Effect of Chest Physical Therapy on Pediatrics Hospitalized With Pneumonia

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Abstract

Background: Pneumonia is a major cause of death among all age groups resulting in 4 million deaths yearly especially in those under five years. Chest physical therapy has been used to treat pediatrics hospitalized with pneumonia with lack of scientific evidence for the beneficial effect in pediatrics.

Objectives: The aim of this study was to evaluate the effect of chest physiotherapy on pediatrics hospitalized with pneumonia.

Method and Materials: A randomized controlled study was conducted in Pediatric University Hospital and Cairo University Hospitals. Fifty children aged 29 days to 5 years hospitalized with pneumonia between October 2014 and January 2015 was obtained, 25 were randomly allocated to the study group (chest physical therapy and standard treatment for pneumonia) and 25 to the control group (standard treatment for pneumonia alone without chest physical therapy). The primary measurement was time to clinical resolution. The secondary measurements were changes of respiratory rate and arterial oxygen saturation.

Results: There were significant differences in terms of median time to clinical resolution (4.0 vs 7.0 days, p=0.012) and the study group had greater improvement in respiratory rate (40 to 30 b/m vs 39 to 34 b/m) and in arterial oxygen saturation (93 to 98% vs 93 to 95%) than the control group.

Conclusion: It was concluded that chest physical therapy showed significant improvements in pediatrics hospitalized with pneumonia.

Keywords: Pediatrics, Pneumonia, Chest physical therapy

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Introduction:

Pneumonia is an inflammatory condition of the lung affecting primarily the microscopic air sacs known as alveoli\textsuperscript{1,2}. It is usually caused by infection with viruses or bacteria and less commonly by other microorganisms, certain drugs, and other conditions such as autoimmune diseases\textsuperscript{1,3}. Typical signs and symptoms include a cough, chest pain, fever, and difficulty breathing\textsuperscript{4}. Diagnostic tools include x-rays and culture of the sputum. Vaccines to prevent certain types of pneumonia are available. Treatment depends on the underlying cause. Pneumonia presumed to be bacterial is treated with antibiotics. If the pneumonia is severe, the affected person is generally hospitalized\textsuperscript{4}. Pneumonia is a common illness affecting approximately 450 million people a year and occurring in all parts of the world\textsuperscript{5}. It is a major cause of death among all age groups resulting in about 4 million deaths (7% of the world's total death) yearly. Rates are greatest in children less than five, and adults older than 75 years\textsuperscript{5}. It occurs about five times more frequently in the developing world than in the developed world\textsuperscript{5}. Viral pneumonia accounts for about 200 million cases\textsuperscript{5}. In the United States, as of 2009, pneumonia is the 8th leading cause of death\textsuperscript{7}.

In 2008, pneumonia occurred in approximately 156 million children (151 million in the developing world and 5 million in the developed world)\textsuperscript{5}. In 2010, it resulted in 1.3 million deaths, or 18% of all deaths in those under five years, of which 95% occurred in the developing world.\textsuperscript{5,8} Countries with the greatest burden of disease include India (43 million), China (21 million) and Pakistan (10 million)\textsuperscript{10}. It is the leading cause of death among children in low income countries.\textsuperscript{5,6} Many of these deaths occur in the newborn period. The World Health Organization estimates that one in three newborn infant deaths is due to pneumonia\textsuperscript{1}. Approximately half of these deaths can be prevented, as they are caused by the bacteria for which an effective vaccine is available\textsuperscript{12}. In 2011, pneumonia was the most common reason for admission to the hospital after an emergency department visit in the U.S. for infants and children\textsuperscript{13}.

Application of chest physical therapy as an adjunct to the treatment of pediatric hospitalized with pneumonia remains disputable. On the one hand, chest physical therapy has been, and continues to be, widely applied to pneumonic patients in pediatric practice based on beliefs of the benefits of this modality in evacuating inflammatory exudates and tracheobronchial secretions, removing airway obstruction, decreasing airway resistance, improving gas exchange and diminishing the work of breathing\textsuperscript{14,15,16}. On the other hand, there is a lack of strong scientific evidence for the effectiveness of chest physical therapy in hospitalized pneumonic children. The British Thoracic Society guidelines for managing pneumonia in childhood recommend that chest physical therapy is not beneficial and should not be performed in children with pneumonia\textsuperscript{17}, however, these recommendations are based mainly on the results of two randomized controlled trials, one in adults and one in children\textsuperscript{18,19}. Moreover, the validity of this old clinical trial in children is questionable due to the small sample size, exclusion of patients with pneumonia of presumed bacterial origin and inadequate randomization and blinding\textsuperscript{19}. More data are therefore needed from high quality randomized trials to make a more precise recommendation on the use of chest physical therapy for acute pneumonia in childhood\textsuperscript{19}. 

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Purpose:

This study was conducted to evaluate the effect of chest physical therapy on pneumonic hospitalized children. It was hypothesized that chest physical therapy as an adjunct to standard treatment could improve the clinical resolution of hospitalized pediatrics with pneumonia.

