAYER

Kellis, E; Galanis, N; Chrysanthou, C; Kofotolis, N

J Sports Sci Med, 2016 vol. 15(1) pp. 75-9

ABSTRACT

This study examined the use of ultrasound to monitor changes in the long head of the biceps femoris (BF) architecture of aprofessional soccer player with acute first-time hamstring strain. The player followed a 14 session physiotherapy treatment until return to sport. The pennation angle and aponeurosis strain of the long head of the biceps femoris (BF) were monitored at 6 occasions (up until 1 year) after injury. The size of the scar / hematoma was reduced by 63.56% (length) and 67.9% (width) after the intervention and it was almost non-traceable one year after injury. The pennation angle of the fascicles underneath the scar showed a decline of 51.4% at the end of the intervention while an increase of 109.2% of the fascicles which were closer to deep aponeurosis was observed. In contrast, pennation angle of fascicles located away from the injury site were relatively unaffected. The treatment intervention resulted in a 57.9% to 77.3% decline of maximum strain per unit of MVC moment and remained similar one year after the intervention. This study provided an example of the potential use of ultrasound-based parameters to link the mechanical adaptations of the injured muscle to specific therapeutic intervention.

Key points

Changes in fascicle orientation after biceps femoris mild tear were reduced after a 28 day intervention and remained similar one year after injury.Tendon/aponeurosis strain per unit of moment of force decreased during the course of the therapeutic intervention.Future studies could utilize ultrasonography to monitor mechanical responses after various types of hamstring injury and interventions in order to improve criteria for a safe return to sport.

Available at: http://www.ncbi.nlm.nih.gov/pubmed/26957929

THE IMPACT OF EARLY DETECTION AND INTERVENTION OF BREAST CANCER-RELATED LYMPHEDEMA: A SYSTEMATIC REVIEW.

Shah C[1], Arthur DW[2], Wazer D[3,4], Khan A[5], Ridner S[6], Vicini F[7].

[1]Department of Radiation Oncology, Taussig Cancer Institute, Cleveland Clinic, Cleveland, Ohio.
[2]Department of Radiation Oncology, Massey Cancer Center, Virginia Commonwealth University, Richmond, Virginia.
[3]Department of Radiation Oncology, Tufts University School of Medicine, Boston, Massachusetts.
[4]Department of Radiation Oncology, Brown University, Providence, Rhode Island.
[5]Department of Radiation Oncology, Robert Wood Johnson Medical School, Rutgers University, New Brunswick, New Jersey.
[6]School of Nursing, Vanderbilt University, Nashville, Tennessee.
[7]Michigan Healthcare Professionals/21st Century Oncology, Farmington Hills, Michigan.

ABSTRACT

Breast cancer-related lymphedema (BCRL) has become an increasingly important clinical issue as noted by the recent update of the 2015 NCCN breast cancer guidelines which recommends to "educate, monitor, and refer for lymphedema management." The purpose of this review was to examine the literature regarding early detection and management of BCRL in order to (1) better characterize the benefit of proactive surveillance and intervention, (2) clarify the optimal monitoring techniques, and (3) help better define patient groups most likely to benefit from surveillance programs. A Medline search was conducted for the years 1992-2015 to identify articles addressing early detection and management of BCRL. After an initial search, 127 articles were identified, with 13 of these studies focused on early intervention (three randomized (level of evidence 1), four prospective (level of evidence 2-3), six retrospective trials (level of evidence 4)). Data from two, small (n = 185 cases), randomized trials with limited follow-up demonstrated a benefit to early intervention (physiotherapy, manual lymphatic drainage) with regard to reducing the rate of chronic BCRL (→50% reduction) with two additional studies underway (n = 1280). These findings were confirmed by larger prospective and retrospective series. Several studies were identified that demonstrate that newer diagnostic modalities (bioimpedance spectroscopy, perometry) have increased sensitivity allowing for the earlier detection of BCRL. Current data support the development of surveillance programs geared toward the early detection and management of BCRL in part due to newer, more sensitive diagnostic modalities.

