2017

The Association Between High Flow Nasal Cannula Therapy and Intubation in Acute Respiratory Failure Patients, A Single Center Retrospective Analysis

Patrick Nolan
University of Kentucky, pcnolan14@gmail.com

STUDENT AGREEMENT:

I represent that my DNP Project is my original work. Proper attribution has been given to all outside sources. I understand that I am solely responsible for obtaining any needed copyright permissions. I have obtained and attached hereto needed written permission statements(s) from the owner(s) of each third-party copyrighted matter to be included in my work, allowing electronic distribution (if such use is not permitted by the fair use doctrine).

I hereby grant to The University of Kentucky and its agents a royalty-free, non-exclusive and irrevocable license to archive and make accessible my work in whole or in part in all forms of media, now or hereafter known. I agree that the document mentioned above may be made available immediately for worldwide access unless a preapproved embargo applies. I also authorize that the bibliographic information of the document be accessible for harvesting and reuse by third-party discovery tools such as search engines and indexing services in order to maximize the online discoverability of the document. I retain all other ownership rights to the copyright of my work. I also retain the right to use in future works (such as articles or books) all or part of my work. I understand that I am free to register the copyright to my work.

REVIEW, APPROVAL AND ACCEPTANCE

The document mentioned above has been reviewed and accepted by the student's advisor, on behalf of the advisory committee, and by the Assistant Dean for MSN and DNP Studies, on behalf of the program; we verify that this is the final, approved version of the student's DNP Project including all changes required by the advisory committee. The undersigned agree to abide by the statements above.

Patrick Nolan, Student

Dr. Melanie Hardin-Pierce, Advisor

Final DNP Project Report

The Association Between High Flow Nasal Cannula Therapy and Intubation in Acute Respiratory Failure Patients, A Single Center Retrospective Analysis

Patrick Nolan, BSN, RN

University of Kentucky
College of Nursing
April 20, 2017

Melanie Hardin-Pierce, DNP, RN, APRN, ACNP-BC…Committee Chair
Elizabeth Burckardt, DNP, RN, APRN…Committee Member
Jason Mann, DO…Clinical Mentor
Peter Morris, MD…Clinical Mentor

Dedication

This is dedicated to my wife. Thank you so much for all the love and support during this three-year journey**.** You have kept me sane during all of this. Finally, thank you for all of the sacrifices you have made so I could pursue this dream.

Acknowledgements

They say that it takes a village. I definitely feel like I have had that amount of help throughout this project and along the past three years. I would like to thank my committee chair and advisor, Dr. Melanie Hardin-Pierce. You have been an invaluable mentor and friend. Thank you for all your guidance, advice and encouragement. I would also like to thank Dr. Elizabeth Burkhardt and Dr. Jason Mann. Thank you for being part of my doctoral committee and for your guidance with this doctoral project. Both of you have challenged me clinically and have helped shape my views on healthcare and improved my clinical skills. Dr. Peter Morris, thank you for guiding me to the topic for my project. Working with you on this project has helped develop the academic aspect of my professionalism.

Finally, I would like to thank people outside of my committee members that have been extremely helpful throughout this program and project. Amanda Wiggins, thank you so much for your help and guidance in tackling the data set for this project. I don't think I would have been able to do it alone. In extracting the data for this project, Andy Kelly has been an awesome resource. Thank you for helping extract the data and for your time and patience. Finally, I would like to thank Whitney Kurtz-Oligvie. You have helped elevate the level of my writing and led me to develop a more professional tone to my academic writing.

Table of Contents

List of Tables

List of Figures

Abstract

Background: High flow nasal cannula therapy is becoming a more common therapy in the adult population. Multiple studies have been conducted on the potential benefits of this therapy such as increased patient tolerance of the therapy, improved secretion clearance and the ability for providers to deliver a greater range of FiO2 settings at a wider range of flow rates. With the increasing utility of this therapy, the research for best practices, setting (FiO2 and LPM) and duration of therapy to guide clinicians is lacking.

Aim: 1) Does high flow nasal cannula therapy reduce the need for intubation or re-intubation in patients with hypoxic respiratory failure, as compared to continuous positive airway pressure or bi-level positive airway pressure therapy? 2) How do variations in setting of high flow nasal cannula therapy affect the need for intubation or re-intubation, mortality and hospital length of stay?

Methods: Subjects for this study were adults, ages 18-99 years old with a diagnosis of respiratory failure. Group 1 (n=213) was created to determine whether initial high flow treatment for respiratory failure may decrease intubation rates, as compared to continuous positive airway pressure or bi-level positive airway pressure therapy. Group 2 (n=88) examined whether high flow nasal cannula therapy was associated with lower re-intubation rates when high flow was administered to post ventilator respiratory failure patients. An in-group analysis of high flow nasal cannula therapy was done in both groups to examine how variation in setting affected patient outcomes. Statistical analysis was performed with SPSS version 24.

