



Whole-Body Vibration in En Route Care Providers: Validation of Performance Challenges and Mitigation Strategies

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Conflict of Interest



The presenting author and co-authors do not have any conflicts to report.



Acknowledgements



This research was supported in part by an appointment to the Postgraduate Research Program at the U.S. Army Aeromedical Research Laboratory administered by the Oak Ridge Institute for Science and Education through an interagency agreement between the U.S. Department of Energy and the U.S. Army Medical Research and Development Command.

The authors would also like to thank Lieutenant Colonel Sarah Snyder for her expertise and support throughout the completion of this work.



Introduction



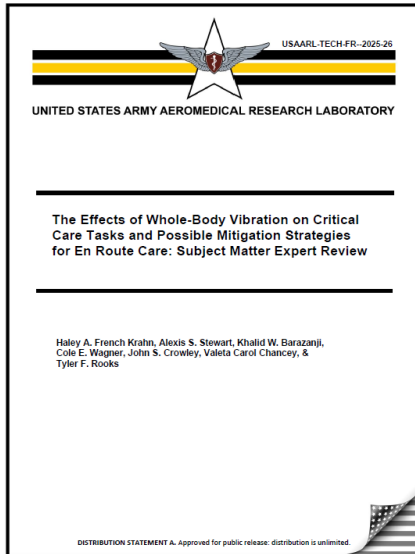
- Military en route care providers (ERCs) execute complex and often invasive lifesaving intervention tasks while exposed to whole-body vibration (WBV) during dynamic air and ground vehicle motion
- Previous USAARL semi-structured subject matter expert (SME) interviews identified ERC tasks highly affected by WBV as well as learned mitigation strategies to cope with WBV effects
- As a follow-up effort, USAARL aimed to validate the SME interview findings by leveraging a standardized survey to determine whether previously identified ERC task challenges and mitigation suggestions align with the larger ERC population experience



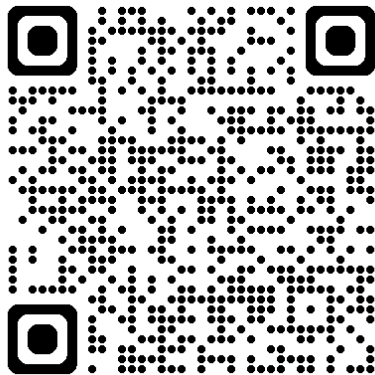
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Background: SME Interviews



Scan QR Code to Access
SME Interview Report



- SME interviews collected information regarding challenges experienced while conducting tasks extracted from the U.S. Army Aeromedical Evacuation standard medical operating guidelines (SMOG) under WBV conditions
- SMOG tasks were evaluated based on the following factors:
 - **Challenge**: Difficulty level of performing task within a WBV environment
 - **Susceptibility**: Likelihood that task is influenced or affected by WBV
 - **Patient Detriment**: Level of harm or consequence to patient if task completion was delayed due to WBV
 - **Mitigation**: Strategies used and recommended by ERCPs to manage or overcome effects of WBV during casualty and medical evacuations (CASEVAC/MEDEVAC)



Methods



- Survey was anonymously administered via SelectSurvey.net under an approved exempt human subjects research protocol
- Target sample size of $N \geq 43$ to reach 95% confidence level
- Inclusion criteria
 - Consent
 - Completed full survey
 - U.S. Army (Active Duty, Reserve, National Guard)
 - Ages 18–60
 - Experience as an ERCP during CASEVAC/MEDEVAC missions
- A subset of 20 questions were used for the current work to validate previous findings in the SME Interviews
- Raw survey data was processed using MATLAB to apply inclusion filters, calculate descriptive statistics and response frequencies, and generate visualizations

Comprehensive Survey

74 Questions

- Demographics and Anthropometry (4)
- Health and Fitness (4)
- Military, Training, and ERCP Experience (16)
- Operational Exposures (OEs) (8)
- Musculoskeletal Injury (MSKI) (12)
- Medical Task Feedback (25)
- Mitigations and Recommendations (5)

**Filtered for
Current Work:**
*Removed Health
& Fitness,
Training, MSKI*

This Presentation

20 Questions

- Task Susceptibility (5)
- Patient Detriment (5)
- Task Difficulty (5)
- Mitigation Strategies (5)



Methods: Validation Analysis



SME Semi-Structured Interview (2025)

