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Review Article

Efficacy of Osteopathic Manipulative Treatment (OMT) with Lymphatic Pump Treatment (LPT), Adjuvant to Conventional Antibiotic Therapy in Hospitalized Patients with Pneumonia: A Systematic Review of Randomized Controlled Trials (RCTs)

Bledar Gjikolaj[1,2], Bruno Morabito[3,4,5], Alberto Castellan[5], Dario Silvestri[3]

[1]Sapienza University of Rome, Italy

[2]Catholic University Our Lady of Good Counsel of Tirana, Albania

[3]Asomi College of Sciences Research Department, Block D Giorgio Mitrovich Street, Malta

[4]Department of Cardiology and Cardiac Surgery, U.C.S.C. Rome A. Gemelli Italy University Hospital Foundation, Italy

[5]CRESO, School of Osteopathic Centre for Research & Studies, Gorla Minore (VA) Italyy

[*]**Corresponding author:** Bruno Morabito, CRESO, School of Osteopathic Centre for Research & Studies, Gorla Minore (VA) Italy

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Abstract

Introduction: Pneumonia is a prevalent problem that generates huge social and economic burdens. Osteopathic manipulative treatment OMT with lymphatic pumping treatment LPT in immune, lymphatic and respiratory system disorders has been used for many years. **Objectives:** Summarize the results of experimental clinical studies, which investigate the effect of Osteopathic Manipulative Treatment OMT in patients hospitalized with Pneumonia. **Methods:** The search was performed through nine electronic databases: MEDLINE, Cinhal, PEDro, Cochrane library, PshycINFO, sciELO, Science Direct, SCOPUS e Web of Science - from inception to March 2022, using the following keywords: Osteopathic Manipulative Treatment or Osteopathic Manipulative Medicine or Osteopathic Physicians or Lymphatic Pump Treatment AND Pneumonia or Pneumoniae or Pneumonias or Pneumoniae's. Randomized controlled trials have been selected that evaluate the effect of osteopathic manipulative treatment OMT with lymphatic pump treatment LPT in people hospitalized with pneumonia, which had as outcome: Duration of hospital Length of Stay (LOS), ventilator-dependent respiratory failure rate, in-hospital mortality rate, duration of Intravenous antibiotic use (days), duration of oral antibiotic use (days) and duration of total (intravenous+oral) antibiotic use (days). **Results:** Four RCTs meet the inclusion criteria, three are of high methodological quality and one is of medium quality, all studies have low risk of bias according to the analysis through the Pedro score and the Risk of Bias Cochrane tool. **Conclusions:** Manipulative treatment osteopathic OMT adjuvant to conventional care can reduce the use of intravenous antibiotics, the duration of hospitalization, the rate of ventilator-dependent respiratory failure and mortality rate in hospitalized patients with pneumonia, according to well-conducted RCTs with high methodological quality and low risk of bias.

Keywords: Osteopathic manipulative treatment; Osteopathic manipulative medicine; Osteopathic Physicians; Lymphatic pump treatment; Pneumonia; Pneumoniae; Pneumonias; Pneumoniae's

Introduction

Pneumonia is one of the main infectious diseases that afflicts elderly patients. Antibiotic therapy is the mainstay of treatment, although the appearance of resistant bacteria is worrisome [1-3]. The elderly are a vulnerable population: the majority of hospital admissions for pneumonia occur in people aged 60 or over, the elderly have a longer hospital Length of Stay (LOS) and an increased severity of lung infection disease, also have higher mortality than younger age groups [4]. Community-acquired pneumonia is the most common among potentially fatal infectious diseases, *Streptococcus pneumoniae* remains the main etiological pathogen. While antibiotic treatments have reduced the rate of death from pneumococcal pneumonia, the prevalence of organisms resistant to antimicrobial therapy has increased substantially, increasing the possibility that these pharmacological treatments become less effective for the treatment of infectious diseases in the future. Therefore, it is necessary to examine the advantages of additional methods that can help in the treatment and prevention of infectious diseases [5].