KEY WORDS: Breast cancer; detection; intervention; lymphedema; prevention

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ACUTE EFFECTS OF DIFFERENT TYPES OF ACTIVE STRETCHING IN A SPORTS WARM-UP SESSION

Laura Pacheco Arajol[1], Ramon Balius Matas[2], Caritat Bagur Calafat[1], Montserrat Girabent Farrés[1], Montserrat Pujol Marzo[1-2], Carles Pedret Carballido[3]

[1]Universitat Internacional de Catalunya, Barcelona, Spain
[2]Consell Català de l'Esport, Barcelona, Spain
[3]Clínica Diagonal, Barcelona, Spain

ABSTRACT

The aim of this study was to demonstrate the immediate effects of active stretching on the lower limbs during warm-up. A randomised prospective controlled trial (crossover) was conducted. The sample was formed of 48 adult volunteers enrolled in NVQ courses to become recreation and sport coordinators. The exercise interventions were: no stretching (NS), active static stretching in active tension (AT), and dynamic stretching (DS). Each participant did the three interventions in three different sessions: a ten-minute low-intensity steady run followed by NS or stretching, AT, and DS. After this, the Bosco jump test for squat jump (SJ), counter movement jump (CMJ) and drop jump (DJ) was done to assess explosive power. The protocol followed was a jump test, general warm-up with a steady run and some stretching randomly assigned during the session. At the end of the assessment session, the jump test was repeated. A statistical intra-group analysis (comparing post-intervention and pre-intervention values) with a paired sample T-test was performed and significant differences in all the variables analysed were found, with a higher value in the post-test jump. In the AT stretching, the post-intervention increase was found in SJ and CMJ whereas in DS, it occurs in DJ. Using one-way ANOVA, it was analysed whether the increase in the variables was different depending on the exercise intervention. The results showed no significant differences. Although the participants showed a significant improvement in the post-intervention jump, the fact that there were no differences in the increase would indicate that stretching does not seem to alter the warm-up protocol. In conclusion, the results of the study seem to suggest that active stretching is appropriate during warm-up in sport disciplines requiring explosive power.

KEY WORDS: Sports and physical activity, acute effects of stretching exercises, active static stretching in active tension, dynamic stretching, warm-up, explosive power (jumping).

Abstract from the poster presented at VII Congress ***MuscleTech Network***. Barcelona 7-9 October 2015.

Col·legi de Fisioterapeutes de Catalunya

PHYSIOTHERAPY UPDATES

LEARN HOW TO DO RESEARCH

EVIDENCE-BASED PHYSIOTHERAPY AND TRANSLATIONAL RESEARCH

Dr. Josep Sánchez Aldeguer, MD, PhD[*‡] Dr. Jordi Esquirol Caussa, MD, PhD[*†]
Dr. Ishar Dalmau Santamaria, MD, PhD[*§]

[*] Physiotherapy Research Centre. Escoles Universitàries Gimbernat (affiliated with Autonomous University of Barcelona (UAB)).
[‡] College of Medicine. Autonomous University of Barcelona (UAB).
[†] Teknon Medical Centre. Barcelona.
[§] Dept. of Medicine, Physiotherapy. Autonomous University of Barcelona (UAB).
Contact (first author): Dr. Josep Sánchez Aldeguer Tel.: 93.589.37.27 josep.sanchez@eug.es

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ABSTRACT

Healthcare professionals must offer the best clinical care based on the most appropriate scientific knowledge for each individual case, combining the healthcare provider's clinical expertise and experience and the preferences expressed by the informed patient (evidence-based practice). This process prevents the persistence of medical paternalism and increases healthcare quality and outcomes. Evidence-based physiotherapy adapts clinical interventions to the development of scientific knowledge resulting from clinical research and adjusts the application of this knowledge to the healthcare provider's clinical experience and the patient's values and preferences.

As a result of the evolution of evidence-based science, a translational perspective of science and research foresees the direct clinical application of outcomes and acquired knowledge as part of the initial approach to research projects. Therefore, the development of scientific knowledge fosters the improvement of procedures and outcomes in healthcare processes. Taking into account individual biomarkers for predicting disease, evolution and response, it is possible to predict those individuals who have a higher risk of getting a disease or of reacting positively or negatively to a given treatment (predictive healthcare) and predict the most appropriate treatment option for each individual patient (personal healthcare).

Physiotherapy professionals must develop competences that allow them to go through the evidence-based process in their clinical practice: formulate an adequate clinical question, find and assess published scientific evidence and integrate it into their clinical experience, make decisions together with their patients and assess the clinical outcomes of the process. Clinical guidelines and action plans can help in this process related to their everyday clinical practice.

KEYWORDS: Physical Therapy Specialty, Evidence-Based Practice, Patient-Centred Care.

