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Clinical Uses:
NUCALA™ should be reconstituted and administered by a qualified healthcare professional who is experienced in the monitoring of signs and symptoms of hypersensitivity after administration of biologic agents and prepared to manage anaphylaxis that can be life-threatening. There is limited safety and efficacy experience with NUCALA™ in patients >65 years of age.

Relevant Warnings and Precautions:
- Hypersensitivity and Administration-Related Reactions: acute and delayed systemic reactions, including hypersensitivity reactions (e.g., urticaria, angioedema, rash, bronchospasm, hypotension), have occurred following administration of NUCALA™.
- NUCALA™ should not be used to treat acute asthma exacerbations.
- Asthma-related adverse events or exacerbations may occur during treatment. Patients should be advised to seek medical advice if their asthma remains uncontrolled or worsens after initiation of therapy.
- Abrupt discontinuation of corticosteroids after initiation of treatment with NUCALA™ is not recommended. Reductions in corticosteroid doses, if required, should be gradual and performed under the supervision of a physician.
- Parasitic infections: patients with pre-existing helminth infections should be treated for their infection prior to therapy with NUCALA™. If patients become infected whilst receiving treatment with NUCALA™ and do not respond to recommended anti-helminth treatment, temporary discontinuation of NUCALA™ should be considered.
- Herpes Zoster: Consider varicella vaccination if medically appropriate prior to starting therapy with NUCALA™.
- Use during pregnancy should only occur if the potential benefit justifies the potential risk. Women should be advised to contact their physicians if they become pregnant while receiving NUCALA™ and for up to 4 months after treatment is stopped. Healthcare professionals are encouraged to register patients, and pregnant women are encouraged to enroll themselves in the NUCALA™ pregnancy registry to monitor maternal-fetal outcomes.
- In nursing women, a decision should be made to discontinue breastfeeding or discontinue NUCALA™.

Adverse Events:
Adverse drug reactions include headache (very common; >10%) and pharyngitis, lower respiratory tract infection, urinary tract infection, nasal congestion, upper abdominal pain, eczema, back pain, pyrexia and injection site reactions (all common; 1% to <10%).

Recommended Dose:
- NUCALA™ is a fixed dose of 100 mg mepolizumab administered subcutaneously once every 4 weeks.

Dosing Considerations:
- Do not shake the solution during reconstitution or administration as this could lead to foaming or precipitation.
- No dosage adjustment is required in patients over 65 years of age. Dosage adjustments in patients with renal or hepatic impairment are unlikely to be required.

For More Information:
Please consult the Product Monograph at http://www.gsk.ca/nucala/en for important information relating to adverse reactions, drug interactions, and dosing information, which have not been discussed in this piece. The Product Monograph is also available by calling 1-800-387-7374. To report an adverse event, please call 1-800-387-7374.

IL-5 = Interleukin 5
*Comparative clinical significance has not been established.
†MENSA, a 24-week, multicentre, randomised, double-blind, placebo-controlled, parallel-group study comparing the efficacy and safety of NUCALA™100 mg SC and mepolizumab 75 mg IVs, placebo in the add-on treatment of severe eosinophilic asthma. All patients received maintenance therapy: high-dose ICS plus additional controller(s), with or without OCS. (N=396). Mepolizumab 75 mg IV is not available in Canada. NUCALA™ should only be administered by the SC route.
‡Clinically significant eosinophilic bronchospasm was defined as worsening of asthma requiring use of oral/systemic corticosteroids and/or hospitalization and/or ER visits. For subjects on maintenance OCS, an exacerbation requiring OCS was defined as the use of oral/systemic corticosteroids ≤1.5× the existing dose for ≥3 days.

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- NUCALA™ reduced the rate of clinically significant exacerbations by 53% vs. placebo++ (NUCALA™: 0.83/year, placebo: 1.74/year; rate ratio: 0.47; p<0.001).

- Adverse drug reactions (events considered to be possibly related to treatment with mepolizumab) identified following evaluation of all data from 3 randomized, placebo-controlled trials of mepolizumab include headache (very common, >1/10); and pharyngitis, lower respiratory tract infection, urinary tract infection, nasal congestion, upper abdominal pain, eczema, back pain, pyrexia and injection site reactions (all common, >1/100 to <1/10).†
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INTRODUCING AN ASTHMA TREATMENT SHOWN TO IMPROVE LUNG FUNCTION (FEV₁) DAY & NIGHT

BREO® ELLIPTA® 100/25 mcg provided improvements in FEV₁ vs. placebo that were sustained over 24 hours at week 12, as demonstrated by serial FEV₁ measurements taken at 5, 15, and 30 minutes and 1, 2, 3, 4, 5, 12, 16, 20, 23, and 24 hours.1,2

BREO® ELLIPTA® 200/25 mcg demonstrated improvements in FEV₁ vs. an ICS (fluticasone furoate 200 mcg) that were sustained over 24 hours at week 24, as demonstrated by serial FEV₁ measurements taken at 5, 15, and 30 minutes and 1, 2, 3, 4, 5, 12, 16, 20, 23, and 24 hours.3,4

BREO® ELLIPTA® (fluticasone furoate/vilanterol) 100/25 mcg and BREO® ELLIPTA® 200/25 mcg are indicated for the once-daily maintenance treatment of asthma in patients aged 18 years and older with reversible obstructive airways disease.

BREO® ELLIPTA® is not indicated for patients whose asthma can be managed by occasional use of a rapid onset, short duration, inhaled beta-agonist or for patients whose asthma can be successfully managed by inhaled corticosteroids along with occasional use of a rapid onset, short duration, inhaled beta-agonist.

BREO® ELLIPTA® is not indicated for the relief of acute bronchospasm. BREO® ELLIPTA® 200/25 mcg is not indicated for COPD.

* ICS=inhaled corticosteroid; LABA=long-acting beta, adrenergic agonist
** A 12-week, treatment, multi-center, randomized, double-blind, placebo controlled, parallel group study to compare the efficacy and safety of BREO® ELLIPTA® 100/25 mcg, fluticasone furoate 100 mcg, and placebo administered once daily in the evening in subjects with persistent bronchial asthma (NCT01656128)
1 ITT population, FEV₁ data included BREO® ELLIPTA® vs. placebo, respectively: Smoker: 455 vs. 424, 516 vs. 475, 305 vs. 290, 12h: 546 vs. 237, 24h: 616 vs. 244, 30min: 530 vs. 298, 45min: 537 vs. 217, 15min: 538 vs. 227, 12h: 494 vs. 176, 16h: 530 vs. 245, 30min: 428 vs. 238, 24h: 571 vs. 227, 30h: 508 vs. 290
2 A 24-week treatment, multi-center, randomized, double-blind, parallel group study to compare the efficacy and safety of BREO® ELLIPTA® 200/25 mcg administered once daily each evening with 200 mcg of fluticasone furoate administered once daily each evening and fluticasone propionate 500/50 mcg administered twice daily in subjects with persistent asthma (NCT01656128)
3 ITT population, FEV₁ data included, BREO® ELLIPTA® vs. Flut 200 mcg, respectively: Smoker: 469 vs. 372, 15min: 666 vs. 388, 30min: 472 vs. 348, 12h: 513 vs. 343, 24h: 535 vs. 395, 30min: 530 vs. 340, 45min: 518 vs. 310, 30h: 487 vs. 351, 12h: 541 vs. 324, 16h: 476 vs. 322, 24h: 464 vs. 335, 24h: 464 vs. 373, 48h: 468 vs. 372
Contraindications:
- Patients with severe hypersensitivity to milk proteins.
- In the primary treatment of status asthmaticus or other acute episodes of asthma.

Most Serious Warnings and Precautions:
- **ASTHMA-RELATED DEATH:** Long-acting beta-adrenergic agonists (LABA), such as vilanterol, increase the risk of asthma-related death. Physicians should only prescribe BREO® ELLIPTA® for patients not adequately controlled on a long-term asthma control medication, such as an inhaled corticosteroid, or whose disease severity clearly warrants initiation of treatment with both an inhaled corticosteroid and a LABA. Once asthma control is achieved and maintained, assess the patient at regular intervals and do not use BREO® ELLIPTA® for patients whose asthma can be adequately controlled on low- or medium-dose inhaled corticosteroids.

