INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X

Impact factor: 4.295

(Volume 4, Issue 2)

Available online at: www.ijariit.com

To study the effects of manual hyperinflation and tracheal suctioning in mechanically ventilated patients with ventilator-associated pneumonia as compared to tracheal suction alone on static lung compliance (C_L) and inspiratory airway resistance

Dr. Shiril Nagarkar
subratsamal17@gmail.com
Ravi Nair Physiotherapy College, Wardha, Maharashtra

Dr. Varsha Nagarkar
shirilnagarkar@gmail.com
Datta Meghe Institute of Medical Sciences, Wardha, Maharashtra

ABSTRACT

Ventilator-associated pneumonia results from bacterial colonization of the aerodigestive tract or aspiration of contaminated secretions into the lower airways. As a consequence of infection of the lung parenchyma and alveolitis, accumulation of inflammatory exudates and infiltration of airway mucosa can lead to unfavorable respiratory mechanics in ventilator-associated pneumonia. Tracheal suction is often employed by Physiotherapists in the management of mechanically ventilated patients with ventilator-associated pneumonia but this technique has the potential to increase respiratory resistance. Manual hyperinflation is used by physiotherapists to improve lung volume and mobilise secretions and has been shown to increase lung compliance. Aims and Objectives: To demonstrate an additional mechanical benefit to the respiratory system when manual hyperinflation and suction techniques are combined, by comparing the application of manual hyperinflation and suction with suction alone on static lung compliance (CL) and Inspiratory resistance (RAW) in mechanically ventilated patients with ventilator-associated pneumonia. Study Design: Thirty patients with ventilator-associated pneumonia were recruited and a Crossover study with Randomisation of sequences was done. Manual hyperinflation followed by suction (manual hyperinflation plus suction) and suction alone were applied consecutively, in random order, on two occasions, four hours apart. Respiratory variables, CL and RAW, were measured five times and the averaged value documented. Data were recorded before, immediately after, and 30 minutes after each intervention protocol. Results: CL increased by 4% and RAW decreased by 10%, up to 30 minutes after Manual hyperinflation plus suction, but not after suction alone. Conclusion: This study suggests that manual hyperinflation in conjunction with suction induces beneficial changes in respiratory mechanics in mechanically ventilated patients with ventilator-associated pneumonia.

Keywords: *Manual hyperinflation, Static lung compliance,(raw): Inspiratory airway resistance, (simv): synchronized intermittent mandatory ventilation.*

1. INTRODUCTION

The care of the mechanically ventilated patient is at the core of a Physiotherapy practice in the Intensive Care Unit1, (Shapiro et al, 1985). Work relating to the numerous Physiotherapeutic issues for the care of mechanically ventilated patient in the ICU is growing significantly. The Physiotherapy management of the mechanically ventilated patient is challenging on many levels, from the acquisition of highly technical skills; expert knowledge on invasive monitoring; and implementation of interventions to care for the patient2, (Stiller K et al 2000).

Each critically ill patient brings the clinical rationale for mechanical ventilation and additional complexities associated with their illness. Mechanical ventilation may impair mucociliary clearance and lead to sputum retention, airway occlusion, atelectasis, and Ventilator-associated pneumonia3, (Valles J et al 1995).

Ventilator associated pneumonia is a parenchymal lung infection occurring at least 24 hrs after initiation of mechanical ventilation4,5, (Day T et al, Moorehead RS et al 2002). Ventilator associated pneumonia results from bacterial colonization of aero digestive tract or aspiration of the contaminated secretions into the lower airways4, (Day T et al 2002). As a consequence of infection of lung parenchyma and inflammation of alveoli accumulation of inflammatory exudates and infiltration of airway mucosa can lead to unfavorable changes in respiratory mechanics predominantly static lung compliance and Inspiratory airway resistance in ventilator associated pneumonia. Clinicians may find it challenging when repositioning such a heavily sedated, intubated, ventilated patient who has poor or absent cough and secretion retention, because repositioning may result in substantial arterial hypoxemia, hypercarbia, and increased patients work of breathing6, (ACCN 2008).

2. MATERIAL AND METHODS

The Study is designed to correlate the Effects of Manual Hyperinflation and Suctioning on Static lung compliance (CL) and Inspiratory airway resistance (RAW) in Mechanically Ventilated patients with Ventilator associated pneumonia. Ethical clearance for the study was obtained from the Ethics committee of the institute before conducting the study.