INTRODUCTION

We would like to start this collection of articles on methodology and physiotherapy emphasizing the importance and application of scientific knowledge in clinical practice. Healthcare professionals are committed to and are responsible for offering their patients the best possible diagnostic and treatment options since the highest standard of health is a fundamental human right (World Health Organisation, New York, 1946). In any healthcare intervention, scientific knowledge must be adapted to each specific case and be adjusted to the healthcare provider's expertise and the patient's own preferences. From this central concept derive: evidence-based practice, outcomes research, clinical reasoning, principles of bioethics, patient-centred care, and shared clinical decision-taking, which prevent medical paternalism so deeply entrenched until the end of the 20th century.

Healthcare based on scientific knowledge has existed for, at least, 180 years: healthcare must not only be based on the healthcare provider's experience, so given to speculation, but also on experimental findings that show the effects of clinical interventions in quantifiable or numerical terms (Pierre Alexander Louis, "An Essay on Clinical Instruction", Paris, 1830). But it is not until the 80s and 90s in the 20th century that this concept spreads among medical sciences starting with the concept of evidence-based medicine, which is defined as "the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients" (David Sackett *et al*, 1996), both in clinical practice and in public health policies and programmes.

Evidence Based Practice

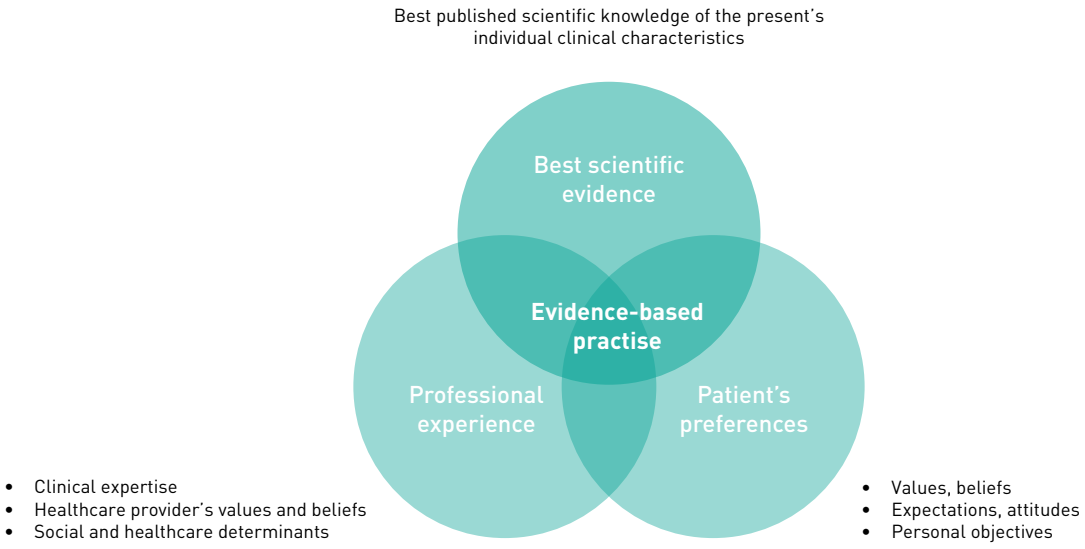
The aim of any healthcare process is to positively affect the patient's health and well-being. The practice of healthcare professions requires that, when making any clinical decision, the best available scientific information is taken into account and adapted to the patient's personal conditions and environment. This is then how the triad of Evidence Based Practice (EBP) is seen as the integration of (Fig. 1):

- the best available evidence applicable to each specific case,
- the clinical experience of the healthcare provider,
- and the informed patient's expectations and preferences.

EBP involves the process of systematic search, critical assessment and application of research findings to clinical practice, in contrast with the old paternalistic approach based on opinions (empiricism) and on the subjective, personal experience of each healthcare professional. Treatment is no longer prescribed according to the doctor's opinion and experience (or fallible memory), allowing therapeutic outcomes not to depend on the opinion, memory or experience of one or another professional. Clinical interventions should be based on the adaptation of scientific knowledge to each individual patient, and so reduce unwanted clinical variability and uncertainty of therapeutic outcomes and increase healthcare quality. Treatments are prescribed because they have proven to be useful in analogous cases

Figure 1

Triad of Evidence Based Practice.



(and they have proven to be more efficient than other alternative options) and because they agree with the patient's expectations and values and the healthcare provider's clinical competence. Clinical interventions are not prescribed based on personal opinions but on knowledge obtained through scientific research.

