CLINICAL PERFORMANCE AND MULTITASKING : A SIMULATION-BASED STUDY

Findings on Cognitive Availability under Multitasking Conditions: The FOCUS Study

STUDY PROTOCOL: 06/05/2026

STUDY N°: IRB 00010254 - 2026 – 078

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LIST OF ABBREVIATIONS

GAUH: Grenoble-Alpes University Hospital

E-CRF: e-Case Report Form

EtCO2: end-tidal CO2

HR: heart rate

RR: respiratory rate

NFC: need for cognition

NIBP: non-invasive blood pressure

SpO2: peripheral oxygen saturation

SCT: Script Concordance Test

Vti: inspiratory tidal volume

BACKGROUND

Task interruption and multitasking are part of the daily reality of healthcare professionals, particularly in the operating room, and have been widely associated in observational studies with an increased risk of medical errors (1,2). Furthermore, these phenomena have been shown to induce cognitive failure in controlled laboratory studies (3,4), but studies conducted in complex healthcare environments, whether real or simulated, remain scarce (5–7).

Two studies involving simulated laparoscopic procedures interrupted by clinical questions demonstrated a significant increase in errors compared with clinical questions asked in a quiet environment; however, the questions were not standardized or externally validated (8,9). To our knowledge, no similar simulation study has been conducted in anesthesiology.

The objective of this study is to assess the clinical performance of anesthesiologists in a simulated multitasking environment compared with quiet conditions.

STUDY PROTOCOL

1 Description of the research

This is a simulation-based study comparing clinical reasoning under multitasking conditions with clinical reasoning under calm conditions. Multitasking work will consist of manual mask ventilation on a mannequin, disrupted by oral clinical questions in the form of a Script Concordance Test (SCT). Clinical reasoning under calm conditions will also consist of answering oral clinical questions in the form of an SCT.

Each subject will be their own control. The study will comprise two visits: one visit with a multitasking work simulation session, constituting the intervention; and one control visit, with clinical questions asked in calm conditions. The order of the visits will be randomized among participants (cross-over design), to limit a potential learning bias.

2 Objectives and outcome criteria

2.1 Primary objective

To assess clinical reasoning during multitasking compared with quiet conditions.

2.2 Primary outcome

Concordance score with the expert panel on a Script Concordance Test (SCT)

2.3 Secondary objectives

To compare, in a multitasking situation compared with quiet conditions:

1. Variance of expiratory tidal volume: baseline; ventilation-only; ventilation plus clinical-question
2. Variance of respiratory rate: baseline; ventilation-only; ventilation plus clinical-question
3. Cognitive workload:
    a. NASA-TLX score (/100) : baseline; ventilation plus clinical-questions

   b. Response time to questionnaire items (seconds): time between end of question and answer of participant. Simulation; control.

4. Exploratory subgroup analysis of the primary outcome according to:
   a. Clinical anesthesia experience (≤ 5 semesters vs. > 5 semesters)
   b. Handedness (left-handed vs. right-handed)
   c. Advanced musical practice (< 5 years vs. ≥ 5 years)
   d. Need for Cognition Scale score (< or > the group median; 5-point scale)
5. Exploratory subgroup analyses of expiratory tidal volume variance and respiratory rate variance according to:
   a. Clinical anesthesia experience (≤ 5 semesters vs. > 5 semesters)
   b. Handedness (left-handed vs. right-handed)
   c. Advanced musical practice (< 5 years vs. ≥ 5 years)
   d. Need for Cognition Scale score (< or > the group median; 5-point scale)
6. Descriptive analysis of ventilation parameters: training phase (baseline), simulation phase (ventilation-only and ventilation plus clinical questions):
   a. Inspiratory tidal volume (ml)
   b. Expiratory tidal volume (ml)
   c. Respiratory rate (cycles/minute)
   d. Resumption lag: time required to re-establish stable ventilation following interruption (seconds)

3 Type of study

- Simulation-based study on healthy volunteers
- Comparative
- Prospective
- Single-center
- Randomized in a crossover design

4 Population

The study population is a sample of anesthesia and intensive care physicians working at Grenoble University Hospital: residents, and hospital practitioners. Each subject will be contacted by email; inclusions will take place from 26/05/2026 to 31/12/2026.