Osteopathic Manipulative Treatment (OMT) is an additional treatment that can be used for patients with pneumonia, is a non-pharmacological manual therapy, developed in the late XIX century before the use of antibiotics. It was used by osteopathic physicians the osteopathic manipulative treatment OMT with lymphatic pump treatment LPT in the era of the Spanish flu pandemic of 1918-1919 [6]. During the Spanish flu pandemic, patients treated with standard medical care had an estimated 33% mortality rate, compared to a 10% mortality rate of patients treated by osteopathic physicians [7]. The OMT includes a series of manipulative techniques aimed at improving the patient's defenses and physiological functions [8]. When applied to the management of pneumonia, manual manipulation techniques strengthen the flow of the lymphatic system, respiratory function and immunological defense, aiming at the anatomical structures involved in these systems [9-11]. Clinical studies report that LPT improves antibody responses to bacterial vaccines [12,13], reduces the duration of coughing in patients with respiratory diseases [11], shortens the duration of intravenous antibiotic therapy and reduces hospital Length of Stay (LOS) in patients with pneumonia [14]. Animal studies show that LPT promotes the absorption of interstitial antigens into the lymphatic system [15], increases the lymphatic flow [16,17], increases the lymphatic concentration of leukocytes [18-19] and increases the lymphatic flow of inflammatory cytokines, also reduces bacterial load in rat lungs [20]. Osteopathic manipulative treatment OMT with lymphatic pump treatment LPT can protect against pneumonia by inhibiting bacterial growth in the lungs, LPT can be optimally applied in patients with pneumonia, which can substantially reduce morbidity, mortality and frequency of hospitalization [21]. Many techniques included in OMT can treat a multitude of disorders, including the lymphatic system. Problems within this system lead to the accumulation of lymph, decreased immune responses, accumulation of fat, swelling of tissues and accumulation of connective tissue [22]. Osteopathic manipulative treatment OMT is used to treat somatic dysfunction. OMT focuses on improving neuromuscular connection, improving biomechanical balance, reducing pain, and increasing movement [23]. Many of these techniques, rib raising, doming of the diaphragm with myofascial release and, thoracic lymphatic pump treatment, have been developed specifically for the treatment of pneumonia [24]. Some manual medicine procedures have been designed to increase lymphatic flow or to prevent the accumulation of fluid in the tissues, these procedures can be used for the treatment of edema and infectious diseases. These procedures include the connective compression of certain tissues and body districts [25]. Osteopathic doctors use manual medicine techniques called Lymphatic Pump Techniques (LPT) they use them to improve lymphatic flow and improve immunity. These manipulations can be applied to the rib cage (thoracic pump), abdomen (abdominal pump), feet and legs (pedal pump), spleen and liver areas [25,26]. Randomized controlled clinical trials suggested that OMT in elderly patients hospitalized with pneumonia reduced the hospital length of stay LOS and the duration of intravenous antibiotic therapy [27,28]. A randomized multicenter study, with the creation of a detailed experimental protocol called MOPSE, reported together with the results of the trial, tried to evaluate the effectiveness of OMT as a complementary treatment for pneumonia in elderly hospitalized patients. These have highlighted significant improvements of length of stay LOS, In- hospital mortality rate, duration of intravenous antibiotic therapy and in the ventilator- dependent respiratory failure, in favor of the experimental group OMT [14,24].

Material and Methods

Search Strategy and Eligibility Criteria

The research was performed on nine electronic databases-MEDLINE, Cinhal, PEDro, Cochrane library, PshycINFO, sciELO, Science Direct, SCOPUS and Web of Science – from inception to March 2022. The keywords used to search on databases were: Osteopathic Manipulative Treatment or Osteopathic Manipulative Medicine or Osteopathic Physicians or Lymphatic Pump Treatment AND Pneumonia or Pneumoniae or Pneumonias or Pneumoniae's (Pneumonia Mesh terms). The combination of search terms was defined using the population, intervention, comparison, and outcome (PICO) model. Randomized controlled trials have been selected that evaluate the effect of osteopathic manipulative

treatment OMT with lymphatic pump treatment LPT in people hospitalized with pneumonia, which had as outcome: Duration of hospital Length of Stay (LOS), ventilator- dependent respiratory failure rate, in-hospital mortality rate, duration of Intravenous antibiotic use (days), duration of oral antibiotic use (days) and duration of total (intravenous+oral) antibiotic use (days). Through the search in the electronic databases, emerge altogether 708 articles. In the research carried out through other sources (as in the gray literature), 3 additional articles are taken. So the total number of articles identified through the search strategy is 711. Of these 520 remain after the elimination of duplicates. Then 191 remain after deleting all titles with different arguments. After reading, the abstracts there are 20 articles that are read the full tests to check if they met the criteria of inclusion. At the end, 4 studies are included in the qualitative summary of the review, as they are the only studies dealing with the topic according to the inclusion criteria. These included studies shall be extrapolated to the data, the results, the materials, methods used, and the characteristics of the samples. Always these 4 studies are carried out the evaluation of methodological quality through the Pedro score and the risk of bias through the Risk Of Bias Tool Chocrane.

