Pulmonary Vest Therapy in Pediatric Long-Term Care

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Objectives: Pulmonary infections are common in children with quadriplegic cerebral palsy. High frequency chest wall oscillation with the vest therapy (VT) is used to promote pulmonary clearance and to prevent pneumonias in cystic fibrosis patients. The purpose of this study was to ascertain the effectiveness of VT in patients with quadriplegic cerebral palsy who reside in pediatric skilled nursing facilities.

Methods: Seven individuals with quadriplegic cerebral palsy, who had frequent pulmonary infections were identified (age range: 7–28 years; median 19 years; 2 females and 5 males). Five had a tracheostomy and three an active seizure disorder. Clinical data was collected for 12 months before starting VT and during 12 months of VT.

Results: The total number of pneumonias that required antibiotics decreased from 36 per year before VT, to 18 during the year of VT ($P < 0.05$). The number of hospitalizations due to pneumonia decreased from 9 to 3. With VT, the frequency of effective suctioning of pulmonary secretions was significantly increased ($P < 0.01$). In the patients with epilepsy, with VT, the average monthly frequency of seizures decreased from 4 to 1, from 9 to 2, and from 9 to 1.

Conclusion: VT resulted in more effective suctioning of pulmonary secretions, reduced incidence of pneumonia, and reduced number of hospitalizations for pneumonia. In patients with epilepsy, VT resulted in reduced seizure frequency. VT was tolerated well, without complications or side effects. Further clinical investigations of the use of VT in cerebral palsy are indicated. **(J Am Med Dir Assoc 2002; 3: 318–321)**

Keywords: Cerebral palsy; high frequency chest wall oscillation; pediatric long-term care; pneumonia; vest therapy

Pneumonias are common in children with quadriplegic cerebral palsy. Neuromuscular insufficiency produces inadequate clearance of pulmonary secretions. Vest therapy (VT), otherwise known as high frequency chest wall oscillation therapy (HFCWO), is used to promote pulmonary clearance in children with cystic fibrosis and to prevent pulmonary infections.[1,2] Recent reports of 41 and 157 cystic fibrosis patients have shown that VT, in 1-year and 3-year treatment programs, have equivalent clinical outcomes as compared with manual chest physical therapy (mCPT).[3,4] Both of these studies indicate that VT is an acceptable alternative to mCPT. However, cystic fibrosis patient satisfaction, and compliance with treatment, was much greater with VT than with mCPT.[5,6] Furthermore, in ventilator-dependent individuals, VT has been shown to be much more effective in promoting pulmonary airway secretion clearance and weaning from a ventilator, than mCPT.[7] It is possible that VT would likewise be of benefit in individuals with quadriplegic cerebral palsy. To the authors' knowledge this is the first report of a series of patients in pediatric long-term care settings, who have cerebral palsy, being treated with VT. Our results have been presented in abstract form.[8]

METHODS

Seven individuals who had frequent pulmonary infections were identified (age range: 7–28 years; median 19 years; 2 females and 5 males). They were all residents of pediatric skilled nursing facilities (SNF). Three resided at Facility A, and four at Facility B. All had severe quadriplegic cerebral palsy, were wheelchair bound, and were fed by gastrostomy tube (G-tube). Five had a tracheostomy, and three an active seizure disorder. Clinical data was abstracted from the nursing records for 12 months before starting VT and during 12 months of VT. As per SNF routine protocols, the nursing staff maintains detailed daily clinical records on all residents.