- $N = 21$
- At least 5 years ERCP experience
- Sixty (60) minutes
- Subjective open response followed by scale-based SMOG questions

Appendix B. Semi-Structured Interview Questions

1. Time in service
2. Current rank
3. Background and experience (e.g., MOS/AFSC, civilian position/background, credentials, certifications, etc.)
4. Experience in en route care specifically (deployments, training, etc.)? Experience in military capacity? Experience in civilian capacity? Hands-on patient care versus training? Provide percentage.
5. What's the most challenging task you have ever performed while en route?
6. Are there tasks you cannot or will not perform while en route due to vehicle vibration or motion (e.g., the vehicle must stop to complete)?
7. What's the most challenging task(s) you must do while en route?
8. Which task is (or tasks are) the most susceptible to vehicle vibration or jolt?
 - a. Were there any lessons or training materials that helped make these tasks easier? If so, can you describe?
 - b. Are there any improvements you would recommend either in training courses or material for mitigating the vibration effects?
9. Have you learned or identified any additional strategies that were not taught in your training courses to make these medical tasks easier? If yes, can you describe these strategies or lessons learned?
10. Is there anything else regarding lessons learned or strategies that you would like to discuss or bring up?

Part I: Interview

Ten (10) Open Response Questions

- Demographics
- Challenging tasks due to WBV
- Mitigation strategies used to improve performance of difficult tasks
- Recommended training applications
- Career experiences and lessons learned



Methods: Validation Analysis



SME Semi-Structured Interview (2025)

- $N = 21$
- At least 5 years ERCP experience
- Sixty (60) minutes
- Subjective open response followed by scale-based SMOG questions

Appendix C. En Route Medical Tasks Included in the SMOG

Medical Tasks	Task Likelihood to be Affected by WBV (1-Low 2-Med 3-High)	Detriment to Patient if Care is Delayed due to WBV (1-Low 2-Med 3-High)	WBV and Jolt Mitigation Strategy
1 Airway Pearls			
2 Blind Insertion Airway Device (BIAD)			
3 Nasopharyngeal Airway			
4 Rapid Sequence Intubation (RSI)			
5 Cricothyroidotomy			
6 Needle Cricothyroidotomy			
7 Simple (Finger) and Tube Thoracostomy			
8 Needle Thoracostomy			
9 Ventilator Management			
10 CPAP/BIPAP			
11 Tourniquet Application			
12 Functional Tourniquet Application			
13 Tourniquet Conversion			
14 Vascular Access (Intravenous)			
15 Vascular Access (Intraosseous)			
16 Vascular Access via Central Catheters			
17 Vascular Access via External Jugular Vein Cannulation			
18 Blood Component/Fresh Whole Blood Use			
19 Blood Glucose Analysis			
20 Invasive Pressure Monitoring			
21 REBOA Management			
22 Cardiac Defibrillation			
23 12-Lead Electrocardiogram			
24 Foley Catheter Placement			
25 Naso/Gastric Tube			
26 Hypothermia Prevention and Management			
27 Medications			
28 Dress Wounds			
29 Monitor Use			
30 Pelvic Binder			
31 Occlusive Chest Seal			
32 Fluid Resuscitation			
33 Cervical Collar			
34 Documentation			
35 Suction			
36 Administer Oxygen			
37 Measure Vital Signs			

Part II: SMOG Task Analysis

Thirty-seven (37) SMOG Tasks

- Rating Scale (1-3)
 - Susceptibility
 - Detriment
- Open Response
 - Mitigation Strategy



Methods: Validation Analysis



SME Semi-Structured Interview (2025)

- $N = 21$
- At least 5 years ERCP experience
- Sixty (60) minutes
- Subjective open response followed by scale-based SMOG questions

Part I: Interview

Appendix B. Semi-Structured Interview Questions

1. Time in service

Interview questions about WBV challenges and mitigation strategies heavily relied on recall memory.