Studies Selection and Quality Assessment

Two authors independently researched the articles using the search terms and independently screened titles and abstracts according to the eligibility criteria to select relevant studies. The quality of the included studies was assessed by using Cochrane Collaboration's tool for assessing risk of bias by RevMan [29] and by extracting PEDro (Physiotherapy Evidence Database) scores from the PEDro website. Each score on the PEDro website is generated by two accredited raters scoring the trial; any discrepancies in rating are resolved by a third accredited rater (https://www.pedro.org.au/).

Outcome Measures

The primary outcomes of interest included: hospital Length of Stay (LOS), ventilator-dependent respiratory failure rate and in- hospital mortality rate, duration of Intravenous antibiotic use (days), duration of oral antibiotic use (days) and duration of total (intravenous+oral) antibiotic use (days).

Results

Search Results

The study selection process is diagrammed in (Figure 1). A total of 411 records were identified and screened through the initial search strategy, and a total of 707 records were excluded based on irrelevant titles and abstracts. Four RCTs (randomized controlled trials) met the eligibility criteria.

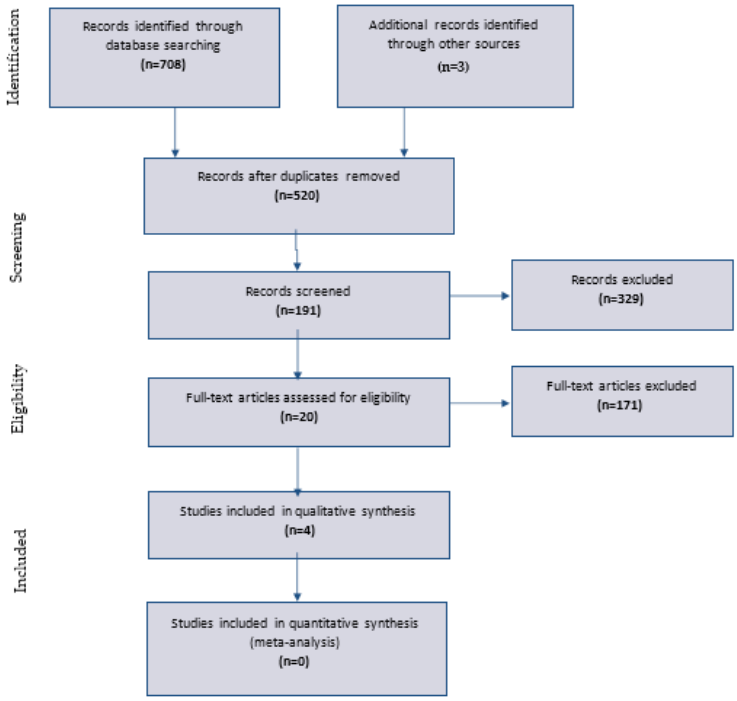

Figure 1: PRISMA flow diagram.

Characteristics of Included Studies

A summary of studies characteristics is shown in (Table 1). All studies are RCTs and recruit elderly patients hospitalized with pneumonia, among them there are two multicenter studies with triple control arm. All as intervention group carry out the standard protocol of manipulative treatment osteopathic OMT in addition to conventional antibiotic therapy treatment. All studies have a standard protolocus control group of dummy LT light touch in addition to conventional antibiotic therapy. The LT protocol occurs at the same points and in the same positions of the OMT intervention protocol, in this group unlike the intervention group, the actual manipulation of the districts is not carried out. Two studies (DR Noll 2016 and DR Noll 2010) also have a third group, which is given only the conventional antibiotic wiper CCO. In all RCTs the standard protocol OMT and LT are performed for 15 minutes, twice a day, for 6 hours away. All protocols begin within 24 hours of admission or nosocomial infection and have as end point: hospital discharge, cessation of antibiotic therapy, ventilator- dependent respiratory failure, death or withdrawal from the study (Tables 1-4).