Other Relevant Warnings and Precautions:
- BREO® ELLIPTA® should not be used for the relief of acute symptoms of asthma (i.e., as rescue therapy for the treatment of acute episodes of bronchospasm).
- Patients who have been taking a rapid-onset, short duration, inhaled bronchodilator on a regular basis (e.g., q.i.d.) should be instructed to discontinue the regular use of these drugs and use them only for symptomatic relief if they develop acute symptoms while taking BREO® ELLIPTA®.
- BREO® ELLIPTA® should not be initiated in patients with acutely deteriorating asthma, which may be a life-threatening condition.
- Exacerbations may occur during treatment. Patients should be advised to continue treatment and seek medical advice if symptoms remain uncontrolled or worsen after initiation of therapy.
- BREO® ELLIPTA® should not be used more often than recommended, at higher doses than recommended, or in conjunction with other medicines containing a LABA, as an overdose may result.
- Caution in patients with cardiovascular disease: vilanterol can produce clinically significant cardiovascular effects in some patients as measured by an increase in pulse rate, systolic or diastolic blood pressure, or cardiac arrhythmias such as supraventricular tachycardia and extrasystoles. In healthy subjects receiving steady-state treatment of up to 4 times the recommended dose of vilanterol (representing a 10-fold higher systemic exposure than seen in patients with asthma), inhaled fluticasone furoate/vilanterol was associated with dose-dependent increases in heart rate and QTc prolongation. Use with caution in patients with severe cardiovascular disease, especially coronary insufficiency, cardiac arrhythmias (including tachyarrhythmias), hypokalemia, a known history of QTc prolongation, risk factors for torsade de pointes (e.g., hypokalemia), or patients taking medications known to prolong the QTc interval.
- Effects on Ear/Nose/Throat: localized infections of the mouth and pharynx with Candida albicans have occurred.
- Endocrine and Metabolic Effects: possible systemic effects include Cushing's syndrome, Cushingoid features, HPA axis suppression, growth retardation in children and adolescents, decrease in bone mineral density.
- Hypercortisolemia and adrenal suppression (including adrenal crisis) may appear in a small number of patients who are sensitive to these effects.
- Adrenal insufficiency: particular care should be taken in patients transferred from systemically active corticosteroids because death due to adrenal insufficiency has occurred during and after transfer to less systemically available inhaled corticosteroids.
- Bone Effects: decreases in BMD have been observed with long-term administration of products containing inhaled corticosteroids.
- Effect on Growth: orally inhaled corticosteroids may cause a reduction in growth velocity when administered to children and adolescents.
- Monitoring recommendations: serum potassium levels should be monitored in patients predisposed to low levels of serum potassium. Due to the hyperglycemic effect observed with other beta-agonists, additional blood glucose monitoring is recommended in diabetic patients. Monitoring of bone and ocular effects (cataract and glaucoma) should be considered in patients receiving maintenance therapy. Patients with hepatic impairment should be monitored for corticosteroid effects due to potentially increased systemic exposure of fluticasone furoate.
- Use with caution in patients with convulsive disorders or thyrotoxicosis and in those who are unusually responsive to sympathomimetic amines.
- Hematologic Effects: may present with systemic eosinophilic conditions, with some patients presenting clinical features of vasculitis consistent with Churg-Strauss syndrome. Physicians should be alerted to eosinophilia, vasculitic rash, worsening pulmonary symptoms, cardiac complications, and/or myocarditis presenting in their patients.
- Hypersensitivity effects: immediate hypersensitivity reactions have occurred after administration, and patients should not be re-challenged with BREO® ELLIPTA® if it is identified. The following are reports of anaphylactic reactions in patients with severe milk protein allergy with other inhaled dry powder drug products containing lactose.
I want to begin what will be my last message as Editor-in-Chief by saying a simple “thanks” to everyone who has worked so very hard to make our Journal what it is today—our Editors, Peer Reviewers, Authors, Editorial Board, and Managing Editor have done a tremendous job in bringing the journal to where we are, and for that I will be forever grateful. Thank you.

There are certain liberties afforded to the Editor-in-Chief, one of them being the ability to write and publish editorials on topics of personal interest or concern and a certain creative license to try and push new ideas for how the profession and the journal can bring the best care possible to our patients and deliver needed improvements to our health care systems. I want to share some reflections to help guide the next generation of leaders within the profession: some of you may be students, some of you may be mid-career respiratory therapists, and others with decades of experience and expertise may be looking for a new challenge. The point is not where in your career you are, it is about what challenges you are willing to take on, how reflexive and responsive you can be in adapting to and promoting new ideas, and how truly reflective you can be about your professional practice and the role of respiratory therapists in driving innovation in our health systems and the best possible care for our patients.

As respiratory therapists, we are given a tremendous privilege to sit with our patients and their families, often during times of crisis. We are one of the few professions who, upon entry into practice, are afforded the opportunity to work with some of the sickest patients in Canada, a responsibility that demands not only a clinical acumen but also the ability to empathise and reflect on issues that confront our senses and ethics. This is a heavy burden, but I truly believe that it is a privilege to be invited to play such a seminal role in a person and a family’s life, and one that none of us takes lightly. My advice here is to reflect not only on what immediately confronts you in a visceral sense, and to situate your understanding of our patients not only in the context of their medical needs, but also in the moral and social worlds that they create and that influence them and their health. Sit with your patients, learn from them and their families, and use this knowledge to drive change socially, politically, and morally—wherever you might find it—in meaningful ways. To be able to use that to influence the care that you provide and to shape the policies and practices that have importance to you, your patients, and your community. Do not settle for what is easy or comfortable. Confront the obstacles. Understand the challenges of life in a rural community, for Canada’s indigenous people, for the homeless, for immigrants and refugees, for people who use drugs, for people in low- and middle-income countries. Hear their stories and find ways to work with them to improve their health and the systems that we all depend on. Keep exploring.

I want to thank you all for allowing me to embark on this journey as Editor-in-Chief. I have learned so much about what it truly means to be a respiratory therapist over these years. It has been a fascinating opportunity to learn from you and to work with you to build capacity in our profession to research and understand respiratory health in Canada and around the world. This profession has a tremendous number of people with immense talent that I know are doing important things—thank you for allowing me to have been a part of that.

Jason W Nickerson RRT FCSRT PhD, Editor-in-Chief

Quality improvement rejects the idea that “better” is the enemy of “good enough”. Our profession and our patients demand more, and it is incumbent upon us to work toward delivering not only the highest quality patient care, but also the best health systems that balance prevention with reaction and the policy frameworks that ensure the benefits of health innovations are shared equitably among all members of our population. To that end, I challenge you to reject the apathy that too often creeps into professional lives and allows us to settle into care patterns or systems that are comfortable, but unambitious. Be part of something that is bigger than yourself, your department, or your profession and change things for the better. Challenge the world and be bloody-minded when the situation demands it, but be driven by purpose.

Finally, while much of the clinical work that we do as respiratory therapists takes place in a hospital, our patients’ lives take place largely outside of these walls. Their health, families, friends, and moral and social worlds all exist beyond the boundaries of our hospital, and to understand the true social determinants of our patients’ health, we have to bring respiratory therapy to the community. This is not solely about engaging respiratory therapists in primary care or community care; it is about pushing ourselves and our profession to understand and engage the communities where we work and what influences the options and choices that our patients are able to make. The world is a very big, interesting place—understand as much of it as you can and use that to influence the care that you provide and to shape the policies and practices that have importance to you, your patients, and your community. Do not settle for what is easy or comfortable. Confront the obstacles. Understand the challenges of life in a rural community, for Canada’s indigenous people, for the homeless, for immigrants and refugees, for people who use drugs, for people in low- and middle-income countries. Hear their stories and find ways to work with them to improve their health and the systems that we all depend on. Keep exploring.

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We’re not making evidence-based decisions: Introducing a tool to assess strengths and weaknesses in healthcare providers

Kathleen F Spurr BSc RRT MHI FCSRT1, Kelly Lackie PhD RN2, Robert Gilbert PhD (Pharm)3

In an ideal world, respiratory therapists (RTs) would use the evidence-based decision-making (EBDM) process to identify, appraise, and integrate new research evidence with clinical expertise and patient values to optimize patient care [1]. Competence in this process is essential to the development of best practices, programs, policies, services, and clinical practice guidelines that are current, evidence-based, maximally effective, and affordable. Lack of knowledge of the EBDM process or failure to apply it in practice may lead to the delivery of suboptimal or even ineffective treatment, poor patient outcomes, provision of unnecessarily expensive services, and decreased patient quality of life [2, 3].

The need for EBDM competency is justified with the explosion of new knowledge pertaining to respiratory care in recent years and the challenges respiratory care professionals have faced in integrating this knowledge into practice quickly [4]. To demonstrate the challenges we face, one only needs to consider that since 2006 there have been approximately 30,000 English, peer-reviewed published studies pertaining to mechanical ventilation. It is not acceptable or realistic to rely solely on the sporadic and limited efforts of external bodies (societies, academics) to translate such knowledge for us. In fact, the timely closing of knowledge gaps requires the collective effort of all respiratory care providers. The judicious integration of emerging knowledge transforms the way in which we care for individuals affected by respiratory disorders. Therefore, the more people we support in becoming proficient and confident in EBDM, the easier it will become to achieve our goals of timely, safe, and efficient integration of new knowledge into our practices.

There are significant gaps between what we know (best available evidence) and what we do (clinical practice) [4]. EBDM is an entry level competency for today’s graduate RT; however, the majority of current practicing RTs were educated prior to this becoming a requirement and therefore, did not receive education in all components of the EBDM process. Consequently, many RTs do not possess comprehensive knowledge and skills (i.e., the ability and confidence to find, appraise, integrate, and implement new knowledge into practice) required of EBDM practice [5–8]. To support RTs in attaining full EBDM competency, we first need a better understanding of where their shortcomings are. To facilitate such understanding, a tool for assessing comprehension of the EBDM process (Halifax ACE Tool) for practicing healthcare professionals has been created [8].