5 The Script Concordance Test

5.1 General considerations

The Script Concordance Test (SCT) is a tool used to assess clinical reasoning in situations of uncertainty. Its use makes it possible to discriminate between different levels of expertise among medical students, residents, and attending physicians (10).

The examination consists of several clinical vignettes associated with questions, commonly referred to as items. Each clinical vignette describes a deliberately complex clinical situation that does not provide sufficient information to establish a diagnosis, indicate further investigations, or guide medical decisions. Each item introduces new information that may or may not influence clinical management; the participant must assess the impact of this information using a 5-point Likert scale ranging from −2 to +2. Items associated with the same clinical vignette are independent of one another and may be diagnostic, therapeutic, or investigative in nature.

The participant's score is calculated according to the degree of concordance between their responses and those of an expert panel previously administered the test. Each item is scored out of one point, and the total score is converted to a percentage reflecting concordance with expert responses, which is the outcome measure commonly used in the literature.

The standard SCT consists of 20 clinical vignettes with three items each, corresponding to a total of 60 questions (11). Depending on the stakes of the examination, the expert panel should include between 10 and 20 experts. Items are subsequently selected according to the variability of expert responses and may undergo post-processing according to published recommendations in order to improve their discriminatory power (12). After administration to students, the examination is generally considered to demonstrate moderate reliability with a Cronbach's alpha coefficient above 0.7, and good reliability above 0.8.

5.2 In the present study

Our study uses a 60-question SCT distributed across 20 clinical anesthesia vignettes, which demonstrated its ability to differentiate a group of 60 junior anesthesia and intensive care residents from a group of 47 senior residents, despite a Cronbach alpha of 0.63 (13). After analysis and processing of the items based on the responses of the panel of 10 experts, 44 items were retained, distributed across 8 vignettes with 3 items, 8 vignettes with 2 items, and 4 vignettes with 1 item. The vignettes were then adapted, without changing their content, to be compatible with oral delivery and the simulation scenario.

For each subject, the SCT clinical vignettes will be randomized between "simulation vignettes" and "control vignettes", with stratification on the number of items per vignette. This will make it possible to limit the effect of differences in difficulty between vignettes, which could bias the results. In total, at the group level, all clinical vignettes will be assessed in the simulation session and in the control situation.

6 Intervention and control

6.1 Inclusion

At inclusion, subjects' demographic characteristics will be collected: experience in anesthesiology (semesters). A Need for cognition test (18 questions) will be performed, assessing the subject's propensity for complex cognitive tasks; as well as two psychometric characteristics (advanced musical practice, handedness).

6.2 Intervention

The multitasking simulation session consists of an anesthesia induction scenario performed on a manikin, involving manual face-mask ventilation interrupted by telephone calls during which clinical vignettes are presented.

Participants will be instructed to manually ventilate the manikin with a target inspiratory tidal volume (VTi) of 500 mL at a respiratory rate of 16 breaths/minute. Participants will have a

ventilation training phase before simulation during which their baseline performances will be recorded.

Telephone calls will be handled by a facilitator playing the role of a student to whom the on-call phone has been entrusted and who will orally relay the clinical questions to the participant, thereby allowing the participant to keep both hands free during ventilation.

Five vignettes will be randomly selected from the set of 20 vignettes, with stratification according to the number of items per vignette (2 vignettes with 3 items, 2 vignettes with 2 items, and 1 vignette with 1 item; corresponding to a total of 11 items). As each vignette constitutes one interruption, each participant will therefore be interrupted five times during manual ventilation. The order of vignette presentation will also be randomized.