Results: In Group 1, the analysis of high flow nasal cannula therapy vs. continuous positive airway pressure or bi-level positive airway pressure therapy found no significant difference in intubation rates, p=0.119. No significant difference was found between type of NIV therapy used for post extubation patients and the rate of re-intubation for Group 2, p=0.789. In-group analysis of high flow cannula setting (FiO2 and LPM) found that there was no significant difference associated with high flow administration and reduced mortality in Group 1 (FiO2 p=0.0988, LPM p=0.502 or Group 2 (FiO2 p=0.194, LPM p=0.449). There was no significant difference in the need for intubation or re-intubation in both Group 1 (FiO2 p=0.992, LPM p=0.716) and Group 2 (FiO2 p=0.746, LPM p=0.592).

Conclusion: This study suggests that high flow nasal cannula therapy performed similarly as continuous positive airway pressure or bi-level positive airway pressure therapy in preventing intubation and re-intubation rates. The group analysis of high flow nasal cannula therapy settings suggests that variation in the setting did not impact intubation or re-intubation rates.

Background

High flow nasal cannula (HFNC) therapy is a noninvasive ventilation (NIV) modality that has recently gained increased attention in the adult critical care world. This form of noninvasive ventilation allows for the delivery of warm, humidified oxygen therapy with a FiO2, the percentage of oxygen inspired, of 0.21-1 and flow rates up to 60 liters per minute (LPM) (Nishimura, 2016). HFNC therapy allows for a more predictable delivery of FiO2 than other noninvasive ventilation strategies (Nishimura, 2016). In addition, HFNC therapy has the ability to improve oxygenation (Stephan et al., 2015; Cirio et al., 2016) and decreases the work of breathing (Stephan et al., 2015; Roca, Riera, Torres, & Masclans, 2010). In a study by Frat et al. (2015), patients with a pO2/FiO2 ratio of $\leq$ 200 HFNC showed a reduced need for intubation when compared to standard oxygen therapy (i.e., low flow oxygen therapy) and other noninvasive ventilation modalities, p=0.01. This open label, multicenter, randomized control studyf examined the effects that HFNC therapy had on clinical outcomes and intubation rates in acute respiratory failure patients admitted to the intensive care unit (ICU). The population consisted of adult patients, 18-99, admitted to the ICU with respiratory failure secondary to community acquired pneumonia, hospital acquired pneumonia, extra pulmonary sepsis, aspiration/drowning, pneumonia related to immunosuppression and other causes (Frat et al., 2015). This study also found that HFNC therapy leads to a significant reduction in ICU mortality, standard oxygen therapy vs. HFNC therapy p=0.046 and HFNC therapy vs. noninvasive ventilation p=0.006. Strengths of this study were that it followed a well-delineated research protocol, and pre determined definition of the need for intubation, and multicenter design. A limitation of this study was that blinding of therapy delivered was in the selection of setting for HFNC therapy, as there was no documented justification for the setting used in the study. In the study by Frat et al. (2015), the potential for bias was addressed by having the data masked until collection was completed.

HFNC therapy was also found to have clinical benefits when applied post extubation. When compared to BiPAP, HFNC was found to be non-inferior in reducing the rate of re-intubation (Hernadez et al., 2016; Stephan et al., 2015). Both of these studies were well-designed, multicenter, prospective, randomized control trials. Hernadez et al. (2016) examined how HFNC therapy could affect re-intubation rates in patients that experienced post extubation acute respiratory failure. This study evaluated how HFNC performed vs. CPAP and BiPAP in reducing the re-intubation rates in patients deemed high risk for the need to be re-intubated. In the study by Stephan et al. (2015), researchers examined if HFNC was inferior to BiPAP in preventing or reducing acute respiratory failure in postoperative cardiothoracic patients. Both studies followed a well-delineated study protocol and predetermined definition of outcomes to conduct their collection and analysis. A limitation for both of these studies is that there is no documented justification for the settings that were used in the study. In Hernandez et al. (2016), the

selection criteria for patient inclusion was for patients that are at higher risk for intubation, which could have skewed results. In addition, no current literature provides any evidences for a tool to identify these patients. An additional limitation of Stephan et al. (2015) is that the therapies were not blinded. This could potentially have resulted in bias in the data collection process.

The current state of literature has been focused on the potential benefits of HFNC study. In the field of HFNC therapy, research or Medical Society Consensus Statements examining the best practices for FiO2 and LPM setting to guide clinicians are currently lacking. This is due to the lack of current literature examining the affects from variation in therapy. It is to our knowledge that no previous studies have been conducted to evaluate the equipoise of practice for HFNC therapy settings.

Aim

This study examined a single quaternary academic medical center's current practices of high flow nasal oxygen administration to identify trends in practice for variability. In addition, this study looked at how current practices in HFNC therapy relate to the subsequent need for intubation or re-intubation, patient mortality, length of stay and time on NIV in acute respiratory failure patients. This study will also examine how HFNC therapy, compared to CPAP/BiPAP, affects the need for intubation or re-intubation, mortality, length of stay and time mechanical ventilation. This study will examine a single center's administration of oxygen therapies prior to intubation and post-intubation in patients with acute respiratory failure. In addition, this study will examine the effects that variations in HFNC therapy settings have on patient outcomes. This study will help establish whether equipoise exists in the current single center's practice. Information from this study may help define future study groups in order to define which HFNC parameters may be best, or define which disease states might benefit most from administration of HFNC therapy.