The Halifax ACE tool, developed using a Delphi process, consists of 26 multiple-choice questions evaluating understanding of the five components of EBDM: (i) developing a clinical question, (ii) developing and implementing an appropriate search strategy for finding knowledge specific to the clinical question, (iii) identifying sources of evidence (internal and external), (iv) appraising knowledge for its validity and appropriateness to the clinical question, and (v) integrating (synthesizing) evidence. Knowledge and use of EBDM was then evaluated through pilot testing with individual healthcare providers from six different professions, including respiratory therapy. This work demonstrated a need for knowledge and skill development in various components of EBDM across these healthcare professions.

Having established content validity, the Halifax ACE Tool provides an opportunity for RTs wanting to assess their EBDM knowledge and skills. It is also a resource to support organizations (i.e., regulatory bodies, government, and healthcare institutions) in the creation of continuing education programs that support the development of EBDM competency across the health professions. By improving RTs’ confidence and ability in the EBDM process, knowledge-to-practice gaps will be reduced. The Halifax ACE tool and resources for supporting the development of EBDM skills in practising professionals are available for free of charge. These resources can be accessed by contacting the authors.

REFERENCES

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A partnership for Indigenous knowledge translation: Implementation of a First Nations community COPD screening day

Cory Leanne Bendall BHSc (RT) MPH (HP)1,2, Danielle Marie Wilson MPH2, Kelly Rose Frison BHSc (RT)2, Jessica Ann Inskip PhD3,4, Pat G Camp BSc(PT) PhD3,4,5

ABSTRACT

This article suggests a method for integrating the principles of Aboriginal knowledge translation (KT) in the implementation of a pilot for chronic obstructive pulmonary disease (COPD) screening to improve current practice and provide health programming that is culturally sensitive and relevant. The elements of the Consolidated Framework for Implementation Research model guided a community informed design for the Lung Health Day that was planned with two communities of the Secwepemc Nation in British Columbia. By integrating the principles of Aboriginal KT, program implementation design can address the current disparities in respiratory care and management of COPD and improve the health status of First Nations patients.

Key Words: Aboriginal health; First Nations; knowledge translation; knowledge exchange; implementation; chronic obstructive pulmonary disease

INTRODUCTION

Smoking is the primary cause of chronic obstructive pulmonary disease (COPD) in Canada [2]. The prevalence of smoking in the Aboriginal population is almost twice as high as the non-Aboriginal population (39% vs. 20.5%, respectively) [3]. As a result, Aboriginal Canadians shoulder a large burden of health-related illness due to the effects of smoking [2, 4–6]. Ospina et al. [2] recently reported a higher incidence of new cases of COPD among a First Nations cohort compared to a non-First Nations comparison group (incidence rate ratio of 2.1; 95% CI; 1.97, 2.27). Correspondingly, in their study the prevalence of COPD in the First Nations population was approximately 2.4 times higher than the non-First Nations cohort [2]. There is an increased need for COPD-related health services in First Nations communities; however, services are either not available or are not accessed by this population [6]. Therefore, more effective programming is required to address the lung health needs of First Nations communities in Canada.

Many Aboriginal people have experienced, and continue to experience, cultural alienation and multi-generational trauma from residential school incarceration [7]. Economic and political marginalization and racism also erode resiliency and the ability to maintain health and well-being [7]. Thus the residual aspects of colonization magnify the impact of key social determinants of health. Financial need, food insecurity, reduced educational opportunities, social isolation, and poor housing conditions potentiate the COPD risk factors of tobacco use and childhood exposure to second-hand smoke in the Aboriginal population [2]. Research completed by the Wellesley Institute [8] details systemic racism in the Canadian health system. This is supported by the findings of the Truth and Reconciliation Commission where all levels of government are asked “...to acknowledge that the current state of Aboriginal health in Canada is a direct result of previous Canadian government policies including residential schools...” [9, p. 2]. The Indigenous population has current and historical health care experiences that mirror the previous trauma and neglect of institutional care (including residential schools and child welfare practices) [9]. These experiences reduce individual confidence in the care they receive and may create reluctance to seek treatment [9].

Aboriginal people in Canada may also experience inconsistent care and management once faced with a diagnosis of COPD when compared with non-Aboriginal patients with COPD [5, 6, 10]. Sin et al. [6] reported a differential use of health care services for COPD between Aboriginal and non-Aboriginal patients that was not explained by socioeconomic status or living location. They reported that Aboriginal patients experienced gaps in COPD care and treatment, and were 55% (95% CI; 52–58%) less likely to see a specialist and 66% (95% CI; 63–70%) less likely to undergo spirometry than non-Aboriginals [6]. These results highlight the need for an assessment of how health care providers (HCPs) approach care, including how stereotyping and bias may unconsciously limit the care and treatment options for Aboriginal respiratory patients [8].

Gaps in care hinder respiratory health. There are numerous knowledge translation (KT) strategies that aim to increase uptake of research-based clinical practice to ultimately improve the health outcomes for patients [10, 11]. However, to facilitate uptake into practice in a First Nations context, an optimal KT strategy should incorporate principles of Indigenous knowledge sharing, which includes a community-developed approach, experiential knowledge, and an emphasis on oral traditions [7, 11, 12]. Strategies to improve respiratory care that integrate the principles of Indigenous KT may have the greatest potential to address existing health status...
inequities and disparities in COPD treatment. This paper describes how a KT strategy that incorporated the principles of Indigenous KT was used to implement a First Nations community-based screening day in partnership with the Adams Lake and Neskonlith First Nations of the Secwepemc Nation in British Columbia, Canada.

INTEGRATED KNOWLEDGE TRANSLATION

It has been estimated that it takes an average of 17 years for 14% of research findings to be adopted into clinical practice [13]. KT uses different strategies to encourage and support clinicians to embed evidence-based research into clinical best practice to improve patient outcomes. The Canadian Institutes of Health Research define western-medicine based KT as an “iterative process that includes synthesis, dissemination, exchange and ethically sound application of knowledge” [11]. However, a western-based approach to KT may not be relevant in Indigenous health care. The scientific method for gathering and disseminating evidence is largely unidirectional from researcher to clinician to patient. In contrast, Aboriginal KT fosters an approach where the researcher, clinician, and the community are seen as resources for each other [11, 14]. There is a mutual sharing of knowledge that is inclusive of a variety of perspectives. Table 1 indicates the components of western-medicine based KT and applies them in an Aboriginal context. Aboriginal knowledge structures include community voices that illustrate “different ways of knowing” [11, 12, 14–16]. Dr. Jeanette Armstrong, an adjunct professor at the University of British Columbia Okanagan and a member of the Syilx Nation, noted in a recent keynote presentation at the 2nd Okanagan Cultural Safety symposium that:

<table>
<thead>
<tr>
<th>Non-Indigenous</th>
<th>Indigenous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify the problem</td>
<td>Establish community trust and partnership to identify a problem of significance to the people...</td>
</tr>
<tr>
<td>Analyze the context</td>
<td>Recruit culturally competent field workers and community members to inform context and guide all stages of research</td>
</tr>
<tr>
<td>Select the knowledge</td>
<td>Create ongoing opportunities for knowledge sharing to facilitate collaborative decision making</td>
</tr>
<tr>
<td>Select the intervention</td>
<td>Commit to return results to communities for verification and validation before dissemination, implement the intervention in the most appropriate mode of delivery for the community context</td>
</tr>
<tr>
<td>Support the use in practice</td>
<td>Communicate results to inform policy and practice</td>
</tr>
</tbody>
</table>

Just as written grammar systems have rules that establish preciseness of meaning, Indigenous languages develop preciseness from the understanding that has been established by the people... who have created information packages that are represented by characters in nature (plants and animals) developed over 12 thousand years of oral tradition. [12]

Thus, in a First Nations context, local understanding is often shared through linguistic constructs such as story, song, or ceremony. This method for intergenerational knowledge sharing has supported the health and wellness of Aboriginal people for centuries [11]. While western-medicine based KT gains academic rigor through iterative scientific method, levels of evidence, and established research methodologies, Indigenous KT shares best societal practices and social instruction through a system of oral documentation practiced over thousands of years [11, 12].

It is critical that health interventions integrate the principles of Aboriginal KT and align with the community’s geographical, social, cultural, and political history [11, 15, 16]. For example, often the four quadrants of the medicine wheel (physical, emotional, mental, and spiritual) guide the content and context of health interventions considered by the community when promoting wellness as part of their unique oral history [12]. The final synthesis of the information takes into account the priorities of the people involved and asks for their contribution to implementation in order to sustain the knowledge and practices within the community. The design and implementation of Indigenous health programs that integrate the principles of Indigenous KT may be more relevant, have more emphasis on an equity-focused approach to health care, and ultimately may be more successful at improving Indigenous health outcomes.

