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CSRT/CARESTREAM STUDENT EXCELLENCE AWARD WINNERS 2011

The CSRT is proud to partner with CAREstream Medical Limited, to provide recognition to students in the twenty educational programs across Canada. This award recognizes students in each respiratory therapy program (accredited through the Council on Accreditation for Respiratory Education) who have successfully completed the certification examination and have made a substantial achievement as a student.

Congratulations to our winners!

Melissa Field - College of the North Atlantic, NL
Sara Kristin Kohler - New Brunswick Community College (NBCC) - Saint John, NB
Jenny Macdonald - College communautaire du Nouveau-Brunswick (C.C.N.B.), campus Dieppe, NB
Lisa Marie Bates - QEII/Dalhousie School of Health Sciences, NS
Shaun Edgar Lockhart - Vanier College, QC
Nathalie Roberge - Le Collège de Rosemont, QC
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Kathleen Larouche - Cegep de Chicoutimi, QC
Ileana Diaz - Algonquin College of Applied Arts and Technology, ON
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John Michaels - The Michener Institute for Applied Health Sciences, ON
Mr. Phucquoc Mai - University of Manitoba-School of Medical Rehabilitation, ON
Calvin Loewen - Northern Alberta Institute of Technology, AB
Chelsea Francis - Southern Alberta Institute of Technology, AB
Emily Chiu - Thompson Rivers University, BC
As I reflect on the scope and diversity of presentations at the CSRT annual Education Conference, held in June in Quebec City, I was impressed by the quality of presentations by respiratory therapists. Each year the number of RTs presenting pertinent and progressive information grows — a sure sign that the respiratory profession is coming into its own.

As well, we had an outstanding number of posters presented in two categories — RT and Student. The judging panel had some lively debates as we worked towards picking our winners. Not an easy task with so many high-quality submissions. All posters abstracts are included in this issue of the CJRT.

The ever-increasing participation of RTs at this conference is one of the ways we advance our profession. By actively participating in professional development activities we highlight our skills, knowledge and expertise to our peers, other professionals and the public.

I encourage respiratory therapists who presented at conference to consider submitting their work to the journal in the form of a case presentation, literature review or as basic research. I would also like to draw your attention to the Call for Papers for a special edition of the CJRT. Associate Editor, Jason Nickerson will be spear-heading a special issue that will focus on how respiratory therapy services are delivered to different patient populations or in unique settings or circumstances. Details can be found on page 39.

In this issue, Dan Cashen has written a paper, Drawover Anesthesia, where he reviews the challenges of anesthesia in unresourced and difficult environments. The Association of Body Mass Index and Airways Obstruction is presented by Andrew West where he discusses the association between obesity and asthma. Kathy Spurr presents her paper Characterizing Obstructive Sleep Apnea and its Management in Paediatric and Adolescent Patients Hospitalized in Canada and reviews the need for accurate and complete data in the management of obstructive sleep apnea. Dr. Mark Heulitt has prepared a directed reading on Update in Neonatal and Pediatric Mechanical Ventilation: Patient Ventilator Interaction. Dr. Heulitt provides information to readers on the relationship between the two controllers involved in patients breathing spontaneously on mechanical ventilation, as well as identifying the different types of patient-ventilator asynchrony.

We also present the abstracts from all 13 poster presentations at the CSRT Education conference, held in Quebec City in June. Congratulations to our two winners — Julia Infantino for the best RT Poster - Securing Endotracheal Tubes in Neonates: An Audit After Modification of Practice; and Thomas Fudge for his Student RT Poster - 2009 H1N1 Pandemic: an Evaluation of Planning and Management Strategies.

With yet another successful and informative conference behind us, we are calling on more respiratory therapists to step into the spotlight. Consider presenting at the Education Conference next year in Vancouver. The CSRT is issuing a special invitation to respiratory therapists to submit an abstract of a presentation for consideration by the program committee. The goal is to have the majority of presentations delivered by respiratory therapists. We wish to cover all areas of practice and you may submit more than one abstract. The deadline is October 31st, 2011. Details can be found on the CSRT website. Why not share your expertise and build on your own professional development activities?

As always, I encourage you to submit your manuscripts to the journal for consideration. We have a dynamic tool available to disseminate knowledge and provide RTs with a vehicle to publish their papers. Please feel free to contact me at amy.cjrt@gmail.com.
Je suis fortement impressionnée par la qualité, la portée et la diversité des exposés entendus au congrès éducatif annuel tenu cette année à Québec en juin. D’année en année, nous assistons à la croissance du nombre de thérapeutes respiratoires qui présentent de l’information percutante et évolutive, un signe évident de la maturité de notre profession.

En outre, nous avons eu un grand nombre d’affiches provenant des thérapeutes respiratoires et des étudiants. Leur évaluation par les juges et le choix des lauréats ont certainement suscité un débat animé. La tâche n’a pas été facile devant des présentations d’une si grande qualité. Vous pourrez consulter les résumés des affiches dans le présent numéro du JCTR.

Le nombre croissant de thérapeutes respiratoires participant au congrès nous permet de faire avancer la profession. C’est en prenant part aux activités de perfectionnement professionnel que nous mettons en évidence nos aptitudes, nos connaissances et notre expertise à l’intention de nos collègues, des autres spécialistes de la santé et du grand public.

J’invite les thérapeutes respiratoires qui ont présenté des exposés au congrès à soumettre leur travail au Journal sous forme d’un cas, d’une analyse documentaire ou d’une recherche. Je tiens également à attirer votre attention sur l’invitation à présenter des communications lancée pour un numéro spécial du Journal. En effet, le rédacteur adjoint Jason Nickerson s’est chargé d’un numéro qui portera sur la façon dont les services de thérapie respiratoire sont fournis à différentes populations dans des endroits uniques ou des circonstances particulières. Pour de plus amples détails, voir la page 40.

Dans le présent numéro, Dan Cashen nous présente Drawover Anesthesia où il passe en revue les défis de l’anesthésie dans les milieux particuliers où les ressources sont déicientes. Andrew West quant à lui nous propose The Association of Body Mass Index and Airways Obstruction où il examine le lient entre l’obésité et l’asthme. Kathy Spurr nous offre son article Characterizing Obstructive Sleep Apnea and its Management in Paediatric and Adolescent Patients Hospitalized in Canada où elle aborde la nécessité de données précises et complètes pour la gestion de l’apnée obstructive du sommeil. Le Dr Mark Heulitt a préparé la lecture dirigée Update in Neonatal and Pediatric Mechanical Ventilation: Patient Ventilator Interaction. Il fournit au lecteur de l’information sur la relation entre les deux contrôleurs en action dans la respiration spontanée des patients soumis à la ventilation mécanique et il présente les différents types d’asynchronisme patient-ventilateur.


Au terme d’un autre congrès informatif et réussi, nous faisons appel aux thérapeutes respiratoires : songez à faire une présentation dans le cadre du Congrès éducatif à Vancouver l’an prochain. La SCTR lance une invitation spéciale aux thérapeutes respiratoires, les incitant à soumettre un résumé d’une présentation aux fins d’évaluation par le Comité du programme. Le but consiste à ce que la majorité des présentations soient données par des thérapeutes respiratoires. Tous les domaines d’exercice doivent être abordés et il est possible de soumettre plus d’un résumé. La date limite est le 31 octobre 2011. Les détails sont affichés sur le site Web de la SCTR. Pourquoi ne pas partager votre expertise et étoffer l’ampleur de vos activités de perfectionnement professionnel?

Comme toujours, je vous encourage à soumettre vos manuscrits au Journal. C’est un outil puissant de diffusion des connaissances et de publication des articles des thérapeutes respiratoires. Si vous avez des commentaires, veuillez communiquer avec moi -amy.cjrt@gmail.com
ABSTRACT
In the face of recent natural disasters happening around the world, the realities of field anesthesia during war time, and the challenges of anesthesia in unresourced, difficult environments, anesthesia practitioners and respiratory therapists face constant challenge. More than ever, health care professionals need to know and understand the capabilities and limitations of the equipment needed to safely administer an anesthetic. Draw-over anesthesia can be performed without O2, or electricity, and this technology warrants attention and development.

INTRODUCTION
Overwhelming challenges will confront an anesthesia provider in many developing countries, during routine operative care, natural disasters, or war. There will be no oxygen, no electricity and primitive unserviced equipment on site.

Draw-over anesthesia is simply the act of drawing a carrier gas through a vaporizer and over a volatile liquid, for the purpose of providing anesthesia. Draw-over anesthesia is not a new concept: William T.G. Morton used ether and a draw-over vaporizer on October 16, 1846, in the first public demonstration of volatile agent anesthesia. Ether was widely used as a volatile anesthetic in the military from 1846 until the end of World War II, in both plenum (push-over) and draw-over (pull-over) systems, and a draw-over anesthesia kit can be invaluable as a primary or back up device. Indeed, many experienced anesthesia volunteers take portable draw-over equipment on missions, in anticipation that ingenious technology may fail.

A modern draw-over system consists of a reservoir tube, a vaporizer, an oxygen inlet, a delivery tube and a non-rebreathing valve. (See Figure 1). Ambient air enters the system from the atmosphere due to negative pressure generated by a patient’s spontaneous efforts and is then drawn over the vaporizer to collect anesthetic agent and deliver it to the patient. The tubing proximal (upstream) of the vaporizer is used to supply a reservoir to which oxygen can be added. The delivery tubing distal to the vaporizer transports the mixed gas (carrier gas and agent) to the patient. A non-rebreathing valve, fitted to the patient end, allows the patient to inspire and expire without any rebreathing of carbon dioxide.

The common vaporizers used for draw-over anesthesia are the PAC (Portable Anesthesia Complete), EMO (Epstein Macintosh, Oxford), OMV (Oxford Miniature Vaporizer) (Figure 3), and more recently the DDV (Diamedica Draw-over Vaporizer). All these systems are still available, however, all but the DDV are crafted one order at a time. Airflow, drawn through the vaporizer, is determined by the patient’s tidal volume and respiratory rate. Since anesthesia is maintained by the patient’s efforts, all draw-over vaporizers need to have a low resistance, to accommodate intermittent gas flow and large variations in gas flow through the vaporizer. The resistance of these vaporizers range from 0.5 – 2 cwp at 30 L/min. To put this in perspective, a regular continuous flow plenum vaporizer (modern day pushover) resistance is approximately 4cwp/L/min.

These draw-over vaporizers weigh approximately 1.6 – 2.6 Kg, with the exception of the EMO which is approximately 10Kg. They maintain their stated accuracy from 1°C, to as high as 50°C. Most have thermal buffering,
and the PAC and EMO have thermal compensation. These are all acceptable for use as plenum/pushover vaporizers except for the PAC, since it becomes inaccurate when used as a plenum. It is common to use such methodology in small children.

When air is mixed with vapor from the vaporizer, it allows for a potentially “hypoxic mixture” to be delivered to the patient. This is a theoretical problem rather than a practical one, as the vapor concentration is small, and it is unlikely that the inspired oxygen concentration would fall below 18%, the international standard for oxygen analyzer alarms. This fact notwithstanding, a hypoxic mixture could ensue as vaporizers are developed to deliver a 7% sevoflurane mixture. It is far more important to consider the negative respiratory physiological effects of general anesthesia (with agents other than diethyl ether), which tend to reduce ventilation and increase shunting of blood within the lung (V/Q mismatch). Accordingly, supplemental oxygen should be included in draw over circuits whenever possible.

While there is evidence that normoxia can be maintained in healthy patients in the presence of controlled ventilation, clinical anesthesia can cause significant hypoxemia with spontaneous ventilation (p<0.05).

Supplemental oxygen may be administered via a T-piece connection mounted on the intake port of the vaporizer. Oxygen may be provided by cylinders, however, in developing countries, O$_2$ cylinders require two-way transportation, regular maintenance, the cost can be high, and availability can be variable. Another option is an Oxygen concentrator. The use of concentrators in a District hospital setting can reduce the cost of oxygen by between one half and two thirds, even when the purchase and maintenance costs are included.

The fractional oxygen concentration delivered to a patient is dependent on O$_2$ output of the concentrator, minute volume of the patient, and the presence of the OET (oxygen economizer tube, aka reservoir). The FiO$_2$ concentrations are independent of the pattern of ventilation with the OET in place. Without an OET, the performance of the system is considerably impaired and the final FiO$_2$ concentration depends on flow of O$_2$, minute volume, and pattern of ventilation.

Using a one metre length of tubing (internal volume of 415 ml) will produce an inspired oxygen concentration of at least 30% with an O$_2$ inflow rate of 1.0 l/min, and 60% with 4 l/min, at normal adult ventilation. Using a larger inflow reservoir can be cumbersome. Eales, Rowe and Tully described a modified reservoir employing a bag (rather than a tube) to increase the internal volume of the reservoir. They also added a one-way valve at the inlet of the bag, to prevent spillage of O$_2$ when using high flow rates, and an adjustable pressure limiting APL valve (5cwp continuous positive airway pressure) to prevent excessive pressure developing. Such a reservoir permits a predictably high FiO$_2$ when high minute ventilation is required.

Anesthetic agents that can be used in most of these vaporizers include Ether, Halothane, Isoflurane, and Sevoflurane. Due to their similar vapour pressures, Halothane and Isoflurane, (243 vs 238 respectively) can be interchanged without significant differences in calibration or scale change on the vaporizer. One must be careful to identify and label the agent in the vaporizer, as there is a huge difference in potency between Halothane and Isoflurane. A major concern with Halothane is thymol build up in the vaporizers. Thymol is a preservative found only in Halothane which over time results in a sticky residue build-up in the vaporizers. It can go as far as seizing the concentration dial on the OMV. Halothane should not be used in an EMO vaporizer. The alloys inside...
The output of sevoflurane from a PAC vaporizer is between 0.1 and 3.6% (v/v), which would be sufficient for anesthetic maintenance but inadequate for routine inhalation induction.\textsuperscript{10} Two OMV vaporizers in series will deliver from 0.5% to 5.9\%, sevoflurane and this dynamic would seem a feasible technique for induction and maintenance of sevoflurane anesthesia.\textsuperscript{11} Recently, a new Diamedica vaporizer has been developed that delivers an adequate concentration (8\%) of Sevoflurane.

The OIB was designed in the era when Heidbrink – type Adjustable Pressure Limiting Valves (APL) were generally used for anesthesia circuits, rather than non-rebreathing valves, and the one way valve (Outlet Valve) that is on the patient side of the OIB was built into the device to prevent expired gases from being aspirated retrograde into the bellows. On the other hand, in present times, when non-rebreathing valves are employed at the patient end of the circuit, a magnet must be used to keep the OIB outlet valve open. This is to allow the pressure on the inlet side of the non-rebreathing valve to return to atmospheric pressure with the rise of the bellows, and allow the patient to exhale through the non-rebreathing valve, out to atmosphere. If a non-rebreathing valve is used, and the integral one way outlet valve is NOT disabled by using a magnet, the positive pressure remains on the inspired side of the non-rebreathing valve and prevents the patient from exhaling. With each successive inspiration, pressure within the breathing system increases, eventually possibly causing barotraumas.\textsuperscript{12}

Laerdal IV, Ambu E1 and Ruben valves, can be used effectively at the patient end of the draw-over circuit. (See Fig 4) These valves may become soiled and inoperable during use. If the inspiratory side sticks open, the patient may be

an EMO are so rapidly corroded by halothane that a single filling of an EMO with halothane will destroy the vaporizer.\textsuperscript{4}
prevented from exhaling therefore leading to increased pressure build up in the lung. If the expiratory side of the valve sticks open, the patient may draw from room air rather than the circuit. A PEEP apparatus can be used with the Laerdal valve, but not with the other non-rebreathing valves. Non-rebreathing valves may stick with prolonged use without cleaning and proper maintenance. Inspection and testing are required to ensure functional operation of the valves and safe use with patients.  

Pediatrics can be a large percentage of the cases seen in the developing world. Three physiological parameters to consider are apparatus dead space, resistance, and work of breathing. In pediatrics, two types of circuits are commonly used: a regular draw-over circuit, preferably with a pedi-valve; and an Ayres “T” piece (Mapleson E circuit). The same draw-over vaporizers can be used, as with adults. However, most practitioners will opt for an Ayres “T” piece in children less than 10-15 kg, in consideration of the limitation for air flow generation in small children. Provided the inflow rates are above 4l/min, the accuracy of draw-over vaporizers, in this plenum mode, are adequate to be used as a fresh gas source for the “T” piece. 

The Ayres “T” piece, is ideal for children under 20Kg. A version commonly used is a Jackson-Rees modification, which has an open bag attached to the expiratory limb (Mapleson F). It is recommended that a FGF 2-3 times the minute volume is required to prevent rebreathing of CO₂ and the minimum flow should be >3L/min. The minimum minute ventilation should be 150 ml/kg/min.

In conclusion, the attraction of Draw-Over lies in the fact that it is fundamentally simple, robust, easily portable and can function without compressed gases and even without supplementary oxygen, when absolutely necessary. A failure of the oxygen supply will result in a default to room air and this will be adequate (though not desirable) for most patients. Understanding the limitations of all aspects of equipment is important for safe operation. A thorough understanding of the operation of these circuits and the completion of a checkout procedure is a vital component to ensuring safety for the staff and patients. Assessing the situation with regard to patient’s age, size, procedure, availability of equipment and personnel, and obtaining the proper kit is essential for patient safety. (see Table 1)

### TABLE 1

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
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<tbody>
<tr>
<td>Simplicity of concept and assembly</td>
<td>Decreasing familiarity with the technique and equipment</td>
</tr>
<tr>
<td>No need for pressurized gas supply, regulators and flow meters</td>
<td>Vaporizer limitations</td>
</tr>
<tr>
<td>Minimum FiO₂ is ~18-21%</td>
<td>Filling systems not agent specific (potential advantage)</td>
</tr>
<tr>
<td>Robust, reliable, easily serviced equipment</td>
<td>Basic temperature compensation, affecting performance at extremes</td>
</tr>
<tr>
<td>Low cost (purchase and maintenance)</td>
<td>Less easy to observe spontaneous ventilation with self inflating bag</td>
</tr>
<tr>
<td>Portable, suitable for field anesthesia (easy to transport and set-up)</td>
<td>Cumbersome in pediatric use, unless lightweight tubing is available</td>
</tr>
<tr>
<td>Easy to service by locally trained staff</td>
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The Association of Body Mass Index with Airway Obstruction in Non-Asthmatics: Implications for the Inaccurate Differential Diagnosis of Asthma in Obesity

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ABSTRACT

Introduction: An association between obesity and asthma has been reported, with disparity between males and females in this association that is not fully explained. Studies investigating the association typically have not identified asthma using accepted objective diagnostic methods, possibly leading to the inaccurate diagnosis and management of asthma in those with obesity.

Objective: This study investigated the association, including gender differences, between obesity and airway obstruction in non-asthmatics identified by spirometric protocols.

Methods: The pulmonary function test results of non-asthmatic subjects were reviewed. Statistical analyses were employed to determine the association between pulmonary function measures and BMI.

Results: Significant differences in the pulmonary function values, measured as a percentage of predicted, existed between BMI ranges including FVC (p < 0.001), FEV1/FVC (p < 0.001), and FEF50% (p < 0.02). Gender differences were evident in FVC, FEV1, FEV1/FVC, FEF25% , and FEF50% (all p < 0.001). When age and smoking were controlled for, gender differences remained in the pattern of the effect of BMI on FVC. FVC was progressively compromised for females as BMI increased above normal range (≥ 25 kg/m²), and was diminished in males with a BMI ≥ 30 kg/m².

Conclusions: Clear association was not found between indices of airway obstruction and increasing BMI in this non-asthmatic group. The study findings suggest a restrictive pulmonary function profile in obesity which is specific to non-asthmatics and unique to each gender. The compromising effects of increasing adiposity on FVC may be experienced at a lower BMI in females than in males.

Keywords: Airway Obstruction; Asthma; Body Mass Index; Obesity; Pulmonary Function Tests

RÉSUMÉ

Introduction : Certains chercheurs ont signalé une association entre l’obésité et l’asthme, avec des disparités entre les hommes et les femmes dans cette association qui n’ont pas été entièrement expliquées. Les études portant sur cette association n’ont généralement pas relevé l’asthme selon des méthodes diagnostiques objectives acceptées, ce qui peut avoir mené à des erreurs de diagnostic et de gestion de l’asthme chez les personnes obèses.

Objectif : Cette étude a examiné les liens, incluant les différences liées au sexe, entre l’obésité et l’obstruction des voies respiratoires chez les personnes non asthmatiques identifiées par les protocoles spirométriques.

Méthodologie : Les résultats des tests de fonction pulmonaire pour les sujets non asthmatiques ont été examinés. L’analyse statistique a été utilisée pour déterminer l’association entre les mesures de fonction pulmonaire et l’IMC.

Résultats : Des écarts significatifs, en pourcentage des prévisions, ont été mesurés dans les valeurs de fonction pulmonaire entre les plages d’IMC, incluant FVC (p < 0.001), FEV1/FVC (p < 0.001), et FEF50% (p < 0.02). Des écarts entre les sexes apparaissent dans FVC, FEV1, FEV1/FVC, FEF25% et FEF50% (tous p < 0.001). Lorsqu’on tient compte de l’âge et du statut de fumeur, les différences entre les sexes subsistent dans la distribution des effets de l’IMC sur la FVC. La FVC est progressivement compromise chez les sujets féminins à mesure que l’IMC augmente au-delà de la plage normale (≥ 25 kg/m²) et diminue chez les sujets masculins présentant un IMC de ≥ 30 kg/m².