Methods

Design

This study was a non-experimental, descriptive, retrospective medical record review.

Subjects

Subjects included in this study consisted of adults 18-99 years old that developed or presented with acute respiratory failure and were admitted to UK Chandler Hospital and received NIV therapy during their stay. Exclusion criteria included patients with tracheostomy or do-not-intubate status. For inclusion in this study, each instance of NIV therapy recorded was designed, in order to be considered evaluable, to simultaneously coincide with a hypoxic event documented within the electronic medical record. Hypoxia for this study was defined as a $SpO2 \leq 92\%$, RR>20 per minute, heart rate >100 beats per minute and a PaO2 of less than 80. This criterion was adapted from definitions of hypoxia from previous studies, Frat el al. (2015), Hernadez et al. (2016), Roca, et al. (2010) and Stephan et al. (2015).

Each event of NIV needed documentation of at least one of these variables up to four hours prior to the initiation of therapy. If a patient had an additional encounter of NIV therapy documented within 12 hours of the previous NIV therapy documentation, the additional encounter was considered to be treating the same hypoxic event. This study is designed so that for NIV therapy to be considered successful in preventing intubation, the subjects could not have been intubated and placed on mechanical ventilation within 12 hours of the last NIV documentation. To determine if NIV therapy is successful in reducing the need for re-intubation, subjects re-intubated within 48 hours of extubation were considered as failing NIV therapy.

A sample size of 400 patients was selected to ensure that the study was adequately powered to detect a moderate correlation and from parameters in previous randomized controlled trials (Hernadez et al., 2016; Stephan et al., 2015). An electronic medical record review of the Sunrise Clinical Manager (SCM) database was conducted to identify BiPAP, CPAP and HFNC use in the emergency department, ICUs and floors of UK Medical Center. The time frame for this medical record review was July 1, 2014-July 1, 2016. The initial search of SCM data based produced 46,218 unique patient encounters, Figure 1. From this patient pool, those with a primary or secondary diagnosis of acute respiratory failure and solely receiving HFNC or CPAP or BiPAP were to be included for this study. This gave the final pool of 1,885 patients, 329 HFNC, 1,227 CPAP or BiPAP and 329 that received both therapies. From these patients, a computerized random number generator was used to select 200 that only received HFNC therapy and 200 patients that only received CPAP or BiPAP. These patients made up the final sample of patients for this study. The sample for this study was further divided in to two groups. Group 1 comprised of patients that received either HFNC therapy or CPAP or BiPAP and the initial form of NIV therapy as initial treatment prior to the need for intubation. Group 2 comprised of patients that received HFNC therapy or CPAP or BiPAP after liberation from mechanical ventilation. Of the 400 patients, 308 meet the inclusion criteria for Group 1. Of the 308 patients, 95 had to be excluded from the study due to improper documentation of NIV, NIV setting and discharge disposition. This left 213 patients to be included in the sample for Group 1. In Group 2, 92 patients were originally selected, but four had to be excluded due to incomplete charting and missing data, leaving the final sample at 88.

Data Collection

General patient characteristics (age, gender) and primary diagnosis were collected. Data collection for HFNC, BiPAP and CPAP began at the documented time the therapy was started. Hourly documented settings of HFNC, BiPAP and CPAP were collected. If no documentation for an hour was available, the settings from the previous hour were used. For BiPAP, CPAP and HFNC, the amount of time that a subject was on a therapy was collected. Onset of therapy was defined as the first documentation of settings for HFNC, BiPAP and CPAP. The cessation of therapy was defined as the

documented time that HFNC, BiPAP and CPAP were discontinued or the time that another oxygen supportive therapy was documented. The time of intubation was the time that post intubation chest x-rays were obtained to confirm endotracheal tube placement or the documentation of mechanical ventilation settings.

Arterial blood gases (ABGs) documented within four hours to the initiation/change in oxygen therapy of therapy will be collected. The nearest documented vital signs (heart rate, blood pressure, respiratory rate and SpO2) and oxygen settings (L/min) to 0700, 1100,1300,1700, 2100, 2400 (0000) and 0300 hours were collected.

Time on mechanical ventilation was collected. The first documented ventilator settings of the day were recorded until the time of extubation. The time of extuabtion was determined to be the documentation of extubation or initiation of a different oxygen supportive therapy. Ventilator days were defined as any portion within a calendar day on mechanical ventilation. Hospital length of stay was calculated as the documented time of admission to the documented time of disposition (discharge or death). Diagnosis related groups were collected on for each subject on the time of discharge. Disposition location was collected. Data collection was done through the Center for Health Service Research. See Table 1 for data points recorded.

