

Cardiopulmonary Physical Therapy Practice in the Paediatric Intensive Care Unit

Jennifer McCord, MScPT;* Nelin Krull, MScPT;* Jennifer Kraiker, MScPT;*
Rachelle Ryan, MScPT;* Erica Duczeminski, MScPT;* Alison Hassall, MSc;†
Jamil Lati, MScPT;† Sunita Mathur, PhD*

ABSTRACT

Purpose: Physical therapists play an important role in the pediatric intensive care setting. The purpose of this study was to describe current cardiopulmonary physical therapy (CPT) practices in a pediatric cardiac critical care unit (CCCU) and a pediatric intensive care unit (PICU), as well as to determine the feasibility of obtaining clinically relevant outcome measures in this setting. **Methods:** We obtained reasons for admission, CPT treatment patterns, and availability of chest X-rays interpretation via a retrospective chart review of children who received CPT while in the PICU and CCCU ($n = 111$). **Results:** Congenital cardiac conditions (34.2%) and primary respiratory deterioration (27.9%) were the most common reasons for admission; 50% of the children had associated diagnoses (e.g., developmental delay). Manual hyperinflation with expiratory vibration was the most common CPT treatment. Chest X-ray interpretation was available in 72% of the charts. **Conclusions:** Manual hyperinflation with expiratory vibration was used across diagnostic groups in the CCCU and PICU; its effectiveness therefore requires further study. Chest X-ray is an important clinical outcome and therefore needs to be recorded in a standardized manner to be useful for future clinical research studies.

Key Words: intensive care unit; pediatric; cardiopulmonary physiotherapy.

RÉSUMÉ

Objet : Les physiothérapeutes jouent un rôle important dans le contexte des soins intensifs en pédiatrie. Cette étude visait à décrire les pratiques courantes en physiothérapie cardiopulmonaire (PTC) dans une unité des soins intensifs cardiaques (USIC) en pédiatrie et une unité des soins intensifs en pédiatrie (USIP), ainsi qu'à déterminer s'il était possible d'obtenir des mesures de résultats pertinentes sur le plan clinique dans ce contexte. **Méthodes :** On a réuni des données sur les motifs de l'admission, les tendances des traitements de PTC et la disponibilité d'interprétations de radiographies pulmonaires en procédant à un examen rétrospectif des dossiers d'enfants qui ont reçu des traitements de PTC pendant qu'ils étaient à l'USIP et à l'USIC ($n = 111$). **Résultats :** Les problèmes cardiaques congénitaux (34,2 %) et la détérioration respiratoire primitive (27,9 %) constituaient les motifs d'admission les plus courants; 50 % des enfants avaient reçu un diagnostic connexe (p. ex., retard du développement). L'hyperinflation manuelle combinée à une vibration expiratoire constituait le traitement de PTC le plus courant. Une interprétation de radiographies pulmonaires était disponible dans 72 % des dossiers. **Conclusions :** On a utilisé l'hyperinflation manuelle combinée à la vibration expiratoire dans tous les groupes de diagnostics à l'USIC et à l'USIP et c'est pourquoi une étude plus poussée de son efficacité s'impose. La radiographie pulmonaire constitue un résultat clinique important et il faut donc la consigner d'une façon normalisée pour qu'elle soit utile à de futures études de recherche clinique.

Cardiopulmonary physical therapy (CPT) is widely used in hospital intensive care units (ICUs) to facilitate secretion clearance, improve oxygenation, assist with weaning from mechanical ventilation, and minimize the effects of prolonged bed rest.^{1,2} CPT includes manual hyperinflation, positioning and postural drainage, percussion, vibration, assisted coughing, breathing exercises,

and mobility.¹ There are few studies examining the effectiveness of CPT on mechanically ventilated children in the ICU setting.³ Because several CPT techniques are applied together, it can be difficult to determine their individual effectiveness⁴; in addition, study populations vary in terms of both age and diagnoses, which also makes drawing any useful conclusions challenging.^{5,6} To

From the: *Department of Physical Therapy, University of Toronto; †Department of Rehabilitation, The Hospital for Sick Children, Toronto.

Correspondence to: Sunita Mathur, Department of Physical Therapy, University of Toronto, 160–500 University Ave., Toronto, ON M5G 1V7; sunita.mathur@utoronto.ca.

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design a clinically relevant study of the effectiveness of CPT in pediatric patients, we need a better understanding of which techniques are commonly used in clinical practice and what types of patients are referred for CPT in the pediatric intensive care setting. The purpose of our study, therefore, was to describe current CPT practice and referral patterns in a pediatric cardiac critical care unit (CCCU) and pediatric ICU (PICU) and to determine the feasibility of obtaining chest X-rays as a clinically relevant outcome.