The manikin used is a Resusci Anne (Laerdal®), monitored with heart rate, peripheral oxygen saturation, and non-invasive blood pressure. Neuromuscular blockade will be monitored using Train-of-Four (TOF) stimulation. The manikin will be manually ventilated with a bag-valve device and connected to a TestChest® lung simulator (Organis, 2015). The simulator is connected to a computer allowing automated collection of ventilation data (AQAI SIS® software) and adjustment of the physiological parameters of the artificial lung. An extended monitor displays the interface of an anesthesia ventilator in manual ventilation mode, including measured flow, pressure, and volume parameters.
The simulation sessions will be video- and audio-recorded in order to allow retrospective assessment of the primary outcome measure.

The complete simulation framework, developed in accordance with French guidelines for good practice in simulation-based education, is presented in Appendix 1.

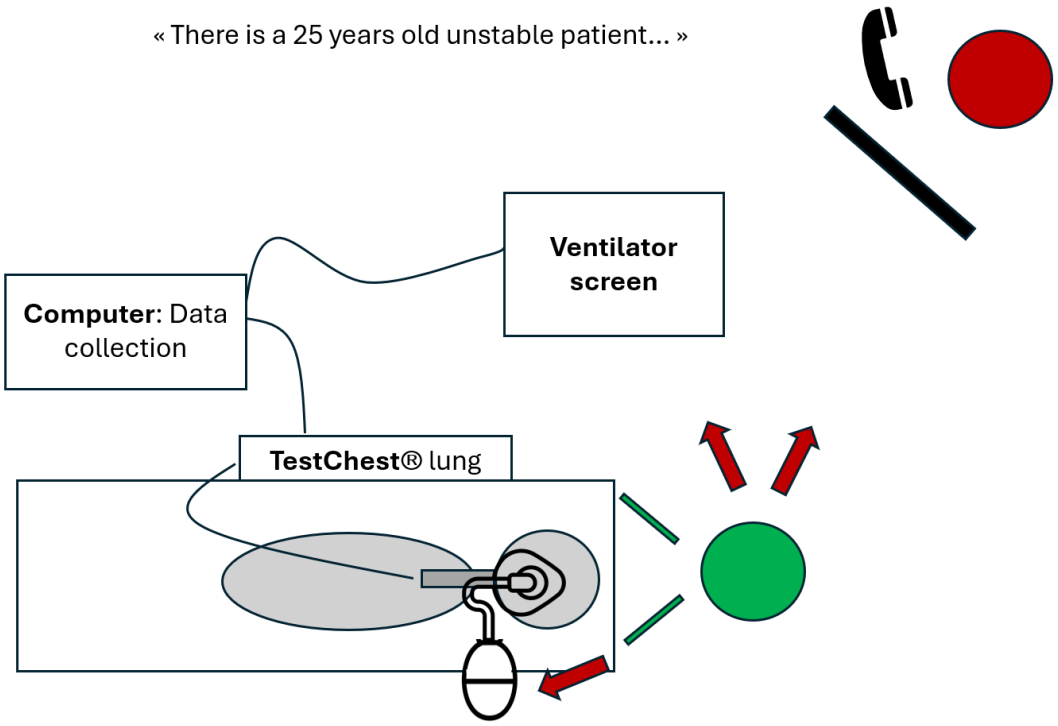

Figure 1: simulation setting

6.3 Control

During the control situation, each subject will respond to the clinical vignettes not assessed during the simulation (15 vignettes, 33 items). The vignettes will be stated orally by the investigator, and answered orally by the subject, in the same format as during the simulation.