Plan for Analysis

Descriptive statistics were used to summarize the study sample using means and standard deviations, medians and ranges or frequencies and percentages. The Chi-square test of association was used to compare mortality by patient category. The Mann-Whitney U test was used to compare groups on non-normal clinical variables (hospital length of stay, time on mechanical ventilation and time on noninvasive ventilation). An in-group analysis of HFNC therapy was done with the Mann-Whitney U and Kruskal-Wallis test, where appropriate, to assess how changes in FiO2 and LPM could affect the need for intubation, hospital length of stay, mortality, time on noninvasive therapy and time on mechanical ventilation. All data analysis was conducted using SPSS, version 24, with an alpha level of .05.

Results

Group 1: HFNC vs. CPAP or BiPAP and Intubation

Group 1 was created to examine the effects of HFNC therapy vs. CPAP or BiPAP on preventing the need for intubation when delivered as initial therapy in patients with acute respiratory failure. In this group, there was even distribution between patient groups, those receiving HFNC (n=88) therapy and those receiving CPAP or BiPAP (n=125). Between HFNC therapy and CPAP or BiPAP, there was no significant difference between age (p=0.188) and sex (p= 0.216). In each group, there was a similar distribution of men and women. This is shown in Table 2. As determined by DRG weighting, there was a significant difference in the patient acuity between HFNC therapy and CPAP or BiPAP, p= 0.046.

Table 2 shows that patients that received HFNC therapy had a higher median DRG weight than those in the CPAP or BiPAP group, 3.16 vs. 1.88. The difference in DRG-determined acuity may also explain the significant difference in the hospital length of stay between HFNC therapy and CPAP or BiPAP, p= 0.048. Patients that received HFNC therapy had a median hospital length of stay of 14.82 days, and patients that received CPAP or BiPAP had a 10.65 days median hospital length of stay, a difference of 4.17 days.

Comparing CPAP or BiPAP vs. HFNC therapy for the duration of NIV treatment, a Mann-Whitney U test indicated a significant difference between therapies and the amount of time subjects were on therapy, HFNC 6.50 hours, CPAP or BiPAP 4.00 hours, p=<0.001. A Mann-Whitney U test indicated a significant difference in hospital length of stay, p=0.048. A Chi-square test, with Yates Continuity Correction, was conducted to assess the association of HFNC therapy and mortality. The percentage of subjects that expired was similar between groups, 22.4% (28) in the CPAP or BiPAP group and 27.3% (24) for subjects receiving HFNC therapy, p= 0.415, Table 2. HFNC therapy was compared to CPAP or BiPAP to determine if one therapy was associated with a reduction in respiratory failure and a patient's need for intubation, Table 3. A Chi-square test, with Yates Continuity Correction, indicated no difference in intubation rates between HFNC therapy or CPAP or BiPAP, p=0.119. There was no difference in the number of days a subject was on mechanical ventilation post NIV therapy, p=0.801.

A secondary analysis of patients in Group 1 who received HFNC therapy was done. This secondary analysis was done to determine if different initial settings for FiO2 and LPM had any significant association with the need for intubation, and to determine if the settings impacted clinical outcomes, Table 4 and Table 5. Between initial settings for LPM, no significant difference was found in patient acuity, p=0.692 (Table 5). However, for the subjects in Group 1, there was significant difference in initial FiO2 settings and the acuity of the patient, p=0.003 (Table 4). There was no significant difference between the quartiles of initial LPM (p=0.716) and FiO2 (p=0.992) and the need for intubation, Table 4 and Table 5. The comparison of initial FiO2 and LPM setting and mortality was also assessed to decipher which setting was associated with reduced mortality. Findings for this comparison showed no significant difference in mortality in initial FiO2 (p=0.099) and LPM settings (p=0.502). When looking at variation in initial FiO2 setting, no significant difference was found between hospital length of stay, p=0.062, and time patients were on the ventilator post intubation, p=0.082. There was no significant difference between initial LPM setting and hospital length of stay, p=0.476. Variation in setting of initial LPM delivered to the patient was found to have a significant impact on the amount of time a patient was mechanically ventilated after receiving HFNC therapy, p=0.046. No significant difference, p= 0.476, was found in patient length of stay among different flow rates. No significant difference was found between

initial FiO2 settings and duration of NIV, p=0.103. However, there was a significant difference between flow rate settings and the duration of NIV therapy, p=0.033.

Group 2 HFNC vs. CPAP or BiPAP and Re-intubation

Of the 88 patients in Group 2, 62 (70.45%) received HFNC therapy and 26 (29.55%) received CPAP or BiPAP. Between HFNC therapy and CPAP or BiPAP, there was a significant difference in the age of the patients, p= 0.048 (Table 6). As shown in Table 6, there was no statistical difference in the gender distribution between HFNC and CPAP or BiPAP, p= 0.376. For patient acuity, there was no statistical difference between HFNC therapy (5.17) and CPAP or BiPAP (5.37), p= 0.905.