Although in general western-based approaches to KT may not be a good match with Indigenous health and learning values, there are some existing KT strategies or frameworks with components that do align with Indigenous health and learning values. The Consolidated Framework for Implementation Research (CFIR) is a model that combines several implementation theories to create a standardized method for applying knowledge across diverse contexts [17]. Developed in 2009 by Damschroder et al. [17], it outlines implementation strategies based on five fundamental components: (i) individual characteristics, (ii) intervention characteristics, (iii) inner setting, (iv) outer setting, and (v) the process of implementation. One component of the CFIR model details five implementation actions to guide KT planning [17] (Table 2). Two strengths of this model are that it utilizes an approach that focuses on knowledge sharing among all participants and the model components can be tailored to the principles of Indigenous KT. The following sections of this article describe how the CFIR was used as the theoretical foundation for the Secwepemc Lung Health Day held approximately three hours north of Kelowna B.C. in the Adams Lake and Neskonlith traditional territory.

ACTIONING INDIGENOUS KNOWLEDGE TRANSLATION—SECWPEMC LUNG HEALTH DAY

The Secwepemc community hosted this opportunity for knowledge sharing and actively promoted attendance by all community members. Table 3 describes the agenda for the event. The day began with an Elders teaching circle for the HCPs and included chronic disease learning sessions. The Chief and her council presented on the community traditions for promoting wellness and preventative care such as the traditional diet that is sourced from the land and how seasonal activities maintain the Nation’s health through this connection with their land. Lunch was provided by the Elders and all participants continued to share knowledge and network during the meal. The afternoon contained COPD screening and follow up of the results with the HCPs. The day finished with a participant evaluation and a small gift exchange between the Elders and the HCPs.

<p>| TABLE 1 |
| The process of non-Indigenous and Indigenous knowledge translation of research results |</p>
<table>
<thead>
<tr>
<th>Non-Indigenous</th>
<th>Indigenous</th>
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<tbody>
<tr>
<td>Identify the problem</td>
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<td>Support the use in practice</td>
<td>Communicate results to inform policy and practice</td>
</tr>
</tbody>
</table>

Adapted from Jardine and Furgal [16] and Hoens et al [19].

| TABLE 2 |
| Five implementation actions that support community-established meaning |
| Actions |
| Identify stakeholders, prioritize content, and integrate methods for knowledge translation |
| Create a shared vision and recruit internal and external change agents that have gained community respect |
| Remain faithful to implementation plan created by consensus |
| Create a safe atmosphere for information sharing, debriefing, and further adaptation |
| Identify formative goals that are S.M.A.R.T. (specific, measurable, attainable, relevant, and timely) from the community’s perspective |

Adapted from Jardine and Furgal [16] and Damschroder [17].
of Multiple Perspectives." In 2009, Estey et al. [11] emphasized that the "large gaps in our knowledge about all Aboriginal health" would only be addressed if health interventions incorporated a "multiplicity of perspectives". Interventions characteristics should be legitimate, valid, and adaptable [17]. Legitimacy and validity are related to the community and the HCPs’ perception of who created the intervention and design for implementation. For the Lung Health Day it was essential to have the Secwepemc Elders, First Nation employed HCPs, health authority HCPs, and the University of British Columbia Family Practice Residents’ Supervisor form a planning team to ensure respectful representation of all stakeholders and to reinforce the legitimacy and validity of the event [16]. Feedback from the community members highlighted the importance of bringing new physicians out into the community to witness, experience, and learn about local First Nation culture and health practices. Adaptability of program components was essential as the stakeholders planned to bring the model for the Lung Health Day to many of the Secwepemc communities as well as other First Nations communities that are part of the health authority. The Lung Health Day pilot was evaluated by the participants and the HCPs to improve future events. Success of the event was determined by a participant survey which indicated that 100% of participants would recommend participation in a repeat of the community event to friends and family. Evaluations of the day were also shared with the planning stakeholders and Secwepemc leadership, who suggested further improvements to the implementation to support sustainability of the KT by creating an online learning module.

**Inner setting—different sources of knowledge and outer setting—intergenerational knowledge sharing**

The second CFIR domain is "Inner Setting," which relates to the within-organization "structural, political, and cultural contexts through which the implementation process will proceed" [17]. It acknowledges that to be successful, the intervention must acknowledge and incorporate the tangible and intangible networks and lines of communication that exist within an organization. The CFIR "Outer Setting" domain refers to "the economic, political and social context within which the organization resides" [17]. In practice, there is overlap between inner and outer settings, and these domains closely aligned with the Aboriginal KT concept of "Different Sources of Knowledge" and of "Intergenerational Knowledge Sharing" (8, 12).

Different sources of knowledge can facilitate an optimal climate for implementation by contributing to the social architecture, methods of communication, and opportunity for cultural recognition [17]. The foundation of the Lung Health Day’s inner setting were the health authority HCPs who were comfortable with their established divisions of labour and professional scope of practice, but who also looked for opportunities for coalitions of service with this First Nations community [14]. The inner setting for the Lung Health Day also relied on existing receptivity to health learning within the Adams Lake and Neskonlith First Nations their role in adjusting the day’s content to improve community engagement; and the link of the event with the community priorities for addiction awareness, prevention, and treatment.

The planning team also felt that the lung health day could create a setting for intergenerational knowledge sharing and cultivate learning about smoking and the risk of developing COPD. However, this component was difficult to implement. Although the health authority team participated in a recent student health fair to promote lung with the community youth, it became apparent that more emphasis on this younger population would be required to address the community priorities and reflect a service partnership that was truly patient and community centered [11]. As the Lung Health Day was targeted to coincide with the Secwepemc Addiction Awareness week and World COPD Day 2014, there was only a small window of time for relationship building related to lung health for the community’s youth [16], and would require added resources to increase the scope of the lung health day to include prevention.

**Individual characteristics—mutual sharing of knowledge**

The fourth domain of the CFIR framework is the "Individual", which refers to the unique characteristics of the people involved in the implementation. It recognizes that individuals make choices, experiment with interventions, and influence others [17]. This domain aligns with the Indigenous KT principle of "mutual sharing of knowledge", which also emphasizes the importance of including the perspectives of the multiple stakeholders of the event. To formalize the importance of the mutual sharing of knowledge, the Secwepemc Lung Health Day relied on the
relationship that had been established between the Adams Lake and Neskonlith First Nations and the Government of British Columbia’s Interior Health (IH) Authority via a letter of understanding. This letter described the collaborative relationship between the First Nation and the IH employees to inform the components of the day and clearly described how the mutual sharing of knowledge would be facilitated. One key feature of the sharing of knowledge was the use of a talking circle with the community Elders. The talking circle gave the HCPs time with the Elders who shared their knowledge of culturally appropriate approaches to building care relationships such as mutual sharing of family history. This approach strengthened the credibility of the day as the Neskonlith chief and council members presented on the importance of prevention and appropriate care in sustaining the health of the people, and how seeking and sharing knowledge has ensured the well-being of the community [12].

Process of implementation—community established meaning
The final domain of the CFIR focuses on the “Process of Implementation” [17]. Process is recognized as having many components which may be happening simultaneously or in a non-linear fashion. This domain is reflected in the Indigenous KT concept of “community-established meaning,” which emphasized that the creation of the lung health day was transparent and included multiple stakeholders from the health authority, the community health workers, and the Elders. There was also an emphasis on discussing the event, revising the main objectives of the day, and revising as new suggestions arose.

Evaluation and knowledge dissemination
Evaluation of the day was completed using participant and provider surveys that were collaboratively developed by the community-based planning team. Fifty-five of 800 First Nation community members came to the event (7%). Forty-four individuals were screened for COPD using the COPD6™ (Vitalograph, Hamburg, Germany) device which measures forced expiratory volume in one second (FEV1), forced expiratory volume in 6 seconds (FEV6), the FEV1/FEV6 ratio, and the percent of predicted values, as well as a calculated obstructive index or lung age. Twenty-six participants completed an evaluation at the end of the day. As well, an online HCP survey completed one week after the event ensured the event organizers to gain insight as to how the program design could be improved and possibly adapted for other chronic diseases. A summary of the survey results was presented to the Secwepemc Nation Leadership Council in January of 2015, and the HCP surveys were shared with the Neskonlith and Adams Lake First Nation health directors for future use.

The screening day identified 10 individuals who required spirometry testing and follow-up with their family physicians. All the testing results were submitted for IH respirologist interpretation, and the results and interpretations were sent to patients’ family physician or community nurse practitioner. The screening day exposure has helped increase awareness of chronic lung disease in the community and the HCPs have been asked to repeat the screening day with different communities within the Secwepemc Nation.

DISCUSSION
Indigenous health care principles use a community-focused approach to ensure that care is based on building relationships and fostering trust within the health system as well as addressing the reasons behind a reluctance to seek care [8, 18]. This social approach to care may not be well suited to western-based KT strategies that tend to target a specific medical audience without necessarily understanding of the context within which health care takes place. The integration of the principles of Indigenous KT with those of western-medicine based KT creates an opportunity to contextualize health care and, in so doing, may address racial inequalities as they relate to COPD management [18].