10. Is there anything else regarding lessons learned or strategies that you would like to discuss or bring up?

Part II: SMOG Task Analysis

Medical Tasks	Tasks Likelihood to be Affected by WBV (1-Low 2-Med 3-High)	Detriment to Patient if Care is Delayed due to WBV (1-Low 2-Med 3-High)	WBV and Job Mitigation Strategy
1. Airway Pouch			
2. Blind Insertion Airway Device (BIAD)			
3. Nonplanarized Airway			
4. Rapid Sequence Intubation (RSI)			
5. Chondrodesmosis			
6. Needle Cricothyrotomy			
7. Single Patient and Tube Thermistor			
8. Needle Thermistor			
9. Ventilation Management			
10. CRAP/CRAP			
11. Transducer Application			
12. Functional Transducer Application			
13. Transducer Connection			
14. Vascular Access (percutaneous)			
15. Vascular Access (catheters)			
16. Vascular Access via Central Catheter			
17. Vascular Access via External Jugular Vein Cannulation			
18. Blood Component Transfusion Whole Blood Use			
19. Blood Component Analysis			
20. Sedation Process Monitoring			
21. ERCPA Management			
22. Cardiac Catheterization			
23. 12-Lead Electrocardiogram			
24. Fetal Catheter Placement			
25. Non-Contrast Tube			
26. Hypertension Prevention and Management			
27. Medication			
28. Open Wounds			
29. Monitor Use			
30. Pelvic Binder			
31. Cerebral Aneurysm Seal			
32. Fluid Resuscitation			
33. Cervical Collar			
34. Documentation			
35. Suction			
36. Abdominal Organ			
37. Monitor Vitals Data			

Survey Assessment (2026)

- Target sample size of $N \geq 43$
- Any ERCP experience
- Self-paced
- Twenty (20) standardized questions on SMOG tasks under WBV/vehicle motion conditions
- Response options influenced by SME interview outcomes

SMOG Task Difficulty

Rating Scale

- 1 – Not Challenging
- 2 – Slightly Challenging
- 3 – Moderately Challenging
- 4 – Very Challenging
- 5 – Extremely Challenging

Patient Detriment SMOG Tasks

Rating Scale

- 1 – Not Detrimental
- 2 – Slightly Detrimental
- 3 – Moderately Detrimental
- 4 – Very Detrimental
- 5 – Extremely Detrimental

SMOG Task Susceptibility

Rating Scale

- 0 – Not Susceptible
- 1 – Low Susceptibility
- 2 – Medium Susceptibility
- 3 – High Susceptibility