EBP does not mean treating all patients based on clinical trial results, systematic reviews or clinical practice guidelines; it does not intend to diminish the importance of clinical experience or of knowledge and experience acquired throughout the years; it does not limit the freedom of healthcare professionals at decision-taking. EBP aims to integrate personal clinical experience with systematic and revised experiences of researchers all over the world (published evidence) in order to adapt clinical decisions and increase the efficiency of medical interventions by offering the patient the right to "enjoy the highest standard of health".

When facing the claim that a particular treatment "works" or that it is "the best treatment", what must be asked is "Is it the 'best'? Why and who for?". The biospsychosocial approach to healthcare is based on the correct application of scientific evidence adapted to each specific circumstance taking into account the informed patient's environment, expectations and preferences.

Evidence Based Physiotherapy (EBP)

In 1999 the Evidence Based Physiotherapy Centre (EBPC) was founded, shortly after the appearance of Evidence Based Medicine (EBM) and Evidence Based Nursing (EBN). The 2001 congress of the World Confederation for Physical Therapy (WCPT) focused monographically on the implementation of EBP in physical therapy, shaping and putting EBP on the same level as other healthcare sciences. The WCPT defines physiotherapy as a "science-based healthcare profession that emphasises the use of physical means in the promotion, maintenance, and restoration of our physical, psychological, and social well-being taking account of individual variations in health" and the EBCP stresses that "effective physiotherapy focuses on the patient and on safe and technically expert prevention based on the best available evidence and efficiently managed":

EBP means adapting clinical interventions to the progress of knowledge and technology, requiring a regular review of new scientific evidence. Clinical research uses the experimental scientific method to reach conclusions that can provide new data about the clinical usefulness of a procedure or theory and, this way, improve diagnostic capacity, assessment reliability, and effectiveness of treatment or prevention approaches, allowing physiotherapy practice to move forward. This places major importance on basic and applied research as the core of healthcare-related activities and the dissemination of new knowledge (publication of results).

Translational research

Basic research allows the development of scientific knowledge but applied research is fundamental in order to obtain useful evidence for clinical practice. Translational research proposes that any investigation effort translates into direct benefits so that, from the very early stages of project design, the direct application to clinical practice is anticipated (from bench to bedside). Translational research is the most advanced stage of evidence based science, which aims to hasten the transference (translation) of new knowledge into innovations for clinical practice. Conversely, it also intends clinical practice to stimulate research in the most practical sense for the community. Therefore, a translational scientific approach is the bridge between research and clinical practice.

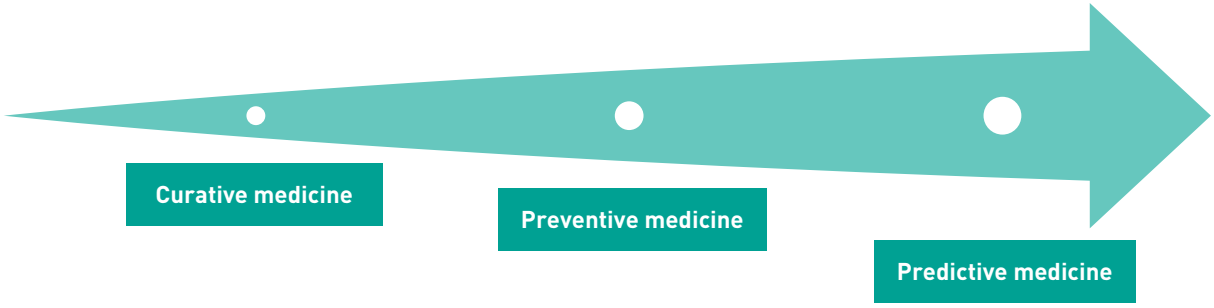
From translational research come predictive healthcare and personalised healthcare, more specifically from the concept of health biomarkers that can predict the patient's response in a clinical intervention. A biomarker is any kind of quantifiable biological measure of a process correlated with a physiological, pathological or clinical observation: a characteristic that is recognised as an indicator of the relationship between the patient and his/her disease, the medical technology and procedures available or the patient's response to treatment. Biomarkers are useful to define a diagnosis, prognosis or therapeutic indication as well as to measure treatment response and monitor the patient's evolution.

The development of predictive healthcare is changing traditional disease-based systems (curative medicine), which in Western Europe have already evolved into health-based systems (preventive medicine), to positively defined systems predicting the probability of disease in each individual person (predictive medicine), allowing individualised preventive measures adapted to each person (illustration 2), preventing the appearance of disease or minimising its impact, acting on each individual instead of dealing with prevention from the point of view of populations.

