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Reference Article: Hayes-Bradley, Clare, et.al. "Efficacy of Nasal Cannula Oxygen as a Pre-oxygenation Adjunct in Emergency Airway Management." *Annals of Emergency Medicine* 68.2 (2016): 174-80.

PICO Question: In emergency airway management does the use of non-rebreather/bag-valve-mask plus nasal cannula improve pre-oxygenation when compared to non-rebreather/bag-valve-mask alone with and without a mask leak?

Study Design: Randomized Crossover Trial

Introduction: Emergency airway management is utilized on a daily basis by emergency physicians. A crucial step in the management of a critical airway prior to endotracheal intubation is pre-oxygenation. Pre-oxygenation prior to endotracheal intubation improves the oxygen reservoir of the lungs by "washing-out" nitrogen and increasing the functional residual capacity of the lungs. This in turn helps prevent hypoxemia during periods of apnea required for intubation. Many methods are used among emergency providers to obtain satisfactory pre-oxygenation and this study aimed to determine whether or not there was a role for nasal cannula oxygenation in addition to standard measures using a bag-valve-mask or non-rebreather with and without a simulated air leak.

Methods: This was a randomized crossover trial using healthy volunteers from the staff of St. George Hospital in Sydney, Australia. Required sample size in order to prove statistical significance was determined using a 2-sample t test as well as Cohen's method. The study enrolled 60 participants with similar age, sex, and BMI. The non-rebreather mask group ultimately ended up being slightly older than the bag-valve-mask group. 30 participants were randomized to a Bag-Valve-Mask (BVM) group and 30 to a Non-Rebreather (NRB) mask group. Exclusion criteria included: known cardiopulmonary disease or use of cardiopulmonary medications including inhalers, pregnancy, and facial hair or previous facial injury. The entire study took place in the operating room or ICU of St. George Hospital with the use of an anesthesia circuit. Participants underwent 4 trials of pre-oxygenation consisting of mask alone, mask with a simulated air leak, mask + nasal cannula (NC) and mask +NC with a simulated air leak. Both mask types, NRB and BVM were set at 15L/min and NC O₂ was delivered at 10L/min. Simulated air leaks were done using a 16 Fr nasogastric tube placed under both sides of the mask. Each subject underwent 3 minutes of pre-oxygenation for each of the 4 airway trials. At the end of the 3 minute period, subjects exhaled a single breath into an End Tidal Concentration of Oxygen device (ETO₂). Each trial was followed by a 2-3 minute wash out period with re-evaluation of ETO₂ to ensure that it had reached patients baseline ETO₂ levels. Data was analyzed using ANOVA testing with P = 0.05 as statistically significant. It was determined that a difference of 5% or more in ETO₂ would allow for an additional 30 seconds of safe apnea time in an 80kg man.

Results: The primary outcome was ETO₂ concentration. In the absence of an air leak the ETO₂ was similar for BVM alone and BVM +NC. In the presence of an air leak, BVM+NC had improved ETO₂ compared to BVM with leak with a difference in ETO₂ concentration of 25% between groups. However, despite improved levels of ETO₂ with BVM+NC with leak, BVM alone without air leak still had highest ETO₂ concentrations. NC + NRB improved final ETO₂ both with and without an air leak (difference of 15% and 17% respectively). When comparing BVM to NRB, the BVM alone resulted in the highest ETO₂ values compares with NRB alone with ETO₂ difference of 27%. In the presence of a mask leak, ETO₂ was high for NRB than BVM, with ETO₂ difference of 7%. There was no statistical difference when comparing ETO₂ level of NRB+NC+Leak with BVM+NC+Leak.

Discussion: This study sought to determine whether or not NC played a valuable role in pre-oxygenation. The results would suggest that in the presence of mask leak with BVM, utilizing NC O₂ at 10L/min would improve the length of safe apnea time when compared to BVM with mask leak alone. In patients on NRB the results indicated a statistically significant difference when using NC+NRB both with and without mask leak versus NRB alone with or without mask leak. The use of NC O₂ did not change the ETO₂ of BVM alone vs BVM+NC. This could be explained by maximum nitrogen washout obtained with BVM alone and therefore no additional benefit could be obtained with the additional of NC or the NC device created a small air leak thus not allowing for correct measurement of ETO₂. However, overall the study showed that proper use of BVM without a leak resulted in the best final ETO₂ measurements, thus practitioners must consider switching to a BVM pre-oxygenation.

Limitations: This study had many limitations. Notably that all subjects were healthy without known cardiorespiratory disease which would make a comparison to the typical emergency department patient requiring emergency airway intervention difficult. The participants also were to be clean shaven and not have any history of facial trauma, another characteristic common to the patient population requiring airway intervention in the emergency department. Also, this study was conducted using an anesthesia circuit which in many emergency departments is unavailable. The mask leak simulated does not necessarily correlate with the types of leaks present in the emergency department. This study utilized a pre-determined pre-oxygenation time of 3 minutes, which although ideal is hardly ever possible in the emergency management of an airway. Finally, this study was conducted using a single hospital and all aspects of the study were based on the equipment used and resources available at that location which may not be generalizable to the masses.

Bottom Line: This study provides a basis for continued analysis of use of nasal cannula oxygenation in conjunction with standard measures to improve pre-oxygenation and provide additional safe apnea time for emergency providers prior to airway intervention. BVM alone with good mask seal remains supreme and should be considered as first line in departments based on the results of this study. However, if unable to obtain a good mask seal then the use of NC at 10L/min+ BVM or NRB should be used during pre-oxygenation attempts prior to airway intervention.