6.4 Synthetic course of the study

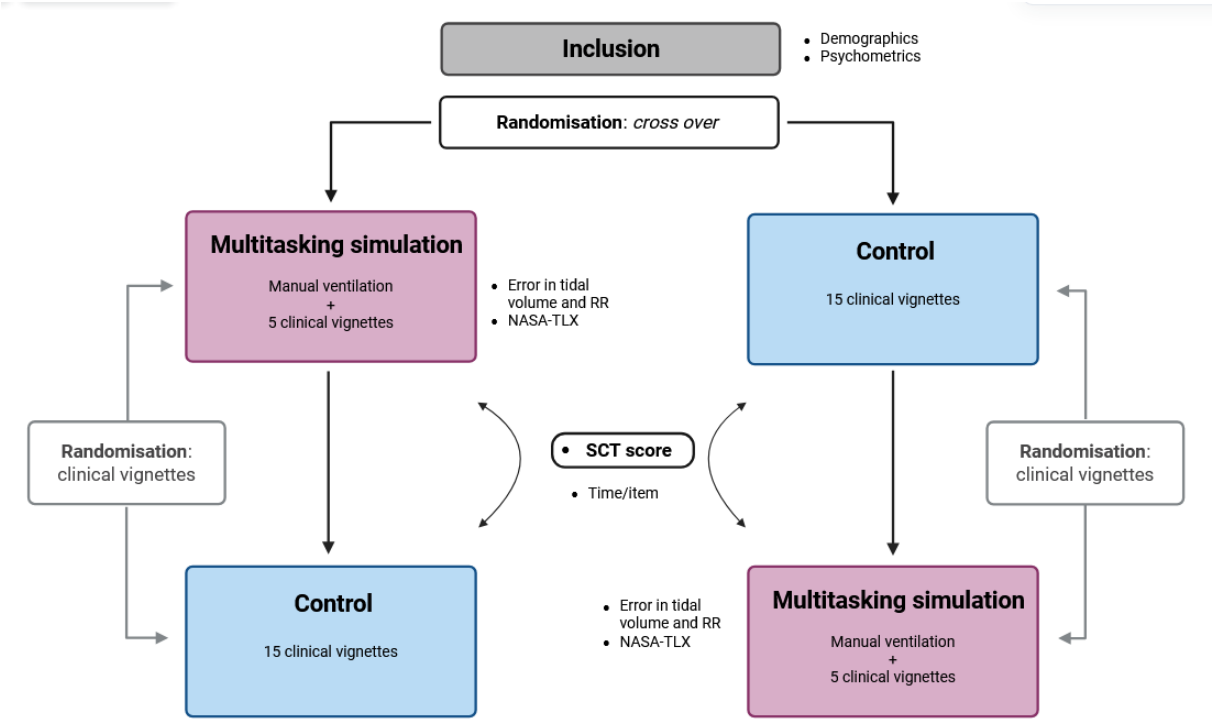

Figure 2: synthetic course of the study

7 Statistical analysis plan

7.1 Required Number of Participants

Based on the results of the study by Ducos et al. (13), from which the Script Concordance Test items used in this study were derived, and assuming a minimal clinically relevant difference in expert concordance of 6% (14) with a type I error rate (alpha risk) of 5%, the estimated statistical power was 98% for the inclusion of 35 participants responding to 11 randomized items under multitasking conditions and 33 items under control conditions.

This estimate was based on simulations using a linear mixed-effects model replicated 1,000 times, testing different combinations of participant number, number of items administered under multitasking conditions, structured effects (inter-subject and inter-item variability), and residual effects.

The retained distribution of total item variance was as follows: 30% structured effect (18% inter-subject variance and 12% inter-item variance) and 70% residual effect. This distribution was considered conservative, as it retained the highest residual effect while maintaining statistical power above 95%. The distribution of the structured effect, consisting of 60% inter-subject variability and 40% inter-item variability, is consistent with classical test theory and with the Cronbach's alpha coefficient of the SCT used (63%).

7.2 Data analysis

A descriptive analysis of the entire population will be performed. Quantitative variables will be described by mean and standard deviation or by median and interquartile range if normality conditions are not graphically verified. Qualitative variables will be described by count and percentage. The number of missing data will also be presented.

SCT scores will be calculated using a score calculator available on the website https://cpass.umontreal.ca/formation-graduee/concordance/tcs/corriger_tcs/ and RStudio (2026.01.1 or later).

The primary outcome criterion will be described by mean and standard deviation, then analyzed using a linear mixed-effects model accounting for individuals and items.

Secondary ventilation-related outcomes (variance of tidal volume and variance of respiratory rate) will be analyzed using linear mixed-effects models accounting for individuals

The exploratory analysis will use a Student's t-test (Welsh if variances between groups are significantly unequal, or Wilcoxon in the event of a graphically asymmetric distribution) for each subgroup.