Authors (condition of RCT and participants)	n. total; n. male; n. female.	Age mean	Subgroups Age	Subgroups PSI class	SAPS score Treatment group – Control group (Mean)	Subgroups Type of Pneumonia
Donald R. Noll et al. 2016 Randomized controlled multicenter double-blind trial on patients with PSI-class pneumonia I-II-III-IV-V, triple arm: 1) experimental group of antibiotic therapy + OMT 2) control group of antibiotic therapy + LT 3) control group of conventional care only CCO	ITT analysis n tot. 387 n 174 male n 213 female PP analysis n tot. 318 n 141 male n 177 female	ITT analysis 73,7 PP analysis 73,8	ITT analysis: • Age 50-74 (n 186) • Age ≥75 (n 201) PP analysis: • Age 50-74 (n 153) • Age ≥75 (n 165)	ITT analysis: I-II (n 73) III (n 109) IV (n 149) V (n 56) PP analyisis: I-II (n 64) III (n 90) IV (n 125) V (n 39)	It is not measured.	ITT analysis: Community-acquired (n 306) Nursing home-acquired (n 81) PP analysis: Community-acquired (n 253) Nursing home-acquired (n 65)
Donald R. Noll et al. 2010 Randomized controlled multicenter double-blind trial on patients with PSI-class pneumonia I-II-III-IV-V, triple arm: 1) experimental group of antibiotic therapy + OMT 2) control group of antibiotic therapy + LT 3) control group of conventional care only CCO	ITT analysis n tot. 387 n 174 male n 213 female PP analysis n tot. 318 n 141 male n 177 female	ITT analysis 73,7 PP analysis 73,8	There is no stratification by age groups.	ITT analysis: I-II (n 73) III (n 109) IV (n 149) V (n 56) PP analyisis: I-II (n 64) III (n 90) IV (n 125) V (n 39)	It is not measured.	ITT analysis: Community-acquired (n 306) Nursing home-acquired (n 81) PP analysis: Community-acquired (n 253) Nursing home-acquired (n 65)
Donald R. Noll et al. 2000 Randomized controlled double-blind trial in hospitalized patients with pneumonia	n total 58; n 30 male n 28 female	77,35	There is no stratification by age groups.	There is no stratification according to the severity class groups of PSI pneumonia.	Treatment group: 9.4 Control group: 9.6	Community-acquired (n 31) Nursing home-acquired (n 25) Hospital-acquired (n 2)
Donald R. Noll et al. 1999 Randomized controlled pilot study on hospitalized patients with pneumonia	n total 21 n 6 male n 15 female	80,6	There is no stratification by age groups.	There is no stratification according to the severity class groups of PSI pneumonia.	Treatment group: 9.7 Control group: 9.4	Community-acquired (n 8) Nursing home-acquired (n 9) Hospital-acquired (n 4)

Table 1: Characteristics of the included studies according to the PICO strategy. Number of participants; Age mean; Subgroups Age; Subgroups PSI class; SAPS score; Subgroups Type of Pneumonia. PSI: Pneumonia Severity Index; SAPS: Simplified Acute Physiology Score; ITT: Intention-To- Treat analysis; PP: Per-Protocol analysis; OMT: Osteopathic Manipulative Treatment; LT: Light Touch Treatment; CCO: Conventional Care Only; LOS: Hospital Length of Stay.