Conclusions : Aucune association claire n’a été établie entre les indices d’obstruction des voies respiratoires et l’augmentation de l’IMC dans ce groupe de non asthmatiques. Les conclusions de l’étude semblent présenter un profil de restriction de la fonction respiratoire chez les personnes obèses propre aux non asthmatiques et unique à chaque sexe. Les effets négatifs de l’augmentation de l’adiposité sur la FVC peuvent apparaître à un IMC plus faible chez la femme que chez l’homme.

Mots-clés : Obstruction des voies respiratoires; Asthme; Indice de masse corporelle; Obésité; Examens fonctionnels respiratoires
INTRODUCTION
The worsening global epidemic of obesity is a significant contributor to morbidity and mortality (1). An estimated 59.2% of the Canadian population is either overweight or obese (2) with an increasing trend expected to continue into the future (3). The magnitude of the increase in obesity has been paralleled by an increase in the prevalence of asthma in many global locales (1,4). Asthma now affects 8.3% of the population (5), an increase of more than 1% over the last decade (6). The phenomenon of a concurrently increasing prevalence for these two disorders may be more than coincidental. A mounting body of data describes obesity as a significant risk factor for the development of asthma (7), and offers compelling evidence of several complex interactions between the two that are worthy of careful consideration (8,9). The purpose of this study was to investigate the association between obesity and asthma which constitutes a growing public health concern.

A meta-analytical study of the dose-response effect of elevated body mass index (BMI) on asthma incidence (10) determined that the likelihood of asthma was 1.51 times higher in subjects with a BMI ≥ 25 kg/m² compared to those of a normal weight (18.5-24.9 kg/m²) [Odds Ratio (OR) 1.51, 95% CI, 1.17-1.62]. Numerous other studies are also suggestive of an increased prevalence of obesity amongst adults with asthma (7,8,11), but do not adequately describe any cause and effect relationship between the two. These studies have typically defined asthma status based on patient self-reported symptoms, or by physician diagnosed asthma that was then self-reported and/or lacked control for the methods used to obtain the diagnosis (8,12-15). These self reports without objective confirmation do not ensure consistency with accepted standards for the diagnosis of asthma such as those endorsed by the Canadian Thoracic Society (16). Preferred diagnostic techniques include bronchodilator response as determined by spirometry, or bronchial provocation testing (16).

The obstructive effect of obesity on pulmonary function, including a compromised FVC, is well described (17). Various authors also report distinctly obstructive elements seen in the pulmonary function profile of obese individuals [BMI ≥ 30 kg/m² (11)]. It has been shown that forced expiratory volume in one second (FEV1) diminishes with increasing BMI in subjects with no underlying respiratory pathology (17-19). BMI related compromise of other indicators of airflow obstruction such as forced expiratory flow at 25%, 50% and 75% of forced vital capacity (FEF25%, FEF50%, and FEF75%, respectively), and forced expiratory flow between 25% and 75% of forced vital capacity (FEF25-75%) has also been described in the literature (20,21). A correlation between asthma and obesity, however, was not found by studies that investigated the association of obesity and airway responsiveness (22-24).

Hyperresponsiveness of the airway determined by objective methods is a hallmark of asthma diagnosis, distinguishing the pathology from others that cause an obstructive pulmonary profile (16). Mounting evidence suggests that obesity is associated with an over-diagnosis of asthma, due to airflow limitation that is not associated with hyper-responsiveness, a phenomenon attributed to the lack of use of objective diagnostic methods. Such over diagnosis may result in the overuse of costly asthma therapies (13,25).

Several studies have reported the association between asthma and obesity either to be strongest in females, or to only be significant in females (7,11,12,15,26-28). Most of these studies, however, defined asthma by methods that did not include measurement of airway hyperresponsiveness. Indeed, there are conflicting reports that show no significant association between BMI and airway responsiveness (as measured by either bronchial challenge with methacholine or bronchodilator response) in both males and females (14,24), while others showed a strong relationship between increasing BMI and bronchial hyperreactivity in males with only a weak relationship in females (22). One possible explanation for these various outcomes is that the increased asthma prevalence reported in obese females is due to an obstructive profile determined from studies based on symptomatic evaluation, rather than actual airway hypersensitivity or responsiveness. In light of the lack of objective measures used to quantify reported disparities between the genders, misdiagnosis of asthma in obese females is a likely factor.

The obstructive effects of obesity on the pulmonary airway (17-19), and the resultant respiratory symptomology, may lead to an unwarranted diagnosis of asthma (14,25). Identifying any disparity in the underlying pulmonary function profile between the genders in obese non-asthmatic subjects would be helpful in ascertaining which factors may explain the differences between males and females with respect to the reported association between obesity and asthmatic symptomology. This study was developed to investigate the primary mechanisms that may be responsible for the reported association between obesity and subjectively diagnosed asthma, and the disparity described between genders for that association. It was hypothesized that there would be a positive correlation between BMI status and measures of pulmonary function obstruction in non-asthmatic individuals, and that there would be a significantly greater effect of BMI on specific pulmonary function variables of females when compared to those of males. Any noted differences between genders in relation to the primary pulmonary function effects of obesity might offer some insight into the etiologic basis for this gender-based disparity.

METHODS
A retrospective analysis was conducted of spirometry results obtained between June 1, 2006 and August 31, 2007. The charts of patients referred by physicians to a pulmonary function laboratory in Regina, Saskatchewan, Canada, were reviewed with respect to their relevant history and pulmonary function test results. As such, participants were referred by a variety of medical specialties including General Practice, Respiriology, Oncology, Pediatrics, and Internal Medicine. Ethical approval was granted by both the Charles Sturt
University Ethics in Human Research Committee, and the Regina Qu’Appelle Health Region Research Ethics Board.

All measures of pulmonary function that occurred in the lab were performed on a Collins GS pulmonary function apparatus (Collins Medical, Inc., Braintree, MA), in accordance with the standards of lung function testing of the American Thoracic Society/European Respiratory Society (ATS/ERS) (29). Post bronchodilator testing was performed a minimum of 10 minutes after administration of salbutamol 2 puffs (200 mcg) metered dose inhaler via a spacer device to determine airway responsiveness, based on laboratory protocol. All pulmonary function testing was performed by a Registered Respiratory Therapist trained in the use of laboratory equipment and evaluation of test results to ATS/ERS standards. Each pulmonary function report included a record of the patient’s gender, height, weight, age, smoking status as measured by pack years, and standard spirometric measures including forced vital capacity (FVC), the ratio of forced expiratory volume in one second to forced vital capacity (FEV/FVC), FEV1, FEF25%, FEF50%, FEF75%, and FEF25%-75%. Each subject’s height, weight, and smoking history were self-reported. Pulmonary function variables were recorded as a percentage of the normal value predicted based on reported height and age (30). The predicted normal reference values for pulmonary function employed were based on those derived by Knudson et al. (30).

**Participant Selection**

The study sought to identify subjects who were asthma free. All criteria for the objective evaluation of asthma status and airway obstruction were based on Canadian Thoracic Society recommendations (16,31). The inclusion and exclusion criteria are summarized in Table 1. Criteria were designed to exclude those subjects who, based on pulmonary function measures, had evidence of asthma, reversible airway obstruction, or airway obstruction that could not be differentiated from either of these based solely on the available test results. The study therefore included the results of any initial test done as part of a pre and post bronchodilator test where the post test showed no significant improvement in FEV1. Improvement in FEV1 was defined as an increased test score ≥ 12% (and a minimum of 180 ml) above the pre-test (baseline). The results of tests where no post-bronchodilator testing was performed (either pursuant to laboratory procedure or for other clinical reasons) were also included when the results demonstrated a lack of airway obstruction. A lack of airway obstruction was defined as either a FEV1 ≥ 80% of predicted normal, or, a FEV1 < 80% of predicted normal with a ratio of forced expiratory volume in one second to forced vital capacity (FEV1/FVC) ≥ 70% of predicted normal. The computerized diagnostic record database of the laboratory was used to identify 1114 subjects whose test results met the study criteria. Of the 1114 test results recorded in the study database, 195 were excluded after review revealed testing had been repeated in the laboratory two or more times for clinical reasons. Only the earliest test performed on any one subject was included in the analysis in order to minimize the possible effects of any pharmacotherapy or other treatment strategy that may have been initiated before the follow up test was performed.

**Table 1: Study Inclusion and Exclusion Criteria**

<table>
<thead>
<tr>
<th>Inclusion Criteria</th>
<th>Exclusion Criteria</th>
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<tbody>
<tr>
<td>Non-Asthmatic Subjects</td>
<td>Asthmatic Subjects or those with Other Airway Obstruction</td>
</tr>
<tr>
<td>FEV1 ≥ 80% of predicted ‡ with no bronchodilator response testing ‡</td>
<td>FEV1 &lt; 80% of predicted ‡ with no bronchodilator response testing ‡</td>
</tr>
<tr>
<td>FEV1 &lt; 80% of predicted † and FEV1/FVC ≥ 70% of predicted † with no bronchodilator response testing ‡</td>
<td>FEV1 &lt; 80% of predicted † and FEV1/FVC &lt; 70% of predicted † with no bronchodilator response testing ‡</td>
</tr>
</tbody>
</table>

Criteria were designed to control for the inclusion of non-asthmatic subjects only. * Based on Canadian Thoracic Society (CTS) guidelines for the diagnosis of asthma (16), † predicted values for pulmonary function as proposed by Knudson et al. (30), ‡ and † on CTS definition of airway obstruction (31). FEV1 Forced Expiratory Volume in one second; FEV1/FVC ratio of Forced Expiratory Volume in one second to Forced Vital Capacity.

**Statistical Analysis**

Descriptive analyses of all pulmonary function variables recorded in each BMI range for males, females, and both genders combined were performed. In order to assess the two main hypotheses the study compared each of the recorded measures of pulmonary function to varying degrees of body mass index, and examined for gender differences in the relationship between BMI [weight (kg)/height (m²)] and pulmonary function. The data analysis was performed in two unique phases. The first phase served two key purposes: (1) to allow for comparison of results to those previously reported in the literature using similar analysis techniques, and (2) to act as a baseline from which further analysis of data could be made when controlling for significant confounders. There is much ambiguity with regards to control for confounders in the literature, thus, the second phase of the analysis identified and controlled for potential confounders. This allowed for more accuracy in identifying differences between the genders, and indicated the potential influence of these confounders on previously reported findings. The results of the first analysis phase were then compared to the results of the second analysis phase to examine variance between the two that could have been a result of the potential confounding factors.
First Analysis

Data were grouped for analysis into BMI ranges according to the World Health Organization classification system for analysis [normal weight (BMI 18.5-24.9 kg/m²); overweight (BMI 25.0-29.9 kg/m²); obese I (BMI 30.0-34.9 kg/m²); obese II (BMI 35.0-39.9 kg/m²); obese III (BMI ≥ 40.0 kg/m²)] (Table 2) (1). Analysis of Variance (ANOVA) was performed to examine for differences between the BMI groups in all other variables. ANOVA was also performed to examine for differences in variables between genders.

The distributions of the data sets of each of the pulmonary function variables were skewed. A square root transformation was used to improve the normality of their distribution as recommended by Tabachnik and Fidell (32). The benefit of the square root transformation of data is that it improves the normality of the distribution, a key assumption for parametric analysis (32). For variables that were negatively skewed (FVC, FEV₁, FVC/FEV₁, and FEF₂₅%), the data were first “reflected” before the square root transformation was applied (32). The square root transformed data was used for all further statistical analysis of these variables, but are accompanied by the non-transformed data values when presented in Tables and Figures, to allow readers to conceptualize the potential trends more easily. This method of data analysis and presentation has been employed by other authors in this field (33).

Second Analysis

The second phase of the analysis was performed after removal of outliers and control for covariates. Multivariate outliers were identified in BMI, age, and smoking history, using Mahalanobis distance (32). This led to the deletion of ten outliers for these variables. Multivariate analysis of covariance (MANCOVA) was then performed, and age and smoking history were entered as covariates since they were each found to be significantly different between BMI groups. The covariates were further explored and extreme cases, identified again by Mahalanobis distance, were removed until box plots indicated that there were no remaining outliers. Analysis was then performed on the remaining 904 cases.

Data were then regrouped for the remainder of the analysis into three BMI ranges [normal (BMI 18.5-24.9 kg/m²); overweight (BMI 25.0-29.9 kg/m²); obese (BMI ≥ 30.0 kg/m²)]. This regrouping increased group size and minimized the impact of sample size on the results of further analysis. To further examine the potential gender differences in the pulmonary function variables, separate data files were made for males and females, and analyses were applied independently.

All statistical analyses were performed using commercially available software (SPSS version 15.0, SPSS Inc., Chicago, Illinois). Differences were considered statistically different when p < 0.05.

<table>
<thead>
<tr>
<th>TABLE 2: Comparison of Pulmonary Function and Demographic Variables between BMI Ranges, Males and Females Combined*</th>
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</thead>
<tbody>
<tr>
<td><strong>BMI Groups (kg/m²)</strong></td>
</tr>
<tr>
<td><strong>Gender</strong></td>
</tr>
<tr>
<td>Female (n = 406)</td>
</tr>
<tr>
<td>Male (n = 513)</td>
</tr>
<tr>
<td><strong>Age</strong></td>
</tr>
<tr>
<td><strong>Smoking History</strong></td>
</tr>
<tr>
<td><strong>FVC</strong></td>
</tr>
<tr>
<td><strong>FEV₁</strong></td>
</tr>
<tr>
<td><strong>FEV₁/FVC</strong></td>
</tr>
<tr>
<td><strong>FEF₂₅%</strong></td>
</tr>
<tr>
<td><strong>FEF₇₅%</strong></td>
</tr>
<tr>
<td><strong>FEF₅₀%</strong></td>
</tr>
<tr>
<td><strong>FEF₂₅⁻₇₅%</strong></td>
</tr>
</tbody>
</table>

* Values are presented as a percentage of the No. or mean (SD) percentage of predicted values, except for FEV₁/FVC which is an absolute ratio. Smoking history is measured in pack years.
† BMI grouping based on the World Health Organization classification system (1). ‡ For pulmonary function variables actual indicates non-transformed values, √ indicates mean (SD) of square root transformed variables. § For pulmonary function variables P indicates statistical significance between BMI categories for the square root transformations of those variables.

RESULTS

First Analysis

Significant differences in the square root transformations of several of the pulmonary function variables existed between the BMI ranges including FVC (p < 0.001), FEV₁/FVC (p < 0.001), FEF₂₅% (p < 0.05), and FEF₅₀% (p < 0.02), as well as gender (p < 0.005) and the mean age of the groups (p < 0.02). FEV₁, FEF₇₅%, FEF₂₅%-₇₅%, and smoking history measured by pack years each showed no significant differences between BMI ranges (Table 2).

Figure 1 shows the difference between BMI groups in age, FVC, FEV₁/FVC, and FEF₅₀%. Post hoc tests indicated that the obese group III was significantly younger than all other groups except obese group II, and that FVC was significantly higher in subjects in the normal weight category compared to those in either the obese groups II or III. FEV₁/FVC and FEF₅₀% were both significantly higher in obese group III compared to all other groups except for obese group II when post hoc Tukey's HSD was applied. No significant differences between obese II and obese III groups in any of the pulmonary function variables were found.

Second Analysis

The results of the ANOVA between genders are shown in Table 3. Significant differences between genders were found between several of the square root transformations of pulmonary function variables including FVC, FEV₁, FEV₁/FVC, FEF₂₅%, FEF₅₀% (all p < 0.001), but not for FEF₂₅%-₇₅% and FEF₇₅%. Significant differences were also found between genders in pack year smoking history (p < 0.001), height (p < 0.001), and weight (p < 0.001) but not in BMI. These results indicated the need for separate analyses for males and females.

TABLE 3: Comparison of Pulmonary Function and Demographic Variables between Genders*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Females N = 406</th>
<th>Males N = 513</th>
<th>P ±</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>60 (14.7)</td>
<td>61 (15.1)</td>
<td>-</td>
</tr>
<tr>
<td>Smoking History</td>
<td>16 (19.3)</td>
<td>24 (24.1)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>BMI</td>
<td>30 (7.2)</td>
<td>30 (7.0)</td>
<td>-</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>161 (6.8)</td>
<td>174 (7.1)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>77 (20.0)</td>
<td>93 (25.5)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>FVC (%)</td>
<td>93 (19)</td>
<td>87 (19)</td>
<td>7.4 (1.3)</td>
</tr>
<tr>
<td>FEV₁ (%)</td>
<td>95 (24)</td>
<td>89 (23)</td>
<td>8.2 (1.4)</td>
</tr>
<tr>
<td>FEV₁/FVC (%)</td>
<td>75 (12)</td>
<td>71 (12)</td>
<td>6.1 (1.0)</td>
</tr>
<tr>
<td>FEF₂₅% (%)</td>
<td>90 (35)</td>
<td>81 (33)</td>
<td>9.6 (1.7)</td>
</tr>
<tr>
<td>FEF₅₀% (%)</td>
<td>66 (36)</td>
<td>58 (32)</td>
<td>7.3 (2.2)</td>
</tr>
<tr>
<td>FEF₇₅% (%)</td>
<td>45 (34)</td>
<td>42 (28)</td>
<td>6.2 (1.9)</td>
</tr>
<tr>
<td>FEF₂₅%-₇₅% (%)</td>
<td>74 (37)</td>
<td>72 (36)</td>
<td>8.2 (2.2)</td>
</tr>
</tbody>
</table>

* Values are presented as a mean of the No. or mean percentage of predicted values (SD), except for FEV₁/FVC which is an absolute ratio. Smoking history is measured in pack years.
† For pulmonary function variables ‘actual’ indicates non-transformed values, √ indicates mean (SD) of square root transformed variables.
‡ For pulmonary function variables P indicates statistical significance between genders for the square root transformations of those variables. √ indicates mean (SD) of square root transformed variables.

BMI Body Mass Index; FEF₂₅%, Forced Expiratory Flow at 25% of Forced Vital Capacity; FEF₅₀%, Forced Expiratory Flow at 50% of Forced Vital Capacity; FEF₇₅%, Forced Expiratory Flow at 75% of Forced Vital Capacity; FEV₁, Forced Expiratory Volume in one second; FEV₁/FVC, ratio of Forced Expiratory Volume in one second to Forced Vital Capacity; FVC, Forced Vital Capacity.
Separate analyses were then performed for each gender using the three regrouped BMI ranges. The results of these analyses are presented in Table 4. For female subjects, the square root transformations of FVC, FEV1/FVC, FEF25%, and FEF25%-75% were significantly influenced by age. Pack years had a significant effect on FEV1, FEV1/FVC, FEF25%, and FEF25%-75% in women. After controlling for both these covariates a significant effect of BMI remained for FVC between genders (F(2, 400) = 2.94, P < 0.05). Pairwise comparisons adjusted using the Bonferroni correction indicated that this was due to a difference between normal weight and obese women, normal weight women having significantly higher FVC scores than obese (p < 0.05).

In men, age and pack years were significant interacting factors for the square root transformation of FEV1, FEV1/FVC, and FEF50%. After controlling for the effects of age and smoking, a significant impact of BMI was noted on FVC (F(2, 494) = 7.02, p < 0.001), FEV1 (F(2, 494) = 3.15, p < 0.05), and FEF25% (F(2, 494) = 2.93, p < 0.05). Pairwise comparisons adjusted using the Bonferroni correction indicated that significant differences were found in FVC between the obese patients and those who were normal weight (p < 0.02) and those who were overweight (p < 0.002). FVC values therefore dropped significantly from the normal and overweight categories to those with a BMI in the obese range. For FEV1, the significant change occurred between the overweight and obese categories (p < 0.05), resulting in lower FEV1 values in obese subjects. Finally, in FEF25%, it was the difference between normal weight and overweight categories that was significant (p < 0.05), resulting in higher FEF25% values in overweight subjects compared to those of normal weight. The variance in results found between genders for FVC, FEV1, and FEF25% are displayed in Figure 2.
DISCUSSION

First Analysis

The results of our study’s first analysis confirm the findings of other authors who have demonstrated that FVC is compromised as BMI increases (17,20,21,33,34). The results presented here are unique in that they demonstrate a similar phenomenon, but in a group of subjects where the incidence of asthma as a comorbidity has been controlled for using objective diagnostic techniques. There has been diversity in the subject inclusion criteria employed by many authors of previous studies investigating the effect of BMI on pulmonary function. Biring et al. (21) did not exclude subjects who may have had asthma, while others like Jones and Nzekwu (33) controlled for subjects who demonstrated normal forced expiratory flow rates. The results of such studies, while relevant to this discussion, can not all be reliably generalized to the non-asthmatic subject pool being investigated here. However, based on their results, Jones and Nzekwu (33) predicted a compromise in several lung volume parameters including a reduction in VC of 0.5% compared to predicted for each unit increase in BMI in a subject pool that may have included asthmatics. Our results echo this prediction for FVC, demonstrating a 9.03% decrease in mean FVC values, compared to predicted, between the normal and obese III ranges, or a 0.56% increase for each unit decrease in BMI (between BMI 22 kg/m$^2$ and 40 kg/m$^2$). These similarities are important as they demonstrate that the restrictive pulmonary function effects of increasing BMI occur in those groups comprised exclusively of non-asthmatics, as well as in those groups which may include both asthmatics and non-asthmatics.