Materials and Method

A randomized controlled study was conducted in pediatric university hospital, Cairo University Hospital. Fifty children aged 29 days to 5 years hospitalized with a diagnosis of acute pneumonia were assessed for suitability for intervention in this study. Children were included in the study as they assembled all of the clinical and radiological criteria for pneumonia\(^1\)\(^,\)\(^2\)\(^,\)\(^9\); (1) presence of coughing and/or fever; (2) tachypnea, defined as respiratory rate above age-dependent upper limits: \(<2\) months: 60 breaths/min (b/m); 2–12 months: 50 b/m; \(\geq 1–5\) years: 40 b/m; \(\geq 5\) years: 30 b/m; (3) consolidations and/or infiltrates associated or not with other findings compatible with pneumonia on the chest radiograph. All chest radiographs were interpreted routinely in the department of radiology and reviewed by pediatric chest physician. Patients who suffered a chest drain, hemodynamic instability, bone fragility or rib fractures and any other contraindication to chest physical therapy were excluded\(^14\). The selection of participants occurred between October 2014 and January 2015. The parents gave their informed consent before enrolment in the study. Subjects were randomly assigned into two groups, 25 in each group, study group and control group. The study group received chest physical therapy three times daily with standard treatment for pneumonia and the control group received standard treatment for pneumonia alone without chest physical therapy. Each session of chest physical therapy was about 20 min and included postural drainage, thoracic squeezing, chest percussion, vibration, cough stimulation and aspiration of secretions (if needed)\(^14\)\(^,\)\(^18\)\(^,\)\(^19\). The positions for postural drainage were directed by the chest radiograph to provide more effective drainage of secretions and exudates from the most affected areas\(^14\)\(^,\)\(^19\).

The standard treatment for pneumonia in each patient was administered by the attending pediatrician based on the recommendations of guidelines for the diagnosis and treatment of pneumonia\(^20\). It included antibiotic therapy, fluid therapy and oxygen therapy if needed. The pediatrician was blinded to group assignment and study protocol.

Children were clinically evaluated at enrolment of the study and at discharge. A standardized protocol was taken to record respiratory rate, arterial oxygen saturation. The standard technique for measurement of respiratory rate and arterial oxygen saturation was the same as previously reported\(^21\). The definition of adventitious sounds on lung auscultation was based on the recommendations of the 1985 International Symposium on Lung Sounds\(^22\). The daily maximum body temperature was noted by the pediatrician based on the patient’s nursing record. The patient’s axillary temperature was measured by the attending nurses every 3 hours throughout the hospital stay. All physicians and nurses were blinded to group assignment and study protocol. Different schedules were arranged for the physicians and physiotherapist to avoid their chance encounter at a patient’s bedside.

Measurements:

The primary measurement was time to clinical resolution which was defined as the number of days needed for a patient to achieve the following clinical parameters: afebrile (daily maximum body temperature \(\leq 37.5^\circ\)C), absence of severe signs (chest indrawing, nasal flaring, and cyanosis), normal respiratory rate and arterial
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Oxygen saturation ≥95%. Secondary measurements were changes of respiratory rate and arterial oxygen saturation.

**Statistical analysis**
Statistical analysis was performed using the Stata Version 8.0 program (Stata Corporation, Texas, USA). The χ² test was used for analysis of data and the unpaired t test was used for comparing between the quantitative data of the two groups. Analysis was based on the intervention-to-treat principle. P-value of ≤0.05 was considered statistically significant.

**Results**
Fifty children with pneumonia were evaluated for suitability during the study period and were included in this study. The fifty children were randomly classified into two groups, 25 to study group and 25 to control group. Table 1 shows the baseline characteristics of the 50 patients. There were non-significant differences between the study and control groups in terms of the baseline characteristics. Table 2 compares the time to clinical resolution in the study and the control groups. The study group had short median time to clinical resolution (4.0 vs 7 days, p= 0.012).

Table 3 compares the clinical assessment in the study group and control group; the study group had greater improvement in respiratory rate (40 to 30 b/m vs 39 to 34 b/m) and in arterial oxygen saturation (93 to 98% vs 93 to 95%).

There was a significant difference between the study group and control group at the end of this study.