When assessing HFNC therapy's effect on hospital length of stay, there was no significant difference as compared to CPAP or BiPAP (16.08 vs. 18.16 days), p=0.387. Between HFNC therapy and CPAP or BiPAP, there was no significant difference in mortality, HFNC vs. CPAP or BiPAP, p=0.975. In comparing the need for re-intubation, no significant difference, p=0.969, was found between NIV therapies. As with the finding in Group 1, subjects received HFNC therapy a significantly longer amount of time than subjects on CPAP or BiPAP, p=<0.001. This study found that there was a significant difference in the delay of initiation of NIV therapy post extubation and the need for a patient to be re-intubated, p=0.075.

A secondary in-group analysis of HFNC therapy was performed to establish if there was any difference between FiO2 settings and LPM and re-intubation. There was no significant difference across quartiles for both FiO2 (p=0.746) and LPM (p=0.592) and re-intubation. For mortality and differences in FiO2 therapy (p=0.194) and LPM (p=0.449) setting, no significant association was established between HFNC and mortality. Variation in initial HFNC setting of FiO2 (p=0.145 and LPM (p=0.582) had no significant association with hospital length of stay.

Discussion

Findings

The analysis comparing NIV therapies (HFNC vs. CPAP or BiPAP) showed that there was no significant difference in the ability of either therapy to reduce the rate of intubation. This finding is consistent with the Frat et al. (2015) conclusion that HFNC therapy has no significant effect on the intubation of subjects with hypoxic respiratory failure. These findings suggest that HFNC therapy is non-inferior to CPAP or BiPAP in reducing the need for intubation. Subjects in this study on NIV had a lower rate of intubations than seen in Frat et al (2015). This could be due to the inclusion criteria for the subjects. In this study, subjects who developed a secondary diagnosis of respiratory failure were included. Subjects who developed respiratory failure in the hospital could have received interventions to treat their respiratory failure sooner than the subjects in Frat el al. (2015) that presented with the primary diagnosis of respiratory failure. The difference in the ability to detect a significant difference between

groups could be due to this study being underpowered. It could also be attributed to the difference in mortality in-groups. Another factor that could affect the difference in mortality rates between this study and Frat et al. (2015) is that patients in this study could have had a higher acuity. It is impossible to determine if there was a difference in acuity because different measures of acuity were used in each study. It is interesting to note that the amount of time a patient was on NIV therapy had a significant association with the need to be intubated. When looking at the amount of time a patient was on NIV, patients who received HFNC were on therapy significantly longer than those that received CPAP or BiPAP.

When looking at the use of HFNC therapy in post extubation acute respiratory failure, findings in this study suggest that HFNC therapy had no significant difference in effecting the rate of re-intubation. This finding suggests that HFNC therapy is non-inferior to CPAP or BiPAP in reducing the need for re-intubation in patients that experience respiratory failure after being liberated from mechanical ventilation. These findings are consistent with those found by Hernadez et al. (2016) and Stephan et al. (2015). The number of subjects requiring re-intubation was also similar across studies, Hernadez et al, 2015 (HFNC 22.8%, CPAP/BiPAP 19.1%) and Stephan et al., 2016 (HFNC 21%, CPAP/BiPAP 21.9%). Analysis of Group 2 suggests that there is no significant difference between the time NIV therapy was started and the need for intubation. As with Stephan et al. (2016), this study found that there was no significant reduction in mortality between HFNC therapy and CPAP/BiPAP when used to treat post extubation acute respiratory failure.

Within both Group 1 and Group 2, the effects of various FiO2 and LPM settings were examined to determine associations with improved clinical outcomes (need for intubation or re-intubation, the hospital length of stay and mortality). In comparing the interquartile ranges for FiO2 and LPM, this study suggests that there is no significant difference between HFNC therapy initial settings and clinical outcomes. This finding suggests that variations in the amount of oxygen subjects received and the rate at which it was delivered have no impact on whether a patient died, required intubation or re-intubation and the hospital length of stay. The inability of this study to detect a significant difference between FiO2 and LPM setting and the need for intubation or re-intubation could be due to the study being underpowered.

In this study, current practices for HFNC therapy were assessed. It was found that there was a large variance in practices in the initial settings that are used. In Group 1, FiO2 setting ranged from 40% to 100% with a median of 70%. The flow rate was also found to have a large variance in the settings that were administered. Patients in Group1 received oxygen at a flow rate ranging from 9 LPM to 40 LPM, with a median flow rate of 25 LPM. In Group 2, there were a variety of HFNC settings for FiO2 and LPM used for initial therapy. Flow rates in this group ranged from 10 to 40 LMP with a median flow rate of 25 LPM. This study suggests that in current practice no equipoise of practice exists for initial settings of HFNC therapy.

Limitations and Strengths

A limitation of this study was the design. This study was designed to be a non-experimental, retrospective, medical chart review. This is a known limitation because the data collected in the chart audit relied on the documentation of others. Missing data in the charts led to the exclusion of 99 patients from the study. This reduced the sample size, which may have reduced the ability of the study to discover any significant association between variables. There were fewer patients in Group 2 than in Group 1. Group 2 had an unequal distribution of subjects between NIV therapies. These factors could have skewed results and prevented significance from being detected.

