## Bleeding

Technically known as hemorrhaging or hæmorrhaging (see American and British spelling differences), is blood escaping from the circulatory system.

Impaired hemostasis represents a major risk factor for bleeding complications in neurosurgical patients.

## Prevention

To reduce the risk of bleeding, coagulopathy need to be identified and corrected prior to the procedure. Ideally, patients should have an INR $\leq$ 1.6, platelet count>100K, and no recent antiplatelet medication (can be screened by checking thromboelastogram (TEG)).

Elevated INR: for patients with an elevated INR (such as patients on warfarin), it has generally been recommended the procedure be delayed until the INR is  $\leq 1.6$  in order to reduce the risk of hemorrhage to an acceptable level.

Severe bleeding during neurosurgical operations can result in acute stress affecting the bimanual psychomotor performance of the operator, leading to surgical error and an adverse patient outcome.

Virtual reality simulators, such as NeuroTouch, allow the testing of acute stress on psychomotor performance in risk-free environments. Thus, the purpose of this study was to explore the impact of a simulated stressful virtual reality tumor resection scenario by utilizing NeuroTouch to answer 2 guestions: 1) What is the impact of acute stress on bimanual psychomotor performance during the resection of simulated tumors? 2) Does acute stress influence bimanual psychomotor performance immediately following the stressful episode? METHODS Study participants included 6 neurosurgeons, 6 senior and 6 junior neurosurgical residents, and 6 medical students. Participants resected a total of 6 simulated tumors, 1 of which (Tumor 4) involved uncontrollable "intraoperative" bleeding resulting in simulated cardiac arrest and thus providing the acute stress scenario. Tier 1 metrics included extent of blood loss, percentage of tumor resected, and "normal" brain tissue volume removed. Tier 2 metrics included simulated suction device (sucker) and ultrasonic aspirator total tip path length, as well as the sum and maximum forces applied in using these instruments. Advanced Tier 2 metrics included efficiency index, coordination index, ultrasonic aspirator path length index, and ultrasonic aspirator bimanual forces ratio. All metrics were assessed before, during, and after the stressful scenario. RESULTS The stress scenario caused expected significant increases in blood loss in all participant groups. Extent of tumor resected and brain volume removed decreased in the junior resident and medical student groups. Sucker total tip path length increased in the neurosurgeon group, whereas sucker forces increased in the senior resident group. Psychomotor performance on advanced Tier 2 metrics was altered during the stress scenario in all participant groups. Performance on all advanced Tier 2 metrics returned to pre-stress levels in the post-stress scenario tumor resections. CONCLUSIONS Results demonstrated that acute stress initiated by simulated severe intraoperative bleeding significantly decreases bimanual psychomotor performance during the acute stressful episode. The simulated intraoperative bleeding event had no significant influence on the advanced Tier 2 metrics monitored during the immediate post-stress operative performance <sup>1)</sup>.

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## **Blood loss estimation**

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Bajunaid K, Mullah MA, Winkler-Schwartz A, Alotaibi FE, Fares J, Baggiani M, Azarnoush H, Christie S, Al-Zhrani G, Marwa I, Sabbagh AJ, Werthner P, Del Maestro RF. Impact of acute stress on psychomotor bimanual performance during a simulated tumor resection task. J Neurosurg. 2016 Mar 11:1-10. [Epub ahead of print] PubMed PMID: 26967787.

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