Personalised medicine (from which precision medicine derives) manages healthcare interventions based on the study of each patient and his/her biomarkers, offering the right treatment to the right patient with the right condition, at the right moment and with the right intensity and duration. Biomarkers allow planning "tailor-made treatments" beforehand (individualisation), taking into account the patient's background and therapeutic response prediction.

Figure 2

Evolution of health systems, from disease-based systems to prevention-based and disease prediction systems.



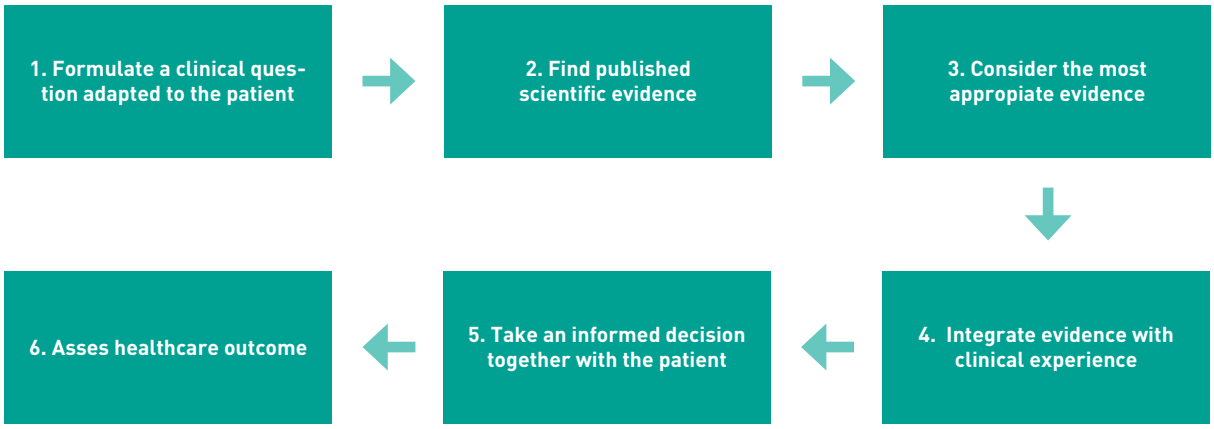
As in any other healthcare discipline, physiotherapy professionals need to develop competences and abilities that allow them to follow all the necessary steps to apply EBP in their clinical practice (illustration 3):

1. Formulate a clinical question adapted to the patient's reality (clinical reasoning: identifying the problem).
2. Find scientific evidence regarding a topic (searching for the best evidence in the scientific literature).
3. Consider the most appropriate evidence for the medical case at hand (critical reading of the selected scientific literature).
4. Integrate the evidence with clinical experience (designing diagnostic or therapeutic plans and clinical guidelines).
5. Take a clinical decision together with the informed patient (patient-centred care and shared decision making).
6. Assess the outcomes and compare them to reference values (outcomes analysis and clinical research).

Tools like clinical guidelines and intervention plans are of great help to EBP since they help physiotherapy professionals to simplify this process. Each of these steps will be further developed in the next articles to be published in this series about methodology.

Figure 3

6-step sequence of Evidence Based Practice.



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Col·legi de Fisioterapeutes de Catalunya

PHYSIOTHERAPY UPDATES

THE CLINICAL AND RESEARCH QUESTION IN PHYSIOTHERAPY: THE ACRONYM PICO

Dr. Jordi Esquirol Caussa, MD, PhD[*†] Dr. Josep Sánchez Aldeguer, MD, PhD[*‡]
Dr. Ishar Dalmau Santamaria, MD, PhD[*§]

[*] Physiotherapy Research Centre. Escoles Universitàries Gimbernat (affiliated with Autonomous University of Barcelona (UAB)).
[†] Teknon Medical Centre. Barcelona.
[‡] College of Medicine. Autonomous University of Barcelona (UAB).
[§] Dept. of Medicine, Physiotherapy. Autonomous University of Barcelona (UAB).
Contact (first author): Dr. Jordi Esquirol Caussa Tel.: 93.589.37.27 jordi.esquirol@eug.es

We would like to thank the Chartered Society of Physiotherapy of Catalonia for their collaboration and support in this project.