One strength of this study was the inclusion criteria for subjects. Examination of a broad class of patient syndromes under the DRG parameters of acute respiratory failure may allow these results to be more generalizable. Another strength of this study was that the inclusion and exclusion criteria were determined prior to data extraction from the electronic medical record. In addition, the delineated structured randomized selection of patients was done to mitigate the risk of selection bias.

Call for Future Research

Further research into the effects of HFNC therapy is needed. Large, robust, multicenter, prospectus, randomized controlled trials need to be conducted to establish the relationship between HFNC therapy vs. CPAP or BiPAP and intubation and in re-intubation rates. As noted in the discussion, further studies need to illuminate the effects that delays in the initiation of post mechanical ventilator NIV have on intubation rates. Continued research on this topic could increase knowledge of the best practices for de-escalation of therapy. Further research needs to be conducted to better establish how various HFNC FiO2 and LPM settings impact patient care and clinical outcomes. Increased research in this area can lead to a better understanding of HFNC therapy and help guide best practices for initiation and titration of therapy.

Conclusion

The aim of this study was to assess current practices of HFNC therapy to determine if it had an impact on intubation rates and clinical outcomes, as well as describe current practices to help guide clinicians in their use of HFNC therapy. HFNC therapy has been shown to be non-inferior to CPAP or BiPAP in reducing the need for intubation/re-intubation, and clinical outcomes between groups were similar. This combined with previous research demonstrating increased patient tolerance of HFNC therapy should lead to the continued adoption and use of this therapy. This study was unable to establish which setting of FiO2 and LPM would be a best practice for this therapy. As a result, clinicians should use their clinical expertise and patient response to guide which setting to use in the initiation of this therapy until future research can establish which settings are best practice.

Table 1

Data points collected

Data recorded	Time data recorded
Age	At time of admission
Sex	At time of admission
Primary diagnosis	At time of admission
Vital signs (HR, BP, Sp02, respiratory rate	Every 4 hours starting at 0700, closest value
Arterial Blood gases (ABGs)	Closest value1 hour, 6 hours and 12 hours post oxygen supportive therapy initiation
Noninvasive ventilation Type and Settings (HFNC or BIPAP/CPAP, and FiO2 and O2 L/min)	Hourly setting and Type
Ventilator settings (Mode, tidal volume, rate, FiO2, PEEP)	First documented settings of the day
Time on Noninvasive ventilation	Documented start of noninvasive ventilation therapy to time of intubation
Oxygen settings	Every 4 hours starting at 0700, closest value
PaO2/FiO2 ratio	Closest value 1hour, 6 hours, 12 hours post noninvasive ventilation therapy
Time of intubation	Chest x-ray confirming endotracheal tube placement
Time of extubation	Documented time of extubation in chart
Length of stay	Time of admission to time of d/c or death
Disposition	Time of discharge home or time of death
DRG	At time of discharge

Table 2

Characteristics of Group 1

NIV therapy	Age, mean ± SD	Sex, % (n)	LOS, median	DRG, median	Mortality, % (n)
HFNC	57.80 ± 16.66	M: 48.9% (43)	14.82 days	3.16	Alive: 72.7% (64)
n=88		F: 51.1% (45)			Expired: 27.3% (24)
CPAP or BiPAP	58.92 ± 14.11	M: 58.4% (73)	10.65 days	1.88	Alive: 77.6% (97)
n=125		F: 41.6% (52)			Expired: 22.4% (28)
p value	p=0.188	p=0.216	**p=0.048**	**p=0.046**	p=0.415

Table 3

Group 1: HFNC vs. CPAP or BiPAP and Intubation

	HFNC therapy	CPAP or BiPAP	p value
Time on NIV, median	6.50 hours	4.0 hours	**p= <0.001**
Time on vent post NIV, median	94.0 hours	90.0 hours	p= 0.801
Need for intubation, % (no.)	Yes: 24.4% (30)	Yes: 35.2% (31)	p= 0.119
	No: 75.6% (93)	No: 64.8 % (57)	

Table 4

Group 1: HFNC FiO2 Setting and Clinical Outcomes

Quartile (range)	Mortality, % (no.)	LOS, median	Vent need, %(no.)	Time on vent, median	DRG, Median
Q1 (40-55%)	Alive: 76.2% (16) Expired: 23.8% (5)	12.17 days	Yes: 38.1% (8) No: 61.9% (13)	51 hours	3.80
Q2 (56-70%)	Alive: 80% (16) Expired: 20% (4)	12.50 days	Yes: 35% (7) No: 65% (13)	94 hours	3.42
Q3 (71-99%)	Alive: 85.7% (12) Expired: 14.3% (2)	32.94 days	Yes: 42.9% (6) No: 57.1% (8)	267 hours	5.31
Q4 (100%)	Alive: 56.7% (17) Expired: 43.3% (13)	11.70 days	Yes: 36.7% (11) No: 63.3% (19)	96 hours	1.81
p value	p= 0.099	p= 0.062	p= 0.992	p= 0.082	**p= 0.003**