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Table 1. *Participant Characteristics*

Characteristics	Place of Residence		*P* value
	Facility A (N = 3)	Facility B (N = 4)	
Gender—M/F, %	100.0/0.0	50.0/50.0	0.43*
Age	21.3 (6.08) Md = 21.5 Range 17–28	14.7 (6.81) Md = 17.0 Range 7–20	0.38†
Tracheostomy—No/yes, %	0.0/100.0	50.0/50.0	0.43*
Epilepsy—No/yes, %	66.7/33.3	50.0/50.0	1.0*
Pneumonias—Before/during	23/11	13/7	0.84††
Hospitalizations—Before/during	5/1	4/2	01.0*
Seizures—Before/during	48/4	219/39	0.16††
Effective Suctioning—Before/during	3,424/6,121	1,401/4,324	<.0001††

* Fisher's Exact Test
† Mann-Whitney Test
†† Chi-Square Test

These records include flow sheets that document frequency of mCPT, suctionings performed, nebulizers administered, vital signs, O_2 saturation, emeses, frequency and length of seizures, among many other clinical parameters. The flow sheets also record whether a suctioning attempt resulted in aspiration of sputum from the trachea. When sputum was obtained, this was deemed to be an effective suctioning attempt.

The same VT units (Advanced Respiratory Inc., St. Paul, Minnesota) were used at both SNFs. VT was initiated using standard protocols, which differed slightly at the two facilities. At Facility A, each individual received two 10-minute VTs daily. At Facilty B, each individual received one 20-minute VT daily, with additional treatments every 8 hours if needed.

At both facilities, the VT pulse pressure setting on the vest was between 3 and 5 cm H_2O, and the frequency of oscillation was between 13 and 15 Hz. The exact settings were determined by the patient's individual tolerance of the treatment procedure, under the supervision of a certified respiratory therapist. This range of settings has been shown to produce optimal clinical response in cystic fibrosis patients.[9]

The mCPT and postural drainage treatment programs differed between the two SNFs. At Facility A, each resident received mCPT and postural drainage three times a day before and after starting VT. VT was administered in addition to the already ongoing mCPT and postural drainage program. At Facility B, mCPT and postural drainage were administered on an as needed basis before and after starting VT. Thus, the number of mCPT sessions was highly variable and depended upon the patient's clinical picture. At both facilities, mCPT and postural drainage was administered by the nursing staff according to standard protocols that had been developed and supervised by certified respiratory therapists.

The definition of pneumonia in the SNFs was on the basis of clinical parameters. The required symptoms included fever, cough, purulent pulmonary secretions, increased oxygen requirements (as measured by a transcutaneous O_2 monitor), and abnormal pulmonary findings on auscultation. Chest X-rays were not obtained to confirm the clinical diagnosis of pneumonia. Bacterial cultures were not done at the time of diagnosis of pneumonia, only when a child failed to respond to an initial antibiotic. At the SNFs, all cases of pneumonia were treated with a 10-day course of antibiotics administered by G-tube.

Those cases whose pulmonary status continued to deteriorate, despite G-tube–administered antibiotics, nebulizer treatments and maximum mCPT, were transferred to a local hospital for parenteral antibiotics. In all cases, chest X-rays obtained during hospitalization confirmed the clinical SNF diagnosis of pneumonia. In all cases, hospitalized patients received intravenous antibiotics. Upon return to the SNF, the parenteral antibiotics were discontinued and changed to ones that could be administered by G-tube. Typically, each patient received a 10-day course of antibiotics for pneumonia.

To assess for differences between the residents of the two pediatric SNFs before starting VT, a 2-sided chi-square test—or Fisher exact test for categorical data as appropriate—and the Mann-Whitney test for continuous, nonnormally distributed data were used.

In this study, we compared clinical data collected on these seven individuals, during the 12 months before starting VT, to the clinical results obtained during the first 12 months of VT. There was no control group for comparison. The change scores, during treatment minus before treatment, for incidences of pneumonia, hospitalization, seizures due to epilepsy, and effective suctioning, were compared using Wilcoxon signed rank test. One-tailed tests results were computed as outcomes indicating decreases or increases of an incident were of primary importance. A P value of less than 0.05 was considered significant.

All data were transferred to a computerized database, and analyzed by use of SAS version 8.2 and Minitab release 13.31.

The protocols were reviewed and approved by the Human Subjects Ethics Review Committees of both facilities. In all cases, informed consent was obtained from the guardians before starting VT.