The high prevalence of Indigenous tobacco use often results in an increased need for healthcare services over time. This burden may be further amplified in the Indigenous populations if there is a lack of diagnostic services or reluctance to seek care because of structural racism in the health system. To combat this, a COPD screening day that was developed for and by First Nation peoples relied on approaching the community as equals and used a knowledge translation framework that incorporated Indigenous KT principles. This model for implementation created processes that were adaptable and balanced standardized evidence-based care with community informed priorities for health.

Specifically, the community members were acknowledged as experts in their knowledge of the people, culture, wellness, and health traditions; instead of a unidirectional approach, there were opportunities to develop a day that was based on the knowledge held by all the stakeholders.

LIMITATIONS
This paper describes the pilot COPD screening day held in one First Nations community in British Columbia. In general, Aboriginal knowledge is developed by the community over time. This increases community engagement and uptake into practice. Different First Nations may have different approaches to learning, collaboration and health care so the approach we used may not be transferable to other communities [14]. Sustainability relies on maintaining collaborative relationships where all stakeholders can inform further health initiatives based on evolving community priorities. However, health system pressures challenge sustainability. As local health authorities are funded based on changing system priorities, it is not clear if future screening days will be funded, and community partners may see this as a lack of commitment to advance Aboriginal health, reduce treatment disparities, and apply Indigenous KT.

CONCLUSION
Quantifying the current respiratory health status of Canada’s Indigenous population is limited due to sparse data compared to the Non-Indigenous population. Further research is required to address community identified barriers to effective, appropriate, accepted, accessible services that promote improved culturally safe, health outcomes for Indigenous people. Integrating Indigenous KT into program implementation is one way to effect change in the health system, and amend the approach to care for Indigenous patients. Our experience suggests that by integrating principles of Indigenous KT, program implementation can begin to address racial and ethnic disparities in current respiratory care and management of COPD. Ultimately, we believe that incorporating the principles of Indigenous KT as part of health programming design and implementation will improve evidence informed practice for Indigenous patients with chronic respiratory illness.

ACKNOWLEDGEMENTS: The authors would like to thank the people of the Secwepemc Nation who participated in this event and the key individuals who felt strongly about promoting lung health within the community including the health director for the Neskonlith First Nation, Ms. Jody Leon, and the health director for the Adams Lake First Nation, Ms. Shirley Anderson.

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A partnership for Indigenous knowledge translation
High-flow nasal cannula therapy for patients with blunt thoracic injury: A retrospective study

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Objective: High-flow nasal cannula (HFNC) has been shown to reduce the need for mechanical ventilation (MV) and to decrease hospital and ICU days for patients with severe respiratory compromise. HFNC has not been evaluated in trauma patients, thus the goal of this study is to describe the use of HFNC in a chest-injured population.

Methods: A retrospective study examined trauma patients with moderate to severe thoracic injury admitted to the ICU at a tertiary hospital between March 2012 and August 2015. HFNC was delivered by the Fisher & Paykel Optiflow system. Primary outcomes were the need for intubation after HFNC for respiratory failure, length of hospitalization, and mortality.

Results: During the study period, 105 patients with blunt chest trauma were admitted to the ICU and received HFNC therapy. Eighteen percent received MV prior to HFNC. Overall, 69% of patients who received HFNC never received MV, and 92% of patients were discharged alive. The intubation rate for respiratory failure after HFNC was 18%. For patients who did not receive MV prior to HFNC, delay to first HFNC was correlated with increased hospital days (s = 0.41, p = 0.001) and ICU days (s = 0.41, p < 0.001).

Conclusions: Study results suggest that HFNC is comparable with other methods of noninvasive ventilation and may be beneficial for patients with thoracic injury. Additional investigation is warranted to determine if early use of HFNC can deliver effective respiratory support and prevent intubation in this population.

Key Words: high-flow nasal cannula; respiratory failure; mechanical ventilation; blunt chest trauma; Optiflow

INTRODUCTION

Humidified, high-flow nasal cannula (HFNC) is a technique of respiratory support that allows for oxygen to be heated to body temperature, saturated with water, and delivered at high flow rates (1–14). Many benefits have been noted in post-surgical adult populations and patients with severe respiratory compromise, including improved mucociliary clearance, better ventilation-perfusion ratios, increased oxygenation, reduced work of breathing and inspiratory effort, increased end-expiratory lung volume, and lowered respiratory and heart rates (1–3, 5, 9–13, 15–18). Notably, HFNC has the additional benefit of increased patient comfort and reduced mucosal injury (2, 9, 11–14, 17, 19–20). Unlike non-invasive ventilation (NIV), it does not impede mobility, oral intake, or speaking (21, 22).

HFNC studies have also found that the therapy can decrease hospital and intensive care unit (ICU) days and prevent the need for invasive mechanical ventilation (MV) (11, 19, 23–25). The efficacy of HFNC therapy has been established in post-surgical adult populations and patients with severe respiratory compromise (10, 11, 15, 16, 23, 25), but there are no studies that examine the safety and efficacy of HFNC in a population comprised solely of blunt chest-trauma patients. In the only known HFNC study to include trauma patients, delay to first use of HFNC was associated with increased ICU days and post-ICU days in a mixed medical and trauma population, even after controlling for MV and unplanned intubation (23). It is possible that many of the HFNC benefits demonstrated in other clinical populations may be present in the trauma population, but this has not been evaluated. The purpose of this retrospective study is to describe the use of HFNC in a population of patients with blunt thoracic injury to examine if HFNC was associated with positive patient outcomes such as reduced rates of intubation and decreased hospital days.

Methods

Study design

A retrospective study was conducted at a tertiary hospital with a mixed medical and surgical adult ICU. The hospital is verified by the American College of Surgeons as a Level I Adult Trauma Center. The trauma registry was used to identify patients with moderate to severe thoracic injury (Abbreviated Injury Scale (AIS) chest score 23) admitted to the ICU between March 2012 and August 2015 (n = 358), and 105 patients (29%) received HFNC during their stay. At the time of the study, HFNC was not specified in a respiratory protocol; the decision to initiate HFNC was made at the discretion of the trauma surgeon and respiratory therapist when supplemental oxygen delivery was required. HFNC was delivered by the Optiflow system (Fisher & Paykel Healthcare, Auckland, New Zealand). At the study hospital, initial settings are routinely set at 50 L/min and 50% FIO2, and the device is titrated by respiratory therapists.

Chart review of the electronic medical record was conducted for data not included in the trauma registry, and inter-rater reliability was assessed for 10% of the records to ensure consistency in data abstraction. The study was approved by the institutional review board at the hospital.

The requirement of patient consent was waived because chart review occurred retrospectively after patient discharge. No funding or support was received from the manufacturer to conduct this study.

Study variables

Demographic and injury variables included patient sex, age, body mass index (BMI), and mechanism of injury. Patients were considered do-not-resuscitate (DNR) if they had a DNR or a do-not-intubate (DNI) order at any time during the hospital stay. Admitting diagnoses were abstracted from ICD-9-CM codes in the trauma registry for the following thoracic injuries: three or more rib fractures (807.0–807.2), flail chest...
(807.4), pneumothorax (860.0–860.1), hemothorax (860.2–860.3), pneumomediastinum (860.4–860.5), and pulmonary contusion (861.2, 861.3). Acuity was represented by the Injury Severity Score (ISS), which is an anatomical coding system ranging from 0 (no injury) to 75 (most severe). ISS is derived from the AIS, with all diagnoses coded to AIS-1998 values. Comorbidities included smoking history (current or former), Chronic Obstructive Pulmonary Disease, and asthma. Delay to HFNC is the length of time between ICU admission and initiation of HFNC, presented in days to assist in interpretation. Duration of initial HFNC therapy is presented in hours.

Patient outcomes included hospital days, ICU days, and post-ICU days. Discharge disposition was reported for patients without mortality and included home (with or without home health services) or facility (skilled nursing or inpatient rehabilitation). Finally, it is consistent with the literature to define HFNC failure as the need for invasive MV (intubation) after HFNC for respiratory failure [6, 19, 24]. If a subject received MV after HFNC, arterial blood gas (ABG) analysis values (pH level, PO2, P CO2, bicarbonate [HCO3], and arterial oxygen saturation (SaO2)) were abstracted from the period 24 h prior to intubation to determine the type of respiratory failure. In cases where an ABG was not drawn prior to intubation due to rapid clinical deterioration, we used the physician bedside assessment of reason for intubation. Subjects were categorized as having hypoxic respiratory failure if PO2 < 60 mmHg or hypercarbic respiratory failure with or without hypoxia if P CO2 ≥ 50 mmHg [26]. If a patient was intubated for a change in mental status or an operative procedure and did not have hypoxic or hypercarbic respiratory failure, the patient was excluded from the HFNC failure rate.

Statistical procedures
Analyses were performed with IBM SPSS Basic Statistics for Windows, version 20.0 (IBM Corp, Armonk, New York, 2011). Categorical data are reported as counts and percentages. Distributions of continuous data were examined using the Komogorov–Smirnov test; because some variables were not normally distributed, all continuous data are reported as medians and interquartile ranges (IQR). Correlations were computed as Spearman rho (r_s) or Biserial (t_b) coefficients. All statistical tests were two-tailed and based on a 0.05 significance level.