**Table 1: Baseline characteristics of the both groups patients:**

| Characteristics                  | Study group N=25 | Control group N=25 | p-Value |
|----------------------------------|------------------|--------------------|---------|
| Age (Months)                     | 36.0±21.3        | 35.0±28.1          | 0.82    |
| Male sex                         | 15 (60%)         | 16 (64%)           | 0.71    |
| Prematurity (<37 weeks)          | 5 (20%)          | 4 (16%)            | 0.84    |
| Low birth weight (<2500gm)       | 3 (12%)          | 3 (12%)            | 1.00    |
| Respiratory rate b/m             | 40±7.6           | 39±9.8             | 0.81    |
| Arterial oxygen saturation (%)   | 93±1.3           | 93±1.6             | 0.76    |
| Tachypnea                        | 16 (64%)         | 15 (60%)           | 0.80    |
| Cough                            | 24 (96%)         | 22 (88%)           | 0.23    |
| Fever >37.5 °C                   | 22 (88%)         | 21 (84%)           | 0.80    |
| Chest indrawing                  | 11 (44%)         | 9 (36%)            | 0.74    |
| Wheezes                          | 10 (40%)         | 10 (40%)           | 0.81    |
| Antibiotic therapy               | 25 (100%)        | 25 (100%)          | 1.00    |

- Numbers were described as mean±SD or n (%).
Table 2: Time to clinical resolution in both groups, study and control

| Parameter                  | Study group N=25 | Control group N=25 | p-Value  |
|----------------------------|------------------|--------------------|----------|
| Time to clinical resolution (days) | 4.0 (2.0-4.0)    | 7.0 (4.0-7.0)      | 0.012*   |

*Significance at p-value≤0.05. Numbers were described as mean±SD.

Table (3): Statistical analysis of mean differences for respiratory rate (b/m) and oxygen saturation (%) between study group and control group pre- and post-chest physical therapy.

| Clinical Parameters     | Study group N=25 | Control group N=25 | p-Value  |
|-------------------------|------------------|--------------------|----------|
|                         | Pre-             | Post-              | Pre-     | Post- | Pre- | Post- |
| Respiratory rate (b/m)  | 40±7.6           | 30.2±5.3           | 39±9.8   | 34.1±8.7 | 0.81 | 0.001* |
| Oxygen saturation (%)   | 93±1.3           | 98.0±2.1           | 93±1.6   | 95±1.2 | 0.76 | 0.002* |

- Numbers were described as mean±SD.
- *Significance at p-value≤0.05.

DISCUSSION

This randomized controlled study confirmed that chest physical therapy as an adjunct to standard treatment hastens the clinical resolution of pediatrics hospitalized with pneumonia. The time to clinical resolution was shorter in the study group than control group. This study showed that pediatrics who received chest physical therapy had greater improvement in respiratory rate and arterial oxygen saturation.

In this study, chest physical therapy was effectively mobilizing tracheobronchial secretions in this group of pediatrics with pneumonia assessed by time to clinical resolution, and improvement of other individual clinical parameters such as respiratory rate and arterial oxygen saturation.

In the present study the study group had a shorter median time to clinical resolution than the control group (4.0 vs 7.0 days, p=0.012) and had greater improvement in respiratory rate (40 to 30 b/m vs 39 to 34 b/m, p=0.001) and in arterial oxygen saturation (93 to 98% vs 93 to 95%, p=0.002) than the control group.

In agreement with this study, there was a significant relationship regarding improvement in
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Chest sound between study and control groups after applying chest postural drainage & percussion. These results are in congruent with what presented by McIlwaine as he found in his study that chest physical therapy in the form of airway clearance techniques and exercise has played an important role in the treatment of pneumonia and improvement of pulmonary function.

In addition the result of the present study is similar to result showed by Holland, et al. as he approved in his study that postural drainage & percussion help unstick mucus from the lungs so that it can be coughed out which remove airway secretions, improve chest sound, enhance gas exchange and reduce the work of breathing.

Also, Hill and Webber mentioned in their study that with effective postural drainage & percussion therapy, breath sound improved following the therapy as secretions move into the larger airways and increase and improve respiration.

Furthermore results also in agreement with results of study done by Mathews, et al. as they found in their study that post percussion therapy auscultation resulted in improvement in chest sound because of the better air entry and oxygenation.

This result was in congruent with what stated by Slonim as he found in his study that effective chest physical therapy mobilize tracheobronchial secretions in his sample of children which resulted in clearance and improvement in chest sound.

Also Susan and Hintz added that chest physical therapy used in infants has been reported to be associated with improved oxygenation and secretion clearance and improvement in respiration and chest sound.

In agreement with present study results found in a study done by Oermann, Swank and Sockrider as they indicated that the use of postural drainage, percussion and vibration for airway clearance has been a cornerstone in therapy for > 40 years, that studies have clearly shown chest physical therapy to be effective. Also the function of chest physical therapy is to assist in the removal of tracheobronchial secretions resulting increasing gas exchange and reduction in the work of breathing. On the other hand, the present study results are in contradiction with what reported by Paludo et al. and Janice et al. as they approved that no evidence support the beneficial effect of chest physical therapy in pediatrics hospitalized with pneumonia.

Overall, the results of the study indicated the beneficial effect of chest physiotherapy in pediatrics hospitalized with pneumonia which supports the study hypothesis.

Conclusion

Finally it could be concluded that, there were significant improvements in pediatrics hospitalized with pneumonia with chest physical therapy. It is recommended to implement chest physiotherapy program in the management of pediatrics hospitalized with pneumonia.

Conflict of Interests

Authors of this work declare that there is no conflict of interests regarding the publication of this study.
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