ABSTRACT

Patient-centred care and evidence-based practice both require the integration of the best scientific evidence with the expertise of the healthcare provider and the patient's individual preferences. In order to design the best individualised care planning in the process of shared decision making, we must formulate well-built clinical questions that lead to clear evidence-based answers. The structure of the clinical question with the acronym PICO (Patient, Intervention, Comparison and Outcome) allows us to get an appropriate evidence-based answer in each individual case (including questions about therapeutic or aetiological interventions, about prevalence or incidence, or about the reliability of diagnostic methods), using the most adequate type of scientific study according to the aim of each specific question (systematic reviews, clinical trials, cohort studies, etc.). The questions following the PICO structure also allow us to generate research questions for a research plan. In physiotherapy, as in any other field of health science, the use of well-built questions allows us to have an individualised patient approach, integrating scientific evidence with the healthcare professional's expertise and the patient's individual characteristics.

KEYWORDS: Physical Therapy Specialty. Evidence-Based Practice. Patient-Centred Care.

INTRODUCTION

The practice of healthcare professions requires an individualised approach (patient-centred care). For any health-related aspect (prevention, diagnosis or treatment), the best clinical decisions will be made based on the integration of scientific evidence, clinical expertise and the healthcare professional's experience with the patient's values, objectives, and preferences: this is what is called evidence-based practice (EBP). In order to set and reach goals it is essential to correctly and specifically formulate the appropriate clinical question, which will eventually facilitate the finding of the best available research evidence. A well-built clinical question helps construct adequate questions, identify the best evidence to answer them, and assess them according to their quality, reliability, exactness and relevance. Finally the best clinical decisions for each individual case will be defined.

Research questions

There are two basic types of research or clinical questions: background questions and foreground questions. Background questions mainly refer to general knowledge and consist of two essential elements: the core of the question (who, what, where, how, why) and a medical condition or a specific clinical aspect of a disease, illness or medical condition. Textbooks usually answer these questions, they tend to be relatively economical and be written by experts in a specific field but they often don't cover all relevant aspects, are not easy to use, are preferably based on the author's opinion and may not be updated.

On the other hand, foreground questions are more structured and descriptive and inquire about specific knowledge related to a health problem. In research, constructing a question in the most adequate format allows us to set specific research goals. In clinical practice (and also in research), questions are often formulated in a way that makes it difficult to find the answer in scientific literature. Developing a question with its basic components will facilitate finding an evidence-based clinical answer. Foreground questions can be divided into four basic components.

Formulating a well-built question

Known by the acronym PICO, foreground questions consist of four structural elements (Table 1): patient (or problem), intervention, comparison (or control) and final outcome:

- **P**atient (or population): the type of patient or population that the question refers to must be exactly described, including its most relevant features. These relevant features must be defined in enough but not excessive detail so as to get a precise answer since too much concision could prevent finding a solution (scientific evidence may not have answers that are that specific).
- **I**ntervention (or indicator): it determines the intervention or strategy that is assessed or compared: type of intervention (diagnostic test, management strategy, therapy, diet, medication, procedure, exposure to risk factors, etc.), level of intervention (dose, frequency, intensity, duration), stage in the natural history of a disease (prevention, early detection, early treatment, advanced-stage treatment, rehabilitation) or healthcare provider (caregiving service or professional).
- **C**omparison (or control): particularly relevant for questions related to therapeutic interventions that analyse the effect of a specific intervention, compared to non-intervention or to a contrastive alternative treatment (if there is one).
- **O**utcome: clinical outcomes of an intervention, responding to patient-relevant consequences (improvement of symptoms, effect on quality of life, cost-benefit relationship, benefit-risk relationship, etc.).

To a well-built clinical question, we must add two additional elements that focus the question and determine the most appropriate type of evidence: the clinical field and the type of study that can answer our question. The concept of clinical field has to do with whether the question is about the exposure to a risk factor, aetiological factors, diagnostic actions, therapeutic actions or

Table 1

Example of the structure of a "PICO" question.

P	I	C	O
In the patient P	Does the intervention I	Compared to C	Improve O?
Exact and precise definition of the type of patient that the question refers to	Exact definition of the intervention, diagnostic procedure or risk factor (dose, intensity, and duration)	Comparison with another intervention, diagnostic test, placebo, "gold standard" or nothing (non-intervention)	Outcome to be assessed: clinical, laboratory, etc. (mortality, symptoms, complications, evolution, prevalence, etc.)

the prognosis of a disease. The concept of type of study relates to those designs that can offer quality evidence for a specific clinical field (clinical trials, meta-analyses, cohort studies, case and control studies, observational studies, transversal studies, etc.).

There are computer programmes that can help us start to formulate a PICO question.

Types of PICO questions

In evidence-based physiotherapy (EBP) the most common type of question is about the treatment of a specific medical condition or disease ("therapeutic intervention") but there are other clinical fields that are relevant from a clinical-healthcare and research perspective that also require a PICO question.