RESULTS
The study sample included 105 patients with blunt thoracic injury, and demographic characteristics of the sample are presented in Table 1. The majority of patients were male (68%), with a median age of 63 years (IQR: 53, 76) and median BMI of 30.5 (IQR: 25.0, 35.4). Patients had a median ISS of 21, indicating a severe level of injury. Eighty-eight percent of patients had three or more rib fractures, 34% had a pulmonary contusion, and 28% sustained a pneumothorax. More than half the patients were current or former smokers.

Timing and duration of HFNC
Figure 1 illustrates the timing of HFNC and MV for all patients in the study. Overall, 69% of patients in the study were never intubated. Nineteen patients (18%) were intubated prior to HFNC; 5 of the 19 patients (26%) who were extubated to HFNC required reintubation for respiratory failure. Conversely, 86 patients (82%) did not receive invasive MV prior to HFNC.

On average, HFNC was started 6 h and 40 min after ICU admission (IQR: 0:1:40, 1:00:20), with a median therapy duration of 30 h (IQR: 0:14:15, 2:04:19). However, time to HFNC was related to whether the patient received MV before HFNC. Patients who were not intubated prior to HFNC started the therapy approximately 3 h after admission to the ICU, and the average duration of therapy was 30 h. Delay to first HFNC was associated with increased hospital (r_s = 0.41, p = 0.001) and ICU days (r_s = 0.41, p < 0.001). Patients who were extubated to HFNC started therapy 120 h (5 days) after admission to the ICU and average duration of therapy was 26 h. Neither the delay to HFNC initiation nor the duration of therapy was correlated with any demographics or injury characteristics in this population.

HFNC outcomes
The median hospital stay for all patients was 12 days, with a median stay of 5 days in the ICU (see Table 2). There was a strong correlation between receiving MV during the ICU stay and hospital (r_s = 0.53, p < 0.001) and ICU (r_s = 0.56, p < 0.001) days. Eight percent of patients died in the hospital; none of the deaths were related to use of HFNC and 75% of these patients were DNR or received comfort care. For patients who were discharged alive, 41% returned home after hospitalization and 59% discharged to a skilled-nursing or inpatient rehabilitation facility.

---

**TABLE 1**

Demographics and injury characteristics of sample

<table>
<thead>
<tr>
<th>Demographic or characteristic</th>
<th>All trauma patients (n = 105)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male, n (%)</td>
<td>71 (88)</td>
</tr>
<tr>
<td>Age in years, median (IQR)</td>
<td>63 (53–76)</td>
</tr>
<tr>
<td>Body mass index, median (IQR)</td>
<td>30.5 (25.0–35.4)</td>
</tr>
<tr>
<td>Do-not-resuscitate order at any time during</td>
<td></td>
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<tr>
<td>hospital stay, n (%)</td>
<td>17 (16)</td>
</tr>
<tr>
<td>Mechanism of injury, n (%)</td>
<td></td>
</tr>
<tr>
<td>Motor vehicle collision</td>
<td>54 (51)</td>
</tr>
<tr>
<td>Fall</td>
<td>44 (42)</td>
</tr>
<tr>
<td>Other</td>
<td>7 (7)</td>
</tr>
<tr>
<td>Injuries (not mutually exclusive), n (%)</td>
<td></td>
</tr>
<tr>
<td>Rib fractures</td>
<td>92 (88)</td>
</tr>
<tr>
<td>Pulmonary contusion</td>
<td>36 (34)</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>29 (28)</td>
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<tr>
<td>Flail chest</td>
<td>10 (10)</td>
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<tr>
<td>Hemothorax</td>
<td>9 (9)</td>
</tr>
<tr>
<td>Pneumomediastinum</td>
<td>6 (6)</td>
</tr>
<tr>
<td>Injury Severity Score, median (IQR)</td>
<td>21 (14–26)</td>
</tr>
<tr>
<td>Comorbidities</td>
<td></td>
</tr>
<tr>
<td>Former smoker, n (%)</td>
<td>31 (30)</td>
</tr>
<tr>
<td>Current smoker, n (%)</td>
<td>26 (25)</td>
</tr>
<tr>
<td>Chronic Obstructive Pulmonary Disease, n (%)</td>
<td>14 (13)</td>
</tr>
<tr>
<td>Asthma, n (%)</td>
<td>8 (8)</td>
</tr>
</tbody>
</table>

IQR, interquartile range.
TABLE 2
Outcomes of study sample (n = 105)

<table>
<thead>
<tr>
<th>Outcome</th>
<th>All trauma patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital days, median (IQR)</td>
<td>12 (8–18)</td>
</tr>
<tr>
<td>ICU days, median (IQR)</td>
<td>5 (3–11)</td>
</tr>
<tr>
<td>Post-ICU days, median (IQR)</td>
<td>5 (3–8)</td>
</tr>
<tr>
<td>Mortality, n (%)</td>
<td>8 (8)</td>
</tr>
<tr>
<td>High-flow nasal cannula failure, n (%)</td>
<td>19 (18)</td>
</tr>
<tr>
<td>Discharge home, n (%)</td>
<td>40 (41)</td>
</tr>
<tr>
<td>Discharged to skilled nursing or rehabilitation facility, n (%)</td>
<td>57 (59)</td>
</tr>
</tbody>
</table>

*Excludes deceased patients.

IQR, interquartile range; ICU, intensive care unit.

HFNC failure was defined as receiving MV (intubation) after HFNC for hypoxic or hypercarbic respiratory failure, and 19 patients (18%) met that criterion. Failure was not statistically related to any pattern of injuries but was associated with increased hospital days ($r = 0.40$, $p = 0.001$) and ICU days ($r = 0.54$, $p < 0.001$). In Table 3, we report the values from ABG analyses for subjects who were intubated after HFNC. Nine of 19 subjects (47%) failed HFNC due to hypoxic respiratory failure. Conversely, 12 of 19 subjects (63%) failed HFNC due to hypercarbic respiratory failure. In the latter group, there was an associated respiratory acidemia (median pH of 7.27; normal: 7.35–7.45), as well as higher $P_{CO_2}$ and lower $P_{O_2}$ than the hypoxic subjects.

DISCUSSION

This is the first known study to describe the use of HFNC therapy in a population comprised solely of blunt thoracic injury patients. In this high acuity sample of trauma patients with moderate to severe thoracic injury, more than two-thirds of patients never received invasive MV and 18% were intubated after HFNC for respiratory failure. Outcomes are similar to rates reported in the trauma literature for MV after NIV, which typically range from 12 to 18% [27–29]. Clinical outcomes are comparable; however, there are also indirect and unmeasured benefits to patients. HFNC does not impede mobility, oral intake, or speaking, which all improve patient outcomes [21, 22]. The findings suggest that use of HFNC may be a suitable respiratory treatment to provide optimal oxygen support to blunt thoracic trauma patients.

HFNC failure has been defined in the literature as the need for MV (intubation) after HFNC therapy [3, 6, 25]. However, we question if HFNC should be considered ineffective if patients require intubation for hypercarbia. The primary indication for HFNC is hypoxic respiratory failure [13, 19], with a secondary purpose to improve alveolar ventilation by decreasing the work of breathing and flushing the anatomical deadspace, thereby improving hypercarbia [2, 7, 14]. Early HFNC studies did not support the modality for improving carbon dioxide ($CO_2$) retention [16], but some work supports use of the modality for this purpose [7, 30, 31]. Our results suggest that HFNC may be efficacious in supporting patients with hypoxic respiratory failure but less effective for patients with hypercarbic respiratory failure.

The mortality rate of the sample was 8% and there were no cases where HFNC caused harm or delayed definitive care. The literature notes that blunt chest trauma patients have a mortality rate between 3 and 9% when receiving conventional NIV [26, 27], thus results from the study are within this range. It is noteworthy that 16% of patients were DNR/DNI at some point during the hospital stay, and three-quarters of patients who died were DNR/DNI or received comfort care. HFNC is a potential method of oxygenation for palliative patients because it is more comfortable and better tolerated than other NIV methods and does not inhibit speaking or oral intake [21, 22]. HFNC may provide a method of oxygen support for patients who wish to avoid invasive measures, and further examination is warranted to determine the utility of HFNC in these phases of care.

Study findings indicate a moderate relationship between delay to first HFNC and total length of the hospital stay ($r = 0.36$, $p = 0.001$) for patients who did not receive MV prior to HFNC. It may benefit patients with thoracic injury to start HFNC immediately after ICU admission, and efforts are in place to make that the standard of care at the study hospital.

An additional reason to start HFNC as early as possible is because patient improvement has been found to progress rapidly after HFNC initiation. Szmyt et al. [25] found that patients with acute respiratory failure noted improvement within 1 h of therapy initiation, and Vargas et al. [32] noted that short-term HFNC use had positive effects on respiratory effort and oxygenation. Although patients in these two studies were not trauma patients, the physiologic effect of HFNC was evident soon after starting the therapy and may work similarly in a trauma population.