TABLE 4: Comparison of Pulmonary Function Variables between BMI Ranges, Males and Females Separated*

<table>
<thead>
<tr>
<th>BMI Groups (kg/m$^2$)</th>
<th>FEMALES (n = 405)</th>
<th>MALES (n = 499)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI</td>
<td>18.5-24.9</td>
<td>25.0-29.9</td>
</tr>
<tr>
<td></td>
<td>actual</td>
<td>$\sqrt{adj\ _a}$</td>
</tr>
<tr>
<td>FVC</td>
<td>97 (18)</td>
<td>6.7 (0.1)</td>
</tr>
<tr>
<td>FEV$_1$</td>
<td>98 (23)</td>
<td>7.7 (0.1)</td>
</tr>
<tr>
<td>FEV$_1$/FVC</td>
<td>74 (12)</td>
<td>6.0 (0.1)</td>
</tr>
<tr>
<td>FEF$_{25%-75%}$</td>
<td>88 (36)</td>
<td>9.3 (0.2)</td>
</tr>
<tr>
<td>FEF$_{50%}$</td>
<td>63 (34)</td>
<td>7.5 (0.2)</td>
</tr>
<tr>
<td>FEF$_{75%}$</td>
<td>44 (36)</td>
<td>6.3 (0.2)</td>
</tr>
<tr>
<td>FEF$_{25%-75%}$</td>
<td>71 (37)</td>
<td>8.1 (0.2)</td>
</tr>
</tbody>
</table>

* Values are presented as percentage of the No or mean (SD) percentage of predicted values, except for FEV1/FVC which is an absolute ratio. † For pulmonary function variables ‘actual’ indicates non-transformed values, ‘$\sqrt{adj\ _a}$’ indicates the adjusted marginal mean (SE) for the square root transformed variables with covariates being evaluated at age = 60.5 yrs, and smoking history (pack years) = 16.3 years. ‡ For pulmonary function variables P indicates statistical significance between BMI categories for the square root transformations of those variables.

BMI Body Mass Index; FEF$_{25\%-75\%}$ Forced Expiratory Flow at 25% of Forced Vital Capacity; FEF$_{50\%}$ Forced Expiratory Flow between 25% and 75% of Forced Vital Capacity; FEF$_{75\%}$ Forced Expiratory Flow at 75% of Forced Vital Capacity; FEV$_1$ Forced Expiratory Volume in one second; FEV$_1$/FVC ratio of Forced Expiratory Volume in one second to Forced Vital Capacity.
The significant increase in FEV₁/FVC demonstrated throughout increasing BMI ranges is suggestive that the restrictive pulmonary effects of the increased BMI were more evident than any obstructive airway processes. This phenomenon has also been commonly reported in research which investigated groups where asthma was not objectively excluded (13). Further suggestion of the predominance of a restrictive pulmonary function profile is offered by the lack of any significant effect of BMI on FEV₁ in our study’s subjects. These results conflict with the findings of several previous investigations (13,20,21) where FEV₁ compromise was seen in association with increasing BMI. We suggest that the most likely explanation for this finding is our study’s identification of a unique subject pool, where reversible airway obstruction has been controlled. This is perhaps an indication that the results of previous studies may be describing, at least in part, the effect of a mainly reversible form of airway obstruction, as opposed to that of mechanically and obesity mediated airway obstruction per se.

Further evidence for classification of the unique respiratory function pattern of non-asthmatic overweight and obese subjects is offered by the patterns of their expiratory flow rates. Previous studies have identified a clearly obstructive pattern when evaluating these expired flow rates (20,21,35), such as a correlation between increasing body weight and decreasing FEF₂₅% and FEF₅₀% (35). Interestingly, in one study much of this effect remained even after normalizing these expired flows for the associated and reduced FVC, indicating that airway narrowing remained an effect despite control for the restrictive effects of obesity (21). These studies, however, did not control for asthma diagnosed by objective measurement and as such, the remaining obstructive indices may be indicative of the presence of asthmatics in the subject pool. The results of our analyses are quite distinct from those previously described. For many of the expired flow indices measured, including FEF₂₅%, FEF₂₅% and FEF₅₀%, no significant association existed between any BMI groups. Perhaps most intriguing was the unanticipated finding that FEF₅₀% actually increased in the most severe forms of obesity (BMI > 40.0 kg/m²), an effect not previously recorded. These findings not only reinforce the suggestion that airway obstruction is not an obvious effect in these subjects, but also clearly demonstrate a significant difference from previously published results. We postulate that this is also most likely secondary to the distinctive and unique profile of the study’s subject pool due to its unique exclusion criteria. The compromised FVC, increased FEV₁/FVC, and lack of compromise in expired flow rates, are together suggestive that the effects of chest wall restriction, and/or diaphragmatic limitation, are the dominant effects of obesity. We have also allowed for the isolation of this effect by inclusion of only non-asthmatic participants. If asthma were present in this subject pool, then we anticipate that airway obstruction would be exaggerated by the reduced lung volumes. Our findings demonstrate a marginal increase in airflow secondary to chest wall impedance.

The results of the first phase of our data analysis examined the differences in the respiratory function pattern of each gender. The results suggested that an underlying rationale could exist for the previously reported differences found in asthma prevalence in obese individuals (23,24) and the patterns of airway hyperresponsiveness between genders (22). Unlike several investigations that did not report differences in the pulmonary function profiles of the genders (17,21,33,35), we observed significant differences between their mean predicted values for FVC, FEV₁, FEV₁/FVC, FEF₂₅%, and FEF₅₀%. These results do not demonstrate a correlation for any of these variables with BMI, though they do offer an important demonstration of the clear difference in pattern of airflow compromise between genders in non-asthmatic subjects. The reference sets derived by Knudson et al. (30) were employed to determine predicted normal values for males and females in

FIGURE 2

<table>
<thead>
<tr>
<th>BMI (kg/m²)</th>
<th>FVC (% predicted)</th>
<th>FEV₁ (% predicted)</th>
<th>FEF₂₅% (% predicted)</th>
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<tbody>
<tr>
<td>18.5-24.9</td>
<td></td>
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<tr>
<td>≥ 25.0-29.9</td>
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<td>≥ 30</td>
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this study. It is possible these references may more accurately correct for the effects of height and age for one of the genders than for the other. Since a variety of similar reference sets for predicting pulmonary function values have been employed in the literature reviewed, it is suspected that the unique subject exclusion criteria may again help explain the divergence from the results described by those studies. The Jones and Nzekwu (33) study for example, identified no significant difference between genders in any pulmonary function variables in a subject pool where airway obstruction in general was excluded. There is potential that the differences we have described are more likely representative of the non-asthmatic population. Unlike several studies previously referred to, our results prompted us to perform a second analysis on these two distinct pulmonary function profiles individually, and to consider any other confounding factors that could have had an effect on the results.

**Second Analysis**

The impact of smoking in reducing pulmonary function is well known (36). Not surprisingly, pack year smoking history was found to be a significant covariate indicating impact on all pulmonary function variables in these subjects. In one other study investigating the pulmonary effects of morbid obesity, the authors reported no control for smoking history amongst participants (21). Subgroup analysis reported that smoking had no impact on pulmonary function variables in one group of obese subjects [weight (kg)/height (cm) ratio 0.90-1.0], while it found it to have a significant impact on FVC, FEV1, and FEF25% to 75% on another group with a more extreme form of obesity [weight (kg)/height (cm) ratio > 1.0]. It is possible that this demonstrates a synergistic effect of smoking history and BMI on pulmonary function. Furthermore, there is also data supporting the hypothesis that the adverse effects of smoking on pulmonary function may be greater in females than in males (37-40). The fact that smoking history has not been consistently controlled for in previous investigations into the association of BMI and pulmonary function lead us to consider that previous results should not be extrapolated to answer the research questions which are posed by this study. The suggestion that smoking may have varying degrees of impact on pulmonary function, dependant upon either gender or the degree of obesity, reinforces the importance that it was controlled for in this analysis. This is noteworthy considering both our data, which show smoking history to be an important covariate impacting pulmonary function between BMI ranges, and our study aim which sought to identify non-smoking related differences between the genders.

The other covariate identified to have a significant impact on respiratory function was age, and it is well known that respiratory function declines with age greater than 25 years (30). Much of the literature surveyed pertaining to the effect of obesity on pulmonary function offered no indication of any methods employed to control for the effect of age. There have been a limited number of studies investigating the effect of weight gain and pulmonary function which have employed a variety of different age limits as inclusion criteria (26,33,34), though methods of statistically controlling for the effect of age within those or other groups have rarely been reported. There have been studies which have described the effects of aging on pulmonary function variables (41-43), and as such demonstrate value in controlling for their effects. While these effects could be partially accounted for through the use of regression equations to determine predicted pulmonary function values, the effects that remain uncontrolled for may have significant impact on their results. This should be considered when reviewing the previously reported findings where the effects of age have not been adequately controlled for. In an effort to more reliably control for any factors which would cloud identification of the effect of BMI on any of these pulmonary function variables, age and smoking history were both controlled for in our second analysis. The subgroup analysis for each gender resulted in several pertinent findings after control for these covariates.

The second phase of the analysis saw subjects regrouped into three BMI ranges including normal (BMI 18.5-24.9 kg/m2), overweight (BMI 25.0-29.9 kg/m2), and obese (BMI ≥ 30.0 kg/m2). In the male subgroup, a significant association remained indicating a negative effect of BMI on FVC (p < 0.001), and FEV1 (p < 0.05), while demonstrating positive impact on FEF25-75% (p < 0.05). There was no significant impact of BMI on any of the other pulmonary function variables in men. These results suggest that the compromised FVC indicates pulmonary restrictive characteristics that are an effect of increasing BMI > 30 kg/m2. Airway obstruction is not an obvious finding since the fall in FEV1 was not accompanied by any associated compromise or effect to FEV/FVC. The fact that other expired flows were not affected by BMI, and that FEF25% actually increased with increasing weight, supports this point. A decreased FVC significantly compromised by BMI (p < 0.05) also characterized the profile of the female subgroup. No compromise associated with BMI was noted in any of the other respiratory variables of the female group which also indicated a lack of evidence of airway obstruction. However, it is when we compared the results of the genders that the magnitude of these findings was most apparent.

A compromise in FVC has been postulated to be an underlying factor responsible for a reduction in airway diameter (20,44). The pattern of the effect of BMI on FVC (as a percentage of predicted values) was quite distinct between the genders in the subjects of this study. While the mean results for FVC in males were generally lower in all ranges including at baseline (normal weight, BMI 18-24.9 kg/m2) when compared to females, the impact of increasing BMI on FVC was demonstrated at different BMI ranges for each gender. There was significant compromise demonstrated in the FVC of males, primarily in the obese group (p < 0.002) when compared to the overweight group. In the female group, there was significant compromise to FVC of the obese group (p < 0.05) when compared to the normal group. The FVC values of the female group were progressively compromised throughout all increasing BMI ranges with the largest change occurring between the normal and overweight
ranges. However, the compromise was seen only in males in the obese range. This finding indicates that the restrictive effects of adiposity as measured by FVC may begin to be experienced at lower BMI values in females than in males.

Many studies have documented the commensurate impact of BMI on FVC with the impact of BMI and other measures of pulmonary restriction, such as expiratory reserve volume (ERV), and functional residual capacity (FRC) (20,21,33,45). It is likely that, in light of these studies’ findings and the early effect of BMI on FVC in females found here, that early compromise to other measures of pulmonary restriction could also be an effect in these female subjects. Some authors have reported that obesity is associated with respiratory symptomology without any associated demonstration or evidence of airway obstruction (13). Since there is support that asthma-like symptoms exist without evidence of compromise to obstructive pulmonary function measurement, it is both possible and likely that the presentation of those symptoms may correlate with non-obstructive measures. With much epidemiologic evidence to suggest that asthma symptoms are increased in females compared to males (7,11,12,15,24,26-28), evidence of an early or more pronounced compromise in the pulmonary function pattern of females that is associated with increasing BMI should be considered as a potential underlying determinant. We suggest that variance between the body fat distribution patterns of males and females could potentially influence the pattern of mechanically mediated pulmonary restriction, and thus pattern of symptomology, demonstrated by each gender.

The results of another study are also relevant to this discussion. An investigation by McGregor and Greenberg (46) into the effects of surgical weight loss on the morbidly obese found that when subjects’ mean BMI values dropped from 46 kg/m² to 30 kg/m², there were remarkable improvements, with reduced asthma symptoms in 90% of subjects as measured by medication usage, and frequency of asthma attacks. In fact it was found that 49% appeared to be in complete remission from asthma after the weight loss. No statistically significant correlations were found, however, between the subjects smoking histories and the improvement in their asthma symptoms. It would be expected that control for smoking history in subjects would not inadvertently control for those subjects who may be exhibiting asthma attacks and asthma medication usage. The prevalence of such relevant symptomology would therefore presumably continue to be significant in our analysis. This was an important consideration as our study sought to identify patterns in the respiratory function that might be related to significant asthma-like respiratory symptomology.

Comment should also be made about the remaining effects that BMI appeared to have on the pulmonary function of males that were not seen in females. As has been previously shown in a male population (47), the significant impact of BMI on the male groups FEV₁ values occurred in the obese range, in tandem with the compromise seen in FVC. This supports the suggestion that the higher value at onset of the effect of BMI on the respiratory function of non-asthmatic males, when BMI values are ≥ 30.0 kg/m². With no other variables indicating significant airways obstruction in these subjects, it is likely that the diminished FEV₁ was a consequence of the diminished lung volumes, as has been suggested by other authors (48). The parallel decrease in both FEV₁ and FVC also explains the non-significant association between BMI and the ratio of these two variables, FEV₁/FVC. This phenomenon of a balanced change in FEV₁ and FVC with increased body weight, thus leading to no significant net change in FEV₁/FVC, has been described previously (17,20,48). The fact that this effect was demonstrated in males only is important unto itself.

BMI associated airway obstruction in non-asthmatic men is clearly not demonstrated by this study’s results. Several investigations have found either no effect or a positive association between FEV₁/FVC with increasing adiposity (17,20,21,48) when the genders are considered collectively. One recent study, however, analyzed males and females separately (26). The study authors reported no association between adiposity and FEV₁/FVC ratio was negatively associated with obesity (p < 0.046) in females and was not affected in men when smoking was controlled for. Smoking had no interaction with the FEV₁/FVC ratio in females. As the study did not control for subjects with documented bronchial responsiveness, the fact that it found evidence of airway obstruction in females while this study did not, may indicate the prevalence of obstructive disease within their study sample as those subjects were excluded in our analyses.

**Study Limitations**

The selection of subjects for this study was based primarily on criteria that sought to exclude asthma. The possibility exists however that asthmatics may have been included in the sample. This would be the case if a subject were to have a non-significant bronchodilator response with spirometry testing, though they may have had a positive response to bronchial provocation testing if it had been performed. Also, our criteria sought to exclude subjects with demonstrated airway obstruction that had not post-bronchodilator testing completed. While this was necessary to exclude all possible subjects with asthma, it may also have excluded some subjects who may have been demonstrating a true obesity-related obstructive profile. As subjects self-reported their pulmonary medication usage, the possibility exists that some subjects may have been noncompliant with pulmonary function laboratory requests that medications be withheld prior to testing which may have led to false negative results on bronchodilator responsiveness testing.

Several other variables were generally self-reported including pack year smoking history, and height and weight, which may have influenced the validity of the test results. Previous investigations have found an overestimation of self-reported height and an underestimation of self-reported weight in both males and females (49). It is possible that the references employed to determine predicted normal values may have more accurately reflected the impact of either
height or age on one gender compared to the other, and thus could have influenced the results. The self-reported nature of height could have further impacted this phenomenon. The predicted reference set for normal pulmonary function values employed in this study, as is typical of most reference sets used for spirometry, did not include weight in its regression analysis. It is possible that reference sets such as these may be inappropriate for predicting the pulmonary function values of subjects with a BMI above the normal range, which could account for some of the variance between BMI ranges found in this study.

The use of BMI as an accurate measure of adiposity relative to pulmonary impairment has been criticized (50,51). It has however been shown to be as accurate a tool in determining the effects of body weight on pulmonary function as other measures of adiposity (26). The body mass index (kg/m²) is not a direct measure of body fat but is the most widely investigated and most useful indicator, to date, of health risk associated with overweight (52). BMI was also the method that we found most commonly employed in the published literature relevant to this study.

CONCLUSIONS

There is much epidemiologic evidence supporting an association of asthma with increasing weight and obesity. We believe that our results classify a pulmonary function profile that is specific to non-asthmatics, and unique to each gender. While the pulmonary function values of females measured as percentage of predicted were generally higher than those of males, the effect of BMI on the female group was more pronounced. The unique features of these profiles indicate a compromise in respiratory function at lesser degrees of adiposity when measured by BMI, in females than in males. We postulate that the lower value at onset of compromise in females could also result in earlier onset of respiratory symptoms that could simulate the symptomology of asthma and airway obstruction. Our results do not rule out the possibility of increased asthma prevalence in obese females compared to males as reported by previous epidemiologic investigations. The results do, however, offer a rationale for underlying mechanisms that may be responsible for the different symptomatic patterns identified between the genders. Increases in asthma-like respiratory symptoms could cloud the differential diagnosis of asthma in overweight and obese females, and in obese males. These results are relevant to clinicians who are responsible for the management and diagnosis of respiratory symptoms in overweight and obese subjects. This study offers a rationale to continue to seek alternative physiological explanations for the generally accepted epidemiological phenomenon.

Future research should attempt to further identify the differences in the asthma-like symptomology in a group of female and male asthmatics and non-asthmatics. The trial should objectively diagnose asthma, objectively measure height and weight, and carefully control for the effects of both smoking and age. Investigation should seek to identify correlations between pulmonary function variables and respiratory symptomology in both asthmatics and non-asthmatics, and compare between the genders. Since smoking was controlled for in many of the epidemiologic studies which found a difference in gender distribution of asthma, future investigation should be performed to see if the effect size of smoking is greater than obesity on specific asthma-like symptomology. Consideration should also be given to the development of novel predicted normal reference sets which accurately represent normal spirometric measures for subjects across the range of BMI values.

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ABSTRACT

Accurate and complete data on the prevalence, clinical characteristics, and management of obstructive sleep apnea (OSA), in hospitalized children, is essential to the assessment of clinical practice, resource allocation and the development of research priorities in Canada. This study investigated the potential of the Canadian Institute for Health Information-Discharge Abstract Database (CIHI-DAD), Canada’s largest and most comprehensive health database, to provide such information.

A retrospective analysis of extracted data from the 2007 CIHI-DAD, for all hospitalized paediatric and adolescent patients with a discharge diagnosis that included OSA, was completed. Of the 163,726 acute care abstracts submitted to the 2007 CIHI-DAD, a cohort of 2020 persons (1.2 %) had included among their discharge a diagnosis of OSA, and the 1-9 year-old age range had the highest prevalence of OSA (2.75%). The most common health intervention was adenotonsillectomy.

The prevalence and clinical characteristics of patients with OSA were found to be similar to those described in prospective epidemiological studies on the general population. The clinical management of OSA was found to be in accordance with current recommendations for children, although CPAP therapy appeared to be underutilized.

The potential utility of the CIHI-DAD for assessing the prevalence and clinical management of OSA, in children, was demonstrated.

Keywords: Obstructive sleep apnea, paediatrics, adolescent, continuous positive airway pressure, Canadian Institute for Health Information, adenotonsillectomy, continuous positive airway pressure

INTRODUCTION

Sleep apnea syndromes are a group of disorders characterized by episodic cessations of breathing during sleep, pauses that induce partial arousals and interfere with the continuance of sleep. Sleep apnea syndromes are divided into central, obstructive and mixed central-obstructive types.

Central sleep apnea is typically the result of central nervous system dysregulation of respiratory control or impaired respiratory motor output. It can be distinguished from obstructive sleep apnea (OSA) by the observation of a complete absence of efforts to breathe and it may be idiopathic or associated with lower brain stem lesions, medication effects or other conditions. (1) Obstructive sleep apnea is a chronic condition characterized by the periodic reduction or cessation of breathing during sleep caused by partial or complete collapse of the pharyngeal airway resulting in sleep

RÉSUMÉ

Des données précises et complètes sur la prévalence, les caractéristiques cliniques et la gestion de l’apnée obstructive du sommeil (AOS) chez les enfants hospitalisés sont essentielles à l’évaluation de la pratique clinique, à l’allocation des ressources et à l’établissement des priorités de recherche au Canada. Cette étude se penche sur la possibilité d’obtenir de telles données à partir de la Base de données sur les congés des patients de l’Institut canadien d’information sur la santé (BDCP-ICIS), la base de données sur la santé la plus importante et la plus complète au Canada.

Une analyse rétrospective a été conduite sur des données extraites de la BDCP-ICIS de 2007 pour tous les patients pédiatiques et adolescents hospitalisés dont le diagnostic de congé comprend une AOS. Des 163 726 sommiers de soins aigus déposés à la BDCP-ICIS en 2007, une cohorte de 2 020 personnes (1,2 %) présentait un diagnostic d’AOS dans son congé, avec la prévalence la plus élevée dans le groupe de 1-9 ans (2,75 %). L’intervention la plus fréquente était l’adéno-amygdalectomie.

On a constaté que la prévalence et les caractéristiques cliniques des patients avec AOS étaient similaires à celles décrites dans les études épidémiologiques prospectives dans la population en général. La gestion clinique de l’AOS a été jugée conforme aux recommandations actuelles pour les enfants, bien que la thérapie par ventilation spontanée en pression positive continue semble sous-utilisée.

