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# Simulator-Based angiography and endovascular neurosurgery curriculum: A longitudinal evaluation of performance following simulator based diagnostic angiography and endovascular neurosurgery training.

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**Introduction:** This study establishes performance metrics for angiography and neuroendovascular surgery procedures based on longitudinal improvement in individual trainees with differing levels of training and experience.

**Methods:** After 120 minutes didactic instruction in angiography and endovascular neurosurgery, five trainees performed ten diagnostic angiograms, coiled ten carotid terminus aneurysms in the setting of subarachnoid hemorrhage, and performed ten left middle cerebral artery embolectomies on a Simbionix ANGIOmentor simulator over the course of 30 days. All procedures were nonconsecutive. Total procedure time, fluoroscopy time, contrast dose, heart rate, blood pressures, medications administered, packing densities, number of coils used, and number of stent-retriever passes were recorded. Image quality was rated, and the absolute value of technically unsafe events was recorded. The trainees' device selection, macrovascular access, microvascular access, clinical management, and overall performance of the trainee was rated during each procedure based on a traditional Likert scale score of 1=fail, 2=poor, 3=satisfactory, 4=good, and 5=excellent. (Figure 1)

**Scoring Sheet**

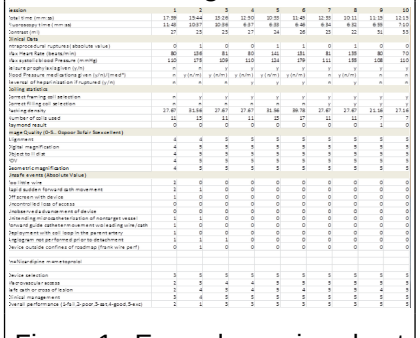

Figure 1: Example scoring sheet used for scoring of participants during aneurysm coiling.

**Results:**

After completion of the diagnostic angiography portion of our simulator curriculum, participants demonstrated an 86 percent reduction in total procedure time, a 75 percent reduction in fluoroscopy time, and a 68 percent reduction in contrast utilized. There was a 25 percent improvement in the image quality. There was a reduction in unsafe techniques from an average absolute value of 4.2 events to 0 events. There was a 64 percent improvement in overall Likert Scale performance score (Figure 2).

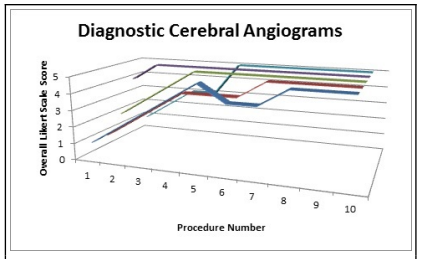


Figure 2: 3D graph of performance over 10 cerebral angiograms.

After completion of the permanent aneurysm coil embolization portion of our simulator curriculum, participants demonstrated a 42 percent reduction in total procedure time, a 57 percent reduction in fluoroscopy time, and a 21 percent reduction in contrast utilization. There was no statistically significant difference in quality of images produced during the coil embolization procedures. There was a reduction in unsafe technique from an average absolute value of 6.4 events to 0 events. There was a 58 percent improvement in overall Likert scale score (Figure 3).

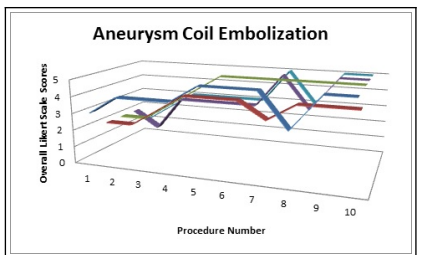


Figure 3: 3D line graph of performance over 10 aneurysm coil embolizations.

After completion of the mechanical embolectomy portion of our simulator curriculum, participants demonstrated a 35 percent reduction in total procedure time, a 41 percent reduction in fluoroscopy time, and a 49 percent reduction in contrast utilization. There was no statistically significant difference in quality of images produced during the mechanical embolectomy procedures. There was a reduction in unsafe technique from an average absolute value of 5.3 events to 0 events. There was a 67 percent improvement in overall Likert scale score (Figure 4).

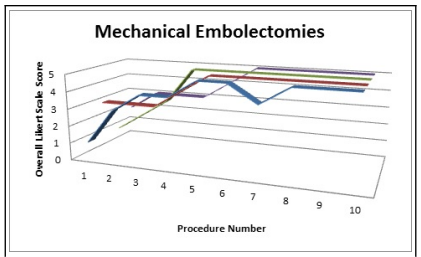


Figure 4: 3D line graph of performance over 10 mechanical embolectomies.

All variables were compared using ANOVA and Tukey's HSD tests to evaluate for significance of each variable between each procedure. All participants demonstrated statistically significant differences in performance after 5 angiograms, 5 embolectomies, and the first 9 aneurysm coil embolizations ($p < 0.05$ all variables). The participants continued to improve after the aforementioned number of repetitions; however, the differences were not statistically significant.

**Discussion:** Based upon our results, we would recommend that trainees should perform a minimum of 5 simulated angiograms, 5 simulated embolectomies, and 10 simulated aneurysm permanent coil embolizations prior to scrubbing for endovascular neurosurgery cases.

**Conclusions:**

In this study, we established an introductory simulator curriculum and statistically validated performance metrics. However, we recognize the need for future studies correlating our simulator curriculum with improvement in clinical performance.

**References:**

1: Fargen KM, Arthur AS, Bendok BR, Levy EI, Ringer A, Siddiqui AH, Veznedaroglu E, Mocco J. Experience with a simulator-based angiography course for neurosurgical residents: beyond a pilot program. Neurosurgery. 2013 Oct;73 Suppl 1:46-50.