Authors (condition of participants)	Duration of the experimental protocol	Intervention; (n)	Comparison; (n)
Donald R. Noll et al. 2016 Randomized controlled multicenter double-blind trial on patients with PSI-class pneumonia I-II-III-IV-V, triple arm: 1) experimental group of antibiotic therapy + OMT 2) control group of antibiotic therapy + LT 3) control group of conventional care only CCO	Start within 24 hours of hospitalization or nosocomial infection. End point= hospital discharge, cessation of antibiotic therapy, ventilator dependent respiratory failure, death or withdrawal from the study.	Standart protocol of OMT for 15 minutes, twice a day (6 hours away, for 7 days a week), starting within 24 hours of admission and continuing until the End Points. In addition to the OMT protocol received conventional antibiotic therapy; • ITT analysis (n 130) • PP analysis (n 96)	Light Touch LT control group: Light touch standart protocol at the same points of the experimental protocol, for 15 minutes, twice a day (7 days a week). In addition to the LT protocol received conventional antibiotic therapy; • ITT analysis (n 124) • PP analysiis (n 95) Control group conventional care only CCO; • ITT analysis (n 133) • PP analysiis (n 127)
Donald R. Noll et al. 2010 Randomized controlled multicenter double-blind trial on patients with PSI-class pneumonia I-II-III-IV-V, triple arm: 1) experimental group of antibiotic therapy + OMT 2) control group of antibiotic therapy + LT 3) control group of conventional care only CCO	Start within 24 hours of hospitalization or nosocomial infection. End point= hospital discharge, cessation of antibiotic therapy, ventilator dependent respiratory failure, death or withdrawal from the study.	Standart protocol of OMT for 15 minutes, twice a day (6 hours away, for 7 days a week), starting within 24 hours of admission and continuing until the End Points. In addition to the OMT protocol received conventional antibiotic therapy; • ITT analysis (n 130) • PP analysis (n 96)	Light Touch LT control group: Light touch standart protocol at the same points of the experimental protocol, for 15 minutes, twice a day (7 days a week). In addition to the LT protocol received conventional antibiotic therapy; • ITT analysis (n 124) • PP analysiis (n 95) Control group conventional care only CCO; • ITT analysis (n 133) • PP analysiis (n 127)
Donald R. Noll et al. 2000 Randomized controlled double-blind trial in hospitalized patients with pneumonia	Start within 24 hours of hospitalization or nosocomial infection. End point= hospital discharge, cessation of antibiotic therapy, ventilator dependent respiratory failure, death or withdrawal from the study.	Standart protocol of OMT for 15 minutes, twice a day (7 days a week), starting within 24 hours of admission and continuing until the End Points. In addition to the OMT protocol received conventional antibiotic therapy; (n 28)	Light Touch LT control group: Light touch standart protocol at the same points of the experimental protocol, for 15 minutes, twice a day (7 days a week). In addition to the LT protocol received conventional antibiotic therapy; (n 30)
Donald R. Noll et al. 1999 Randomized controlled pilot study on hospitalized patients with pneumonia	Start within 24 hours of hospitalization or nosocomial infection. End point= hospital discharge, cessation of antibiotic therapy, ventilator dependent respiratory failure, death or withdrawal from the study.	Standart protocol of OMT for 15 minutes, twice a day (6 days a week), starting within 24 hours of admission and continuing until the End Points. In addition to the OMT protocol received conventional antibiotic therapy; (n 11)	Light Touch LT control group: Light touch standart protocol at the same points of the experimental protocol, for 15 minutes, twice a day (6 days a week). In addition to the LT protocol received conventional antibiotic therapy; (n 10)

Table 2: Characteristics of the included studies according to the PICO strategy. Duration of the experimental Protocol; Intervention (number participants); Comparison (number participants). PSI: Pneumonia Severity Index; SAPS: Simplified Acute Physiology Score; ITT: Intention-To- Treat analysis; PP: Per-Protocol analysis; OMT: Osteopathic Manipulative Treatment; LT: Light Touch Treatment; CCO: Conventional Care Only; LOS: Hospital Length of Stay.