METHODS

We conducted a retrospective chart review in the CCCU and PICU at a specialist acute tertiary pediatric facility, the Hospital for Sick Children (SickKids) in Toronto, Canada. Ethics approval was received from the Health Sciences Research Ethics Board at the University of Toronto and the Research Ethics Board at SickKids.

SickKids serves the Greater Toronto Area, as well as providing specialist treatment to regional, interprovincial, and international patients. It hosts a level III ICU with 18 beds in each of the CCCU and the PICU. The CCCU provides surgical and non-surgical treatment to patients with congenital and acquired cardiac diagnoses, including those receiving heart transplants. The PICU treats patients with a wide variety of medical conditions, associated with specialties including general medicine, neurosurgery, oncology, general surgery, orthopaedics, rheumatology, and burns/plastics.

CPT is performed in the CCCU and PICU only by trained physical therapists; nurses and respiratory therapists provide suctioning between sessions, and nurses assist with position changes as recommended by the physical therapist. Three experienced physical therapists provide daytime weekday coverage on these units; evening and weekend coverage is provided by physical therapists with regular exposure to the ICU.

Patients are referred for CPT by physicians on an individual basis; there are no blanket referrals. Physical therapists use their clinical judgment when accepting referrals and developing treatment plans.

Sample

We included charts from September 1, 2009, to October 1, 2010, in the study, a sample of convenience based on a time frame during which clinical practice was known to be consistent (i.e., the physical therapists were the same and referral patterns were consistent). We included children less than 18 years old who were intubated and mechanically ventilated and who received CPT from a physical therapist, but excluded preterm neonates and children who did not receive CPT, were ventilated for longer than 3 months, died within 1 day after extubation, or stopped receiving CPT more than 2 days before extubation. When a child was intubated on multiple separate occasions (i.e., not re-intubated within 1 day), each intubation was treated as a separate case.

Chart abstraction & data analysis

Five physical therapy graduate students (JM, NK, JK, RR, ED) conducted the chart review. Prior to starting data collection, the graduate students completed pilot data abstraction to improve reliability. Following the abstraction, two of the students reviewed the data abstraction forms to further ensure reliability.

The primary charts reviewed were physical therapy charts; medical charts were reviewed if relevant data were missing from the physical therapy chart. We collected age, sex, reason for ICU admission, associated diagnoses, dates of intubation and extubation, reason for CPT referral, and dates when CPT began and ended. We also collected data on CPT practice, including the type(s), frequency, and duration of CPT treatment. Clinical outcomes included chest X-ray interpretation. We used descriptive statistics to describe the variables of interest (Statistical Package for the Social Sciences, version 16.0; IBM Corp., Armonk, NY).

RESULTS

A total of 111 eligible children (59 female, 52 male) were treated in the CCCU ($n = 59$) and PICU ($n = 64$). Mean age was 4.8 (SD 5.5, range 0–17) years. Most (107, 96.4%) were on synchronized intermittent mandatory ventilation (SIMV) at the time of their first CPT treatment, while the remainder (4, 3.6%) were on continuous positive airway pressure. Mean intubation time was 10.6 (SD 9.5, range 1–56) days. The most common reasons for admission were congenital cardiac conditions (34.2%) and primary respiratory deterioration (27.9%); approximately half the children had associated diagnoses, the most common (26.1%) being developmental delay (see Table 1).

The most common reason for referral to CPT was pathological changes, such as consolidation or atelectasis, noted on a chest X-ray (71.2%); other reasons for referral, in decreasing order of frequency, were secretion retention (64.9%), difficulty weaning from ventilation (5.4%), decreased mobility (4.5%), decreased oxygenation (0.9%), increased work of breathing (0.9%), re-intubation (0.9%), and pre-extubation secretion clearance (0.9%).

The average frequency of CPT treatment was 2 (SD 1, range 1–3) sessions per day; mean duration was 6.1 (SD 7.2, range 1–42) days. The most frequently used CPT treatment was manual hyperinflation with expiratory vibrations (95.5%), which was applied to children across all admission diagnoses. Other treatments included bed mobility (19.8%), percussion (9.9%) and vibration (8.1%), costal lifts (1.8%), and assisted cough (1.8%).

Chest X-ray interpretation was recorded as a clinical impression by the physical therapist after viewing the X-ray or by the radiologist in the X-ray report. Information on chest X-ray interpretation was available in 72% of charts.