The significance threshold will be 5%.

The statistical analysis will be performed by the person responsible for implementing the research, using R-Studio software (2026.01.1 or later), and by the Data Stat unit of Grenoble-Alpes University Hospital (GAUH).

7.3 Database

Subject data will be pseudonymized (initials + number). Data extracted from the TestChest® lung simulator will be stored in an Excel database on a GAUH computer.

All other data will be entered into a RedCap® database and stored under a Grenoble Alpes University Hospital license. Analyses will be performed according to the usual quality procedures of the DataStat unit of Grenoble-Alpes University Hospital after database lock.

8 Projected research timeline

Inclusion period (projected start and end dates): 05/2026 to 12/2026

- Planned duration of data monitoring and statistical analysis: 2 months
- Total duration of the research (=collection period + analysis duration): 8 months

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APPENDIX

1. Appendix 1: Complete simulation scenario: SofraSims template

IMMERSIVE SIMULATION SCENARIO
Anesthesia and multitasking

SCENARIO CONTEXT			
Simulation center	Alpes Research Evaluation and Simulation Center		
Author(s)	LESAGE Alexis, EVAIN Jean-Noël		
Contact email	alesage@chu-grenoble.fr		
Revision date	20/04/2026		
Educational team (specify whether trained in simulation)	EVAIN Jean-Noël: instructor, trained. LESAGE Alexis: technician, actor, not trained.		
Short summary of the scenario for TRAINERS	An anesthesiologist has performed a standard-sequence induction in the operating room for a cervical spine osteosynthesis procedure. He is positioned at the head of the patient and performs manual face-mask ventilation while awaiting complete neuromuscular blockade. At the same time, he must answer clinical questions in the form of a Script Concordance Test, which are transmitted via the resident answering the on-call phone.		
Target learners	Number	Functions (professional attire)	Previous professional experience required in relation to the simulation
	35	**DESAR, MAR. Operating room attire.**	**No**
Possible link with a training program	No link with a training program		

TRAINING OBJECTIVES
Educational and specific needs of learners
Multitasking work has shown cognitive failure in many contexts. However, few anesthesia healthcare professionals are truly sensitized to this issue. The objective of this simulation is to sensitize participants to the limits of their working memory under high cognitive load, and to conduct a study describing the alteration of their clinical performance during multitasking.
Educational objectives (3 to 5 max, in total)

Technical skills	Non-technical skills
- Manual face-mask ventilation	- Working in multitasking

Possible emergent educational objectives
- Detect high-risk situations with high cognitive load for which the task must not be interrupted: induction, emergence, safety checklist, medication preparation. - Identify the multitasking work situations that are most cognitively disruptive: low expertise on the primary task, interruption modality similar to the modality of the primary task (e.g., visual task at the same time as another visual task), high multitasking work time, etc. - Identify strategies for managing task interruption: temporization, refusal, cognitive aids as markers for returning to the initial task. - Identify strategies for reducing cognitive load: stepping back in the event of leadership in a complex situation, writing anesthesia protocols and doses in the event of complex induction, etc.

SCENARIO PREPARATION

Documents associated with the scenario to be provided during the session if needed	
Educational documents to be given to learners pre- and/or post-session	Cognitive aid developed by the educational team: - Key figures on medical errors related to interruptions/multitasking - 4 situations not to interrupt: sterile cockpit in anesthesia - Strategies for managing interruptions and cognitive load (red flags, compensation)
Bibliographic references or recommendations relating to the scenario	Task interruption during anesthesia activities in the operating room and in the post-anesthesia care unit: https://has-sante.fr/upload/docs/application/pdf/2020-04/guide_it_anesthesie_vd.pdf. Wickens, C. (2021) "Attention: Theory, Principles, Models and Applications", International Journal of Human-Computer Interaction, 37(5), p. 403-417.- Brixey, J.J. et al. (2007) "A Concept Analysis of the Phenomenon Interruption"; Advances in Nursing Science, 30(1), p. E26-E42.- Li, S.Y.W., Magrabi, F. and Coiera, E. (2012) "A systematic review of the psychological literature on interruption and its patient safety implications", Journal of the American Medical Informatics Association, 19(1), p. 6-12.-