Table 5

Group 1: HFNC LPM Setting and Clinical Outcomes

Quartile (range)	Mortality, % (no.)	LOS, median	Vent need, %(no.)	Time on vent, median	DRG, Median
Q1 (9-20 LPM)	Alive: 75% (9) Expired: 25% (3)	2.77 days	Yes: 41.7% (5) No: 58.3% (7)	51 hours	2.05
Q2 (21-25 LPM)	Alive: 65.4% (17) Expired: 34.6% (9)	12.78 days	Yes: 34.6% (9) No: 65.4% (17)	42 hours	5.00
Q3 (26-30 LPM)	Alive: 68.4% (13) Expired: 31.6% (6)	17.77 days	Yes: 47.4% (9) No: 52.6% (10)	191 hours	6.85
Q4 (30-40 LPM)	Alive: 78.6% (22) Expired: 21.4% (6)	14.65 days	Yes: 32.1% (9) No: 67.9% (19)	87 hours	5.08
p value	p= 0.502	p= 0.476	p= 0.716	**p= 0.046**	p= 0.692

Table 6

Characteristics of Group 2

NIV Therapy	Age, mean ± SD	Sex, % (no.)	LOS, median	DRG, median	Mortality, % (no.)
HFNC	51.50 ± 16.94	M: 62.9% (39)	16.08	5.17	Alive: 85.5% (53)
n=62		F: 37.1% (23)			Expired: 14.5% (9)
CPAP or	58.62 ± 15.25	M: 50% (13)	18.16	5.37	Alive: 88.5% (23)
BiPAP		F: 50% (13)			Expired: 11.5% (3)
n=26	**p= 0.041**	p= 0.376	p= 0.387	p= 0.905	p= 0.975
p value					

Table 7

Group 2: HFNC vs. CPAP or BiPAP and Re-intubation

	HFNC therapy	CPAP or BiPAP	p value
Time on NIV, median	34 hours	8.50 hours	**p= <0.001**
Need for re-intubation, %, (no.)	Yes: 26.9% (7)	Yes: 23.8% (15)	p= 0.969
	No: 73.1% (19)	No: 71.6% (48)	
Delay in NIV post vent, median	3 hours	1 hour	p= 0.168

Table 8

Group 2: HFNC FiO2 Setting and Clinical Outcomes

Quartile (range)	Mortality, % (no.)	LOS, median	Vent need, %(no.)	DRG, Median
Q1 (21-40%)	Alive: 98.3% (15)	17.68 days	Yes: 31.3% (5)	5.54
	Expired: 6.3% (1)		No: 68.8% (11)	
Q2 (41-50%)	Alive: 88.2% (15)	15.89 days	Yes: 11.8% (2)	3.10
	Expired: 11.8% (2)		No: 88.2% (15)	
Q3 (51-70%)	Alive: 81.8 % (9)	17.38 days	Yes: 18.2 % (2)	5.34
	Expired: 18.2% (2)		No: 81.8 % (9)	
Q4 (71-100%)	Alive: 77.8% (14)	14.50 days	Yes: 33.3% (6)	5.04
	Expired: 22.2 (4)		No: 66.7% (12)	
p value	p= 0.167	p= 0.409	p= 0.749	p= 0.486

Table 9

Group 2: HFNC LPM Setting and Clinical Outcomes

Quartile (range)	Mortality, % (no.)	LOS, median	Vent need, %(no.)	DRG, Median
Q1 (10-20 LPM)	Alive: 87.2 % (7)	25.28 days	Yes: 37.5% (3)	5.56
	Expired: 12.5 % (1)		No: 62.5% (5)	
Q2 (21-25 LPM)	Alive: 82.4 % (14)	13.91 days	Yes: 11.8 % (2)	5.03
	Expired: 17.6% (3)		No: 88.2% (15)	
Q3 (26-30 LPM)	Alive: 82.8% (24)	18.63 days	Yes: 24.1% (7)	5.21
	Expired: 17.2% (5)		No: 75.9 % (22)	
Q4 (31-40 LPM)	Alive: 100% (8)	16.15 days	Yes: 24.2% (3)	
	Expired: 0% (0)		No: 75.8% (5)	2.99
p value	p= 0.554	p= 0.146	p= 0.596	p= 0.423

Table 10

FiO2 Settings and Time on NIV

Quartiles	Group 1 median time on NIV	Group 2 median time on NIV
Q1	12.00 hours	41.50 hours
Q2	14.00 hours	41.00 hours
Q3	25.00 hours	24.00 hours
Q4	37.50 hours	34.50 hours
p value	p= 0.103	p= 0.624

Table 11

LPM Settings and Time on NIV

Quartiles	Group 1 median time on NIV	Group 2 median time on NIV
Q1	5.50 hours	10.0 hours
Q2	30.50 hours	41.00 hours
Q3	25.00 hours	40.00 hours
Q4	30.50 hours	35.50 hours
p value	**p= 0.033**	**p= 0.039**