RESEARCH DESIGN

This is a Cross over study with Randomization of interventions on patients with ventilator associated pneumonia in an Intensive Care Unit with physiotherapy see PLACE OF STUDY:

The study was conducted in an Intensive Care Unit with a Physiotherapy set up from December 2009 till December 2010

POPULATION OF THE STUDY

Patients on mechanical ventilation with ventilator associated pneumonia constituted the population of the study.

SAMPLE SIZE

Total 34 subjects were screened for the study. Of these 2 subjects were weaned off before the second intervention, while the other 2 were put on Volume control mode of ventilation due to deteriorating condition. The remaining 30 subjects formed the subject group.

The purpose and methodology of the study was explained to each subject in the presence of a relative and the risks of the study were also informed. They were made aware about the right to terminate the participation at any time during the procedure. All subjects acknowledged their understanding of the study and their willingness to participate by providing a signed consent. inclusion criteria was Patients on SIMV or CPAP mode of mechanical ventilation who satisfied the diagnosis of Ventilator associated Pneumonia as suggested by Juniper et al (1999) formed the inclusion criteria of the study,New and persistent radiological infiltrate ,Purulent respiratory secretions (+ positive gram stain),Pneumonia developing after mechanical ventilation for at least 48 hrs,Temperature over 38.3 degrees Celsius,Deteriorating blood gases,White cell count >10×109/L or < 5×109/ L.exclusion criteria,Acute respiratory distress syndrome,Unstable blood pressure,Untreated tension pneumothorax, and Patients with peak Inspiratory pressures higher than 40 mmH2O or requiring high respiratory support (FiO2 > 0.7 and PEEP > 10cmH2O)31, Acute pulmonary oedema,Acute head injury.

MATERIALS USED

1. Ventilator 2. Stethoscope. It is used to auscultate the secretions in the lung fields

2. Ambu bag, 3. Litre. It is used as a rebreathing circuit 4. Suction catheter (Rampson plain) It is used to do suction of the secretion
5. Sterile gloves. It is used to maintain hygiene

OUTCOME MEASURES

The subjects were assessed for the following outcome measures

1) Static lung compliance (CL)

It was obtained by pressing the option of respiratory mechanics on to the ventilator or calculated by, Corrected Tidal Volume/ Plateau pressure- PEEP32 (David Chang, Ed.D, and R.R.T in Clinical Applications of Mechanical Ventilation.)

2) Inspiratory resistance (Raw)

It is obtained by pressing the option of respiratory mechanics on to the ventilator or calculated by, Pressure change / Flow, where Pressure change = Peak airway pressure – plateau pressure and Flow is volume32. (David Chang, Ed.D. R.R.T in Clinical Applications of Mechanical Ventilation.)

PROCEDURE

On the day of measurement, each patient received in random order, either manual hyperinflation plus suction or suction alone as the first intervention protocol, and then the other protocol four hours later Manual Hyperinflation.

Attach the ambu bag to Oxygen supply and turn the oxygen flow rate to 15 LPM[33]. (East Kent Hospitals University, Guidelines on manual hyperinflation (Bagging) for Physiotherapists.

- Check the valve on the bag and ensure it is approximately half open.
- The Ventilator alarms were put off.
- Patient was disconnected from the ventilator and the ambu bagging circuit was connected.
- The patient was given some tidal breaths.
- While giving the tidal breaths try and feel the resistance/compliance in the patient's lungs and adjust the valve on the bagging circuit as appropriate.
- The patient was given slow deep breaths, each breath was held for 1 second and then the bag was quickly released to ensure that the elastic recoil of the patient's lungs is used to re-inflate the bag and a huff is stimulated.
- Four sets of eight bag compressions with both hands were delivered during each manual hyperinflation session. The rate of inflation was 10 breaths per minute.
- If a manometer is in the circuit, 40cmH_2O is the maximum pressure that should be reached[33], (East Kent Hospitals University, Guidelines on manual hyperinflation (Bagging) for Physiotherapists.)
- Always return to tidal breaths.
- Throughout bagging the heart rate, blood pressure and SpO2 are monitored.

