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Supplemental material

Interval assessment using task- and procedure-based simulations: an attempt to supplement neurosurgical residency curriculum

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Supplemental Table 1: NETS-SAS system for scoring of task-based exercises.

| S. No. | Criteria | Evaluation parameter | 1 | 2 | 3 | 4 |
|---|--------------------------------|---|---|-------------------------------|-----------------------------|----------------------|
| 1 | Eye hand coordination | -Handling of instruments (Needle holder, forceps, endoscope, grasper) -Depth perception (under magnification) | Continuous struggle throughout the activity | Frequent loss of coordination | Grossly smooth coordination | Perfect coordination |
| 2 | Instrument tissue manipulation | -Tissue handling under magnification with various instruments -Appropriate pressure and force -Confrontation with neighboring objects (Repeated puncture) | Grossly unacceptable | Frequent difficulty | Smooth handling | Perfect manipulation |
| 3 | Dexterity | -Tremors/ jitteriness -Therblig (intraoperative elemental motion) | Irregular therblig/ tremors/ jitteriness throughout the activity | Frequent difficulty | Grossly smooth | Perfect dexterity |
| 4 | Flow of procedure | -Time management during activity -Total duration in task completion -Unnecessary delays in inter or intra therblig | Grossly unacceptable | Frequent lapses | Grossly smooth | Perfect flow |
| 5 | Effectualness | Evaluation of end result on predefined criteria* for: -Microsuturing -Neuroendoscopy | Grossly unacceptable | Partially acceptable | Grossly acceptable | Perfect end result |
| *Criteria for effectualness | | | | | | |
| Microsuturing | | | Neuroendoscopy | | | |
| <ul style="list-style-type: none"> • Margins (overlapped/loose/apposed) • Inter-sutural distance (equal/unequal) • Sutural distance on both sides of the incision (equal/unequal) • Angulation between suture and knot (Near perpendicular- Yes/No) | | | <ul style="list-style-type: none"> • Final position of rings <ol style="list-style-type: none"> 1. \geq 3 rings slipped 2. 2 rings slipped 3. 1 ring slipped 4. All rings in place | | | |

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Supplemental Table 2: Lab Credit system based on the number of iterations and complexity of the task practiced.

| | Level | Task | Lab credits per iteration |
|----------------------|---------------------|-----------------------------------|----------------------------------|
| Microsuturing | Basic | Microsuturing 4-0/5-0 at MF 0.4-1 | 1 |
| | Intermediate | Microsuturing 7-0/8-0 at MF 1 | 1.25 |
| | | Microsuturing 7-0/8-0 at MF 1.6 | 1.5 |
| | Advanced | Microsuturing 9-0/10-0 at MF 1.6 | 1.5 |
| | | Microsuturing 9-0/10-0 at MF 2.5 | 2 |
| Endoscopy | Basic | Papaya and capsicum model | 1 |
| | Advanced | Box-neuro-endo-trainer | 2 |

Supplemental Table 3: In-built score of NeuroVR: ETV module

| Metric | Unit | Thresholds* | | Overall Score weight |
|--|------|---------------|---------------|---------------------------------------|
| | | metric value | metric grade | |
| Probed ideal perforation site? | - | yes no | 100 0 | 25% |
| Perforated ideal site? | - | yes no | 100 0 | 75% |
| Touched wall of lateral ventricle, wall of third ventricle, mammillary body, clivus region, infundibulum recess, supraoptic recess, mesencephalon, pons or pons region? | - | yes no | 100 0 | -10% for each structure reached |
| Touched basilar region, arterial branch region or choroid plexus? | - | yes no | 100 0 | -50% for each structure reached |
| Touched fornix or basilar artery? | - | yes no | 100 0 | -100% for each structure reached |
| Perforated clivus? | - | yes no | 100 0 | -30% |
| Perforated wall of lateral ventricle, wall of third ventricle, mammillary body, clivus region, infundibulum recess, supraoptic recess, mesencephalon, pons or pons region? | - | yes no | 100 0 | -50% for each structure perforated |
| Perforated fornix, basilar region, basilar artery, or arterial branch region? | - | yes no | 100 0 | -100% for each structure reached |
| Similarity of perforation shape to ideal | - | 0 0.7 1 | 100 0 0 | -30% |

