DEM Journal Club

Article Appraisal

Article: Bag-Mask Ventilation during Tracheal Intubation of Critically Ill Adults. NEJM 380 (9); February 28, 2019.

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Background and Study Objective(s):

Peri-procedure hypoxemia complicates up to 40% of intubations occurring in the intensive care unit (ICU) and this is associated with cardiac arrest and death. While hypoxemia can be ameliorated with careful pre-oxygenation, it is unclear whether this should be delivered by bag-valve mask (which can theoretically increase aspiration risk) is unclear.

The objectives of this study were to determine the effect of bag-mask ventilation on hypoxemia during tracheal intubation of critically ill adults. Study authors hypothesized that BMV would significantly increase lowest oxygen saturation between induction and 2 minutes after tracheal intubation compared to no ventilation. They also aimed to investigate the effects of BMV vs no-ventilation on episodes of severe hypoxemia and risk of aspiration.

Study Design:

The authors conducted a multicentre, (7 academic US ICUs) parallel-group, unblinded, pragmatic, randomized trial comparing bag-mask ventilation with no ventilation during the interval between induction and laryngoscopy during tracheal intubation of critically ill adults. Protocols and statistical analysis plan was published prior to completion of enrolment. Institutions providing funding were not involved in study.

Adults (age > 18 years) undergoing induction and tracheal intubation were eligible. Exclusion criteria included: pregnant or incarcerated patients, immediate need for intubation, or treating clinician determination that BMV either required or contraindicated. Randomization was 1:1 in permuted blocks of 2, 4, and 6, stratified by trial site. Trial-group-assignments remained concealed until enrolment. There was no blinding of patients, clinicians, or research personnel after randomization. Data was collected by nurse or physician not involved in the procedure.

Patients assigned to BMV group had manual ventilation by treating clinician between induction and laryngoscopy. All airway operators in study had structured education regarding best practices in BMV. Failure to initiate BMV at the start of induction was considered protocol violation. BMV was not permitted for patients in the no-ventilation group, except after a failed attempt at laryngscoscopy, treatment for hypoxemia (SpO2 <90%), or at any point if treating clinicians determined is was necessary for patient safety. If BMV occurred prior to first laryngoscopy attempt in absence of SpO2 less than 90% in the no-ventilation group, a protocol violation was recorded. Non-invasive

ventilation not allowed in either group between induction and laryngoscopy. All other aspects of procedure including preoxygenation, positioning, apneic oxygenation, (no-ventilation group), laryngoscopy and tube placement technique were deferred to the treating clinician.

The primary outcome was lowest oxygen saturation observed during interval between induction and 2 minutes after tracheal intubation. Secondary outcome was incidence of severe hypoxemia (SpO2 < 80%) during same interval. Additional outcomes included objective clinical manifestations of aspiration in 24 hours after intubation, operator-reported aspiration, and new chest x-ray opacity within 48 h.

Primary statistical analysis was an unadjusted intention-to-treat comparison of lowest oxygen saturation between two groups using Mann-Whitney rank-sum test. Sensitivity analyses were performed accounting for prespecified confounders and correlated measurements within each trial unit with generalized estimating equations. Linear regression models assessed potential effect modification by baseline variables.

Results:

401 patients were enrolled (60% of those screened) with 199 assigned to BMV and 202 to no-ventilation. Baseline characteristics of patients were similar, as was management between enrolment and induction. Pre-oxygenation with a bag-mask was more common in the BMV group (39.7% vs 10.9%), and pre-oxygenation with non-invasive ventilation was more common in the no-ventilation group. Between induction and laryngoscopy, more patients received supplemental oxygenation in the BMV group (100% vs 78%). Mean difference between induction and laryngoscopy was 13.2 seconds longer in the BMV group.

Median lowest SpO2 between induction and 2 minutes post-intubation was 96% in the BMV group and 93% in the no-ventilation group (P=0.01). Mean difference in the lowest oxygen saturation between groups was 4.7% (95% CI, 2.5-6.8%) after adjustment. Mean difference was similar after post-hoc analysis adjusting for preoxygenation, pneumonia or GI bleeding. In prespecified subgroup analysis, patients with lower induction oxygen saturation had greater mean difference in lowest oxygen saturation between induction and laryngoscopy. Significantly more patients had severe hypoxemia (SpO2 < 80%) in the no-ventilation group than BMV group (23% vs 11%; RR 0.48 [0.30-0.77]). There were no significant differences any objective indicators suggesting aspiration, or in mortality.

Validity of Results:

This trial addressed a focused issue: effect of BMV on oxygen saturation between induction and laryngoscopy in RSI. There was a clear population of critically ill adult patients in the ICU setting. The intervention was clearly described, with very few protocol violations, and the outcomes were also relevant to the question. Patients were randomized appropriately, but blinding was not feasible which potentially influences the type of preoxygenation used by clinicians. All patients were accounted for.

The two groups were similar at baseline. Post- enrolment and pre-intubation, clinicians treated patients in both arms differently, but oxygenation at induction was statistically similar and actually numerically lower in the BMV group and post-hoc analyses accounting for pre-oxygenation methods did not alter the results. The use of supplemental oxygen was significantly higher in the BMV group, which could partially account for the study results. This was not accounted for in post-hoc analyses and the authors justified this due to a previous study showing no benefit of apneic oxygenation between induction and intubation.

The 5% difference in the mean lowest oxygen saturation and 12% absolute difference (OR 0.48) in the rate of severe hypoxemia, both favouring the BVM group appear to be of reasonable effect size and clinically relevant.

Generalizability of Results:

This it was a large multicentre trial. The pragmatic design of the trial allowed for clinicians to determine preferred peri-intubation preparation and techniques except for the study intervention, which captured significant variations in practice. Despite this, after post-hoc analyses adjusting for variations in practice, the results were consistent.

The key limitation is the ICU setting. It is likely that these patients had been under medical care for significantly longer than typical ED patients, and there are potential differences surrounding RSI management in the ICU vs ED. Many patients were excluded because their intubation was deemed too urgent to enrol and randomize in time and therefore these results cannot be applied to such patients. Very urgent intubations likely represent a significant portion of ED patients (cardiac arrest, major trauma, severe head injury, etc) in whom this strategy would be helpful to minimize hypoxemia when preparation and preoxygenation is limited. Further, in the ED setting, many intubations may be performed to prevent aspiration, and this is unlikely the case for the study cohort.

The Bottom Line:

Overall, this was a large robust randomized trial comparing bag-mask ventilation with no ventilation in the interval between induction and laryngoscopy during rapid sequence intubation of adult ICU patients. The authors concluded that bag mask ventilation is likely justice he has no ventilation with improved oxygenation and fewer episodes of severe hypoxemia.

The group agreed that the internal validity of this study was very strong, with the only major concern being the higher rate of supplemental oxygenation after induction in the intervention group that could explain some of the results. There were some differing opinions on the external validity of the study, especially in relation to the generalizability of ICU intubations to the emergency department setting. General consensus was that bag-mask ventilation could be a useful strategy in select patients at high risk for hypoxia and low risk for aspiration during intubation. With significant focus on meticulous pre-oxygenation and optimization, most ED intubations would not likely benefit from bag-mask ventilation. However, this study may offer ED providers more comfort with bag-mask ventilation, especially early in scenarios where clinicians run into any difficulty during RSI. Caution must be used not to apply the results of this study too broadly in populations excluded ,which included very urgent intubations, those at high risk of aspiration, pregnant, and pediatric patients.