Authors (condition of participants)	Outcome measures	Main Findings
Donald R. Noll et al. 2016 Randomized controlled multicenter double-blind trial on patients with PSI-class pneumonia I-II-III-IV-V, triple arm: 1) experimental group of antibiotic therapy + OMT. 2) control group of antibiotic therapy + LT. 3) control group of conventional care only CCO.	Primary outcome: • Hospital length of stay LOS ; • Ventilator-dependent respiratory failure rate; • In-hospital mortality rate;	Hospital length of stay LOS was shorter for the OMT group than for the LT and CCO groups, For the 50-74 age subgroup, from the PP analysis (P=0.006); For the ≥75 age subgroup, an improvement of the OMT intervention group, In-hospital mortality rate, was found from ITT and PP analysis (P=0.005). The PSI Class IV subgroup of the experimental OMT group had a statistically significant improvement in the hospital length of stay LOS (P=0. 01). The OMT intervention group had a statistically lower mortality rate than the conventional care only CCO group, in the PSI V pneumonia class subgroup (P=0.05), also in the ventilator-dependent respiratory failure rate for subgroup PSI IV (P=0.05) from PP analysis. In the ITT and PP analysis of the subgroups of community-acquired pneumonia, results a reduction in the rate of ventilator-dependent respiratory failure of the experimental OMT group was found in the analysis of the subgroup class PSI IV (P=0.05) compared to the conventional care only CCO control group. Statistically significant reduction in the mortality rate of the OMT experimental group for the subgroup PSI V class (P=0.05) compared to the conventional care only CCO control group, both from ITT and PP analysis.
Donald R. Noll et al. 2010 Randomized controlled multicenter double-blind trial on patients with PSI-class pneumonia I-II-III-IV-V, triple arm: 1) experimental group of antibiotic therapy + OMT. 2) control group of antibiotic therapy + LT. 3) control group of conventional care only CCO.	Primary outcome: • Hospital length of stay LOS; • Duration of clinical stability (in days); • Symptomatic and Functional RecoveryScore; Secondary outcome: Duration of Intravenous Antibiotic Use (days); Duration of oral antibiotic use (days); Duration of Total (Intravenous+Oral) Antibiotic Use (days); Ventilator-dependent respiratory failure rate; In-hospital mortality rate; Maximum daily temperature; Maximum daily respiratory rate;	The result of the PP analysis is a lower hospital length of stay LOS, for the experimental group OMT in comparison to the control group CCO (P = 0,01 OMT<CCO). Results from PP analysis show a shorter duration of intravenous antibiotic therapy, for the OMT experimental group compared to the CCO control group (P = 0.05 (OMT<CCO). The PP analysis shows a significant difference of lower in-hospital mortality rate for the experimental group OMT, in comparison to the control group CCO (P = 0.006).
Donald R. Noll et al. 2000 Randomized controlled double-blind trial in hospitalized patients with pneumonia	Duration of Intravenous antibiotic use (days), duration of oral antibiotic use (days) and duration of total (intravenous+oral) antibiotic use (days); hospital length of stay LOS; In-hospital mortality rate; Chest X-ray; Leukocyte count; Duration of leukocytosis; Body temperature; Duration of fever; Number of Tachypnea and Tachycardia Events.	Average duration of the use of intravenous antibiotics (P 0,002), total antibiotic therapy (P 0,003), hospital length of stay (P 0,14) were significantly shorter for the OMT intervention group.
Donald R. Noll et al. 1999 Randomized controlled pilot study on hospitalized patients with pneumonia	Duration of Intravenous antibiotic use (days), duration of oral antibiotic use (days) and duration of total (intravenous+oral) antibiotic use (days); hospital length of stay LOS; In-hospital mortality rate; Leukocyte counts; Duration of leukocytosis; Body Temperature; Duration of Fever; Number of Tachypnea and Tachycardia Events .	The experimental OMT group lasted less than days of fever, duration of leukocytosis, duration of antibiotic intra-venous therapy, total duration of antibiotic therapy and days of hospitalization. Although the results of this pilot study did not reach statistical significance. the only outcome that has reached statistical significance is the duration of oral antibiotic therapy (P=0.04) in favour of the control group. Authors think this is due to a direct improvement of the intervention group in the duration of intravenous antibiotic therapy.

Table 3: Characteristics of the included studies according to the PICO strategy. Outcome measures; Main Findings. PSI: Pneumonia Severity Index; SAPS: Simplified Acute Physiology Score; ITT: Intention-To- Treat analysis; PP: Per-Protocol analysis; OMT: Osteopathic Manipulative Treatment; LT: Light Touch Treatment; CCO: Conventional Care Only; LOS: Hospital Length of Stay.

	Dr. Noll 2016	Dr. Noll 2010	Dr. Noll 2000	Dr. Noll1999
Eligibility Criteria	Yes	Yes	Yes	Yes
Random allocation	Yes	Yes	Yes	Yes
Concealed allocation	Yes	Yes	Yes	Yes
Groups similar at baseline	Yes	Yes	Yes	Yes
Participant blinding	Yes	Yes	Yes	Yes
Terapist blinding	No	No	No	No
Assessor Blinding	Yes	Yes	Yes	Yes
<15% dropouts	Yes	Yes	Yes	No

Intention to treat analysis	Yes	Yes	Yes	Yes
Between-group difference reported	Yes	Yes	Yes	No
Point estimate and variability reported	Yes	Yes	Yes	Yes
Total (0-10)	9	9	9	7

Table 4: Pedro scores for included papers (n=4) extracted from website www.pedro.org.au

Trial Quality

The Cochrane collaboration's tool for assessing risk of bias was used to assess risk of bias of each study (Figure 2). All included and evaluated studies are of low risk of bias. All studies were assigned high risk in blinding of participants and personnel (performance bias) due to the nature of treatment; on the other hand, risk of all other bias was low, apart from incomplete outcome data (attrition bias risk), which was unclear in DR Noll1999 trial because of a missing adequate description of outcome data. We also used the PEDro scores to assess the quality of included studies (Table 2). According to the PEDro criteria, the quality of the studies can be classified as three ranges: low quality (scores 0-3), medium quality (scores 4-7), and high quality (scores 8-10). The score of 10 refects the best quality. The score of our papers was: 9 for three RCTs (DR Noll 2016, DR Noll 2010, DR Noll 2000) and an RCT scored 7 (DR Noll 2010). Three RCTs were rated as high-quality studies and one medium-quality study. The quality assessments were initially completed by a single reviewer and then checked for accuracy by one other reviewer.