Limitations

This is a retrospective study to describe the efficacy of HFNC in a trauma population, thus the study has several limitations. First, this study was performed at a single trauma center and results may not be generalizable to other settings. In addition, the study is retrospective and does not include a comparator group of patients that did not receive HFNC. Because use of HFNC was not part of standard protocol at our hospital, it was difficult to retrospectively identify a comparable patient population with equivalent acuity. Future work should be conducted prospectively and in collaboration with other hospitals to further evaluate the utility of HFNC in the chest trauma population. Second, 18 patients in this study received Bilevel Positive Airway Pressure (BiPAP) immediately before or after HFNC, and 6 of these patients oscillated between the two therapies (daytime or nighttime). We have not included data on NIV in this manuscript because it was not part of the original study design or data abstraction; however, in the future it would be important to identify the temporal order of NIV and HFNC therapies to determine how HFNC can best be utilized.

Third, at the time of the study there was no respiratory protocol for the initiation or titration of HFNC therapy; there may be physician and therapist biases in which patients were selected to receive HFNC and the settings that were used during therapy. Because there is historically no work on HFNC in a trauma population, this retrospective study is a first step in directing future research and building protocols suitable for trauma patients with chest injury.

Finally, HFNC was only available in the ICU at the study hospital and not on general inpatient floors. Some patients may have avoided an ICU admission if HFNC was available outside the ICU. Researchers at the study hospital are currently evaluating the feasibility of implementing HFNC on general inpatient floors at the institution, which would allow more patients to benefit from HFNC therapy without admission to the ICU.

In conclusion, this retrospective examination is the first to suggest that HFNC may be considered as an initial respiratory therapy for trauma patients with blunt chest injury. HFNC was well-tolerated and provided adequate oxygen support for patients with moderate to severe blunt chest injury.

### TABLE 3

Arterial blood gas values after high-flow nasal cannula and prior to mechanical ventilation (n = 19)

<table>
<thead>
<tr>
<th>Hyperoxic respiratory failure</th>
<th>Hypercarbic respiratory failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH level (median IQR)</td>
<td>7.40 (7.34, 7.43)</td>
</tr>
<tr>
<td>$P_{O_2}$ (median IQR)</td>
<td>37 (36, 48)</td>
</tr>
<tr>
<td>$P_{CO_2}$ (median IQR)</td>
<td>62 (53, 79)</td>
</tr>
<tr>
<td>Bicarbonate (median IQR)</td>
<td>23.6 (20.5, 26.0)</td>
</tr>
<tr>
<td>Arterial oxygen saturation</td>
<td>91.9 (86.14, 94.7)</td>
</tr>
</tbody>
</table>

IQR, interquartile range
REFERENCES


Clinical simulation is not a new phenomenon in the context of respiratory therapy education. In past years its role has been gradually established across health professions education, although some suggest that there has historically been limited research of sufficient quality to provide robust evidence of its educational utility [1, 2]. In response, an emerging body of research-informed literature is beginning to explicate the complexities of clinical simulation. For instance, a recent systematic review by Cook et al. [2] demonstrated that in comparison with no intervention, simulation-based health professions education can be associated with positive effects on the knowledge, skills, and behaviours of learners. In respiratory therapy in Canada, the knowledge, skills, and behaviours required of learners for entry-to-practice into the profession are identified in the current Respiratory Therapy National Competency Profile (NCP). The identification of effective approaches to developing these entry-to-practice competencies in learners has become a matter of shared interest to many stakeholders within the profession. The Respiratory Therapy NCP was first created in 2003 by the National Alliance of Respiratory Therapy Regulatory Bodies (NARTRB) and updated after a nationwide professional validation survey in 2011 [3, 4]. In this profile the use of clinical simulation was initially introduced with distinct definitions for high- and low-fidelity simulation. These definitions were used when simulation was identified as an acceptable method of evaluation for 20 of the 315 total competencies listed in the profile [4]. This national policy decision was intended to provide some limited flexibility to accommodate competency assessment in respiratory therapy programs that encountered difficulty in ensuring sufficient opportunities for students to gain clinical exposure to those competencies. The direction provided by the 2011 NCP with regards to clinical-simulation-based student evaluation generated some controversy within the Canadian respiratory therapy community (e.g., operationalization of the policy, educational validation of the assessment, etc.). In development of a new iteration of the NCP—the National Competency Framework (NCF)—the NARTRB reaffirmed its desire to continue to recognize the use of simulation as an educational and assessment tool. With expressed uncertainty as to best practices in the use of clinical simulation in entry-to-practice contexts, and in response to action items agreed to in collaboration with CoARTE (Council on Accreditation for Respiratory Therapy Education), the NARTRB requested the creation of an expert workgroup to develop a list of recommendations. The working group was asked to examine and define under what conditions simulation could be used to assess the entry-to-practice competency of graduating respiratory therapy students. The primary mandate of the workgroup would be to determine how clinical simulation can best be employed in respiratory therapy education, with the interest of public safety and protection at the fore.

In response, the Advisory Workgroup on the Use of Clinical Simulation was struck to provide recommendations to the NARTRB on the appropriate use of clinical simulation for the learning and assessment of entry-to-practice competencies for the implementation of the 2011 NCP. The roles and responsibilities of the assembled committee were to: review literature related to the use of clinical simulation in the attainment and demonstration of competencies and related best practices; make recommendations with respect to the use of clinical simulation as a learning method to supplement and/or replace clinical practice to attain and demonstrate the competencies identified as entry-to-practice contained within the NCP; and make recommendations on establishing a plan for the management, administration, and implementation of clinical simulation.
The resulting recommendations are therefore intended to inform the application of clinical simulation in education programs relative to the attainment of entry-to-practice competencies as outlined in the current NCP [3]. It is noteworthy that interpretation of the literature may be different when clinical simulation is used in different contexts, such as in posteducational program licensure examinations, continuing professional development, etc.

**DEVELOPMENT OF RECOMMENDATIONS**

The Advisory Workgroup collaborated over the course of a number of months during 2015 and 2016. During that time the Advisory Workgroup engaged in considerable critical discussion regarding the current literature relative to the application of simulation in education programs for the attainment of entry-to-practice competencies, as was outlined in the 2011 NCP [4]. Consensus was achieved that wherever possible the recommendations would be evidence based on the currently available literature. As a foundational tenet of these recommendations, the Advisory Workgroup agreed that clinical simulation is an adjunct or a technique for learning, and is not a replacement for clinical assessment except in specific limited situations where it approximates clinical conditions.

The relevant literature was critically appraised in relation to the range of key conceptual areas discussed by the workgroup, including its use for enhancing traditional learning models, for replacing learning in clinical contexts, and for assessment of practice readiness. In brief, the Advisory Workgroup agreed that:

- Extensive literature exists supporting the effectiveness of simulation for enhancing learning in both entry-to-practice education and professional development contexts, in particular when quality debriefing is included as part of the educational design [2, 5–9].
- Limited literature exists describing the effectiveness of replacing traditional clinical education exposure with simulated clinical experiences within entry-to-practice health professional education programs [10].
- A paucity of literature exists exploring the use of simulation to assess clinical competencies (for entry-to-practice readiness) in respiratory therapy. Literature available from other health professions describes validated simulation-based assessments that relate to specific professional competencies, typically in the context of Objective Structured Clinical Exam (OSCE) type licensure and certification assessment (i.e., post-completion of entry-to-practice education program) [11–17].

As a result of this work, the Advisory Workgroup has developed recommendations for the use of simulation in both the formative and summative assessment settings. It was the opinion of the Advisory Workgroup that the assessment strategies should be designed to suit the educational purpose [18]. As such, the following recommendations address the use of clinical simulation for each assessment process separately (i.e., summative and formative assessment).

**GENERAL RECOMMENDATIONS**

**Formative assessment of competencies in the 2011 NCP**

With regards to educational practices, the use of formative assessment is encouraged to identify learning gaps and modify learning plans toward developing competencies [19]. The use of formative assessment in clinical simulations along with deliberate practice has been shown to improve learning outcomes for which the simulations are designed [2, 6–9, 14]. The degree of realism required of a clinical simulation is dependent on the level of the learner and the objectives of the simulation [20, 21]. This Advisory Workgroup recommends using formative assessment in clinical simulation activities followed with debriefing and deliberate practice as a mechanism to assist learners with competency development.

**Summative assessment of competencies in the 2011 NCP**

Summative assessment refers to evaluating if learners have achieved defined learning outcomes using traditional methods such as grading tests or providing marks [18]. For the purpose of this report, summative assessment is the assessment of students for confirming entry-to-practice competency. With regards to respiratory therapy practice, there is no direct evidence supporting the notion that summative assessments of competencies for entry-to-practice can be achieved in simulated clinical settings. The Advisory Workgroup cannot therefore recommend the use of simulation for routine summative assessment for entry-to-practice competency based on the current literature.

It is recognized that the degree of realism of a clinical simulation is dependent on the design and attention to approximating reality [20, 21]. It is the recommendation of this Advisory Workgroup that if under exceptional circumstances the use of simulation is deemed necessary for the summative assessment of any competencies, they must be conducted in the most realistic setting, under the most realistic conditions available.