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Specific information for additional contributors during the simulation session	Actor: plays the role of the resident paired with the anesthesiologist during induction; answers the on-call phone and relays the clinical questions orally to the anesthesiologist, so that the latter keeps both hands free to ventilate.
Choice of simulation environment	Simulated operating room
Description of the equipment required in the simulation room with realism adapted to the level of expertise	Mannequin: - Sensors: heart rate, peripheral oxygen saturation, non-invasive blood pressure, train of four - Fictitious catheter and infusion line connected and suspended on a stand (no medication administration) - Cervical collar - Sheet Laerdal® monitor: heart rate, peripheral oxygen saturation, non-invasive blood pressure, train of four TestChest® artificial lung simulator connected to the mannequin's airway Fictitious ventilator: - Table - Screen displaying data from an anesthesia ventilator screen (transmission via TestChest®) - Intubation tray - Bag-valve mask (BVM) - Ventilation bag and fictitious external manual ventilation circuit - Suction equipment Computer for ventilation data collection (AQAI SIS® software) Camera, microphone for audio recording
Preparation of the initial session prebriefing	**1. Welcome and establishment of the simulation framework** - Thank the participant for taking part in the study - Simulation rules: kindness, involvement, confidentiality

	- Structure: prebriefing, briefing, session, debriefing **2. Regulatory aspects** - Consent signature: video and audio recording **3. Information on the Script Concordance Test** - General principles - Two examples with an oral response trial - Announcement that the clinical questions during the simulation will be stated in the form of an SCT **4. Presentation of the role during the simulation and of the equipment** - Anesthesiologist: must respond immediately to the clinical questions addressed to them - Entry into the simulation room: presentation of the equipment, what it is possible to do and not to do, available monitoring parameters - Ventilation of the mannequin and familiarization - NASA-TLX score: cognitive load for ventilation alone

COURSE OF THE SIMULATION		
Synthetic briefing of learners	You are an anesthesiologist in the emergency operating room. You have performed a standard-sequence induction of a 23-year-old patient with non-deficit cervical spine trauma, hospitalized for 48 hours in the intensive care unit. You have administered Cisatracurium and are manually ventilating the patient with a face mask while waiting for peak action with a train of four target of 0/4. Make sure not to perform hyperextension of the cervical spine because your patient is at risk of tetraplegia. You must ventilate them to a target inspired volume of 500 mL and a respiratory rate of 16 cycles/min. Your resident will answer the phone in your place if necessary, so that you can keep your hands free to ventilate and monitor the patient's vital signs.	
Duration of the simulation	10 minutes	
Insert or delete as many rows as necessary according to your objectives		
State / Duration (D) / Triggering element (TE)	**Observable behavior of learners**	**Consequences for the situation (patient, environment, actor entry/exit, etc.)**
Learners' preparatory phase ("immersion airlock")	1 minute of manual face-mask ventilation without interruption	
HR 50 bpm, NIBP 98/65 mmHg, SpO2 94%		
State 1: manual ventilation D: 30 s to 1 min 30 TE: interruption no. 1	Clinical vignette no. 1, with 1 to 3 questions	Asks to repeat: all right Stops ventilating: be careful, you have stopped ventilating

		Leaks or unsuitable ventilation: do nothing
	5 interruptions in total	
End cue: TOF at 0/4		
Preparation of the debriefing	1. NASA-TLX score: cognitive load for the simulation 2. Debriefing - Statement of facts - Statement of the participant's feelings - Relate the situation to the notion of cognitive load and multitasking work - Information on cognitive load: risk of medical errors, critical situations, basic notions of cognitive psychology, elements of compensation and management of task interruptions - Handing over the cognitive aid 3. Conclusion	
QUALITY		
Scenario testing history		
Elements for improving the scenario to be completed after the session		