Suctioning

- Full explanation of the procedure was given to the patient.
- If the patient was coherent and conscious then verbal consent was gained from the patient and documented in the notes.
- Patient was positioned in upright or high side lying.
- Suction system was turned on and the pressure set between 70-120mmHg in adults[34]. (East Kent Hospitals NHS Trust, Guidelines for adult suction).
- Catheter size was chosen for the intubated patient [the catheter size must be no bigger than ½ the internal diameter of the endotracheal tube, (take the size of the ET tube and x3 and then ÷2)] [34]. (East Kent Hospitals NHS Trust, Guidelines for adult suction).
- Sterile suction technique was used on intubated patients.
- The catheter was inserted until a cough was stimulated, if no cough, then the catheter was fed down until it hit the carina, then it was withdrawn about a centimetre, suctioning was applied and the catheter was slowly withdrawn out of the patient.
- The suction procedure was done for not more than 15 seconds.
- The patient's SpO2 and cardiovascular stability was constantly monitored
- Inspired oxygen concentration was maintained at 100% for all patients during the manual hyperinflation and suction procedures.
- The patient was then connected back to the ventilator and monitored that the ventilator is providing the correct ventilation again.

Finally, the option of respiratory mechanics on to the ventilator was pressed to see the outcome measures of the study i.e. Static lung compliance (C_L) and Airway resistance (R_{AW}).

OR was calculated by:

Static lung compliance = Corrected Tidal Volume/ Plateau pressure - PEEP[32] (David Chang, Ed.D, and R.R.T in Clinical Applications of Mechanical Ventilation.)

Inspiratory Airway resistance = Pressure change / Flow[32] (David Chang, Ed.D, and R.R.T in Clinical Applications of Mechanical Ventilation.)

After an interval of 4 hrs the process of suctioning was performed in the same way as mentioned above.
Results: showing comparison of mean pre intervention values of Static Lung Compliance.

Static Lung Compliance (C_L)	Number of patients	Mean	Standard Deviation	p value
Manual Hyperinflation and Suctioning	30	39.7333	± 2.01603	0.397
Suctioning alone	30	40.1667	± 1.91335	

Result: p value for mean pre intervention values of static lung compliance is not significant

Data analysis:

- The data analysis was done using Statistical Program of Social Service (SPSS) Software.
- Mean of pre intervention values of Static lung compliance and Inspiratory airway resistance was calculated.
- Comparison of mean of Static lung compliance and Inspiratory airway resistance of Manual hyperinflation plus Suctioning and Suctioning alone was calculated using Analysis of variance (ANOVA) test.
- When ANOVA was significant, Mann Whitney test was used to calculate the difference of Static lung compliance and Inspiratory airway resistance between both the interventions.
- The level of significance was set at $p < 0.05$.

3. DISCUSSION

The present study was designed to examine the effects of Manual Hyperinflation and Suctioning compared with Suctioning alone in mechanically ventilated patients with Ventilator associated pneumonia on Respiratory mechanics namely Static lung Compliance(C_L) Inspiratory airway resistance. (R_{AW}).The study was conducted on 30 patients who were on Mechanical ventilation and had Ventilator associated pneumonia. The subjects were given 2 random interventions namely Manual hyperinflation and Suctioning and Suctioning alone at an interval of 4 hrs. Respiratory mechanics of C_L and R_{AW} were calculated. The values were taken 3 times i.e Pre intervention, Post intervention and 30 min after the intervention. The results of the present study showed that C_L was increased significantly after giving the intervention of Manual hyperinflation and suctioning as compared to the intervention of Suctioning alone where as R_{AW} was decreased significantly after giving Manual hyperinflation and suctioning as compared to Suctioning alone which shows consistency with the results of Choi ,Jones et al 2005 that suction alone procedure, showed no effect in patients with ventilator-associated pneumonia, while manual hyperinflation plus suction improved the measured respiratory mechanics[23]. Static lung compliance (C_L) improved immediately post manual hyperinflation and the improvement was maintained for 30 minutes post intervention.The difference in improvement may be a combination of volume delivered, number of breaths, as well as total treatment time or it may be related to the circuit type employed by the physiotherapist. Hodgson et al, 2000 in 'An investigation of the early effects of manual lung hyperinflation in critically ill patients' used six sets of six manual breaths with a McGill circuit[35]. Lung compliance increased when inspiratory time was prolonged during mechanical ventilation, and a sustained deep inflation 'likely to occur during bagging' might cause re- expansion and an increased compliance[28], (Patman S et al 2001)