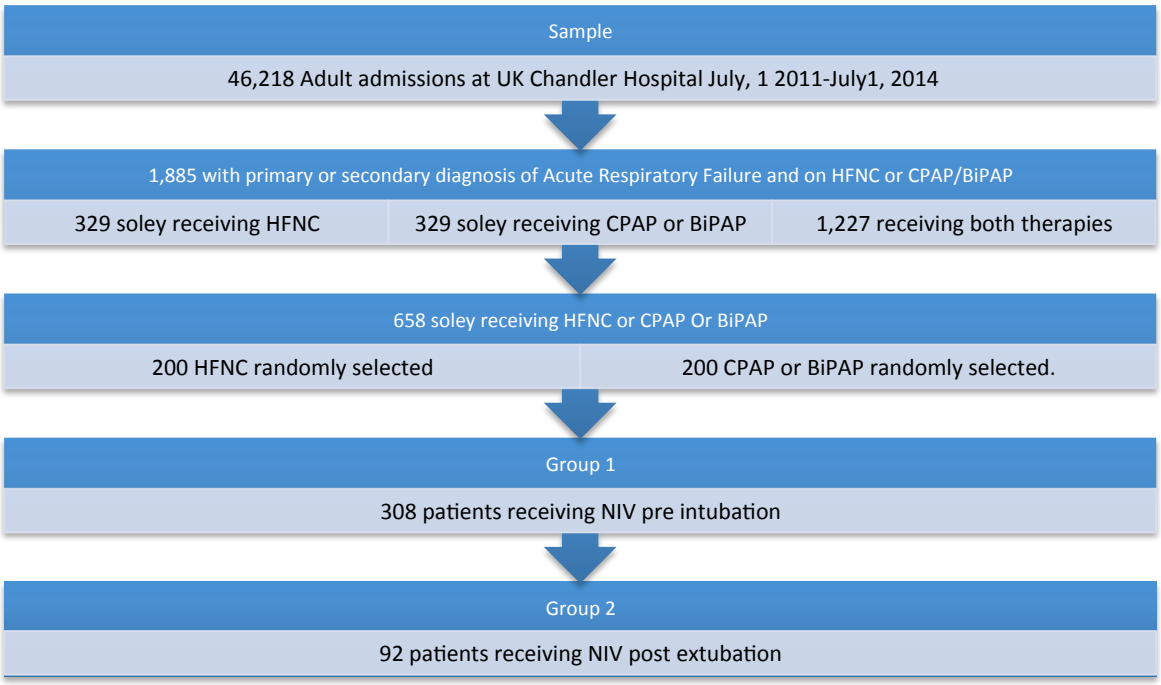

Figure 1. Sample Selection

References

Cirio, S., Piran, M., Vitacca, M., Piaggi, G., Ceriana, P., Prazzoli, M., ... Carlucci, A. (2016, August 8). Effects of heated and humidified high flow gases during high-intensity constant-load exercise on severe COPD patients with ventilatory limitation. *Journal of Respiratory Medicine*, *118*, 128-132. http://dx.doi.org/10.1016/j.rmed.2016.08.004

Frat, J., Thille, A., Mercat, A., Girault, C., Ragot, S., Perbet, S., ... Herbland, A. (2015, June 4). High-Flow Oxygen through Nasal Cannula in Acute Hypoxemic Respiratory Failure. *The New England Journal of Medicine*, *372*(23), 2185-2196. http://dx.doi.org/10.1056/NEJMoa1503326

Hernadez, G., Vaquero, C., Colinas, L., Cuena, R., Gonzalez, P., Canabel, A., ... Fernandez, R. (2016, October 18). Effect of Postextubation High-Flow Nasal Cannula vs. Noninvasive Ventilation on Reintubationand Postextubation Respiratory Failure in High-Risk PatientsA Randomized Clinical Trial. *Journal of American Medical Association*, *316*(15), 1565-1574. http://dx.doi.org/10.1001/jama.2016.14194

Nishimura, M. (2016). High-Flow Nasal Cannula Oxygen Therapy in Adults: Physiological Benefits, Indication, Clinical Benefits, and Adverse Effects. *Journal of Respiratory Care*, *61*(4), 529-541. http://dx.doi.org/10.4187/respcare.04577

Roca, O., Riera, J., Torres, F., & Masclans, J. R. (2010, April). High-Flow Oxygen Therapy in Acute Respiratory Failure. *Journal of Respiratory Care*, *55*(4), 408-413. Retrieved from http://rc.rcjournal.com.ezproxy.uky.edu/content/55/4/408.short

Stephan, F., Burrucand, B., Petit, P., Rezaiguia-Delclaux, S., Medard, A., Delannoy, B., ... Berard, L. (2015, June 16). High-Flow Nasal Oxygen vs. Noninvasive Positive AirwayPressure in Hypoxemic Patients After Cardiothoracic SurgeryA Randomized Clinical Trial. *Journal of the American Medical Association*, *313*(23), 2331-2339. http://dx.doi.org/10.1001/jama.2015.52