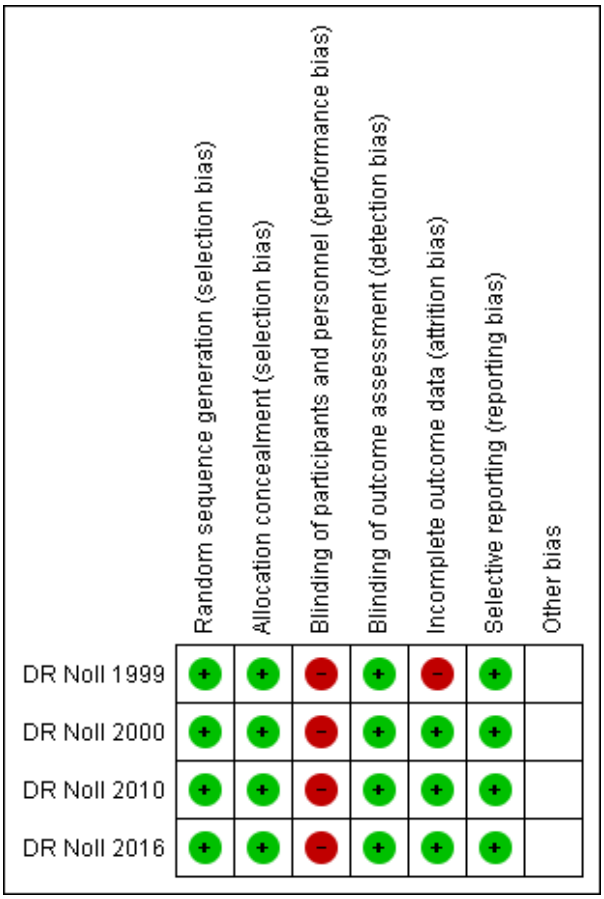

Figure 2: Cochrane risk of bias of the included studies. Quality appraisal. + (green), low risk of bias; ? (yellow), unclear risk of bias; − (red), high risk of bias.