The pathogenesis of pneumonia involves cellular exudates which will likely reduce lung compliance and increase airway resistance, and an improvement in the respiratory mechanics may suggest improved lung function. This study demonstrated a difference of 4% to that of 3% after comparing static lung compliance between Manual hyperinflation with Suctioning and Suctioning alone interventions respectively which was statistically significant, whereas the difference of 10% to that of 1% when Inspiratory airway resistance measured respectively after the interventions of Manual hyperinflation with Suctioning and Suctioning alone which was also statistically significant. Ventilator-associated pneumonia arises from bacterial colonisation of the aerodigestive tract and aspiration of contaminated secretions into the lower airways[4], Secretion retention and decreased lung volume are therefore major clinical problems. (Wilson-Barnet J et al 2002).Suction alone is a frequent technique adopted in the management of ventilator-associated pneumonia to minimise the risk of bacterial colonisation in the airway. Our data suggests that tracheal suction alone was not accompanied by adverse effects and manual hyperinflation plus suction reduced R_{AW} and improved C_L. These Improved respiratory mechanics suggest manual hyperinflation plus suction may be an effective intervention to improve the lung function of patients with Ventilator Associated Pneumonia.

4. CONCLUSION

Manual hyperinflation and suctioning used in the management of Mechanically Ventilated patients with Ventilator Associated Pneumonia had beneficial effects in increasing the Static lung compliance and decreasing Inspiratory resistance as compared to Suctioning alone.

5. REFERENCES

[1] Shapiro BA, Harrison RA, Kacmarek RM, et al. Clinical application of respiratory care. 3rd ed. Chicago, IL: Year Book Medical Publishers, 1985
[2] Stiller K. Physiotherapy in Intensive Care. Chest (2000); 118, 1801-1813