WBV & Vehicle Motion SMOG Task Mitigation Strategies

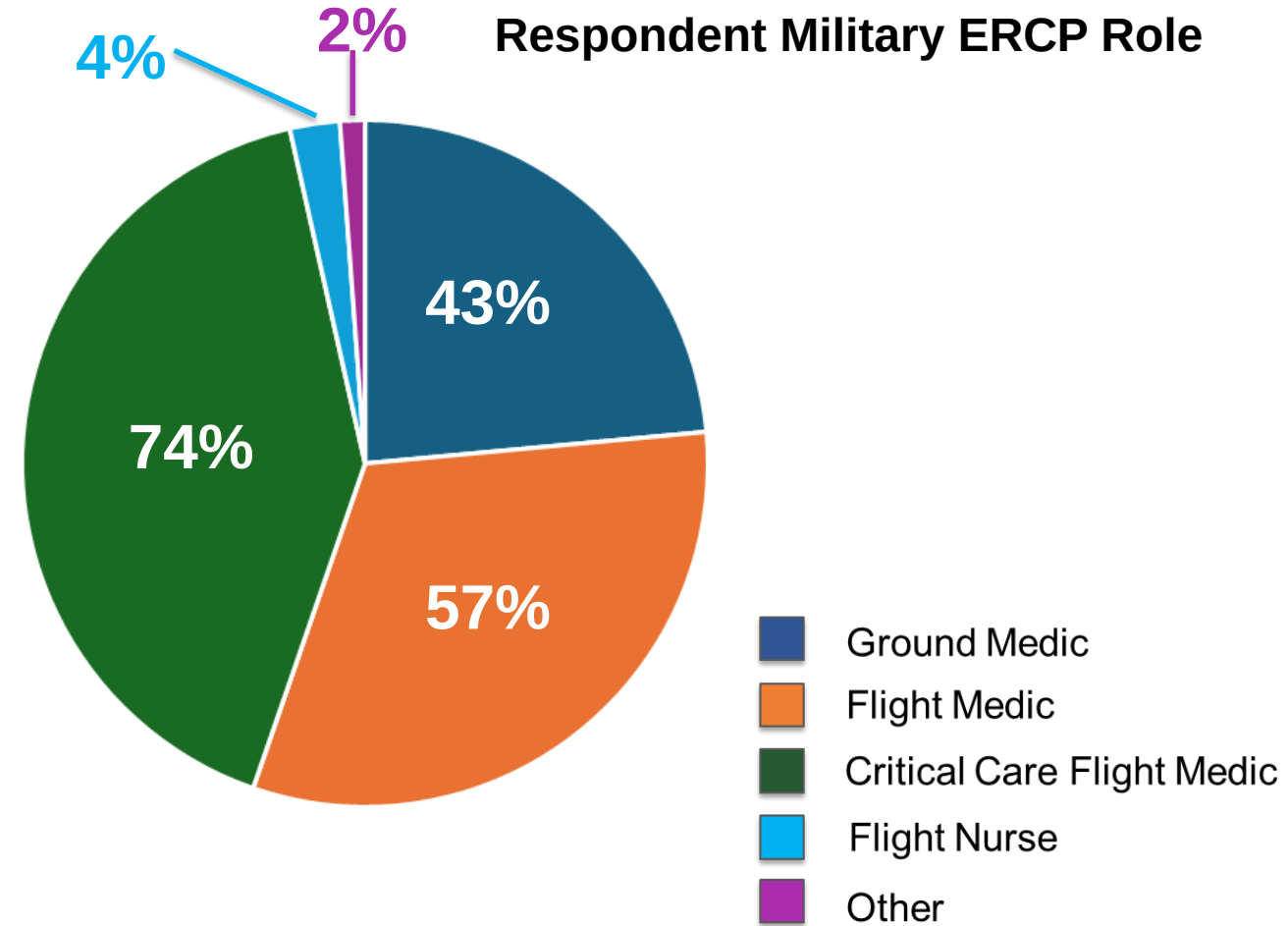
Strategy Selection
Open Response



Results: Demographics



- Responses were analyzed from $N = 47$ ERCPs that met inclusion criteria
- **Respondent Sex ($N = 47$)**
 - Male: 38 (81%)
 - Female: 9 (19%)
- **Respondent Career Experience ($N = 47$)**
 - Average Time of Service: $16(\pm 6.6)$ years
 - Average ERCP Experience: $11(\pm 5.9)$ years
 - Average Number of Deployments: $2(\pm 1.1)$
- **ERCP Environment Exposure ($N = 47$)**
 - Air Evacuations Only: 26 (55%)
 - Ground Evacuations Only: 2 (4%)
 - Both Air and Ground Evacuations: 19 (40%)