Supplemental Table 4: In-built score of NeuroVR: GBM module

| Metric | Unit | Thresholds* | | Overall Score weight |
|---------------------------------|------|--------------|--------------|----------------------|
| | | metric value | metric grade | |
| Percentage of tumour removed | % | 0 | 0 | 100% |
| | | 75 | 50 | |
| | | 80 | 85 | |
| | | ≥85 | 100 | |
| Volume of healthy brain removed | cc | 0 | 0 | -100% |
| | | 4.05 | 0 | |
| | | ≥8 | 100 | |
| Total blood loss | cc | 0 | 0 | -100% |
| | | 5 | 0 | |
| | | ≥10 | 100 | |
| Hemostasis | - | yes | 0 | -50% |
| | | no | 100 | |

Supplemental Table 5: In-built score of NeuroVR: Hemilaminectomy module

| Metric | Unit | Thresholds* | | Overall Score weight |
|---|------|--------------|--------------|----------------------|
| | | metric value | metric grade | |
| Volume of L3 vertebra removed | cc | 0 | 0 | 100% |
| | | 1 | 100 | |
| | | 1.2 | 100 | |
| | | ≥1.8 | 0 | |
| Volume of spinal cord removed | cc | 0 | 0 | -100% |
| | | 0.2 | 0 | |
| | | ≥1 | 100 | |
| Volume of vertebra other than L3 removed | cc | 0 | 0 | -25% |
| | | ≥0.1 | 100 | |
| Volume of flavum ligament (L4-L3) removed | cc | 0 | 0 | -25% |
| | | 0.05 | 0 | |
| | | ≥0.1 | 100 | |
| Volume of flavum ligament (L3-L2) removed | cc | 0 | 0 | -25% |
| | | 0.05 | 0 | |
| | | ≥0.1 | 100 | |

| | | | | |
|--|----|-------------------|---------------|-----------------------|
| Volume of other tissue removed | cc | 0 0.07 ≥0.2 | 0 0 100 | -25% |
| Excessive force to spinal cord (left and right hands) | s | 0 ≥1 | 0 100 | -50% for each hand |
| Total blood loss | cc | 0 ≥0.05 | 0 100 | -25% |

Supplemental Table 6: Allotted scores for each VR exercise and linear transformation of in-built scores to the allotted scores

| VR System | VR exercise | In-built Score (x) | | Allotted Score (y) | | Linear Transformation |
|---------------|-----------------|--------------------|---------|--------------------|---------|--|
| | | Minimum | Maximum | Minimum | Maximum | |
| NeuroVR | ETV | -1350 | 100 | 0 | 10 | $y = \left(\frac{x + 1350}{1450}\right) \times 10$ |
| | Glioma | -250 | 100 | 0 | 15 | $y = \left(\frac{x + 250}{350}\right) \times 15$ |
| | Hemilaminectomy | -325 | 100 | 0 | 5 | $y = \left(\frac{x + 325}{425}\right) \times 5$ |
| ImmersiveView | EVD* | 0 | 16 | 0 | 5 | $y = \left(\frac{x}{16}\right) \times 5$ |
| | Pedicle Screw | 0 | 100 | 0 | 5 | $y = \left(\frac{x}{100}\right) \times 5$ |

*Number of catheter holes in ventricle

Supplemental Questionnaire: Feedback form for the residents regarding the utility of task and procedure-based evaluation model

* Required

1. Using the silastic sheet micro-suturing will help you improve the surgical dexterity. *

Mark only one oval.

| | 1 | 2 | 3 | |
|----------|-----------------------|-----------------------|-----------------------|-------|
| Disagree | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Agree |

2. Using the box endotrainer will help you improve the surgical dexterity. *

Mark only one oval.

| | 1 | 2 | 3 | |
|----------|-----------------------|-----------------------|-----------------------|-------|
| Disagree | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Agree |

3. The feedback in the form of AIIMS NETS scores will help you identify the target areas of improvement. *

Mark only one oval.

| | 1 | 2 | 3 | |
|----------|-----------------------|-----------------------|-----------------------|-------|
| Disagree | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Agree |

4. Virtual Reality based learning helped in better understanding of the surgical procedure. *

Mark only one oval.

| | 1 | 2 | 3 | |
|----------|-----------------------|-----------------------|-----------------------|-------|
| Disagree | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Agree |

5. Using the Virtual Reality system will help you improve the surgical dexterity. *

Mark only one oval.

| | 1 | 2 | 3 | |
|----------|-----------------------|-----------------------|-----------------------|-------|
| Disagree | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Agree |

6. The feedback in the form of scores provided by the Virtual Reality system will help you identify the target areas of improvement. *

Mark only one oval.

| | 1 | 2 | 3 | |
|----------|-----------------------|-----------------------|-----------------------|-------|
| Disagree | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Agree |

7. Were you satisfied with the current combination of task-based and VR-based assessment of neurosurgical skills and would you like this assessment to be made a part of the curriculum and the final exit examination? *

Mark only one oval.

- Yes
 No

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