

## Introduction:

Current guidelines recommend that balloon tamponade devices (BTD) should only be placed in massive esophageal variceal bleed as a temporizing measure until definitive therapy can be implemented (de Franchis et al., 2010). Blakemore tubes are used in approximately 13% of patients who present with variceal hemorrhage with hemodynamic instability (Choi et al., 2016). Physician inexperience is associated with two-fold increase in the expected mortality (Chojkier et al., 1980). However, training programs do not provide formal teaching on the use of Minnesota tubes. Our goal is to create an optimal teaching curriculum for trainees.

## Methods

We conducted a prospective randomized controlled trial starting November 2020 evaluating the use of lecture and simulation-based education compared to lecture-based teaching only for the placement of Minnesota tubes. We created a teaching curriculum involving a PowerPoint presentation and a simulation model (Young et al., 2017). Trainees from the pulmonary, critical care, gastroenterology, emergency medicine, and general surgery departments were invited to voluntarily participate. Those with prior BTD training were excluded. Trainees were evaluated while placing a BTD on the simulator followed by completing a questionnaire for baseline knowledge and confidence. Participants were randomized to the simulation arm and the non-simulation arm. All participants then received the same presentation, and those in the simulation group received hands on training. All trainees were re-tested within 30 days, 5-7 months and 10-12 months after initial presentation date. Primary end point was difference in 40-point comprehensive simulation evaluation and 10-point knowledge testing within and between the two groups. Secondary endpoint was change in confidence on Likert scale.

## Results:

We assigned 21 trainees to the simulation (n=10) and non-simulation (n=11) groups. There was no significant difference in baseline characteristics and testing results between the 2 groups. In the simulation group the mean comprehensive simulation score at baseline, 1-month, and 6-month was 21.0, 29.0 ( $p<0.0001$ ), and 28.7 ( $p<0.001$ ), respectively. The mean knowledge testing score within the simulation group at baseline, 1-month, and 6-month was 5.3, 8.2 ( $p=0.0001$ ), and 6.7 ( $p=0.03$ ), respectively. Within the non-simulation group the mean baseline, 1-month, and 6-month comprehensive simulation score was 20.5, 26.8 ( $p=0.001$ ), and 25.7 ( $p=0.04$ ), respectively. The mean knowledge testing score in the non-simulation group at baseline, 1-month, and 6-month was 6.0, 7.6 ( $p=0.04$ ), and 7.0 ( $p=0.37$ ), respectively.

Similar pattern was noted in confidence evaluation. In the simulation arm, the mean confidence score at baseline, 1-month, and 6-month in placement was 2.40, 3.70 ( $p=0.003$ ), and 3.42 ( $p=0.045$ ) and teaching the Minnesota tube was 1.60, 3.60 ( $p=0.0001$ ), and 3.14 ( $p=0.004$ ), respectively. Within the non-simulation group the mean confidence score at baseline, 1-month, and 6-month in placing a Minnesota tube was 2.18, 3.18 ( $p=0.02$ ), and 3.00 ( $p=0.04$ ) and teaching placement was 1.73, 2.73 ( $p=0.001$ ), and 2.71 ( $p=0.08$ ), respectively. There was no significant difference in testing results between the two groups.

### Conclusion:

Our study showed significant improvement at 1-month testing in knowledge, skill, and confidence in non-simulation and simulation arms compared to baseline. The simulation arm had sustained significant improvement in ability, knowledge, confidence in placing and teaching Minnesota tubes at the 6-month testing. The non-simulation arm had maintained significant improvement in only ability and confidence in placing of a Minnesota tube.

We sought to find a way to teach trainees a procedure that while done infrequently, is potentially lifesaving. However, there is currently no established curriculum to teach this in the United States. Our study shows that combining lecture and simulation-based training had better and sustained outcomes compared to lecture only training. Programs should institute Minnesota tube curriculum into training. Our study is still ongoing, and we plan to continue enrollment over the coming years.