L’utilité potentielle de la BDCP-ICIS dans l’évaluation de la prévalence de l’AOS et sa gestion clinique ont été démontrées.
clinical management of hospitalized children with OSA has perioperatively. To date national data on the prevalence and recommend the use of CPAP therapy, in patients with OSA, (33) and the American Society of Anesthesiologists (34) Thoracic Society Sleep Disordered Breathing Committee analgesia and anesthesia.(31,32) Currently the Canadian especially in patients with co-occurring acute illness and shown CPAP therapy to provide an effective alternative first-line approach to the management of OSA in children.(30)

The first-line therapy for management of OSA in children is adenotonsillectomy, when there is evidence of enlargement of the adenoids and tonsils.(27) However, recent studies have demonstrated the occurrence of residual OSA in a large proportion of children receiving adenotonsillectomy, particularly when OSA is severe or when obesity is present.(28,29) For children with unresolved OSA after adenotonsillectomy, continuous positive airway pressure (CPAP), oral appliances and nasal steroids are generally considered.(9) The intent of CPAP therapy is to prevent apnea, hypoxia and sleep disturbance. Recent studies have shown CPAP therapy to provide an effective alternative first-line approach to the management of OSA in children.(30)

The clinical management of OSA is important, especially in patients with co-occurring acute illness and in those undergoing procedures associated with sedation, analgesia and anesthesia.(31,32) Currently the Canadian Thoracic Society Sleep Disordered Breathing Committee (33) and the American Society of Anesthesiologists (34) recommend the use of CPAP therapy, in patients with OSA, perioperatively. To date national data on the prevalence and clinical management of hospitalized children with OSA has not been analyzed.

Accurate national hospital data is essential to informing healthcare practice and for directing the allocation of healthcare and research resources for OSA in Canada. To obtain national epidemiologic estimates on OSA prospectively would be expensive, and data obtained from a limited population, or collected over a short time period would have poor external validity. In the current study we describe the prevalence, clinical characteristics and management of OSA retrospectively using hospital discharge data, available through the Canadian Institute for Health Information's hospital Discharge Abstract Database (CIHI-DAD).

The specific aims of this study were to use the Canadian Institute for Health Information-Discharge Abstract Database (CIHI-DAD) to describe: (1) The demographic and clinical characteristics of Canadian hospitalized pediatric and adolescent patients with a diagnosis of OSA. (2) The clinical management of OSA in this hospitalized population. (3) The capacity of the CIHI-DAD to provide information on the prevalence and clinical management of OSA in all hospitalized pediatric and adolescent patients in Canada.

METHODS

Data Source

Data for this retrospective study were extracted from the Canadian Institute for Health Information's (CIHI) Discharge Abstract Database (DAD). The CIHI is a federally chartered institution established in 1994 to provide health information pertinent for health services and research initiatives in Canada. The CIHI-DAD includes abstracted information on all patient separations (discharge, sign out, death, or transfer of the patient to another facility (excluding still births and cadaveric donors)) from all acute inpatient institutions, in the Canadian provinces and territories, except Quebec, which did not participate. Abstracts are completed by hospital-based coders.

Data contained within the 2007 CIHI-DAD included demographic (e.g. age, gender, province of residence), administrative (e.g. date of admission, date of discharge) and clinical elements (status at discharge, the most responsible diagnosis (MRDx) and as many as 15 secondary diagnoses (coded according to the International Classification of Diseases, Tenth Revision, Canadian Enhancement 'ICD-10-CA' and, up to 10 diagnostic, therapeutic and support interventions (coded according to the Canadian Classification of Health Interventions (CCCI)) standard).

Data Extraction

For this study the CIHI-DAD was reviewed to identify all patients, 19 years of age and younger (pediatric and adolescent population), with a diagnosis that included obstructive sleep apnea (ICD-10-CA code G47.30 for ‘sleep apnoea, obstructive’) during the 2006-2007 fiscal year (April 1st 2006 through March 31st 2007). Central and ‘other sleep apnoea’s have their own specific code and were not examined in this study. The diagnostic category ‘other sleep apnoeas’ includes sleep apneas of the mixed type, congenital hypventilation syndrome, Ondine’s Curse and unspecified sleep apneas (e.g. cases where sleep apnea was recorded on the patient record but not specified according to type). From a total of 2,400,245 acute care hospital separations (all ages) in the 2007 fiscal year, 163,726 were for patients 19 years of age and under.
1.2% (n = 2020) of this cohort had a discharge diagnosis that included OSA.

For this population we sought information on patients’ age, gender, province of residence, MRDx, secondary diagnoses and health interventions. Ethics approval for this study was obtained from the Dalhousie University Health Sciences Research Ethics Board.

Statistical Analysis

All data were analyzed with SAS statistical software (Version 9.1; SAS Institute, Cary NC, USA), under license to Dalhousie University. Descriptive statistical analyses were completed to evaluate demographic variables, clinical characteristics and the clinical management of sleep apnea.

RESULTS

Prevalence of Sleep Apnea in Acute Care Hospitalizations in Canada: Fiscal Year 2006-2007

Figure 1 demonstrates the age and gender distribution for all patients discharged from acute care Canadian hospitals, ages 0-19 years. Of the 163,726 acute care abstracts submitted to the CIHI-DAD a cohort of 2020 persons (1.2 %) had included among their discharge diagnoses the ICD-10-CA code (G47.30) for OSA. The age and gender distribution of patients with a discharge diagnosis that included OSA, is shown in figure 2. The prevalence rate of OSA was 2.75% in patients 1-9 years of age and was higher in males. For patients ages 10-19 years the prevalence rate was 0.38% equally distributed between males and females.

Demographics and Clinical Elements of Acute Care Patients
with Obstructive Sleep Apnea

Table 1 describes the MRDx for this cohort. The MRDx is defined as the one responsible for the patients’ stay in hospital and does not necessarily correspond to the reason for admission.(35) In this cohort, 1008 (49.9 %) patients had OSA as their MRDx. This was followed by hypertrophy of the adenoids and tonsils (ICD-10-CA code J35.3), chronic adenoiditis (ICD-10-CA code J35.0), hypertrophy of the tonsils (ICD-10-CA code J35.1), Down syndrome, unspecified (ICD-10-CA code Q909), and catarhal tubotympanal (ICD-10-CA code H65.9).

TABLE 1: Most common MRDx for all patients with a discharge diagnosis that included obstructive sleep apnoea, ages 0-19 years.

<table>
<thead>
<tr>
<th>Most Responsible Diagnosis (ICD-10-CA)</th>
<th>Males (%)</th>
<th>Females (%)</th>
<th>% Both Genders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep apnoea, obstructive (G47.30)</td>
<td>50.99</td>
<td>47.95</td>
<td>49.70</td>
</tr>
<tr>
<td>Hypertrophy of the adenoids and tonsils (J35.3)</td>
<td>21.25</td>
<td>18.76</td>
<td>20.20</td>
</tr>
<tr>
<td>Chronic adenoiditis (J35.0)</td>
<td>3.77</td>
<td>6.45</td>
<td>4.90</td>
</tr>
<tr>
<td>Hypertrophy of the adenoids (J35.2)</td>
<td>3.00</td>
<td>2.33</td>
<td>2.67</td>
</tr>
<tr>
<td>Hypertrophy of the tonsils (J35.1)</td>
<td>2.31</td>
<td>2.58</td>
<td>2.43</td>
</tr>
<tr>
<td>Slow rebound following surgery (Z48.8)</td>
<td>1.97</td>
<td>1.88</td>
<td>1.93</td>
</tr>
<tr>
<td>Pneumonia, organism unspecified (J039)</td>
<td>0.60</td>
<td>0.94</td>
<td>0.74</td>
</tr>
</tbody>
</table>
TABLE 2: Most common Secondary Diagnosis for all patients with a discharge diagnosis that included obstructive sleep apnoea, ages 0-19 years.

<table>
<thead>
<tr>
<th>Most Responsible Diagnosis (ICD-10-CA)</th>
<th>Males (%)</th>
<th>Females (%)</th>
<th>% Both Genders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertrophy of the adenoids and tonsils (J35.3)</td>
<td>42.84</td>
<td>37.40</td>
<td>40.54</td>
</tr>
<tr>
<td>Chronic adenoiditis (J35.0)</td>
<td>8.91</td>
<td>11.02</td>
<td>9.80</td>
</tr>
<tr>
<td>Hypertrophy of the adenoids (J35.2)</td>
<td>7.88</td>
<td>5.74</td>
<td>6.98</td>
</tr>
<tr>
<td>Hypertrophy of the tonsils (J35.1)</td>
<td>6.34</td>
<td>6.80</td>
<td>6.53</td>
</tr>
<tr>
<td>Down's syndrome, unspecified (Q909)</td>
<td>4.71</td>
<td>6.80</td>
<td>5.59</td>
</tr>
<tr>
<td>Asthma, predominantly allergic (J4500)</td>
<td>5.66</td>
<td>4.81</td>
<td>5.30</td>
</tr>
<tr>
<td>Catarhrhal tubotympanal (J65.9)</td>
<td>5.14</td>
<td>3.99</td>
<td>4.65</td>
</tr>
</tbody>
</table>

Health Interventions and Patients, 1-19 Years, Coded for OSA

Table 3 describes the most common health interventions (diagnostic, supportive or therapeutic) administered to patients whose discharge diagnosis included OSA according to age. For example, the most common health intervention, delivered to patients ages 1-9 years, was adenotonsillecomy (CCI code 1.FR.89.WJ). For this age group 70.5% of patients received a therapeutic intervention on the tonsils and/or adenoids (CCI codes 1.FR.89.WJ, 1.FR.89.WJAK, 1.FR.78.DAAB) and 17% received tympanostomy tubes (implantation of a ventilation tube device, tympanic membrane (CCI code 1.DF.53.JATS)). The most common health intervention, ages 10-19 years, was similarly adenotonsillecomy (CCI code 1.FR.89.WJ). In this age group 48.7% of patients received a therapeutic intervention on the tonsils and/or adenoids (CCI codes 1.FR.89.WJ, 1.FR.89.WJAK, 1.FR.78.DAAB), 39% received tympanostomy tubes (CCI code 1.DF.53.JATS) and 5.9% received CPAP/BIPAP (CCI code 1.GZ.31.CB-ND or 1.GZ.31.CA-ND) therapy. Figure 3 presents the provincial/territorial and national adenotonsillecomy rates according to provincial/territorial location with Prince Edward Island reporting the highest rate and New Brunswick the lowest.

DISCUSSION

Prevalence and Clinical Characteristics of Hospitalized Patients with a Diagnosis that Included OSA

Accurate and complete data on the prevalence, clinical characteristics, and management of OSA, in hospitalized children, is essential to: the assessment and development of clinical practices, the informing of resource allocation and, the identification of research priorities in Canada. This study investigated the potential of the CIHI-DAD, Canada’s largest and most comprehensive health database, to provide such information.

We provide, for the first time, national data on the prevalence, clinical characteristics, and management of hospitalized pediatric and adolescent patients whose discharge diagnosis included OSA. In this study we determined the peak prevalence of OSA to be between the ages 2-9 years. This data is consistent with prospectively determined estimates of OSA for the general public (3,4,5,6), and has been attributed to the fact that in this age range, children’s tonsils and adenoids are at their largest, relative to airway size. (36) The prevalence rate in children 10-19 years of age was also similar to rates determined in previous studies (7).

We determined the prevalence of OSA to be higher in males in the 1-9 years age range. This finding differs from previous studies which have shown equal prevalence of OSA across genders in this age range. (9) However, this difference may be accounted for, at least in part, by the higher number of hospitalized male patients in this age cohort.

In children, OSA has been linked to adenotonsillar hypertrophy, asthma, Down Syndrome, allergic rhinitis, micrognathia and craniofacial syndromes and abnormalities. (8,10,11) The most common diagnoses (MRDx and secondary) in this present study are similar including adenotonsillar hypertrophy, asthma and Down syndrome.

<table>
<thead>
<tr>
<th>1-4 Years of Age (n=896)</th>
<th>5-9 Years of Age (n=702)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intervention</strong></td>
<td><strong>Intervention</strong></td>
</tr>
<tr>
<td>Tonsillectomy with Adenoidectomy</td>
<td>64.0</td>
</tr>
<tr>
<td>Implantation of ventilation tube device, tympanic membrane</td>
<td>20.5</td>
</tr>
<tr>
<td>Excision partial, tonsils and adenoids</td>
<td>8.5</td>
</tr>
<tr>
<td>Reduction tonsillotomy</td>
<td>5.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>10-14 Years of Age (n=254)</th>
<th>15-19 Years of Age (n=101)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intervention</strong></td>
<td><strong>Intervention</strong></td>
</tr>
<tr>
<td>Tonsillectomy with Adenoidectomy</td>
<td>45.0</td>
</tr>
<tr>
<td>Excision partial, tonsils and adenoids</td>
<td>10.2</td>
</tr>
<tr>
<td>Ventilation, respiratory system; Non-invasive approach (CPAP, BIPAP)</td>
<td>5.5</td>
</tr>
<tr>
<td>Implantation of ventilation tube device, tympanic membrane</td>
<td>5.5</td>
</tr>
</tbody>
</table>
Clinical Interventions used in the Management of Hospitalized Patients with a Diagnosis that Included OSA

The clinical management of OSA is different in children and adults. This reflects the different pathophysiology in these two groups. In children the first-line therapy is adenotonsillectomy, which has been shown to lead to significant improvement in OSA symptoms, in the majority of cases.(27) Our study has identified adenotonsillectomy as the most common health intervention used in hospitalized children coded with a diagnosis of OSA. 70.5% of patients, ages 1-9 years and 49.8% of patients ages 10-19 received a therapeutic intervention that involved the removal of adenotonsillar tissue. Adenotonsillectomy has been shown to improve the quality of life in 71% of non-obese children with OSA.(37) However, 46% of non-obese children who had adenotonsillectomy for OSA, still exhibit apnea/hypopnea indices between 1-5 events per hour.(38) These studies illustrate the importance of using a comprehensive approach when managing OSA in children.

Non-invasive CPAP therapy is an alternative first line treatment for the management of OSA in children of all ages. The advantages of CPAP are that it is non surgical, safe and effective.(30) In patients with OSA and concomitant acute illness or undergoing procedures associated with sedation, analgesia and anesthesia, the Canadian Thoracic Society Sleep Disordered Breathing Committee (33) and the American Society of Anesthesiologists (34) recommend the use of CPAP therapy perioperatively. Despite several published studies demonstrating a beneficial response to CPAP in children, our study revealed that CPAP was not used in patients 1-9 years of age and was used by 5.9% of patients in the 10-19 years of age cohort.

Limitations of Discharge Abstract Data

The strength of this study is that it uses a national population (except Quebec) of acute care patient hospitalizations. The development of accurate and complete national data is essential to informing healthcare practice and for directing the allocation of health care resources and the identification of research priorities, for childhood OSA, in Canada.

Previous work has demonstrated inherent weaknesses with CIHI-DAD, as a source of data for gaining a national perspective on the prevalence and management of OSA in adult populations.(39) These deficiencies have been attributed to a lack of compliance in recording of OSA in patient's charts and/or abstraction of information in the discharge abstracts. It appears to be more accurate and comprehensive for children. Briefly, data collected for the 2006-2007 CIHI-DAD, did not include information from institutions in the province of Quebec. Therefore the CIHI-DAD could not, for that fiscal year, be considered a true national database. Furthermore discharge data is captured only on patients admitted to hospital; therefore, patient activity related to outpatient visits would not be recorded. Finally, a significant limitation of the CIHI-DAD is that certain data elements such as test results, laboratory values, severity of illness and functional status are often not present. Datasets lacking such details may prove insufficient for determining risk assessment, patterns of care, product or outcome of care.

ACKNOWLEDGEMENTS

We wish to thank the Canadian Institute for Health Information for providing data for this study through the CIHI Graduate Student Data Access Program to Kathy Spurr. Additional funding for this work was provided by a Research Development Grant to Robert Gilbert, provided by the Faculty of Health Professions, Dalhousie University. We thank Lisa Dillman for assistance in preparing this manuscript.

REFERENCES


Current ventilators offer the promise of improved synchrony with the patient. To optimize current and future techniques to improve patient ventilator synchrony it is essential for the clinician to understand the physiological basis of patient-ventilator asynchrony. This understanding begins with a discussion of the subdivision of the issues of the response of the ventilator to the patient's effort including the issues of how the breath is initiated, the system is pressurized and the breath is terminated. Patient-ventilator asynchrony is the failure of two controllers to act in harmony. The evaluation of patient-ventilator asynchrony can be subdivided into four phases. These phases consist of triggering, flow delivery, breath termination, and the effects of PEEP. In this article the reader will be presented with examples of each type of asynchrony and potential interventions to reduce them.

Education Aims:
1) Understand the relationship between the two controllers involved in patients breathing spontaneously on mechanical ventilation.
2) Understand the phases of mechanical ventilation and the role they play in the interactions between the patient and the ventilator.
3) Identify the different types of patient-ventilator asynchrony and understand their physiologic implications for the development of asynchrony.

Essentials to remember:
1) Newton's equation of motion explains the interaction of between the patient's generated pressure represented by $P_{\text{mus}}$ and the ventilator's generated pressure $P_{\text{appl}}$ and represents the pressures necessary to overcome the resistance ($R_{\text{rs}}$) and elastance ($E_{\text{rs}}$) of the respiratory system. Although this equation appears to be daunting it can be simply applied to the patient on mechanical ventilation. This concept will discussed in length.
2) Factors affecting the response of the ventilator to the patient can be subdivided into the ventilator factors affecting the initiation of the breath (trigger variable), how the breath is sustained (gas control variable), and how the breath is terminated (cycle off criterion).
3) Patient related factors include the mechanics of the patient's respiratory system and characteristics of the patient generated muscular response or pressure generated by the patient's respiratory muscles or $P_{\text{mus}}$.
4) Patient ventilator asynchrony is the failure of two controllers to act in harmony.
5) The factors that affect patient-ventilator asynchrony can be subdivided into equipment factors, patient factors, and decision-making factors.
INTRODUCTION

Pediatric and neonatal patients breathe spontaneously during mechanical ventilation. This involves the combination of two distinct controllers: the clinician-controlled mechanical pump (the ventilator) and the patient’s own respiratory muscle pump. The interactions between these two controllers can best be described by examining Newton’s equation of motion.

\[ P_t = P_{\text{mus}} + P_{\text{appl}} = (V_x R_{\text{RS}}) + (V_x E_{\text{RS}}) \]

The equation explains the interaction of between the patient’s generated pressure, P_{\text{mus}}, and the ventilator’s generated pressure, P_{\text{appl}}. These pressures overcome the resistance (R_{\text{RS}}) and elastance (E_{\text{RS}}) of the respiratory system. In this equation, inertia is negligible, especially in pediatric patients. This interaction is complex and involves numerous feedback pathways. For example, respiratory muscles are affected by the force-length and force-velocity relationship causing a mechanical feedback to the patient’s motor center and spinal nerves from receptors in the airway, chest wall, or respiratory muscles; this has been described as the reflex feedback. (1) This relationship between the muscle feedback and reflex feedback is not well studied in mechanically ventilated pediatric patients, especially neonates, where the immaturity of the receptors, controllers, and muscle response may impact these relationships. The variables that can potentially impact the patient-ventilator interaction are also complex and include patient and ventilator factors and the patient’s feedback system. These interactions create a response loop that are affected by this interaction between ventilator (controllers of the ventilator breath, including trigger, gas delivery, and how the breath is terminated) and patient factors (mechanics of the respiratory system and muscular response), which cause a volume change with time, affecting the patient’s muscular response, which in turn is affected by the force-muscle and force-velocity relationship of the respiratory muscles. This volume-time profile influences the patient’s feedback system (chemical, mechanical, reflex, and behavioral) that then determines the muscular response of the patient’s to the ventilator breath. (1) The final influence on these interactions involves the clinician and his choice of the trigger, mode of ventilation, and level of support. Our discussion on the monitoring the interaction of spontaneous respiration and mechanical inflation will focus on the identification of asynchrony between the patient controller and the ventilator.

Current ventilators have the ability to display breath-by-breath airway pressure, flow and volume as a function of time necessary to overcome the elastic and resistive forces of the patient, ventilator and circuit. In order to recognize these changes a display screen is required. It is important to note that of pressure, flow and volume, only flow and pressure are measured and volume is calculated from flow by the ventilator. Further, current ventilators also may display calculated values from the above displayed parameters. Modern ventilators are equipped with a graphical display intended to allow the clinician to evaluate interactions between the mechanical ventilator and the patient. These interactions can be specific to the patient’s disease state, the equipment (e.g., modality of ventilation being used) or the decisions of the clinician (e.g., adequacy of settings determined by the clinician). It is important for the clinician to recognize that the displayed and calculated parameters may be influenced by predetermined factors not in their control, such as sampling frequency of the sensor and filtering of the displayed waveform. (2) Also effects of adapters or filters placed in the ventilator circuit may influence the displayed and calculated parameters. In order for the clinician to evaluate and interpret values and waveforms displayed by the ventilator, the clinician must understand the physiologic basis of those displayed values and waveforms.