The questions about **therapeutic interventions** ("intervention questions": what is the best therapeutic approach?) include any therapeutic activity, from lifestyle changes (diet or exercise) or social activities (health education programmes), to physiotherapy, drug or surgical interventions. They can also include questions about specific patient typologies or about public health population interventions (screening programmes). The answer to these questions will mainly come from controlled clinical trials, meta-analyses or systematic reviews. For example, taking a seven-year-old patient with cystic fibrosis and recurrent respiratory infections, we would like to know if bronchial secretion drainage using respiratory physiotherapy can reduce recurrence; a question using the PICO method is constructed: "In seven-year-old patients with cystic fibrosis (P), can the use of respiratory physiotherapy for draining bronchial secretions (I), compared to non-intervention (C), reduce the rate of respiratory infections (O)?":

The questions about **aetiology or risk factors** (what causes the problem?) often arise from questions about public health that try to analyse the possible causes of a health problem (for example, the exposure to a specific risk factor) so the question will have to be formulated analysing the cause of the problem, with the contrary intention expressed in the previous question (trying to find possible prevention measures rather than a treatment). The answer will be provided by systematic reviews or comparative cohort studies. For example, a 23-year-old amateur female basketball player who had a muscle lesion while training asks if neuromuscular warm-up with a specialised trainer could have prevented her lesion. In order to get a specific answer, the following question must be formulated: "In young female amateur basketball players (P), can supervised neuromuscular warm-up (I), compared to her usual warm-up (C), reduce the risk of muscle lesions (O)?".

In questions about **prevalence (frequency)** of a disease or risk factors (what is the frequency of a given problem?) the number or percentage of people presenting a particular characteristic in a specific context (prevalence) is analysed; if the question tries to determine the number of new patients in a given period of time, this will be a question about incidence. The answer will have to be searched for in systematic reviews and analytical observational studies on prevalence or incidence. For example, if the parents of a premature baby ask about the chances that their baby has development problems in adolescence, the evidence-based answer will respond to the question: "In adolescents (P) who were born premature (I), compared to those born full-term (C), what is the prevalence of development problems (O)?". It must be observed that in this case the patient (P) is the current patient in the future and the characteristic being analysed is not a therapeutic intervention but some past circumstances. The structure of the question is kept but the terms are modified in order to adapt to the specific circumstances of each individual case.

In questions about **diagnosis** (does this person have the problem?) we must search for information about the precision of a specific diagnostic intervention (sensitivity and specificity), compared to other reference diagnostic tests (gold standard). It will be necessary to consult sensitivity and specificity studies through systematic reviews or comparative cohort studies. For example, a 65-year-old female patient with a history of early menopause asks if the analytical determination of markers of bone turnover is as reliable, in terms of diagnosis and osteoporosis monitoring, as Bone Mineral Densitometry (BMD). The precise answer will be obtained by the PICO question: "In women with early menopause (P), is the determination of markers of bone turnover (I), compared to BMD (C), the same or more sensitive and specific (O)?".

The questions about **prediction or prognosis** (who will have the problem? What will the result of the intervention be?) try to predict clinical or population situations, often related to qualitative questions of a more general nature: populations and results can be included, unlike interventions or comparative aspects. In this case, the answer will be given by longitudinal cohort studies and systematic reviews. For example, a daughter worried about her mother with cognitive deterioration undergoing rehabilitation for a hip fracture asks about the clinical alarm signals that would recommend stopping the rehabilitation treatment and asking for professional advice. We will need to construct the question: "For the main caregivers of patients with cognitive deterioration undergoing rehabilitation for a hip fracture (P), what are the main alarm signals to stop patient rehabilitation (O)?". In this case, no intervention or comparison is mentioned and the question has a more open answer.

With the formulation of questions using the acronym PICO we can find the most appropriate scientific evidence or construct clinical research questions that help design clinical studies applied to daily physiotherapy clinical practice, integrating, for each individual case, the best scientific evidence with the professional's ex-

pertise and the patient's preferences, allowing a real and optimal shared decision-making process.

After formulating the appropriate question, the next step will be to do a bibliographic review that contains the most relevant scientific evidence.