RESULTS

Participant demographic characteristics are summarized in Table 1. There were no significant differences between the residents of both facilities in regards to gender ($P = 0.43$) or

Table 2. *Clinical Outcomes of Vest Therapy (VT)*

	Before Treatment	During Treatment	*P* value
Pneumonias, N	36	18	0.026*
Hospitalizations, N	9	3	0.16*
Seizures, N	267	43	0.125*
Effective Suctioning, N	4,825	10,455	0.008*

* Wilcoxon Signed Rank Test, one-tailed test

age ($P = 0.38$). Neither were there differences in those who had had a tracheostomy ($P = 0.43$) nor those who suffered from epilepsy ($P = 1.0$). Analysis of summation scores before treatment and during treatment by place of residence using either a chi-square test or Fisher exact test were not significantly different for cases of pneumonia ($P = 0.84$), incidences of hospitalization ($P = 1.0$), or seizures as a result of epilepsy ($P = 0.16$).

A significant difference before treatment and during treatment was found between the residents of the facilities in effective suctioning ($X^2 = 215.2$, $df = 1$, $P < 0.0001$). The residents of Facility A (n = 3) had nearly 71% as compared to 29% of residents of Facility B (n = 4) in effective suctioning before treatment. During treatment, Facility A residents had 59% effective suctioning, whereas Facility B residents had 41%.

During 12 months of VT, there were no significant side effects—in particular, there were no episodes of induced emesis, fractures, or worsening seizures

Table 2 presents the clinical outcomes of VT. Summation scores were compared before and during treatment using the Wilcoxon signed rank test because of the small sample size and the non-normal distribution of the data.

Rank sum analysis between before treatment and after treatment showed significantly fewer cases of pneumonia ($P = 0.026$). The total number of pneumonias, in all seven patients combined, decreased from 36 per year before VT, to 18 per year during VT.

The number of hospitalizations due to pneumonia, in all seven patients combined, decreased from 9 per year before VT, to 3 per year with VT. However, this difference was not statistically significant ($P = 0.16$).

For the three patients at Facility A, the number of pneumonias decreased from 23 to 11, and the number of hospitalizations for pneumonia decreased from 5 to 1. For the four patients at Facility B, the number of pneumonias decreased from 13 to 7, and the number of hospitalizations for pneumonia decreased from 4 to 2.

With VT, the frequency of effective suctioning of pulmonary secretions was increased. In the individual cases, the average number of effective suctionings per month increased from 1 to 28; 4 to 48; 39 to 59; 47 to 87; 65 to 197; 105 to 217; 142 to 234. The summation scores of effective suctioning increased from 4,825 before treatment to 10,445 during the VT, and this increase was statistically significantly ($P = 0.008$).

At Facility A, the number of mCPT sessions with postural drainage was 92 per month before and during VT. At Facility B, the average number of mCPT and postural drainage sessions per month, before and after starting VT, went from 20 to none, 30 to 3, and 70 to none. In one case, the average number of mCPT sessions per month was 10 before and during VT.

At Facility A, the nursing staff was able to administer the VT without an increase in care-giving time. At Facility B, there was a decrease in nursing care time because, with VT, the time necessary for mCPT and postural drainage was decreased.

The number of seizures for Patient 1 decreased from 48 before treatment to 4 during treatment, for Patient 2 from 113 to 25 and for Patient 3 from 106 to 14. The respective monthly seizure frequency decreased from 4 to 1; from 9 to 2; and from 9 to 1. This decrease in seizure frequency was not statistically significant ($P = 0.125$). This statistical finding must be viewed with caution because of the small sample size.

All three individuals with seizures were treated with three anticonvulsants before starting VT. During VT, in two patients there was no change in anticonvulsant medicines (carbamazepine, diazepam and phenobarbital in one, and chlorazepate, phenobarbital and valproic acid in the other), the dosages of the anticonvulsants, nor in serum levels. In the third case, the dose of one of the anticonvulsants (chlorazepate), was decreased by 33%, whereas the dosage of the other two (valproic acid and topiramate) remained unchanged. The serum levels of valproic acid and topiramate were unchanged.