Response of the ventilator to patient effort

Factors affecting the response of the ventilator to the patient can be subdivided into the ventilator factors affecting the initiation of the breath (trigger variable), how the breath is sustained (gas control variable), and how the breath is terminated (cycle off criterion). Patient related factors include the mechanics of the patient’s respiratory system and characteristics of the patient generated muscular response or pressure generated by the patient’s respiratory muscles or P_{\text{mus}}. As can be seen in Figure 1, the pressure generated when a patient is spontaneously breathing while receiving positive pressure ventilation is the sum of the pressure generated by the patient’s respiratory muscles (P_{\text{mus}}) and that generated by the ventilator (P_{\text{appl}}). The proportion of each of these pressures is dependent upon the patient’s respiratory drive, mechanics, and muscular response, the ventilator’s trigger characteristics, and the selected ventilator mode. The mode is dependent upon the control, phase, and conditional variables. The discussion will first focus on patient and ventilator characteristics followed by a review of when there is inability of the patient and ventilator controllers to act synchronously.

FIGURE 1

![Patient-ventilator interface](image-url)
Ventilator-related factors:

The response of the ventilator to a patient's effort is influenced by ventilator variables including the trigger variable that initiates the breath, pressure delivery, and the cycle variable that terminates the breath.

Trigger variable:

The trigger variable is controlled by either a flow or pressure signal derived from the airway. Figure 2 illustrates a comparison of two trigger variables. For pressure triggering the patient must decrease the pressure in the ventilator circuit, by an isometric contraction of the respiratory muscles, to a preset value to completely open the inspiratory valve and initiate a mechanical breath. In flow triggering, the patient must generate a change in flow, sensed between the ventilator's inspiratory and expiratory pneumotachographs, by an isotonic contraction of the respiratory muscles. It has been generally believed that there are distinct advantages of flow triggering. (2, 3, 4, 5, 6, 7, 8) However, current ventilators are microprocessor-controlled, replacing mechanical responses to patient triggering seen in older generation ventilators. The result of the microprocessor controller is a faster response time with decreased trigger delay. (1) This improvement may negate the advantages in adult patients with larger endotracheal tubes and mature respiratory muscles. This does not appear to be true in neonatal and pediatric patients. (9) As can be seen in Figure 2, (8) flow triggering results in a faster response time and decreased effort necessary to trigger in a pediatric sized animal model during pressure support ventilation. These differences are important because during triggering the initial phase of patient effort reflects essentially patient work until the inspiratory valve opens completely and delivers gas to the proximal airway. This is illustrated in Figure 3, where a tracing of pressure, flow, and volume are recorded at an animal's airway during pressure support ventilation. In this example, there is a waveform illustrating the opening and closing of the inspiratory valve with a tracing of the animal's muscular response, illustrated by an EMG tracing of the diaphragm.

In a study of pediatric sized lambs, WOB during flow triggering was reduced by 47% during pressure support and 19% in CPAP. (3) However, there have been no controlled studies in pediatric and neonatal patients to determine if these differences affect outcome measures such as length of ventilation.

Trigger delay is the time from the beginning of inspiratory muscle activity and the beginning of mechanical inflation (increase in pressure at the proximal airway). It is important to note that despite the differences illustrated in the type of triggering there are also differences related to the design characteristics of the ventilator. These differences relate to ventilator control algorithms that can affect trigger delay. Increased trigger delay has been associated with the design characteristics of the pneumatics and electronics of ventilator system and correlated with respiratory drive (10) more time to trigger with less drive. This is especially important in small preterm infants, who have intrinsically short inspiratory times. For instance, if the inspiratory time is 0.2 sec and the trigger delay is 100 msec, the patient will be half-way through the inspiratory phase before mechanical assistance is appreciated.

In a study between two microprocessor controlled neonatal ventilators it was found that there was a significant difference in trigger delay and work of breathing between these two ventilators (7) illustrating the role of ventilator design on both work of breathing and triggering. Once triggering occurs, there is pressurization of both the ventilator circuit and subsequently the patient.

Factors affecting pressure delivery:

Control variables include pressure, flow, and volume. Once the trigger variable is met and the inspiratory valve opens fully, there is pressurization of the ventilator circuit by the delivery of fresh gas flow. This pressurization of the
system is illustrated in Figure 4. The phase of this pressurization can be subdivided into the inspiratory positive pressure area or area 2 on Figure 4, (11) which follows area 1, and is the amount of effort expended to activate the mechanical breath. Area 2 is defined by the start of the inspiratory pressure curve with the return of pressure to baseline and ending at the onset of expiration. Area 2 represents the ability of the ventilator to pressurize the system or the actual area of pressure-versus-time applied during inspiration. The variables that control the delivered pressure depend upon the mode of ventilation and the controller utilized in that mode. For example, in a mode with a preset tidal volume (e.g., volume assist-control), upon triggering the ventilator operates under a preset flow-time profile for the delivery of the tidal volume, and the ventilator determines the mechanical inflation time. In contrast, in a mode where there is a preset pressure (e.g., pressure support ventilation), the inflation time is influenced by both the patient and the ventilator. MacIntyre et al. (12) demonstrated that if a rise in flow is not commensurate with the patient’s demand during pressure support ventilation, there may be a too rapid rise in flow, or flow may be inadequate to meet the patient’s effort. In either case patient-ventilator asynchrony can result. Current ventilators also have dual control capability. Some modes (e.g., proportional assist ventilation (PAV) pressure regulated volume control (PRVC), volume support (VS) offer a theoretical compensation for these limitations. Breaths are regulated by one variable to meet a target variable. For example in PRVC, the clinician sets a target volume and then regulates the delivered pressure between each breath to reach that volume target. In contrast, in PAV the ventilator delivers pressure that is proportional and set by the clinician to instantaneous flow and volume and thus the patient’s own $P_{mus}$. Thus, depending upon the mode, it may or may not reflect corresponding changes in patient’s effort.

**Cycle off variable:**

The cycle off variable is the variable that controls the end of inspiration. This can be adjusted by the clinician. As can be seen in Figure 5, the timing of this trigger signal may not correspond to the end of neural inspiration and the peak of diaphragmatic activity or contraction of inspiratory muscles after the close of the inspiratory valve. Thus, if flow stops either before or after the patient’s own inspiratory flow, expiratory flow occurs before the end of inspiratory effort. In this situation, $P_{mus}$ continues to increase even though inspiratory flow is zero (inspiratory valve closed) or is reversed, and the muscle tension is applied to the elastic recoil of the respiratory system rather than obtaining further inspiratory flow. Thus, at the end of mechanical inspiration, $P_{mus}$ continues to increase the muscle tension applied to overcome elastic recoil of the respiratory system causes a short mechanical inflation and low elastic recoil at end-inspiration and can promote re-triggering or ineffective triggering. The effects of asynchrony depend on the type asynchrony present (13) and will be discussed further below. In the newborn, use of flow cycling is important in achieving expiratory synchrony because of the rapidity with which the respiratory time constant can change.

**Patient-related factors:**

*Mechanics of the respiratory system and characteristics of $P_{mus}$ waveform*

Factors that affect flow because of the mechanical properties of the respiratory system and tubing can affect the pressure delivered by the ventilator (Paw) independent of $P_{mus}$ and may lead to asynchrony. (1) This is usually seen when there is dynamic hyperinflation, where ineffective triggering, increased trigger delay, or prolonged inflation are common. (12)
However, the pattern of the $P_{\text{mus}}$ waveform can affect $P_{\text{aw}}$ in several ways, depending upon factors related to both the patient and the ventilator. If the patient has decreased drive, $P_{\text{mus}}$ increases slowly, and the time between the onset of the patient's inspiratory effort and ventilator triggering increases, causing trigger delay with subsequent asynchrony. In contrast if the patient's inspiratory effort is vigorous and longer than mechanical inflation time, double triggering can occur.

**RESPONSE OF THE PATIENT EFFORT TO THE VENTILATOR DELIVERED BREATH**

Normal reflex responses to changes in chemical, mechanical, or receptor stimulation may cause physiologic changes that may be difficult to interpret by the clinician. For example, it is important to understand the role that mechanical feedback plays in the patient's response to a mechanically delivered breath. The mechanical feedback is related to the delivered lung volume (length of muscular contraction) and flow (velocity of the contraction) delivered. Thus, when lung volume and flow are greater, $P_{\text{mus}}$ will be less. (1) The exact role of mechanical feedback is not well understood and may play only a small role in patient-ventilator interactions, but in a situation of high ventilator demands with hypercapnic hyperventilation, $P_{\text{mus}}$ may underestimate neural output to respiratory muscles and can be reduced by up to 15%. (13)

Another feedback mechanism involves the response of the respiratory system to $P_{\text{O}_2}$, $P_{\text{CO}_2}$, and $pH$ or chemical feedback. In normal subjects in both wakefulness and sleep, chemical feedback determines respiratory motor output. (1) In mechanical ventilation, it is theorized that neuromuscular output is tightly linked to carbon dioxide tension and not to load reduction on the respiratory system. (13) Thus, during mechanical ventilation, chemical feedback remains an important determinant of $P_{\text{mus}}$. However, these effects may differ substantially between wakefulness and sleep or sedation during mechanical ventilation. (14)

During mechanical ventilation in a subject who is conscious, the effects of $P_{\text{CO}_2}$ cause an increased $P_{\text{mus}}$ (respiratory effort) with no change in respiratory rate. However, respiratory rate increases if $P_{\text{CO}_2}$ increases considerably. In contrast, when the drive to breathe from wakefulness is reduced during sleep or sedation, the dependence of the respiratory rhythm upon $P_{\text{CO}_2}$ is increased. (15, 16) Thus, any increase in VT may induce periodic breathing and apnea. In patients with lung diseases such as pneumonia or ARDS, other inputs to the respiratory controller may prevent chemical feedback from diminishing the tendency to increase neural inspiratory time and decrease neural expiratory time to a greater extent, resulting in a higher breathing frequency.

In addition to mechanical and chemical reflexes, other reflexes related to lung volume or flow changes and mediated by receptors located in the respiratory tract—the lung and chest wall—are important in controlling breathing. (16) These changes in volume and flow may elicit a $P_{\text{mus}}$ response caused by other reflexes such as the Hering-Breuer reflex. The ultimate response is dependent upon the interplay of the magnitude and type of lung volume change, the level of consciousness and the relative strength of the reflexes involved. In the premature infant, the chest wall is often more compliant than the lung, contributing to an increased work of breathing. An example of this interplay resulting in a misinterpretation by the clinician is demonstrated in a patient with decreasing levels of pressure support with the concomitant reduction in $V_{\text{T}}$ and inspiratory flow. These changes cause a reflex feedback to increase neural inspiratory time and decrease neural expiratory time to a greater extent, resulting in an increase in breathing frequency. The resultant increase in respiratory rate may be interpreted by the clinician as intolerance by the patient to the attempt to wean ventilator support, and thus delay further weaning by the clinician.

Finally, behavioral feedback is affected by changes in sedation, the sleep–wake state and other aspects of the patient’s environment and may play a role in the patient's response to ventilatory changes made by the clinician. For example, in an awake patient with increased airway resistance, ventilatory changes to compensate for hyperinflation may reduce inspiratory flow to values less than the spontaneous level causing perceived patient discomfort resulting in dyspnea with rapid shallow breathing and resultant patient-ventilator asynchrony.

In conclusion, the interactions between the neonatal and pediatric patient and the ventilator during assisted mechanical ventilation are complex. It may be difficult for the clinician to balance the clinician-controlled ventilator and the patient’s own muscular or reflex response because of the difficulty in interpreting ventilator changes and the patient's physiologic response. The resultant patient’s response may either be a normal physiologic reflex or indicative of patient-ventilator asynchrony requiring further changes. Proper interpretation of patient-ventilator asynchrony requires accurate identification.

**Patient-Ventilator Asynchrony**

Patient-ventilator asynchrony is the failure of two controllers to act in harmony. The patient's work of breathing and effort are affected by the ventilator's ability to meet the patient's peak inspiratory demand. (17, 18) The factors that affect patient-ventilator asynchrony are listed in Table 1 and can be subdivided into equipment factors, patient factors, and decision-making (clinician) factors. The evaluation of patient-ventilator asynchrony can also be subdivided into four phases. These phases consist of triggering, flow delivery, breath termination, and the effects of PEEP. For each phase, waveforms will be reviewed to demonstrate how the clinician can detect patient-ventilator asynchrony.

Asynchrony results in ineffective gas exchange, and has been associated with gas trapping, thoracic air leaks, increased work of breathing, inconsistent tidal volume delivery, and even intraventricular hemorrhage in the preterm infant.

**Trigger Asynchrony:**

Trigger asynchrony is defined as the presence of muscular effort without effective ventilator triggering. The incidence and occurrence of patient-ventilator asynchrony is not well
studied in pediatric patients. Clinical studies in adults have demonstrated trigger asynchrony in all common ventilator modes. In studies by Jubran et al. (19) and Parthasarathy et al. (20) cycle dyssynchrony during the PS mode occurs because of activation of abdominal musculature during the inspiratory phase, increasing patient effort and the number of failed trigger efforts.

**TABLE 1**

<table>
<thead>
<tr>
<th>Patient Factors</th>
<th>Ventilator Factors</th>
<th>Decision Making Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Hering-Breuer reflexes</td>
<td>• Ventilator algorithms and control</td>
<td>• Mode</td>
</tr>
<tr>
<td>• Respiratory Muscle Weakness</td>
<td>• Trigger signal</td>
<td>• Level of support</td>
</tr>
<tr>
<td>• Respiratory system mechanics</td>
<td>• Cycling off</td>
<td>• Sedation</td>
</tr>
<tr>
<td>Pathology</td>
<td>• Rate and character of inspiratory flow</td>
<td>• Nutritional support</td>
</tr>
<tr>
<td>Leaks</td>
<td>• Intrinsic PEEP</td>
<td>• Other treatments</td>
</tr>
</tbody>
</table>

In a recent study by Heulitt et al. (21) of mechanically ventilated pediatric size animals receiving PSV, it was found that trigger asynchrony in healthy animals was evident in 13% of breaths. After creating lung injury by saline lavage followed by lung recruitment with pulmonary compliance recovered to 60-70% of baseline, evidence of trigger asynchrony increased to 60-70%. The most common form of trigger asynchrony is trigger delay. Trigger delay is a delay in the time from the beginning of inspiratory muscle activity to the beginning of mechanical inflation. Causes of trigger delay are listed in Table 2. Trigger delay and ineffective effort can be easily detected by recording esophageal pressure or monitoring diaphragmatic activity with its EMG signal. Inserting an esophageal catheter is, however, a relatively invasive procedure, but there are commercially available catheters that combine EMG sensors with a naso-gastric tube to justify its placement. Unfortunately, only one ventilator manufacturer has the ability to monitor the EMG signal. The EMG catheter may be superior to an esophageal balloon because it more closely reflects neural events. (14, 22) An alternative to an invasive catheter may be found by inspecting the flow waveform. Identifying the abrupt decrease in expiratory flow from the flow trajectory established earlier indicates either the beginning of inspiratory muscle contraction and/or relaxation of expiratory muscles during active expiration (Figure 6). In either case, the point of expiratory flow deviation signifies the beginning of the triggering phase. This can clearly be seen in Figure 6, where the ventilator trigger signal and diaphragmatic EMG are included (these signals enhance the flow signal but are not required). The time lag between this point and the point at which Paw starts to increase is the trigger delay. If there is no mechanical breath following an abrupt fall in expiratory flow, this can be classified as an ineffective triggering. However, the clinician must not confuse changes in the flow signal caused by cardiac oscillations with ineffective efforts.

It is important to note that trigger delay is not always caused by poor inspiratory effort. In adult patients, it has been found that effort is more than a third greater when the threshold for triggering the ventilator is not reached than when it is. Breaths that do not trigger the ventilator have higher VT and shorter expiratory time. (10) Figure 6 illustrates findings of trigger delay. In this example, included are flow, pressure, and volume waveforms in addition to a signal for when the inspiratory valve opens and closes and evidence of muscular activity illustrated by the diaphragmatic EMG signal. Examples of this can be found on the ventilator waveforms but are more easily identified when the ventilator trigger and diaphragmatic EMG signals are included.

**TABLE 2: Trigger Delay**

<table>
<thead>
<tr>
<th>Ventilator Characteristics and Settings</th>
<th>Patient Characteristics</th>
<th>Circuit Characteristics and Interfaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Type and setting of trigger</td>
<td>• Dynamic hyperinflation</td>
<td>• Additional resistance (ET, ventilator circuit, airway sensor, HME)</td>
</tr>
<tr>
<td>• Site of signal recording</td>
<td>• Respiratory drive during trigger phase</td>
<td></td>
</tr>
<tr>
<td>• Valves</td>
<td>• Upper airway resistance (during NIV)</td>
<td></td>
</tr>
<tr>
<td>• Level of pressure assistance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Ventilator modes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**FIGURE 6**
Trigger asynchrony can cause breaths to be stacked. This is defined by when the delta time between the ventilator’s trigger is one half of the mean inspiratory time of the patient. These breaths are classified as stacked breaths. Stacked breaths occur with or without expiratory flow between triggers. Figure 6 illustrates stacked breaths. Auto-triggering, which refers to the phenomenon of the ventilator being triggered in the absence of patient effort, may also occur. This phenomenon may be caused by improper setting of the trigger threshold or Paw distortions caused by circuit leak, presence of water in the ventilator circuit or patient cardiac oscillations. Auto-triggering occurs frequently in neonatal patients because uncuffed endotracheal tubes are used. In small premature infants, clinicians often set a low trigger threshold to avoid ineffective triggering, and thus even small leaks will result in auto-triggering. It may be difficult to distinguish auto-triggering from rapid breathing in these patients. Auto-triggering should be suspected when each breath looks identical and occurs at regular intervals. Rapid breathing will show some variability in rate and the appearance of the waveforms. Figure 7 illustrates auto-triggering with evidence of ventilator response without evidence of patient effort in a spontaneous breathing, patient triggered mode. Auto-triggering can also be detected by inspection of the pressure and flow waveforms by identifying the absence of the initial pressure drop below end-expiratory pressure which would be required in patient triggered breath.

Another issue that can influence triggering of the ventilator leading to ventilator asynchrony is the presence of increased airway resistance leading to the presence of inadvertent positive end-expiratory pressure, PEEP. Mechanically ventilated patients with obstructive lung disease who develop PEEP have to generate a negative intrapleural pressure to match the value of PEEP in addition to the ventilator sensitivity threshold level before triggering occurs and a ventilator breath is initiated. When inspiratory effort by the patient is less than the threshold value, the ventilator will not deliver a breath, causing effort without response from the ventilator. This is illustrated in Figure 8, where there is clear evidence of muscular activity but no evidence of ventilator response. Therefore, dynamic hyperinflation (PEEP) leads to frequent non-triggering of breaths in patients with obstructive lung disease. Such non-triggered breaths represent wasted effort on the part of the patient and lead to patient-ventilator asynchrony. In any spontaneous breathing mode, the ventilator must be set to respond to the patient’s breathing effort in order to provide adequate support. In addition, application of external PEEP could reduce the elastic threshold load and WOB, particularly in patients with flow limitations during tidal expiration.

Flow Asynchrony:

Flow asynchrony occurs whenever the patient and the ventilator flows do not match. Flow from the ventilator can be a fixed or constant flow pattern (such as volume-controlled ventilation) or can be variable (PC, PS, or PRVC). In VC, flow is fixed so that a set level of flow is delivered with each breath. Because WOB is the sum of the work performed by the ventilator and the work performed by the patient, reduction in ventilator support or work will reduce the level of support. During ventilation with variable flow, the peak flow depends upon on the set target pressure, the patient’s effort, and the respiratory system compliance and resistance. During PC, the clinician can set the target pressure and the rate of flow acceleration or rise time. Ideally, in pressure ventilation, the rise in gas flow should match the patient’s demand for flow. The control of flow acceleration varies according to the manufacturer of the ventilator, but the principles remain the same. Changing the rise time can have a profound effect on the flow-time waveform. (23) If the rise time is set to the fastest setting (rise time 0) a sharp increase in inspiratory flow is dictated by the interaction of between Pmus, Paw, and elastic
Figure 9

The patient desires a longer inspiratory time constitutes an ability of the ventilator mode to terminate a breath when time and ventilator inspiratory time do not coincide. The patient. (Figure 9)

Figure 6 illustrates flow asynchrony, with the common finding seen as concavity in the pressure waveform illustrating inadequate flow to meet the patient's needs. Also this can be illustrated in a pressure-volume loop with evidence of the classic “figure 8” due to increased triggering effort by the patient. (Figure 9)
understanding of the interactions between the spontaneously breathing patient and the ventilator because of the recommendations for patients to be maintained at a higher level of wakefulness during mechanical ventilation. Research in the future needs to define the advantages and disadvantages of this practice and further investigate the effects of sleep in these patients. Future advances in mechanical ventilation may require a closed loop system that would allow the patient and ventilator to interact independently of the clinician to allow for better patient ventilator synchrony.

REFERENCES

DIRECTED READING QUESTIONS (Answers Page 55)

1. A spontaneous breath on the ventilator is triggered dependent upon the cycle variable settings.
   True or False?

2. Presence of trigger delay is always detrimental to the patient during spontaneous breathing during mechanical ventilation.
   True or False?

3. Which the following is not a phase of patient-ventilator asynchrony.
   A) Triggering phase
   B) Flow delivery phase
   C) Breath termination phase
   D) PEEPi effects phase
   E) All are patient-ventilator asynchrony phase

4. Trigger delay is always caused by poor patient inspiratory effort.
   True or False?

5. Which of the following component forces does not have to be overcome by the work generated by respiratory muscles during spontaneous breathing mechanical ventilation.
   A) Resistive component
   B) Passive respiratory muscle component
   C) Elastic component
   D) Inertial component
   E) Chest wall and intestinal organs components

6. Trigger asynchrony is defined as the presence of muscular effort without effective ventilator triggering.
   True or False?