Discussion

A significant number of diseases and conditions can be treated or improved with the OMT by integrating LPT maneuvers. The following list includes many, but not all, conditions that can be treated: upper respiratory infections, Chronic Obstructive Pulmonary Disease (COPD), asthma, atelectasia, bronchitis, otitis, pharyngitis, sinusitis, after a myocardial infarction, congestive heart failure, pericarditis, myocarditis, lymphedema, constipation, gastrointestinal infections, Crohn's disease, colitis, cirrhosis of the liver, chronic hepatitis, nephrotic syndromes, pancreatitis, uterine fibroids, uterine contractions, premenstrual syndrome, endometriosis, cystitis, tendinitis, joint infection and hospitalized patients with pneumonia [30].The lymphatic system functions as a part of the circulatory system maintaining fluids in the body at balanced levels and as a part of the immune system by playing a role in the body's defense system against infections. The lymphatic system is comprised of lymphoid organs, lymph tissues, lymph ducts, lymph capillaries, and lymphatic vessels that transport lymph and miscellaneous materials throughout the body [31]. Doctor of Osteopathic Medicine DO have commonly used OMT to remove impediments, or augment lymph flow, and stimulate the body's immune system defenses [32]. The main functions attributed to the lymphatic system are: the reabsorption and return of excess interstitial fluids into the circulatory system [33], also through the lymphatic capillaries that are located within the villi of the small intestine, are able to absorb fats and fat-soluble vitamins for metabolism or storage in the bloodstream and finally participation in the body's immune response and prevention of infectious pathogens [34]. The crucial task attributed to the lymphatic system is the transport of lymphatic fluid from the interstitium to the central circulatory system. The energy for this process comes by way of pumping mechanisms that propel the lymph along with the lymphatic network of vessels. These pumping mechanisms are extrinsic and intrinsic. The extrinsic pump produces cyclical compression and expansion of lymphatic vessels by such actions as joint movements, muscular contractions, myofascial flexibility, mechanical respiration, and postural changes. The intrinsic pump relies on the rhythmic, spontaneous contractions of lymphatic muscle, and neural modulation via the autonomic nervous system [35]. In osteopathy somatic dysfunction SD is defined as "impaired or altered function of related components of the somatic (body framework) system: skeletal, arthrodial and myofascial structures, and their related vascular, lymphatic, and neural elements". SDs that result in restricted joint motion, hypertonic musculature (including restricted thoracoabdominal or pelvic diaphragm motion), abnormal myofascial tension, and/or decreased rib cage motion, may inhibit the cyclical expansion and contraction of the lymphatic vessels, resulting in less than the optimum flow of lymphatic fluid in those regions where SD is present. Any conditions that result in abnormally altered autonomic activity may also reflexively affect the optimum functioning of the intrinsic lymphatic pumping mechanism in segmentally related body regions [36]. The osteopathic manipulative treatment OMT and integration of lymphatic pumping techniques LPT, are indicated in the treatment of conditions of lymphatic system disorders related to pneumonia infections. Treating SD somatic dysfunction that hinders the optimal function of the lymphatic system, secretly related autonomic nervous system areas and lymphatic pumping techniques LPT. OMT techniques can help optimize the functioning of the lymphatic system through changes in muscle tone, attenuation of myofascial restrictions, modulation of neural reflexes, maintaining the balance of autonomic tone and beneficial effects on breathing [14,24,28,36,37]. The mechanisms and principles, for which the OMT can intervene for the benefit of the population with polomintis, as well as other multitudes of pathologies, are analyzed. There appears to be support for the application of OMT osteopathic principles for pulmonary infections and some conditions involving the lymphatic and immune system [25,38,39]. The safety and efficacy of osteopathic lymphatic treatments have been demonstrated in many publications without any significant complications [25,37]. A review evaluates pump and pumping techniques in a multitude of pathologies including also RCTs with pumping techniques, with objective and subjective parameters. They highlighted the possible benefits of such techniques even in patients with pneumonia [40]. This systematic review has a rational and targeted strategy, researching in the international literature, through electronic databases and manual search, all RCTs articles experimenting OMT treatment with LPT, adjuvants to conventional therapy in patients with pneumonia. The specific inclusion criteria allowed us to identify RCTs carried out strictly according to a single research and intervention protocol (MOPSE). The studies that have met the inclusion criteria, result from the qualitative evaluation, overall be of high methodological quality and low risk of bias [14, 24, 27, 28]. It is important to continue research in this field, as OMT treatment can be an excellent support to conventional antibiotic therapy in patients with pneumonia. We recommend future research according to the MOPSE protocol, which is of high methodological quality, effective and respects the principles of osteopathy. So we need future double- blind, triple-arm RCTs. Stratification of patients will also be important: depending on the severity class PSI, depending on whether pneumonia contracted in hospital, nursing home or community, depending on the age of patients from 50 to 74 years and from ≥75 years of age, bringing definite results by stratification in the different subclasses. Prolonging the study in addition to the end points (cessation of antibiotic therapy, discharge from the hospital and death) will allow us to verify whether OMT treatment could bring benefits even in home or outpatient regimen.

Study Limits

It has not been possible to bring the data in meta-analysis because the clinical trials that met the inclusion criteria have differences in the analysis and stratification of the sample. The strictly targeted research strategy allowed us to incorporate RCTs that treated OMT treatment adjuvant to conventional antibiotic therapy or compared to LT light touch in patients with pneumonia, as a result, it has not allowed us to analyze other populations and other pathologies, which could be extended this reasoning.

Conclusions

Well-conducted research with high methodological quality and with low risk of bias, brings important statistically significant evidence regarding the effectiveness of OMT treatment compared with conventional antibiotic only therapy CCO. L'OMT reduced the hospital length of stay LOS, ventilator-dependent respiratory failure rate, the duration of total antibiotic therapy, the duration of intravenous antibiotic therapy and mortality rate compared to the control group CCO. These findings suggest a potential role for OMT in increasing the effectiveness of conventional antibiotic therapy in treating pneumonia. This role can become important with increased antibiotic resistance, the existence of new emerging pathogens, the aging of the world's population, the cost of health care and the likelihood of another flu pandemic. These results of study of high methodological quality and low risk of bias, involve the need for further research in order to implement the current international scientific evidence.

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