DISCUSSION

Our results in quadriplegic cerebral palsy patients indicate that VT increases the clearance of pulmonary secretions, and results in fewer pneumonias, and fewer hospitalizations for pneumonia. Our results are in keeping with the clinical comparability between VT and mCPT in treating cystic fibrosis patients.[3,4] More significantly, however, our results are in keeping with a recent report of ventilator-dependent individuals where VT was clinically more effective than mCPT in promoting pulmonary toilet and in weaning from the ventilator.[7] Our results, with those reported by Ndukwu et al.,[7] suggest that VT is clinically more effective than mCPT in pulmonary patients who do not have cystic fibrosis.

It is not possible to claim that there was a deficiency in the administration of mCPT and postural drainage before VT. The mCPT protocols at both facilities were developed and supervised by certified respiratory therapists, and were administered by trained nursing personnel. The protocols for administering mCPT differed at the two facilities. At one, mCPT was continued three times a day, in addition to VT. At the other, mCPT was administered on an as needed basis, so that there was a reduction in the frequency of mCPT once VT was started. The outcome was the same at both SNFs. There was a marked decrease in the number of pneumonias and hospitalizations for pneumonia.

In three individuals with epilepsy, VT improved seizure control. The best explanation for this observation is that improved pulmonary toilet resulted in improved general health and improved oxygenation, thus leading to improved seizure control.

Of importance is that during the 12 months of VT, there were no significant side effects—in particular, there were no episodes of induced emesis, fractures, worsening seizures, or worsening gastroesophageal reflux.

At Facility A, the nursing staff was able to administer the VT without an increase in care-giving time. At Facility B, there was a decrease in the amount of nursing time administering mCPT and postural drainage.

Our study dealt with only seven cerebral palsy long-term care residents. Further investigations with larger numbers of cases should be undertaken.

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REFERENCES

1. Arens R, Gozal D, Omlin KJ, et al. Comparison of high frequency chest compression and conventional chest physiotherapy in hospitalized patients with cystic fibrosis. Am J Respir Crit Care Med 1994;150:1154–1157.
2. Warwick WJ, Hansen LG. The long-term effect of high-frequency chest compression therapy on pulmonary complications of cystic fibrosis. Pediatr Pulmonol 1991;11:265–271.
3. Greece CA. Effectiveness of high frequency chest compression: A 3-year retrospective study. Pediatr Pulmonol 2000;20:302–303.
4. Tecklin JS, Clayton RG, Scanlin TF. High frequency chest wall oscillation vs. traditional chest physical therapy in CF—A large, one-year, controlled study. Pediatr Pulmonol 2000;20:304–305.
5. Oermann CM, Accurso F, Castile R, Sockrider MM. Evaluation of the safety, efficacy and impact on quality of life of the ThAIRapy vest and Flutter compared to conventional chest physical therapy (CPT) in patients with cystic fibrosis. Am J Respir Crit Care Med 1997;155(suppl 4):A638.
6. Oermann CM, Swank PR, Sockrider MM. Validation of an instrument measuring patient satisfaction with chest physiotherapy techniques in cystic fibrosis. Chest 2000;118:92–97.
7. Ndukwu IM, Shapiro S, Nam AJ, Schumm PL. Comparison of high-frequency chest wall oscillation (HFCWO) and manual chest physiotherapy (MCPT) in long-term acute care hospital (LTAC) ventilator-dependent patients. Chest 1999;116(suppl 4):311S.
8. Plioplys AV, Lewis S. Pulmonary vest therapy in pediatric long-term care. J Am Med Dir Assoc 2001;2:A17.
9. Jones RL, Lester RT, Brown NE. Effects of high frequency chest compression on respiratory system mechanics in normal subjects and cystic fibrosis patients. Can Respir J 1995;2:40–46.