7. When interpreting the flow signal displayed on the ventilator screen evidence of flow changes without ventilator response is always a sign of ineffective effort during triggering of the ventilator by the patient.
   True or False?

8. Reduction in work by the ventilator will lead to reduced level of support to the patient.
   True or False?

9. During pressure support ventilation inspiration is terminated by which of the following measures except:
   A) Rise in pressure above the target setting
   B) Flow
   C) End of inspiratory effort by the patient
   D) Inspiratory time
   E) All of the above are correct

10. Expiratory asynchrony results from a shortened or prolonged expiratory time and the patient attempting effort during expiration when the ventilator is unresponsive.
    True or False?

11. The primary goal of mechanical ventilation is to completely eliminate the patient's respiratory muscle activity thus reduce work of breathing.
    True or False?

12. Increased respiratory rate by the patient during pressure support ventilation is always a sign of intolerance of the patient to weaning ventilatory support.
    True or False?
Special Edition of the CJRT - Access to Respiratory Therapy

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Since the beginning of the profession, respiratory therapists have sought to improve the ways in which patients receive treatment for cardio-respiratory illnesses. While much of this work has grown from the acute and critical care settings, respiratory therapists are increasingly involved in primary health care initiatives where they manage the treatment of acute and chronic respiratory conditions both within hospitals and in the community.

Continuing the Journal’s history of publishing specialty editions, the Summer 2012 edition of the Canadian Journal of Respiratory Therapy (CJRT) will be devoted to examining an aspect of respiratory therapy practice in Canada and the world. This year’s issue will focus broadly on access to respiratory therapy. We are seeking original submissions that will advance thinking and practice within any branch of respiratory therapy, and are particularly seeking to stimulate discussion on how respiratory therapy services are being delivered to different patient populations or in unique settings or circumstances.

We welcome manuscripts from anywhere in the world and will give priority to studies and trials that answer clinical questions of particular importance to a wide variety of practitioners and policy-makers. Given the theme of this year’s specialty issue, we are seeking manuscripts that report on unique projects (long-established or novel pilot projects, alike) that aim to improve patients’ access to respiratory therapy services and care. Examples may be respiratory therapy outreach services for a particular condition within the hospital, or respiratory therapists working in community-based clinics managing chronic conditions.

The Journal encourages authors to submit well-designed and executed evaluations of programs and projects that have improved patients’ access to respiratory therapy. We also invite commentary on how respiratory therapy in Canada might be expanded to enhance our patients’ access to care or how the scope of practice of respiratory therapists could be expanded to improve access. Articles that address issues of equity, or access to health services in unique, difficult-to-reach or marginalized populations are encouraged. Brief (one page) outlines of potential articles are encouraged, but not required, and can be sent directly along with questions to the Associate Editor. Jason.Nickerson@uottawa.ca

The deadline for submissions is May 2, 2012 for the Summer 2012 edition.

SUBMISSIONS ACCEPTED

The CJRT accepts submission of original articles, papers, commentaries, case studies, literature reviews, letters to the editor and directed reading papers. All manuscripts are peer-reviewed.

The CJRT is published four times a year and represents the interests of respiratory therapists nationally and internationally.

For additional information or to submit an article, please contact:
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800-267-3422 ext. 223
Depuis toujours, les thérapeutes respiratoires ont cherché à améliorer les façons de prodiguer les soins de traitement des maladies cardio-respiratoires. Bien que cette tendance soit principalement issue des milieux de soins intensifs et de courte durée, les thérapeutes respiratoires sont de plus en plus au cœur des soins primaires où ils assurent le traitement de difficultés respiratoires chroniques et aiguës, autant dans les hôpitaux que dans la collectivité.

Poursuivant la tradition du Journal de publier des numéros spéciaux, nous préparons un numéro pour l’été 2012 qui portera sur l’examen d’un aspect de la thérapie respiratoire au Canada et dans le monde. Le numéro de 2012 abordera l’accès à la thérapie respiratoire. Nous recherchons des textes originaux qui feront avancer la pensée critique et la pratique de la thérapie respiratoire et qui susciteront le débat sur la façon dont les services de thérapie respiratoire sont prodigués aux différentes populations de patients ou dans des circonstances particulières et uniques.

Nous acceptons des textes internationaux et accorderons la priorité à des études et des essais qui répondent aux préoccupations d’ordre clinique d’une vaste gamme de praticiens et de décideurs. Dans le cadre de ce thème, nous recherchons des textes qui traitent de projets uniques (en place depuis longtemps ou nouveaux) visant l’amélioration de l’accès aux services et aux soins de thérapie respiratoire pour les patients. Les textes pourraient par exemple traiter de l’extension des services de thérapie respiratoire en milieu hospitalier dans des cas particuliers ou porter sur le travail des thérapeutes respiratoires dans des cliniques communautaires où l’on traite les maladies chroniques.

Le Journal invite les auteurs à présenter des évaluations bien structurées de programmes et de projets qui ont amélioré l’accès à la thérapie respiratoire pour les patients. Nous sollicitons aussi les commentaires sur la façon dont la thérapeute respiratoire au Canada pourrait s’étendre pour augmenter l’accès aux soins pour les patients ou comment l’étendue du champ d’exercice des thérapeutes pourrait être élargi pour également améliorer l’accès aux soins. Nous sollicitons aussi des articles qui traitent de la question de l’équité ou de l’accès aux soins pour les populations distinctes, difficiles à atteindre ou marginales. Les auteurs peuvent, s’ils le désirent, soumettre un bref aperçu de leur article (une page) accompagné de leurs questions au rédacteur adjoint. Jason.Nickerson@uottawa.ca

La date limite de la présentation des articles a été fixée au 2 mai 2012, pour le numéro de l’été 2012.

CSRT FELLOWS 2011

The FCSRT professional designation is to recognize registered members of the CSRT who have made a significant and consistent contribution to the development of the science and professional of respiratory therapy and have made a commitment to lifelong learning. At its June 2011 meeting, the Board of Directors has approved the following individuals as Fellows of the CSRT. Congratulations to:

Mary Bayliss  Phoebe Lam  Corrie Menon  Patty Wickson
Debbie Cain  Philip Lau  Larry Mudge  Ted Yachemetz
Helen Clark  Shawna MacDonald  Wade Norquay
Susan Dunington  Barbara MacDonald  Valerie Stevenson
Pamela Kemp  John McGrath  Cynthia Welton

L’attestation professionnelle de Fellow de la SCTR (FSCTR) a été créée pour reconnaître les thérapeutes respiratoires qui sont membres en règle de la Société et qui ont manifesté leur engagement au perfectionnement continu. Le Conseil d’administration a approuvé les thérapeutes respiratoires suivants à titre de Fellow de la SCTR – Nos félicitations à :

Application forms and criteria can be found in the Members-only section of the CSRT website.
### ABSTRACTS FROM POSTER PRESENTATIONS

The following abstracts were presented at the CSRT Conference in Quebec City in June. There were two categories – Best RT Poster and Best Student RT Poster. The submissions were examined by an independent panel of judges.

**Best RT Poster** was presented by **Julia Infantino**, Department of Respiratory Therapy, and Department of Paediatrics, Mount Sinai Hospital, Toronto, ON.

The best Student RT Poster was awarded to **Thomas Fudge**, School of Medical Rehabilitation, Faculty of Medicine, University of Manitoba, Winnipeg, MB

<table>
<thead>
<tr>
<th>- Student RT Poster -</th>
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<tbody>
<tr>
<td><strong>Traumatic Brain Injury: Alternative Management Options</strong></td>
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<tr>
<td><strong>Jessika Beaulieu</strong></td>
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The case study presents a patient who has suffered a traumatic brain injury along with multiple secondary injuries. Management of this patient have included various treatment options. Two management strategies; performing a tracheotomy and the use of Ketamine were investigated in two separate articles. The research question posed in the articles was: Do tracheotomies decrease intensive care unit stay, the need for mechanical ventilation and pneumonia rates and does Ketamine provide any benefits to patients with traumatic brain injury? Benefits include reducing intracranial pressure and promoting neurological improvement. Both articles showed the pros and cons of the respective procedures/drug. Neither of them were conclusive in terms of benefits.

**Comparison of different gas humidification devices during high frequency oscillatory ventilation (HFOV). A bench and clinical study**

**Delisle Stéphane**¹², **Bouchard Pierre-Alexandre**¹³⁴, **Vanderschuren Abel**¹³⁴ and **Lellouche François**¹³⁴

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²-Université de Montréal,  
³-Institut Universitaire de Cardiologie et de Pneumologie de Québec and  
⁴-Université Laval, Québec, Canada

**INTRODUCTION**

Few data are available for gas humidification during HFOV. Commonly, active humidification is used for this purpose, considering that additional dead space may be an issue in this specific situation. Also, the HFOV circuitry only allows the use of heated humidifiers (HH).

**OBJECTIVES**

To assess the performances of different humidification devices during HFOV, including heat and moisture exchangers (HME) and a newly available unclassified system (Hydrate, inline vaporizer).

**METHODS**

We measured on bench gas humidity (with psychrometric method) of different humidification devices (MR 730, MR 850 (with and without compensation actived), Hydrate, Hygrobac S and Hygrobac) using previously described methods [1,2]. The devices were connected to a HFOV ventilator set as per Oscillate study recommendations: Flow 40L/min, Amplitude 90 cmH2O, Ti 33%, Mean pressure 30 cmH2O, at two different oscillation frequencies: 4 and 10 Hz. Two different ambient temperatures were used: normal (22-24°C) and high (28-30°C). Three measurements were performed at steady state. Also, we measured arterial blood gases in patients with HH and with HME after 60 mins.

**Raising a Critical Consciousness for the Reformation of Health Care Culture**

**Andria Darlington BSc, RRT, MHS**

**ABSTRACT**

Respiratory therapists often practice in a dimension where life and death hang in a delicate balance. The care required during resuscitation efforts, goals of care transitioning, and withdrawal of care is extraordinarily complex. Our philosophical assumptions about the ontology: the nature of reality, epistemology: the theory of knowledge construction, and methodology: ways of knowing, of the dominant empirical paradigm in which we practice influences our care delivery. These philosophical assumptions may not appropriately respond to the cultural and psychosocial needs of patients as empirical study and biomedicine often neglects the human context. To deliver holistic, patient centred care at end-of-life, respiratory therapists should first raise a critical consciousness to their own underlying assumptions that drive their practice. Raising a critical consciousness can be accomplished by examining the dominant paradigm in which we practice, along with any power imbalances and cultural issues associated. Strategies suggested to facilitate better patient centred care at end-of-life include cultural synthesis, a paradigmatic shift, re-examining evidence based practice, and practicing cultural safety.
RESULTS

Differents humidification devices during HFOV

Arterial blood gases in patients with HH and with HME after 60 mins.

<table>
<thead>
<tr>
<th>3.5 Hz</th>
<th>PaCO2 Baseline (HH)</th>
<th>PaCO2 after 60 mins (HME)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient 1</td>
<td>85 mmHg</td>
<td>88 mmHg</td>
</tr>
<tr>
<td>Patient 2</td>
<td>84 mmHg</td>
<td>85 mmHg</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5 Hz</th>
<th>PaCO2 Baseline (HH)</th>
<th>PaCO2 after 60 mins (HME)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient 1</td>
<td>52 mmHg</td>
<td>56 mmHg</td>
</tr>
<tr>
<td>Patient 2</td>
<td>44 mmHg</td>
<td>47 mmHg</td>
</tr>
</tbody>
</table>

CONCLUSION

Heated humidifiers deliver low humidity with high ambient temperature as previously described [2], but performed well with normal temperature and with specific setting (40/40 and compensation activated). Both HME tested performed reasonably well with stable results. Impact of the small HME dead space on alveolar ventilation was moderate in 4 patients.


The Implementation of CASS Endotracheal Tubes at University Health Network (UHN)

Tara Fowler, RRT¹; Philip Ma, RRT¹; Ray Janisse, RRT¹; Aimee Hindle, RRT¹; Marianne Ng, RRT¹; Andrew Grace, RRT¹; Sandra Walsh, RRT¹

¹UHN – Toronto General Hospital,
²UHN – Toronto Western Hospital

IDENTIFY THE PRACTICE ISSUE:

Ventilator Associated Pneumonia (VAP) has been shown to increase the number of patient ventilated days, mortality rates and ICU costs. The use of continuous suction above the cuff endotracheal tubes (CASS) was identified as a prevention strategy. The purpose of this study was to determine the effect of implementing CASS tubes at UHN.

PROCESS USED/STEPS TAKEN TO ADDRESS PRACTICE ISSUE:

At UHN, CASS endotracheal tubes were implemented for patients who may require ventilation for greater than 48 hours. At UHN the incidence of VAP is determined using a CPIS score and case review by pharmacy and infection control.

OUTCOME OF PROCESS:

At UHN, from Jan. 2009 to June 2010 the average VAPs/mos was 4.89. The average VAP/mos from July 2010 to Feb. 2011 was 2.65. Interprofessional staff feedback regarding the use of CASS tubes included changing practice to intubating with an ETT a half size smaller compared to previous practice. Further investigation into VAP cases in MSICU at TGH from October 2010 to February 2011 demonstrated that patients who had acquired VAP in this unit (9 of 11) had a tracheostomy tube in situ at time of diagnosis.

CLINICAL IMPLICATIONS/FUTURE DIRECTIONS:

Data collection will need to continue over a longer period of time to determine the significance of the impact of the UHN VAP initiatives. Future direction may require the consideration of the impact, safety and effectiveness of CASS tracheostomy tubes.

Lessons Learned in Rehab: The Evolution of Respiratory Education in Pulmonary Rehabilitation at St. Clare’s.

Susan Haskell BA, RRT, CRE, FCSRT (presenting author) and Dr. Nigel Duguid MB, ChB, MRCP (UK) FRCP (C), FCCP - St. Clare’s Mercy Hospital, St. John’s, NL, Canada.

BACKGROUND

Since inception in 2007, Pulmonary Rehabilitation (PR) at St. Clare’s has been continuously evolving to meet the needs of Chronic Obstructive Pulmonary Disease (COPD) patients and their families. Evaluation of the COPD Toolkit (www.copdtoolkit.org) has inspired further evolution of the respiratory education offered in PR.
PURPOSE
To evaluate the COPD Toolkit, as part of a national pilot project of the Lung Association of Saskatchewan, and to explore the outcomes of an “education only” stream of PR.

METHOD
Seven COPD patients referred to PR were enrolled in a seven-week program of education only. They were encouraged to bring along one family member or friend. Five patients received thirteen educational sessions as presented by a multi-disciplinary health care team, using the corresponding COPD Toolkit scripted Powerpoint presentations. A facilitator-to-participant ratio of 1:8 or less was maintained, as recommended by the Canadian Network for Respiratory Care (CNRC). Two patients withdrew from the pilot for personal reasons.

Patients completed a self-administered Lung Information Needs Questionnaire (LINQ) pre and post program to determine their perceived needs in six different domains: Smoking, Self Management, Disease Knowledge, Medicine, Diet, and Exercise. Scoring range: 0 - 25. The higher the score, the greater the perceived learning need. The mean clinically important difference (MCID) was one point. All participants completed a post program evaluation form as provided by the COPD Toolkit and shared their Lessons Learned in Rehab.

FINDINGS
Pre program, patients knew the name of their condition, but their greatest need was self management. Only twenty percent had written direction on how to handle worsening shortness of breath. After Self Management, the top learning need was Exercise, followed by Disease Knowledge, then Diet and Medicines. Smoking scored zero as all participants were ex-smokers. Toolkit users liked the slides, the layout, and its straightforward usability. They suggested some modifications to language and content. Post program, all participants were satisfied with the information on how to use meds and how much physical activity to do. On a scale from 1-7 (1 = not very and 7 = extremely) they graded all sessions 5 or greater for usefulness of information. The mean scores for all domains dropped post program, as did the mean total scores. The participant with the greatest lung information need (total score = 15/25) had the greatest decrease in total LINQ score post program. Her score dropped by 73% to 4/25.

<table>
<thead>
<tr>
<th>Mean Scores</th>
<th>Pre</th>
<th>Post</th>
<th>Clinically Important Difference Δ = 1+</th>
</tr>
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<tbody>
<tr>
<td>Self Management</td>
<td>3.0</td>
<td>2.4</td>
<td>Δ = 0.6</td>
</tr>
<tr>
<td>Exercise</td>
<td>2.2</td>
<td>1.0</td>
<td>Δ = 1.2</td>
</tr>
<tr>
<td>Disease Knowledge</td>
<td>1.4</td>
<td>0.6</td>
<td>Δ = 0.8</td>
</tr>
<tr>
<td>Diet</td>
<td>1.0</td>
<td>0.6</td>
<td>Δ = 0.4</td>
</tr>
<tr>
<td>Medicines</td>
<td>1.0</td>
<td>0.6</td>
<td>Δ = 1.0</td>
</tr>
<tr>
<td>Smoking</td>
<td>0.0</td>
<td>0.0</td>
<td>Δ = 0.0</td>
</tr>
<tr>
<td>Total</td>
<td>8.6</td>
<td>4.6</td>
<td>Δ = 4.0</td>
</tr>
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</table>

Lessons Learned in Rehab
“Set goals.”
“Walking More.”
“How to pace myself.”
“I really never knew Oxygen was a drug.”
“Know how to live with it better now than before I came here.”
“Action plan in case of Flare-up. Know when and who to talk to. When to go to the hospital.”
“Since this, I don’t anymore (feel down on myself). I’ve learned to accept it (COPD).”

IMPLICATIONS
The COPD Toolkit is an effective and user-friendly tool in the provision of patient lung information needs. It may be a feasible option in areas where few or no formal rehab programs exist. In the vast Eastern Health Region, and possibly throughout Newfoundland and Labrador, it may be a means to help COPD patients better self-manage despite inaccessibility to rehab in remote, rural areas. A regional network of COPD educators and/or other health care professionals, coupled with Telehealth or other technology, are future considerations for the dissemination of COPD self-management education.

APPLICATION
Each PR participant at St. Clare’s is now given a Canadian Thoracic Society (CTS) written action plan. The CTS recommends self management education and written action plans in COPD as a means to reduce health care utilization. Toolkit content is also supplemented by an additional session on applicable Financial Supports in the PR education stream at St. Clare’s. Ignorance about or lack of potential financial resources may prevent patients from employing what they have learned. PR personnel at Eastern Health are sharing their experience with other provincial health care providers and Regional Health authorities seeking to offer COPD education and/or PR.

- Winning RT Poster -

Securing endotracheal tubes in neonates: an audit after modification of practice

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Zehra Hemani RRT, Bianca Lee H.BSc. RRT,
Nancy Mohammed B.Sc, RRT, Selvi Sittampalam B.Sc, RRT,
Prakesh S Shah MSc, MD, FRCPC

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BACKGROUND
Minimal literature currently exists in regards to optimal endotracheal tube (ETT) securing techniques/devices in the neonatal population. Often, unplanned extubations (UE) are attributed to loose securing devices and can lead to the need for an infant to be reintubated. Intubations are distressing,
painful, and have the potential for causing laryngospasm, hemodynamic changes, increased intracranial pressure, airway trauma and subglottic stenosis.1,2

OBJECTIVE
To compare the rates of UE between two ETT securing devices in the level III NICU.

METHODS
All neonates who required intubation for at least 4 hours were included in this single-centre, level III NICU based study. Infants intubated transiently for either surfactant administration or meconium removal were excluded. Our traditional method of securing ETTs using pink tape and Friar’s Balsam (period from Aug 1 2010 to Oct 31 2010) was modified by changing to 3M white cloth adhesive tapes and Mastisol (period from Nov 7, 2011 to Jan 31, 2011). A washout phase was also included between Nov 1 2010 to Nov 6 2010. A retrospective review of 94 patient charts was performed to compare the number of UE for both the traditional and trial method of ETT securing.

ANALYSES
Patient demographics, duration of intubation, number of re-tapes, and clinical outcomes were compared between groups using chi-square test for categorical variables, student t test for continuous variables and wilcoxon rank sum test for non-parametric variables. A p value of <0.05 was considered significant.

RESULTS
64 patients (107 episodes) had pink tape and Friar’s Balsam whereas 30 patients (45 episodes) had white tape with Mastisol. There was no difference in the baseline demographic details (Table 1). However, the episodes of UE were significantly reduced with white tape and Mastisol (odds ratio 0.32, 95% CI 0.11, 0.94). There was no impact of type of ventilation (conventional vs. HFOV), intubation method (oral or nasal), number of re-taping or duration of ventilation on the rate of UE.

CONCLUSION
There was a significant reduction in the number of UE with white tape and Mastisol in neonates requiring mechanical ventilation.

FUTURE CONSIDERATIONS
1. To determine whether it is the mastisol or the white tapes or the combination of both that resulted in a decreased number of UE.
2. Consider trialing and comparing other methods for securing ETT (i.e. Neobar, suturing etc) in an effort to determine the optimal ETT securing method.
3. To investigate the efficacy of other therapeutic interventions in decreasing the rate of UE in the NICU

REFERENCES
RESULTS
NIPPV is shown to reduce the symptoms of CPE associated with respiratory and cardiovascular distress. NIPPV is also shown to reduce the rates of intubation and mechanical ventilation, although there are some conflicting results. New, promising research is being conducted as to whether earlier implementation of NIPPV has any effect on outcomes, but there needs to be additional research conducted before definitive conclusions could be made. The effects of NIPPV on mortality are controversial and conflicting. There is a trend towards improved mortality, but larger, more controlled clinical trials have yet to confirm this.