Table 1 Admitting Diagnoses and Associated Conditions of Children in the Paediatric Intensive Care Unit ($n = 111$)

Conditions	No. (%) of admissions
Reason for admission	
Congenital cardiac condition*	38 (34.2)
Primary respiratory deterioration†	31 (27.9)
Other‡	9 (8.1)
Acquired neurological deficit	8 (7.2)
Acquired cardiac disorder	7 (6.3)
Thoracic or upper abdominal surgery	6 (5.4)
Septic shock	4 (3.6)
Double ventricle disorder	4 (3.6)
RSV/hMPV bronchiolitis	3 (2.7)
Heart transplant	1 (0.9)
Associated conditions	
None	56 (50.5)
Developmental delay	29 (26.1)
Altered chest wall mechanics	11 (9.9)
GERD	9 (8.1)
Neuromuscular disease	6 (5.4)
Other	6 (5.4)
Upper airway obstruction	5 (4.5)
Pulmonary hypertension	5 (4.5)
Chronic lung disease	4 (3.6)
Chromosomal abnormality	2 (1.8)
Sickle cell	2 (1.8)
Left bronchus compression	1 (0.9)

*Including hypoplastic left heart syndrome, single ventricle defects, septal defects, and obstructive lesions.

†Including community-acquired pneumonia, aspiration pneumonia, and respiratory failure.

‡Including chronic lung disease, kidney disease, hypernatremia, seizures, and cervical spine fracture.

RSV = respiratory syncytial virus; hMPV = human metapneumovirus;

GERD = gastroesophageal reflux disease.

DISCUSSION

Our findings show that CPT is used in a variety of patient populations in the PICU and CCCU and that children are most commonly referred for CPT based on abnormal chest X-rays and secretion retention. Children with congenital cardiac conditions and primary respiratory deterioration accounted for the largest portion of those referred for CPT. The large number of patients with cardiac conditions may have been partly due to the inclusion of the CCCU in the study sample. Previous literature has focused on both cardiac and respiratory diagnoses, as similar problems in both patient groups (e.g., secretion retention) may be amenable to CPT.² Children referred for CPT often had associated conditions, most commonly developmental delay; muscular weakness and poor pulmonary reserve may lead to respiratory complications in this population.⁷

Manual hyperinflation with expiratory vibrations was the CPT technique most frequently reported in the charts we reviewed. In a recent study, manual vibrations were shown to increase peak expiratory flow in mechanically ventilated children, which could facilitate secretion clearance.⁸ Future research should explore the effectiveness of this technique, in terms of secretion removal and weaning from mechanical ventilation, in different pediatric populations.

Children were most often referred for CPT as a result of poor chest X-rays; however, our chart review suggests that using chest X-ray as an outcome measure may not be feasible. Although chest X-rays were available on the majority of charts, X-ray interpretation was not reported on in a standardized way by the physical therapists, which made it difficult to determine whether respiratory status had improved or declined after CPT. If chest X-rays are used as an outcome measure for clinical trials, using a quantitative grading scale to detect change in respiratory status may be appropriate, as this has been shown to improve reliability and validity when compared to qualitative individual interpretation of X-rays.⁹

Our study has several limitations. Because the study was retrospective in nature, some inconsistencies in charting may have led to missing data. In addition, we were unable to collect data on weaning from mechanical ventilation from the charts; instead, only data on number of days intubated were included in this review. Since ventilator weaning is a common reason for referral to CPT, future prospective studies could be designed to determine whether CPT facilitates weaning in this patient population.²

CONCLUSION

This study describes CPT practices in a pediatric ICU and shows that manual hyperinflation with expiratory vibrations is a preferred treatment technique for critically ill children. Further research should examine both the mechanism and the effectiveness of this technique. A future prospective study could use the population of children with primary respiratory failure on SIMV who are receiving manual hyperinflation with expiratory vibrations to provide an adequate sample size and diminish confounding variables. However, as our study shows, there are many associated diagnoses in the pediatric ICU population, which makes a homogenous sample difficult to obtain. Chest X-rays are an important outcome for tracking the effectiveness of CPT in the pediatric ICU; however, reliable and valid scoring tools need to be developed to standardize the documentation of clinical outcomes for research purposes.

KEY MESSAGES

What is already known on this topic

There is limited evidence for the effectiveness of specific CPT treatments within the pediatric population.

Few studies have described the pattern of CPT practice in the pediatric ICU.

What this study adds

This study describes the types of patients, reasons for CPT referral, and CPT practice patterns within the pediatric ICU. Recommendations for clinical outcome documentation, including ventilator weaning and chest X-ray, are provided.

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