It is important that the level of realism is sufficient to allow valid assessment of the targeted construct to occur [22, 23]. Summative assessments of competencies should not be performed in settings that do not approximate realistic conditions or lack design and attention to approximating reality and ensuring validity.

**SPECIFIC RECOMMENDATIONS**

1. **Recommendations on the use of clinical simulation for formative assessment for entry-to-practice**

**Recommendation 1.1**

The use of clinical simulation for formative assessment is strongly encouraged in the curriculum of respiratory therapy education programs to foster the development of competencies and skills [2, 8]. Formative simulation may be sequentially incorporated as a component of the broader curriculum design (“at the right place, at the right time, for the right learning”).

**Recommendation 1.2**

Feedback and debriefing are essential elements of effective clinical simulation for formative assessment [5, 21, 24].

**Recommendation 1.3**

Clinical simulation for formative assessment is an effective approach to optimally prepare students for clinical exposure [2, 8, 10].

**Recommendation 1.4**

The following limitations should be considered when using clinical simulation for formative assessment:

- a) The assessment requires development by individuals who have the knowledge, skills, attitudes, and abilities in generally accepted principles in simulation-based education [9, 25].
- b) There are appropriate physical and human resources available [20].
- c) The evidence does not support the definition of high and low fidelity simulation as presented in the 2011 NCP. More effective distinctions with regards to the degree of fidelity can be made by examining three key elements—physical, semantical, and phenomenal—see Appendix A: Definition of Fidelity [6].
- d) Clinical simulation is an approximation of reality and may not be a sufficient replacement for clinical exposure [23].

**Recommendation 1.5**

The following evidence-informed strategies using clinical simulation for formative assessment include:

- a) Use of fidelity as appropriate to the learning objectives in the clinical simulation, to the learning and skills level of the student, and to their level of experience with simulation [16, 20].
- b) Thoughtful instructional design principles should be applied in clinical simulation for formative assessment [20, 21, 27, 28].
- c) Appropriate approaches to debriefing and feedback are selected from amongst those that have been proven effective [24, 25].
- d) Establishment of a learning environment characterized by trust and safe learning practices amongst the participants [16, 29].

**Recommendation 1.6**

The assessment of learning is an ongoing process throughout the education cycle [30].
Recommendation 1.7
These recommendations should be periodically reviewed and updated to meet the requirements of future iterations of the NCF and to ensure consistency with emerging literature.

2. Recommendations on the use of clinical simulation for summative assessment of competencies for entry-to-practice

Recommendation 2.1
Summative assessment within the clinical environment is the gold-standard [23].

Recommendation 2.2
Clinical simulation may be an acceptable alternative to assess competencies in some exceptional circumstances, such as:

a) to address limitations in achieving and/or accessing clinical exposure;
b) to assess internationally educated health professionals who are seeking to work in Canada as Registered Respiratory Therapists;
c) an individual returning to active respiratory therapy practice after extended absence from practice;
d) if clinical simulation is deemed to offer a higher quality of assessment than available in a clinical setting, as long as it supported by rigorous evidence.

Recommendation 2.3
For summative assessment using clinical simulation for entry-to-practice the following limitations should be considered:

a) The assessment using clinical simulation is performed by individuals who have the knowledge, skills, attitudes, and abilities in generally accepted principles of simulation-based assessment [16, 22, 25].
b) The appropriate physical and human resources are available [20].
c) The evidence does not support the definitions of high- and low-fidelity simulation as presented in the 2011 NCP. More effective distinctions with regards to the degree of fidelity can be made by examining three key elements of realism—physical, semantical and phenomenal—see Appendix A: Definition of Fidelity [6].
d) Clinical simulation is an approximation of reality and may not be a sufficient replacement for clinical exposure [23].
e) A single point assessment may be insufficient to determine competency.

Recommendation 2.4
The following are evidence-informed strategies for summative assessment using clinical simulation:

a) Establish a clinical situation and environment that approximates a real-world situation, addressing all three elements of high-fidelity simulation [6].
b) Thoughtful instructional design principles should be applied in clinical simulation for summative assessment [20, 21, 27, 28].

Recommendation 2.5
The assessment of learning is an ongoing process through the education cycle [30].

Recommendation 2.6
It is recognized that assessment spans a continuum from formative to summative assessment and these recommendations are not meant to undermine the value of debriefing in the formative assessment context [8, 31].

Recommendation 2.7
These recommendations should be reviewed periodically and updated to meet the requirements of future iterations of the NCF and to ensure consistency with emerging literature.

3. Recommendations about the use of clinical simulation in the evaluation of the 2011 NCP competencies

Recommendation 3.1
Establish a standing advisory committee to provide ongoing expert advice to the NARTRB on education-related issues.

Recommendation 3.2
As simulation design represents only one component in a program’s curriculum design, it is the opinion of the Advisory Workgroup that imposing conditions, limitations, or encouraging a certain threshold with respect to the use of clinical simulation should not be incorporated into national educational program requirements for formative and summative assessments.

4. Recommendation of the advisory workgroup on the use of clinical simulation

Recommendation 4.1
Several environmental factors have been identified in the literature as essential in creating an effective debriefing environment in clinical simulation, including: fostering a supportive learning environment, ensuring participants feel comfortable, and establishing trust within the circle of participants [25, 29]. In light of the importance of fostering a debriefing environment that supports learning, there is value for educators and regulatory bodies to carefully consider that employing simulation-based summative assessment (e.g., high-stakes examinations) of respiratory therapy learners may impact those essential environmental factors.

The profession should consider how it may ensure that any move towards employing simulation-based high-stakes examinations in respiratory therapy education does not threaten to undermine the effectiveness of the clinical simulation learning environment.

FUTURE DIRECTIONS
In relation to the primary mandate assigned to the Advisory Workgroup by the NARTRB, it is the opinion of the Advisory Workgroup that the responsible use of clinical simulation is in the interest of public safety and protection. The Advisory Workgroup identified the opportunity to engage the collective respiratory therapy education community (e.g., CACERT (Canadian Advisory Council for Education in Respiratory Therapy), CoARTE, CBRC (Canadian Board for Respiratory Care)) as well as other professions on topics of mutual interest such as the integration of simulation into future curriculum design and the development for formative education in addition to the recommendations for summative evaluation as requested by the NARTRB. The Advisory Workgroup also indicated a willingness to continue to advise the NARTRB on the use of clinical simulation in future iterations of the NCF.

Looking forward, a need exists for original respiratory therapy specific research and scholarly work in the area of clinical simulation. In particular, research should be conducted that can enlighten the profession’s understanding of the use of clinical simulation for assessment of entry-to-practice competencies in educational programs.

Beyond these recommendations, it is the opinion of the Advisory Workgroup that it may be in the best interest of respiratory therapy educators to develop their own strategies for implementing these recommendations, or other emerging best practices on clinical simulation-based formative and summative assessment. It is felt that this has the potential to eventually lead to the establishment of national standards in simulation-based respiratory therapy education.

REFERENCES

When considering the appropriate combination of realism elements for achieving optimal fidelity, the incorporation of appropriate interprofessional team members must also be carefully considered. Having the appropriate interprofessional team members present can greatly enhance the phenomenal reality of the simulation. Additionally, especially when team interactions are integral to the objectives of the simulation scenario, their participation could also enhance the physical and semantical reality. For example it may not be common to have five respiratory therapists caring for the same patient; however, it would not be uncommon to have five healthcare professionals caring for a critical illness patient, each bringing different yet overlapping roles and skill sets to the situation. When the professional composition of the care team (simulation participants) is not carefully considered during the development of simulation scenarios, the fidelity of the simulation as experienced by learners is likely to be negatively impacted. The development of an optimal interprofessional simulation experience may require collaboration with other educational institutions. This would allow students to gain exposure and experience working with professions they regularly interact with when providing care to patients, as opposed to limiting interprofessional interactions to only students studying in healthcare programs at the same institution.

APPENDIX A

DEFINITION OF FIDELITY

Fidelity describes the degree of realism in simulated environments and includes physical, semantical, and phenomenal aspects [6]. “Skillful blending of the three... will allow our trainees to 'suspend disbelief' that this is a situation with real relevance to them” [26]. Participant engagement is based on no single element of realism, but assures that no single element “violates their expectations in a way that disrupts their suspension of disbelief” [26].

Physical reality concerns characteristics that are measurable (e.g., the weight of an infant mannequin). In this way physical fidelity might be described as the reality of simulator equipment, measurable elements of the environment, or physical aspects of movements of such characteristics.

Semantical reality concerns those parts of the simulation experience that are “facts only by human agreement” [6]. Semantical fidelity describes “concepts and their relationships... presented as text, pictures, sounds, or events” [6]. Semantical fidelity is therefore assured only when the information presented is interpretable as realistic (e.g., when a simulated patient’s heart stops beating it is also made to stop breathing if the patient’s heart stops beating it is also made to stop breathing as is natural).

Phenomenal reality concerned with participants understanding of how the simulation event relates to another real situation, clinical practice for example (e.g., team interaction a simulated trauma scenario feels lifelike despite obvious physical differences compared with real life). This


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