[3] Valles J, Artegas A, Rello J, Bonsoms N, Fontanals D, Blanch L, Fernandez R, Baigorri F, Mestre J: Continuous aspiration of subglottic secretions in preventing ventilator associated pneumonia. Annals of Internal Medicine (1995); 122: 179–186.
[4] Day T, Farnell , Wilson-Barnett J: Suctioning: A review of current research recommendations. Intensive and Critical Care Nursing (2002); 18: 79–89
[5] Moorehead RS and Pinto SJ: Ventilator-associated pneumonia. Archives of Internal Medicine, (2000); 10: 1926–1936.
[6] Respiratory care (ACCN): Mucus on the move: Embed it or Expel it- The Patient, the Clinician, and now the Ventilator (2008); Vol 53 No.10
[7] Denehy L: The use of manual hyperinflation in airway clearance. European Respiratory Journal (1999); 14: 958–965.
[8] Berney S, Denehy L: A comparison of the effects of manual and ventilator hyperinflation on static lung compliance and sputum production in intubated and ventilated intensive care patients. Physiotherapy Research International (2006); 7: 100–108.
[9] Paratz J, Lipman J, McAuliffe M. Effect of manual hyperinflation on haemodynamics, gas exchange, and respiratory mechanics in ventilated patients. Journal of Intensive Care Medicine (2002); 17, 317-324.
[10] Svantesson C, Drefeldt B, Sigurdsson S, Larsson A, Brochard L, and Jonson B: A single computer-controlled mechanical insufflations allows determination of the pressure-volume relationship of the respiratory system. J Clin Monit Comput 1999; 15:9-16.
[11] Guglielminotti J, Desmonts JM and Durenil B (1998): Effects of tracheal suctioning on respiratory resistance in mechanically ventilated patients. Chest 113: 1335–1338.
[12] Hodgson C, Carroll S, Denehy L : A survey of manual Hyperinflation in Australian hospitals. Australian Journal of Physiotherapy (1999); 45: 185–193
[13] Murugesan Jeganath, Muthusamy Sivaguru, Umamaheshwary Balakrishnan: 'The use of Mapleson-C circuit in airway clearance and lung expansion for patients with neuromuscular disease — a case report' Advances in Palliative Medicine 2010; vol. 9, no. 2
[14] Apicon, Annual conference of physicians of India: Workshop on mechanical ventilation January 29 – February 1 2009.
[15] Tom J. Overend, Cathy M. Anderson: 'What's New in suctioning the adult patient?' The Lung Association Ontario Respiratory Care society Update Volume 25, number 1 (2009)
[16] Northern health and social care trust. Manual hyperinflation of adult patients in critical care, Guideline (2009).
[17] Clarissa Blattner1, João Carlos Guaragna1 and Eduardo Saadi; 'Oxygenation and static compliance is improved immediately after early manual hyperinflation following myocardial revascularisation'. Australian journal of Physiotherapy (2008) vol 54,173-178.
[18] Sanja Jelic, Jennifer A, Cunningham, Phillip Factor. 'Clinical review: Airway hygiene in the intensive care unit' Critical Care 2008, 12:209
[19] Kaye Rolls CNC Kelvin Smith CNC Pauline Jones CNE Megan Tuipulotu CNC, Rand Butcher CNC. Suctioning an adult with a tracheal tube NSW Health Statewide guidelines for Intensive care (2007)
[20] Alison Bergh, 'The effect of passive thoracic flexion rotation movement on total static lung compliance of the respiratory system and respiratory responses in ventilated patients' conducted a pretest posttest physiological study. PT, Department of interdisciplinary health sciences, Faculty of health sciences of the University of Stellenbosch (2007).
[21] Richard D Branson MSc RRT FAARC, Secretion management in Mechanically Ventilated patients Respiratory Care (2007); Vol 52 No 10
[22] Linda Denehy and Susan Berney. Physiotherapy in intensive care Physical Therapy Reviews 2006; 11: 49–56
[23] Choi J.S., Jones A.Y. Effects of manual hyperinflation and suctioning on respiratory mechanics in mechanically-ventilated patients with ventilator-associated pneumonia. Aust. J. Physiother. 2005; 51: 25–30.
[24] Suh-Hwa Maa, Tzong-Jen Hung, Kuang-Hung Hsu, Ya-I Hsieh, Kwua-Yun Wang, Chun-Hua Wang, Horng-Chyuan Lin, 'Manual Hyperinflation Improves Alveolar Recruitment in Difficult-to- Wean Patients'(2005); Chest 2005; 128:2714–2721)
[25] Takeshi Unoki RN, Yuri Kawasaki RN, Taro Mizutani, Yoko Fujino RN, Yaeko Yanagisawa RN, Shinichi Ishimatsu, Fumiko Tamura RN MSN, and Hidenori Toyooka. Effects of Expiratory Rib-Cage Compression on Oxygenation, Ventilation, and Airway-Secretion Removal in Patients Receiving Mechanical Ventilation. Respiratory care, November 2005 Vol 50 NO 11
[26] Thomas Dyhr, Jan Bonde, Anders Larsson 'Lung recruitment (LR) manoeuvres are effective in regaining lung volume and oxygenation after open endotracheal suctioning (ETS) in acute respiratory distress syndrome' Critical Care 2003, 7:55-62
[27] Alice Y. M. Jones 'Secretion movement during manual lung inflation and mechanical ventilation'. Department of rehabilitation sciences, The Hong Kong polytechnic University, Hong Kong. (2002)
[28] Shane Patman, Sue Jenkins, Kathy Stiller. 'Manual Hyperinflation – effects on Respiratory parameters' Physiotherapy research international, (2000) 5(3) 157-171,
[29] Mervyn Singer ; Julia Vermaat; Gareth Hall, RGN; George Latter, and Manesh Patel, 'Hemodynamic effects of Manual Hyperinflation in critically ill mechanically ventilated patients' Chest 1994; 106:1182-87
[30] Juniper M: Ventilator associated pneumonia: Risk factors, diagnosis and management. Care of the Critically Ill (1999); 15:198–200.
[31] Anderson J, Qvist J, Kann T: Recruiting collapsed lung through collateral channels with positive end-expiratory pressure. Scandinavian Journal of Respiratory Diseases (1979); 60: 260–266.
[32] (David Chang, Ed.D, and R.R.T in Clinical Applications of Mechanical Ventilation.).
[33] (East Kent Hospitals University, Guidelines on manual hyperinflation (Bagging) for Physiotherapists.
[34] (East Kent Hospitals NHS Trust, Guidelines for adult suction).
[35] Hodgson C, Denehy L, Ntoumenopoulos G, Santamaria L, Carolls:An investigation of the early effects of manual lung hyperinflation in critically ill patients. Anaesthesia and Intensive Care (2000); 28: 255–261.
[36] Patman S, Jenkins S, and Smith K: Manual hyperinflation: consistency and modification of the technique by physiotherapists. Physiotherapy Research International (2001); 6: 106–117.