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20TH SEPAR WINTER MEETING

Inmaculada Castillo Sanchez
Physiotherapist at the Pneumonology Department of Hospital Universitari General de Granollers.
Coordinator of the Respiratory Physiotherapy Committee of the Chartered Society of Physiotherapy of Catalonia

The 20th winter Meeting of the Spanish Association of Pneumology and Thoracic Surgery (SEPAR) was held in the first term of 2016 in Alcalá de Henares. This year the meeting coincided with the third meeting on respiratory physiotherapy, coordinated by Mr Jordi Vilaró. The day started with an opening ceremony for all the SEPAR specialities. After that, there were different presentations for each of the specialities in different rooms

The talks on respiratory physiotherapy started with a roundtable discussion on the *assessment of exercise capacity and muscle strength*. Dr Diego Rodríguez and Dr Juana Martínez, doctors at Hospital del Mar (Barcelona), presented the measures to be taken into account when doing an exercise stress test, which would be particularly indicated in neuromuscular and systemic diseases and in COPD exacerbations. Finally, Ms Beatriz Valeiro, who works as a physiotherapist in the same hospital, talked about the assessment of peripheral muscles.

The second presentation focused on *advanced examination techniques used in respiratory physiotherapy*. Dr Enrique Cases talked about the effectiveness of thoracic ultrasounds in this field. The literature describes a useful test for the assessment of diaphragm mobility, exacerbation prognosis and sarcopenia in peripheral muscles in COPD patients. After that, Ms Beatriz Herrero, physiotherapist, presented a computerised respiratory sound analysis, on which there is a recent study of the *European Respiratory Society* (ERS) that reaches a consensus on lung sound nomenclature. Finally, there was a conference on *electrical impedance tomography* by Mr Antonio Rios, physiotherapist, who talked about ventilation visualization during a physiotherapy treatment although he specified that this is a field requiring further work.

In the afternoon, there was a joint session with the participation of the areas of Asthma and Respiratory Physiotherapy with a roundtable discussion on *asthma respiratory rehabilitation: from theory to practice*. Different pathophysiologic aspects of asthma were mentioned in relation to possible rehabilitation programmes and muscle training. After this, Mr Jordi Vilaró and Ms Elena Gimeno talked about the role of the physiotherapist in the use of ventilation methods and respiratory and peripheral muscle training. The session was greatly appreciated by both areas and it was proposed including a specific, adequate training programme for patients with this pathology in guides since this does not exist nowadays.

The Meeting continued on the following day with a *workshop on ventilation methods for asthmatic patients* where the Buteyko method was explained. This is a method, included in English guides, that is used to improve ventilatory control and to treat hyperventilation syndrome. It is a technique that needs some training and is practised by briefly inhaling through the nose, then there is a relaxed exhalation and finally a natural pause.

The other workshops focused on different respiratory muscle training devices, threshold and flow devices; how to use a thoracic ultrasound; how to grip the head and identify the images on the monitor; and lung auscultation using an electronic stethoscope complemented with a computer programme and learn how to identify different adventitious sounds.

AGENDA

International Congress: Comprehensive Aquatic Therapy put into Practice
Date and location: From October 29th to November 1st 2016, Queretaro
Information: http://teracuamx.webs.com/cursos

9th Interdisciplinary World Congress on Low Back and Pelvic Girdle Pain
Date and location: From October 31st to November 3rd 2016, Singapore
Information: www.worldcongresslbp.com

4th European Congress of the European Region of the World Confederation for Physical Therapy (ER-WCPT)
Date and location: November 11th and 12th 2016, Liverpool
Information: www.liverpool2016.com

International Forum on Disability Management 2016
Date and location: From November 22nd to 24th 2016, Kuala Lumpur
Information: http://ifdm2016.com.my/

XII Physical Therapy Congress (SCBF)
Date and location: November 26th 2016, Barcelona
Information: www.scfisioterapia.cat

VII Physical Therapy in Geriatrics Congress (CFC)
Date and location: April 1st 2017, Barcelona
Information: www.fisioterapeutes.cat

6th Francophone Conference on Physiotherapy
Date and location: From April 27th to 29th, Disneyland París (Congress Center Hotel New York), Marne-la-Vallée
Information: www.congres-jfk.fr

VIII Neuromusculoskeletal Physical Therapy Congress (CFC)
Date and location: May 20th 2017, Barcelona
Information: www.fisioterapeutes.cat

World Confederation for Physical Therapy Congress 2017
Date and location: From July 2nd to 4th 2017, Cape Town, South Africa
Information: www.wcpt.org/congress

XVIII Physical Therapy Congress (SCBF)
Date and location: November 25th 2017, Barcelona
Information: www.scfisioterapia.cat

PHYSIOTHERAPY UPDATES

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