CONCLUSIONS
Clinicians should consider NIPPV to be an effective strategy for the management of CPE. The effects of symptom reduction alone prove that this is an effective management therapy.

**Key Words:** Cardiogenic Pulmonary Edema, Non-invasive Positive Pressure Ventilation, Continuous Positive Airway Pressure Ventilation, Intubation, Mechanical Ventilation, Mortality

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**An Alternative to the Standard Tracheotomy Tube**

Marianne MacKenzie

**ABSTRACT**

An outpatient Tracheostomy Clinic in Calgary Alberta has used alternative tracheal devices for approximately fifteen years to replace standard tracheostomy tubes in long-term tracheostomy patients. One goal of the clinic staff was to find devices that would minimize the complications of living with a tracheostomy tube. From the devices researched the stoma stents were found to best meet the needs of the patients. Two styles, the Montgomery Cannula and the Hood Stent, have together been inserted in seventy-three patients requiring long-term tracheostomy for a variety of medical conditions. This patient group reports that the stents improve vocal volume, are less cumbersome to use, less visible to others, easier to care for and much more conducive to working environments. Contraindications for using stents are discussed as well as reasons why patients may revert back to a standard tracheostomy tube.

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**Identifying the Barriers to Clinical Practice for Tracheotomy Weaning and Decannulation of Patients**

Marianne Ng

**INTRODUCTION**

It has been estimated that 10% of critically ill mechanically ventilated patients receive a tracheostomy tube. Prolonged tracheostomy tube placement exposes patients to an increased risk of complications including tracheal stenosis, bleeding, fistulas, infections, and aspiration.

Identifying barriers to clinical practices and processes is crucial in continual improvement to achieve advancement of patient care through interprofessional collaboration. Once the barriers are identified, enhancement of knowledge and skills can be attained by education or implementing processes to overcome these barriers. Effective tracheostomy management is a key component for patient centered care, efficient use of resources, and minimizing medical cost through diminishing infection, re-admissions to ICU, and effective discharge planning.

**OBJECTIVES**

To identify the barriers to tracheostomy management within the multidisciplinary team by investigating individual practice, level of knowledge, and the process of communication in regards to tracheostomy weaning and decannulation.

**METHOD**

An electronic questionnaire was designed and distributed to collect quantitative and qualitative information regarding current tracheostomy care, weaning and decannulation practices. Members of the multidisciplinary team surveyed included Respiratory Therapists, Nursing, Physiotherapists, and Speech Language Therapists (n=66). The electronic questionnaire was developed to investigate three themes, which included level of knowledge, individual practice and the process of communication. The survey was administered from November 1, 2008 to March 15 2009.

**RESULTS**

The outcomes can be separated into three categories: knowledge, education and communication.

Overall, respondents had been exposed to and were able to identify the differences between varieties of tracheostomy tubes. A gap in knowledge was noted in the practice of corking and changing tracheostomy tubes in the facilitation of decannulation. The results showed that 18.8% of respondents incorrectly thought it was appropriate to cork with an inflated cuff and 11.1% surveyors incorrectly stated that an RN can change tracheostomy tubes. We also found there was a lack of consistency amongst practitioners with respect to the number of hours required to cork a patient before decannulation, with 5.1% stating less than 24 hours, 18.6% twenty-four hours, 49.2% forty-eight hours, and 27.1% greater than forty-eight hours. Communication between the interprofessional team is a key component to facilitating the weaning and decannulation of patients with tracheostomies. Among the professions of PT, RT, RN, and SLP most respondents indicate use of clinical notes and direct/relayed oral conversion to convey information amongst the interprofessional team. The RN group were noted to be the group that participated most in daily medical team rounds for General Internal Medicine.

**CONCLUSION**

There were no differences between the professional groups in regards to the patient factors that are determinants in the decision to decannulate a patient with a tracheostomy. The
results also demonstrated that there was no clear indication or determinate for determining a patient's readiness for decannulation.

Based on the findings there is a need for education on types of tracheostomy tubes and their clinical implications. Safety issues with regards to tracheostomy corks and decannulation practice should be emphasized. The inconsistent methods of communication amongst the professions may lead to a prolonged time to decannulation. Tracheostomy care algorithms may facilitate standardization of communication and care of tracheostomy patients.

Surgical Care During Recent Crises: What Do The Data Tell Us?

Jason W. Nickerson, RRT¹, Smita Chackungal, MD²,³, Lisa Knowlton, MD²,³, and Kelly McQueen, MD⁴

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3. Division of General Surgery, University of British Columbia, Room 3100, 910 West 10th Avenue, Vancouver, BC, Canada, V5Z 4E3
4. Harvard Humanitarian Initiative, 14 Story Street, 2nd Floor, Cambridge, MA, USA, 02138

Correspondence to: Jason W. Nickerson, 1 Stewart St., Rm. 201, Ottawa, ON, K1N 6N5, Canada Jason.Nickerson@uottawa.ca +1 (613) 562-5800 ext. 2339

BACKGROUND

Humanitarian surgical care is often organized and delivered with short notice and with limited time for developing unique strategies for providing care. As such, humanitarian surgical care providers must learn from the collective knowledge gained through previous crises. While some surgical pathologies can be anticipated by the nature of the crisis, the role of foreign medical teams (FMT) in treating the existing, unmet burden of surgical disease is unclear.

METHODS

We examined surgical caseload data from FMTs providing surgical care during disasters and complex emergencies. We utilized a search strategy to locate manuscripts published in peer-reviewed journals between 1990-2010 in the PubMed, MEDLINE and Embase databases. A qualitative review of the surgical activities reported in the studies was performed.

FINDINGS

11 articles were located that met our inclusion criteria. The methods for reporting surgical activities varied significantly among the included articles, such that pooled statistical analysis was not possible. Qualitative analysis of the studies revealed that the most commonly performed procedures were generally related to soft tissue or orthopedic surgery, but that as the length of reporting increased, the surgical caseload became more reflective of an unmet burden of surgical disease. All of the studies included reported performing significant numbers of procedures such as caesarean sections, hernia repairs and appendectomies, all of which were unrelated to the crisis.

INTERPRETATION

Our review suggests that where FMTs are indicated and requested, multidisciplinary surgical teams capable of providing a range of emergency and essential surgical and rehabilitation services ought to be encouraged rather than teams capable of a limited range of services. Further studies are needed to examine the population-level burden of surgical disease in crisis-affected populations.

FUNDING

This review was undertaken as part of the 2011 Harvard Humanitarian Action Summit. No specific funding was received from any source for this review.

- Student Poster -

Proportional Assist Ventilation (PAV)

Misbah Quraishi

ABSTRACT

Proportional Assist Ventilation (PAV) is a mode of assisted ventilation that has been available for some time, but as a possible consequence of a lack of familiarity, may be underutilized in current ventilation strategies. The purpose of this presentation is to familiarize the reader with the mechanics, and possible advantages and disadvantages of PAV. Evidence suggests there may be some beneficial effects for ARDS, hemodynamic instability, ventilator synchrony and patient weaning. Data used in this presentation was collected from the Covidien website, journal article from the journal “Respiratory Care” and the book, “Mechanical Ventilation” (Branson, R. D., MacIntyre N.R. (2009). Mechanical Ventilation. (2nd ed.). St. Louis, Missouri: Saunders Elsevier).

- Winning RT Student Poster -

2009 H1N1 Pandemic: an Evaluation of Planning and Management Strategies

Thomas S. Fudge BSc (Hons)¹, Andrew West MAppSc, RRT¹

1. School of Medical Rehabilitation, Faculty of Medicine, University of Manitoba, Winnipeg, MB, Canada

BACKGROUND

The 2009 H1N1 influenza A pandemic was cause for concern. The rapidly mutating virus was showing characteristics of a serious threat, which was ultimately realized on June 11th, 2009. At that moment the global community went into pandemic planning. Techniques commonly used to control the threat included border vigilance, isolation, quarantine, personal hygiene, personal protective equipment, social distancing, antiviral treatment, and vaccination.
METHODS
A literature search was conducted to identify the chronological steps taken in pandemic planning and management, and to elucidate the effectiveness in containing viral spread. PubMed, CINAHL, and The Cochrane Library databases were searched using the key words: “H1N1”, “Influenza A”, “swine flu”, “infection control”, “infection prevention”, “pandemic planning”, and “personal protective equipment”.

RESULTS
Seventy-three articles of interest were evaluated. It was determined that not one single method was absolutely protective, but that in combination they helped diminish the spread of the pandemic.

DISCUSSION
The H1N1 virus itself helped slow the pandemic by not reassorting into a more virulent form. The global community did as much as it could to slow the spread of the H1N1 virus. In retrospect we learned much about the weaknesses in our systems including resource mobilization, lack of adequate personnel, equipment, and funding. Of great concern was the lack of standardized guidelines from an accredited agency with detailed instructions regarding influenza containment, in addition to ensuring that impoverished countries are equipped to handle pandemics. Further research into determining which prevention strategies have the greatest success should be employed in order to control pandemic outbreaks at the preventative level.

INTRODUCTION
An association between obesity and asthma has been reported, with disparity between males and females in this association that is not fully explained. Studies investigating the association typically have not identified asthma using accepted objective diagnostic methods, possibly leading to the inaccurate diagnosis and management of asthma in those with obesity.

OBJECTIVE
This study investigated the association, including gender differences, between obesity and airflow obstruction in non-asthmatics identified by spirometric protocols.

METHODS
The pulmonary function test results of non-asthmatic subjects were reviewed. Statistical analyses were employed to determine the association between pulmonary function measures and BMI.

RESULTS
Significant differences in the pulmonary function values, measured as a percentage of predicted, existed between BMI ranges including FVC (p < 0.001), FEV₁/FVC (p < 0.001), and FEF50% (p < 0.02). Gender differences were evident in FVC, FEV₁, FEV₁/FVC, FEF50%, and FEF25% (all p < 0.001). When age and smoking were controlled for, gender differences remained in the pattern of the effect of BMI on FVC. FVC was progressively compromised for females as BMI increased above normal range (> 25 kg/m²), and was diminished in males with a BMI ≥ 30 kg/m².

CONCLUSIONS
Clear association was not found between indices of airflow obstruction and increasing BMI in this non-asthmatic group. The study findings suggest a restrictive pulmonary function profile in obesity which is specific to non-asthmatics and unique to each gender. The compromising effects of increasing adiposity on FVC may be experienced at a lower BMI in females than in males.

Key Words: Airway Obstruction; Asthma; Body Mass Index; Obesity; Pulmonary Function Tests

The Association of Body Mass Index with Airway Obstruction: Implications for the Inaccurate Differential Diagnosis of Asthma in Obesity
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2. Research and Performance Support, Regina Qu’Appelle Health Region, Regina, Saskatchewan
3. School of Biomedical Sciences, Charles Sturt University, New South Wales, Australia

RÉSUMÉS DES PRÉSENTATIONS D’AFFICHES
Les résumés suivants ont été présentés au congrès de la SCTR à Québec en juin. Il y avait deux catégories : meilleure affiche de thérapeute respiratoire et meilleure affiche étudiante de thérapeute respiratoire. Les candidatures ont été examinées par un jury indépendant.

La meilleure affiche de thérapeute respiratoire a été celle présentée par Julia Infantino, Département de thérapie respiratoires et Département de pédiatrie, Hôpital Mount Sinai, Toronto (Ontario).

Le prix de la meilleure affiche étudiante a été remis à Thomas Fudge, École de réadaptation médicale, Faculté de médecine, Université du Manitoba, Winnipeg (Manitoba).
**Affiche Étudiante -**

**Traumatisme cérébral : solutions de rechange pour la gestion**

*Jessika Beaulieu*

L'étude de cas porte sur un patient ayant subi un traumatisme cérébral et de multiples blessures secondaires. La gestion de ce patient a inclus différentes options de traitement. Deux stratégies de gestion, une trachéotomie et le recours à la kétamine, ont fait l'objet d'autres articles. La question de recherche posée dans le présent article est la suivante : la trachéotomie permet-elle de diminuer la durée du séjour aux soins intensifs, le besoin de ventilation mécanique et le taux de pneumonie, et le recours à la kétamine présente-t-il des avantages pour un patient ayant subi un traumatisme cérébral ? Les avantages comprennent la diminution de la pression intracrânienne et la promotion de l'amélioration neurologique. Les deux articles montrent les avantages et les inconvénients de la procédure et du médicament ; ni l'un ni l'autre n'offre une conclusion définitive en ce qui a trait aux avantages.

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**Élever la conscience critique pour la réforme de la culture de la santé**

*Andria Darlington BSc, TRA, MHS*

**ABSTRACT**

Les thérapeutes respiratoires travaillent souvent dans une dimension d'équilibre délicat entre la vie et la mort. L'attention requise durant les efforts de réanimation, les buts des soins de transition et le retrait des soins sont extrêmement complexes. Nos hypothèses philosophiques en matière d’ontologie, la nature de la réalité, l'épistémologie, la théorie de la construction des connaissances, et sa méthodologie, les modes de connaissances, du paradigme empirique dominant dans lequel nous pratiquons, tout cela influe sur notre prestation de soins. Ces hypothèses philosophiques peuvent ne pas répondre adéquatement aux besoins culturels et psychosociaux des patients, puisque les études empiriques et la biomédecine négligent souvent le contexte humain. Pour être en mesure d’offrir des soins holistiques et centrés sur le patient en fin de vie, les thérapeutes respiratoires doivent d’abord avoir une conscience critique de leurs propres hypothèses sous-jacentes, celles qui guident leur pratique. Le développement de la conscience critique peut se faire en examinant le paradigme dominant dans lequel nous pratiquons, avec les déséquilibres de pouvoir et les enjeux culturels qui y sont associés. Les stratégies proposées pour faciliter des soins davantage centrés sur le patient en fin de vie comprennent la synthèse culturelle, le glissement paradigmatique, le réexamen de la pratique fondée sur les éléments probants et la pratique de la sécurité culturelle.

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**Comparaison de différents dispositifs d’humidification des gaz durant la ventilation par oscillations à haute fréquence (VOHF).**

**Essai au banc et essai clinique.**

*Delisle Stéphane 1,2, Bouchard Pierre-Alexandre 3,4, Vanderschuren Abel 3,4 et Lellouche François 3,4*

1-Hôpital du Sacré-Coeur Montréal, 2-Université de Montréal, 3-Institut Universitaire de Cardiologie et de Pneumologie de Québec et 4-Université Laval, Québec, Canada

**INTRODUCTION**

On dispose de peu de données sur l’humidification des gaz durant la VOHF. Habituellement, on fait appel à l’humidification active, en considérant que le volume nominal inutilisable peut poser problème dans cette situation particulière. De plus, les circuits VOHF ne permettent que l’utilisation des humidificateurs chauffants (HC).

**OBJECTIFS**

Évaluer le rendement de différents appareils d’humidification durant la VOHF, incluant les échangeurs de chaleur et d’humidité (ECH) et un nouveau système non classé (nébuliseur en ligne à hydrate).

**MÉTHODES**


**RÉSULTATS**

Différents appareils d’humidification durant la VOHF

![Comparaison de différents dispositifs d’humidification des gaz durant la ventilation par oscillations à haute fréquence (VOHF).](image)
CONCLUSION

Les humidificateurs chauffants fournissent une humidité peu élevée avec une température ambiante élevée, tel que décrit précédemment [2], mais offrent un bon rendement à température normale et avec des réglages particuliers (40/40 et compensation activée). Les deux appareils ECH mis à l’essai ont offert un rendement raisonnablement bon avec des résultats stables. Le volume nominal utilisable plus faible a eu un effet modéré sur la ventilation alvéolaire chez quatre patients.


PROCESSUS APPLIQUÉ / ÉTAPES SUIVIES POUR TRAITER L’ENJEU PRATIQUE

Au Réseau universitaire de santé, les sondes d’intubation endotrachéales CASS ont été adoptées pour les patients susceptibles de nécessiter une ventilation pendant une période supérieure à 48 heures. L’incidence de la PVA est mesurée par un pointage CPIS et un examen par l’unité de pharmacie et de contrôle des infections.

RÉSULTAT

Au sein du Réseau, le nombre moyen de PVA/ mois se situait à 4,89 entre janvier 2009 et juin 2010, alors qu’il a été de 2,65 entre juin 2010 et février 2011. Les commentaires du personnel interprofessionnel concernant l’utilisation des sondes CASS ont inclus une modification de pratique portant sur l’intubation avec un ETT d’une demi-taille inférieure comparativement à la pratique antérieure. D’autres études sur les cas de PVA au service des soins intensifs (MSICU) du Toronto General Hospital entre octobre 2010 et février 2011 démontrent que les patients ayant contracté une PVA dans cette unité (9 sur 11) avaient une canule de trachéotomie en place au moment du diagnostic.

IMPLICATIONS CLINIQUES/ORIENTATIONS FUTURES

La collecte de données devra se poursuivre sur une période plus longue pour déterminer l’importance des effets des initiatives du réseau en matière de PVA. Les orientations futures pourraient comprendre l’examen des répercussions, de la sécurité et de l’efficacité des sondes d’intubation endotrachéales.

Leçons apprises en réadaptation :
Évolution de l’éducation respiratoire en réadaptation respiratoire à St. Clare’s

Susan Haskell BA, TRA, CRE, FCSRT (présentatrice) et Dr Nigel Duguid MB, ChB, MRCP (UK) FRCP (C), FCCP - St. Clare’s Mercy Hospital, St. John’s, NL, Canada.

CONTEXTE

Depuis ses débuts en 2007, la réadaptation pulmonaire (RP) à St. Clare’s évolue continuellement pour répondre aux besoins des patients atteints de maladie pulmonaire obstructive chronique et de leurs familles. L’évaluation de la trousse d’outils de la MPOC (www.copdtoolkit.org) a inspiré la poursuite de l’évolution de l’éducation respiratoire offerte en RP.

OBJET

Évaluer la trousse à outil dans le cadre d’un projet national piloté par la Lung Association of Saskatchewan et explorer les résultats d’un mode de RP axé sur « l’éducation seulement ».

MÉTHODOLOGIE

Sept patients de MPOC traités en RP ont été inscrits à un programme d’éducation seulement d’une durée de sept semaines. Ils ont été encouragés à amener avec eux un membre de leur famille ou un ami. Cinq patients ont assisté à 13 séances d’éducation présentées par une équipe de soins.

| Gaz sanguins artériels chez les patients avec HC et ECH après 60 minutes |
|---------------------------------|---------------------------------|
| **3.5 Hz** | **Patient 1** | **Patient 2** |
| PaCO2 Baseline (HH) | 85 mmHg | 84 mmHg |
| PaCO2 after 60 mins (HME) | 88 mmHg | 85 mmHg |
| **5 Hz** | **Patient 1** | **Patient 2** |
| PaCO2 Baseline (HH) | 52 mmHg | 44 mmHg |
| PaCO2 after 60 mins (HME) | 56 mmHg | 47 mmHg |

Mise en œuvre des sondes d’intubation endotrachéales CASS dans le Réseau universitaire de santé (UHN)

Tara Fowler, RRT; Philip Ma, RRT; Ray Janisse, RRT; Aimee Hindle, RRT; Marianne Ng, RRT; Andrew Grace, RRT; Sandra Walsh, RRT

1UHN – Toronto General Hospital,
2UHN – Toronto Western Hospital

DÉFINITION DE L’ENJEU PRATIQUE

Il a été démontré que la pneumonie sous ventilation assistée (PVA) contribuait à l’augmentation du nombre de jours sous ventilation, du taux de mortalité et du coût des soins en service de soins intensifs. L’utilisation de sondes d’intubation endotrachéales CASS est une stratégie de prévention reconnue. Le but de cette étude est de déterminer les effets de l’adoption des sondes d’intubation CASS dans le Réseau universitaire de santé.
multidisciplinaire, utilisant les présentations PowerPoint scriptées correspondantes de la trousse à outils MPOC. Un ratio animateur/participants de 1:8 ou moins a été maintenu, selon la recommandation du Réseau canadien des soins respiratoires (RCSR). Deux patients se sont retirés du programme pour des raisons personnelles.

Les patients ont rempli un Questionnaire sur les besoins d’information sur les poumons (questionnaire LINQ) avant et après leur participation au programme qui servait à déterminer quels étaient leurs besoins perçus avant et après le programme dans six domaines différents : usage du tabac, autogestion, connaissance de la maladie, diète et exercice. Échelle de notation : 0 - 25. Plus la note est élevée, plus le besoin d’apprentissage perçu est grand. L’écart moyen jugé cliniquement intéressant était d’un point. Tous les patients ont rempli un questionnaire d’évaluation post-programme provenant de la trousse d’outils MPOC et ont échangé sur les leçons apprises en réadaptation.

CONCLUSIONS
Avant d’entreprendre le programme, les patients connaissaient le nom de leur état, mais leur besoin le plus important avait trait à l’autogestion. Vingt pour cent seulement disposaient d’instructions écrites sur la façon de réagir en cas d’aggravation de l’essoufflement. Après l’autogestion, le besoin d’éducation le plus important portait sur l’exercice, suivi par la connaissance de la maladie, la diète et les médicaments. L’usage du tabac a reçu une note de zéro puisque tous les participants étaient d’ex-fumeurs. Les utilisateurs de la trousse à outils ont acheminé des informations sur la façon de réduire l’utilisation des services de santé. Au contenu de la boîte à outils, le programme d’éducation en RP de St. Clare’s a ajouté une séance additionnelle sur les soutiens financiers applicables. Le manque de ressources financières ou l’ignorance des ressources potentielles offertes peut empêcher certains patients de mettre en application ce qu’ils ont appris. Le personnel de RP dans la région de l’Est partage son expérience à mieux gérer leur situation malgré l’inaccessibilité des soins de réadaptation dans les régions rurales éloignées. Un réseau régional d’éducateurs en MPOC ou d’autres professionnels de la santé, de concert avec Télésanté ou une autre technologie, pourrait constituer une avenue pour la distribution de l’information sur l’autogestion de la MPOC.

APPLICATION
Chacun des participants au programme de RP de St. Clare’s reçoit maintenant un plan d’action écrit de la Société canadienne de thoracologie. La SCT recommande l’utilisation de l’éducation à l’autogestion et des plans d’action écrits comme moyens de réduire l’utilisation des services de santé. Au contenu de la boîte à outils, le programme d’éducation en RP de St. Clare’s a ajouté une séance additionnelle sur les soutiens financiers applicables. Le manque de ressources financières ou l’ignorance des ressources potentielles offertes peut empêcher certains patients de mettre en application ce qu’ils ont appris. Le personnel de RP dans la région de l’Est partage son expérience avec les autres fournisseurs de soins de santé de la province et les autorités régionales de la santé désireux d’offrir des services d’éducation à la MPOC ou de réadaptation pulmonaire.

Notes moyenne 

<table>
<thead>
<tr>
<th></th>
<th>Avant</th>
<th>Après</th>
<th>Écart cliniquement important Δ = 1+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autogestion</td>
<td>3</td>
<td>2,4</td>
<td>Δ = 0,6</td>
</tr>
<tr>
<td>Exercice</td>
<td>2,1</td>
<td>1,0</td>
<td>Δ = 1,2</td>
</tr>
<tr>
<td>Connaissance de la maladie</td>
<td>1,4</td>
<td>0,6</td>
<td>Δ = 0,8</td>
</tr>
<tr>
<td>Diète</td>
<td>1,0</td>
<td>0,6</td>
<td>Δ = 0,4</td>
</tr>
<tr>
<td>Médicaments</td>
<td>1</td>
<td>0</td>
<td>Δ = 1,0</td>
</tr>
<tr>
<td>Usage du tabac</td>
<td>0</td>
<td>0</td>
<td>Δ = 0</td>
</tr>
<tr>
<td>Total</td>
<td>8,6</td>
<td>4,6</td>
<td>Δ = 4,0</td>
</tr>
</tbody>
</table>

RÉPERCUSSIONS
La boîte à outils de MPOC est une mesure efficace et conviviale pour fournir de l’information pulmonaire aux patients. Ce pourrait être une option acceptable dans les régions où les programmes formels de réadaptation sont rares ou inexistants. Dans la vaste région sanitaire de l’Est, et peut-être même dans l’ensemble de la province de Terre-Neuve-et-Labrador, ce pourrait être un moyen d’aider les patients atteints de MPOC à mieux gérer leur situation malgré l’inaccessibilité des soins de réadaptation dans les régions rurales éloignées. Un réseau régional d’éducateurs en MPOC ou d’autres professionnels de la santé, de concert avec Télésanté ou une autre technologie, pourrait constituer une avenue pour la dissémination future de l’information sur l’autogestion de la MPOC.

Leçons apprises en réadaptation

- Fixer des objectifs
- Marcher davantage
- Comment établir un rythme
- Je ne sais pas vraiment que l’oxygène était une drogue.
- Je sais mieux comment vivre avec maintenant qu’avant de venir ici.
- Plan d’action en cas de poussée soudaine. Savoir quand et à qui parler. Quand aller à l’hôpital.
- Depuis ce programme, j’ai cessé (de m’apitoyer sur moi-même). J’ai appris à l’accepter (la MPOC).

- Meilleure Affiche -

Fixation des sondes endotrachéales chez les nouveau-nés : une vérification après modification de la pratique

Julia Infantino H.BSc, RRT, Kelly Hassall B.Sc, RRT, FCSRT, Zehra Hemani RRT, Bianca Lee H.BSc, RRT, Nancy Mohammed B.Sc, RRT, Selvi Sittampalam B.Sc, RRT, Prakesh S Shah MSc, MD, FRCPC

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CONTEXTE
Il existe peu de documentation à l’heure actuelle sur les techniques ou dispositifs de maintien en place des sondes endotrachéales chez les nouveau-nés. Il arrive souvent que les extubations non planifiées soient attribuables à un dispositif de retenue mal fixé, ce qui peut obliger la réintubation d’un nouveau-né. L’intubation est stressante, douloureuse, et peut causer un laryngospasme, des changements hémodynamiques, une augmentation de la pression intracrânienne, un traumatisme des voies respiratoires et une sténose sous-glottique.1,2

OBJECTIVE
Comparer le taux d’extubations non planifiées entre deux dispositifs de retenue de sondes endotrachéales dans les soins de niveau III en unité néonatale.

<table>
<thead>
<tr>
<th>Caractéristiques</th>
<th>Ruban adhésif rose et teinture de benjoin</th>
<th>Ruban adhésif blanc et Mastisol</th>
<th>valeur p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gestation</td>
<td>29 ± 5</td>
<td>30 ± 5</td>
<td>0,39</td>
</tr>
<tr>
<td>Poids à la naissance</td>
<td>1427 ± 1025</td>
<td>1489 ± 851</td>
<td>0,77</td>
</tr>
<tr>
<td>Sexe masculin</td>
<td>43 (67 %)</td>
<td>15 (50 %)</td>
<td>0,12</td>
</tr>
<tr>
<td>Notation crib</td>
<td>4,0 ± 2,8</td>
<td>3,2 ± 2,8</td>
<td>0,21</td>
</tr>
<tr>
<td>Anomalies congénitales</td>
<td>7 (11 %)</td>
<td>7 (23 %)</td>
<td>0,13</td>
</tr>
<tr>
<td>Nombre de jours de ventilation</td>
<td>4,4 ± 4,7</td>
<td>5,1 ± 7,0</td>
<td>0,58</td>
</tr>
<tr>
<td>Emplacement de la sonde endotrachéale (nasale)</td>
<td>59/107 (55 %)</td>
<td>24/45 (53 %)</td>
<td>1,00</td>
</tr>
<tr>
<td>Taux d’extubations non planifiées</td>
<td>25/107 (23 %)</td>
<td>4/45 (9 %)</td>
<td>0,04</td>
</tr>
<tr>
<td>Nombre de changements de ruban adhésif</td>
<td>107</td>
<td>45</td>
<td>0,53</td>
</tr>
</tbody>
</table>

RÉSULTATS
64 patients (107 épisodes) étaient en ruban rose et teinture de benjoin alors que 30 patients (45 épisodes) on reçu le ruban adhésif blanc et le Mastisol. Il n’y avait aucune différence dans les données démographiques de base (Tableau 1). Cependant, les épisodes d’extubations non planifiées ont connu une diminution marquée avec le ruban adhésif blanc et le Mastisol (rapport de cotes 0,32, 95 % CI 0,11, 0,94). Le type de ventilation (conventionnelle c. HFOV (ventilation par oscillateur à haute fréquence), la méthode d’intubation (orale ou nasale), le nombre de changement de ruban adhésif et la durée de ventilation n’ont eu aucun effet sur le taux d’extubations non planifiées.

CONCLUSION
Le nombre d’extubations non planifiées chez les nouveau-nés ayant besoin d’une ventilation mécanique a fortement diminué avec l’utilisation du ruban adhésif blanc et du Mastisol.

CONSIDÉRATIONS FUTURES
1. Déterminer si le ruban adhésif blanc, le Mastisol ou la combinaison des deux sont responsables de la baisse du nombre d’extubations non planifiées.
2. Faire un suivi et une comparaison d’autres méthodes de retenue des sondes endotrachéales (p. ex. Neobar, sutures, etc.) afin de déterminer la méthode optimale de retenue des sondes endotrachéales.
3. Examiner l’efficacité d’autres interventions thérapeutiques afin de diminuer le taux d’extubations non planifiées dans les services de soins intensif en néonatalité.

REFERENCES
**Une solution de rechange à la canule de trachéotomie standard**

*Marianne MacKenzie*

**RÉSUMÉ**

Une clinique externe de trachéotomie de Calgary en Alberta utilise des dispositifs de remplacement depuis une quinzaine d’années pour remplacer les canules de trachéotomie standards chez les patients qui ont un trachéotomie de longue durée. L’un des buts visés par le personnel de la clinique était de trouver un dispositif qui minimiseraient les complications liées à la vie avec une canule de trachéotomie. Parmi les dispositifs mis à l’essai, l’endoprothèse pour trachéotomies est celle qui a le mieux répondu aux besoins des patients. Deux styles, la canule Montgomery et l’endoprothèse Hood, ont été implantés ensemble chez 73 patients nécessitant une trachéotomie de longue durée pour différents problèmes médicaux. Ces patients indiquent que l’endoprothèse améliore le volume de la voix, est moins encombrante, moins visibles pour les autres et beaucoup mieux adaptée aux milieux de travail. Les contre-indications à l’usage sont abordées ainsi que les raisons pour lesquelles certains patients choisissent de revenir à la canule de trachéotomie standard.

**Détermination des obstacles à la pratique clinique du sevrage de la trachéotomie et de la décanulation des patients**

*Marianne Ng*

**INTRODUCTION**

On estime que 10 pour 100 des patients gravement malades ventilés mécaniquement doivent avoir un tube de trachéostomie. Un tube mis en place pendant une longue période expose les patients à des complications, dont la sténose trachéale, les saignements, les fistules, les infections et l’aspiration.

Il est essentiel de recenser les obstacles aux pratiques et méthodes cliniques pour faire progresser les soins des patients par le biais de la collaboration interprofessionnelle. Une fois les obstacles recensés, on peut obtenir de plus amples connaissances et compétences par la formation ou la mise en place de processus servant à vaincre les obstacles. La gestion efficace de la trachéotomie constitue un élément clé des soins axés sur le patient, l’utilisation efficace des ressources et la minimisation des coûts médicaux par la réduction des réadmissions à l’urgence; de plus, elle permet une meilleure planification des congés des patients.

**OBJECTIFS**

Recenser les obstacles à la gestion de la trachéotomie au sein des équipes multidisciplinaires en examinant les méthodes, le degré de connaissances et les procédés de communication en matière de sevrage de trachéotomie et de décanulation.
MÉTHODE
On a créé et diffusé un questionnaire électronique pour recueillir de l’information quantitative et qualitative concernant les soins de trachéostomie actuels et les méthodes de sevrage et de décanulation. Les membres des équipes multidisciplinaires sondés étaient les thérapeutes respiratoires, les infirmiers et infirmières, les physiothérapeutes et les orthophonistes (n=66). Le questionnaire servait à examiner trois éléments, soit le degré de connaissances, les méthodes utilisées et les méthodes de communication. L’enquête a été menée du 1er novembre 2008 au 15 mars 2009.

RÉSULTATS
On peut diviser les résultats en trois catégories : connaissances, formation et communication.

Dans l’ensemble, les répondants ont été exposés aux différents types de canules et étaient en mesure de les distinguer. On a constaté un écart de connaissances dans la pratique de l’installation de bouchon et du changement des tubes de trachéostomie au moment de la décanulation. Les résultats indiquaient que 18 pour 100 des répondants ont injustement pensé qu’il était acceptable de poser un bouchon avec un ballonnet et que 11 pour 100 ont incorrectement mentionné qu’une infirmière autorisée peut changer un tube de trachéostomie. Nous avons également constaté un manque d’uniformité chez les praticiens en ce qui a trait au nombre d’heures requises pour installer un bouchon avant la décanulation, 5,1 pour 100 mentionnant moins de 24 heures, 18,6 pour 100, 24 heures, 49,2 pour 100 %, 48 heures et 27,1 pour 100, plus de 48 heures. La communication entre les membres d’une équipe multidisciplinaire est un élément important pour faciliter le sevrage et la décanulation des patients. Chez les physiothérapeutes, les TR, les infirmières autorisées et les orthophonistes, la plupart ont indiqué utiliser les notes ou la communication verbale pour diffuser de l’information au sein de l’équipe. On remarque que les infirmières autorisées font partie du groupe qui participe le plus quotidiennement à la surveillance en médecine interne générale.

CONCLUSION
On n’a pas relevé de différences entre les groupes professionnels en ce qui a trait aux facteurs déterminants chez les patients servant à décider d’effectuer la décanulation à la suite d’une trachéostomie. Les résultats démontrent également qu’il n’existe pas d’indications ou de facteurs clairs pour déterminer que le patient est prêt à la décanulation.

À partir de ces résultats, on constate le besoin de formation sur les divers types de tubes de trachéostomie et les effets cliniques. Il faut aussi insister sur les questions de sécurité concernant l’installation de bouchons et les pratiques de décanulation. Les méthodes non uniformes de communication entre les professions peuvent donner lieu à des retard de décanulation. Les algorithmes des soins de trachéostomie peuvent faciliter la standardisation de la communication et des soins des patients.

Soins chirurgicaux durant les récentes crises : que nous disent les données?
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CONTEXTE
Les soins chirurgicaux humanitaires sont souvent organisés et fournis dans des délais très courts et sans beaucoup de temps pour l’élaboration de stratégies uniques de soins. Pour ces raisons, les fournisseurs de soins chirurgicaux humanitaires doivent tirer parti de la connaissance collective acquise durant les crises antérieures. Bien que certaines pathologies chirurgicales puissent être anticipées du fait de la nature de la crise, le rôle des équipes médicales étrangères (EME) dans le traitement de la charge existante et non traitée de maladies chirurgicale n’est pas clair.

MÉTHODOLOGIE

CONCLUSIONS
Onze articles répondant aux critères d’inclusion ont été retrouvés. La méthode de présentation des activités chirurgicales varie largement entre les articles de sorte qu’une analyse statistique regroupée n’a pas été possible. L’analyse quantitative des études révèle que les procédures les plus fréquentes étaient généralement reliées aux tissus mous ou à l’orthopédie, mais qu’à mesure que la durée de période de rapport augmentait, la charge de travail chirurgicale reflétait davantage un fardeau non assumé de maladie chirurgicale. Toutes les études incluses signalent un nombre significatif de procédures comme les césariennes, la réparation de hernies et les appendicectomies, tous des situations sans lien avec la crise.
INTERPRÉTATION
Notre examen donne à penser que lorsque la présence d'EME est indiquée et requise, le recours à des équipes chirurgicales multidisciplinaires capables d'offrir une gamme de services essentiels et d'urgence en chirurgie et en réadaptation devrait être favorisé par opposition à des équipes qui ne peuvent offrir que des services limités. D'autres études seront nécessaires pour examiner le fardeau des maladies chirurgicales selon le niveau de population dans les populations frappées par des crises.

FINANCEMENT

MÉTHODOLOGIE
Une recherche documentaire a été effectuée afin de déterminer les étapes chronologiques suivies dans la planification et la gestion de la pandémie, et pour élucider l’efficacité de la contention de la propagation virale. Les banques de données PubMed, CINAHL et The Cochrane Library ont fait l’objet d’une recherche selon les mots-clés suivants : HG1N1, Influenza A, grippe porcine, contrôle de l’infection, prévention des infections, planification de pandémie et équipement de protection personnel.

RÉSULTATS
Soixante-treize articles portant sur le sujet ont été recensés. On a conclu qu’aucune méthode employée seule ne permettait d’obtenir une protection absolue, mais qu’elles pouvaient, lorsqu’utilisées en combinaison, aider à diminuer la propagation de la pandémie.

DISCUSSION
Le virus H1N1 a lui-même contribué à ralentir la pandémie en ne se réassortissant pas sous une forme plus virulente. La communauté mondiale a fait tout ce qu’elle pouvait pour ralentir la propagation du virus H1N1. En rétrospective, nous avons appris beaucoup de choses sur les points faibles de notre système, y compris la mobilisation des ressources et le manque de personnel, d’équipement et de financement adéquats. Une préoccupation importante était l’absence de directives normalisées d’un organisme reconnu donnant des directives détaillées sur le confinement de l’influenza, en plus de faire en sorte que les pays les plus pauvres soient outillés pour faire face aux pandémies. D’autres recherches visant à déterminer quelles sont les stratégies les plus efficaces et devraient être appliquées pour lutter contre les poussées de pandémie à un niveau permettant de les prévenir.

ASSOCIATION ENTRE L’INDICE DE MASSE CORPORELLE ET L’OBSTRUCTION DES VOIES RESPIRATOIRES : IMPLICATIONS POUR LE DIAGNOSTIC DIFFÉRENTIEL INEXACT DE L’ASTHME CHEZ LES PERSONNES OBÈSES.

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INTRODUCTION
Certains chercheurs ont signalé une association entre l’obésité et l’asthme, avec des disparités entre les hommes et les femmes dans cette association qui n’ont pas été entièrement expliquées. Les études portant sur cette association n’ont généralement pas relevé l’asthme selon des méthodes diagnostiques...
OBJECTIF
Cette étude a examiné les liens, incluant les différences liées au sexe, entre l’obésité et l’obstruction des voies respiratoires chez les personnes non asthmatiques identifiées par les protocoles spirométriques.

MÉTHODOLOGIE
Les résultats des tests de fonction pulmonaire pour les sujets non asthmatiques ont été examinés. L’analyse statistique a été utilisée pour déterminer l’association entre les mesures de fonction pulmonaire et l’IMC.

RÉSULTATS
Des écarts significatifs, en pourcentage des prévisions, ont été mesurés dans les valeurs de fonction pulmonaire entre les plages d’IMC, incluant FVC (p < 0,001), FEV1/FVC (p < 0,001), et FEF50% (p < 0,02). Des écarts entre les sexes apparaissent dans FVC, FEV1, FEV1/FVC, FEF25% et FEF50% (dans tous les cas, p < 0,001). Lorsqu’on tient compte de l’âge et du statut de fumeur, les différences entre les sexes subsistent dans la distribution des effets de l’IMC sur la FVC. La FVC est progressivement compromise chez les sujets féminins à mesure que l’IMC augmente au-delà de la plage normale (≥ 25 kg/m²) et diminue chez les sujets masculins présentant un IMC de ≥ 30 kg/m².

CONCLUSIONS
Aucune association claire n’a été établie entre les indices d’obstruction des voies respiratoires et l’augmentation de l’IMC dans ce groupe de non asthmatiques. Les conclusions de l’étude semblent présenter un profil de restriction de la fonction respiratoire chez les personnes obèses propre aux non asthmatiques et unique à chaque sexe. Les effets négatifs de l’augmentation de l’adiposité sur la FVC peuvent apparaître à un IMC plus faible chez la femme que chez l’homme.

Mots-clés : Obstruction des voies respiratoires; Asthme; Indice de masse corporelle; Obésité; Examens fonctionnels respiratoires

1) Answer: False
Explanation: The cycle variable determines when the breath is terminated, the trigger variable determines when the breath is triggered.

2) Answer: False
Explanation: Presence of trigger delay although detrimental in most clinical situations the presence of trigger delay may give rise to a short or prolonged expiratory time and decrease neural expiratory time.

3) Answer: E
Explanation: The evaluation of patient-ventilator asynchrony can also be subdivided into four phases. These phases consist of triggering, flow delivery, breath termination, and the effects of PEEPi.

4) Answer: B
Explanation: Work of breathing can be subdivided into the work necessary to overcome the resistive, elastic, and inertial components and the work to move the chest wall and intestinal organs. Spontaneous breathing results in active contraction of the respiratory muscles resulting in expansion of the thoracic compartment with a subsequent decrease in pleural pressure.

5) Answer: B
Explanation: Work of breathing can be subdivided into the work necessary to overcome the resistive, elastic, and inertial components and the work to move the chest wall and intestinal organs. Spontaneous breathing results in active contraction of the respiratory muscles resulting in expansion of the thoracic compartment with a subsequent decrease in pleural pressure.

6) Answer: True
Explanation: Asynchrony is the failure of patient and ventilator to act in harmony. Trigger asynchrony occurs in the trigger phase and is characterized by effort by the patient with ventilator response.

7) Answer: False
Explanation: Changes in the flow signal can be caused by the patient’s cardiac oscillations and is not always evidence of ineffective effort by the patient.

8) Answer: True
Explanation: Because WOB is the sum of the work performed by the ventilator and the work performed by the patient, reduction in ventilator support or work will reduce the level of support.

9) Answer: C
Explanation: During pressure support ventilation inspiration is terminated by one of 3 mechanisms. The primary method is a decrease in flow. The second is a rise in pressure above the target setting. The third is inspiratory time exceeding a specific maximum duration. Flow can continue even when inspiratory effort is terminated, this is especially true when there is evidence of a leak around the endotracheal tube.

10) Answer: True
Explanation: Expiratory asynchrony occurs when there is no response from the ventilator resulting in a short or prolonged expiratory time.

11) Answer: False
Explanation: It is true that it is desirable to decrease the patients work of breathing but during mechanical ventilation the goal is to assist respiratory muscle activity and thus reduce the WOB but not to entirely relieve it.

12) Answer: False
Explanation: An example of this interplay resulting in a misinterpretation by the clinician is demonstrated in a patient with decreasing levels of pressure support with the concomitant reduction in VT and inspiratory flow. These changes cause a reflex feedback to increase neural inspiratory time and decrease neural expiratory time to a greater extent, resulting in an increase in breathing frequency. The resultant increase in respiratory rate may be interpreted by the clinician as intolerance by the patient to the attempt to wean ventilator support, and thus delay further weaning by the clinician.
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