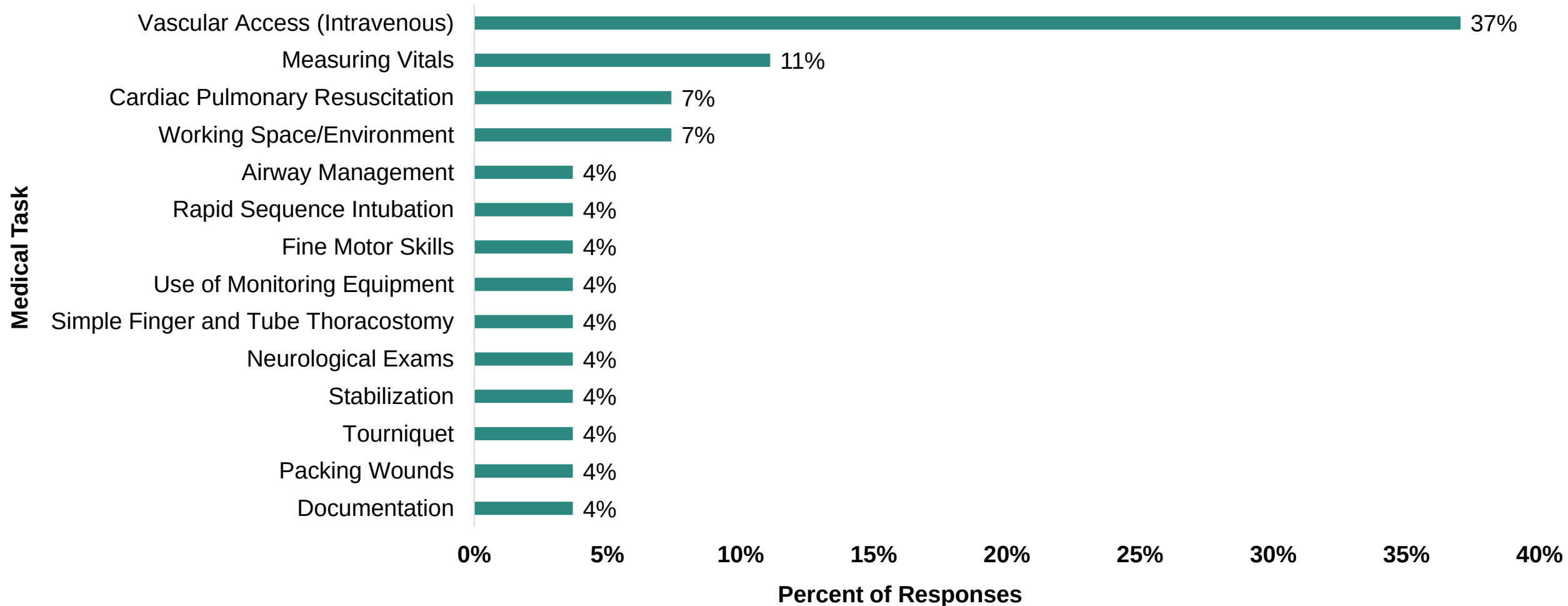




Results: ERCP Challenging Tasks Due to WBV



SME Interviews 2025 Free Response Question Challenging Tasks (N = 21)

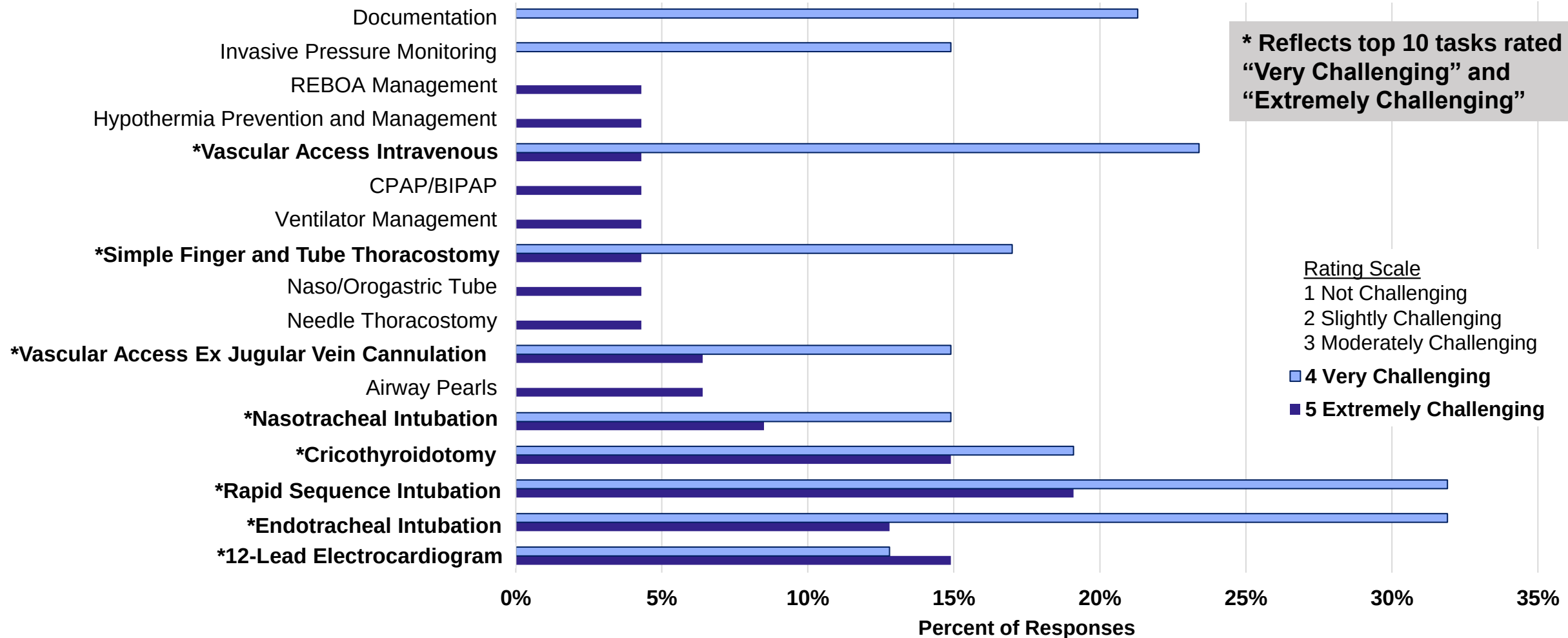




Results: ERCP SMOG Task Difficulty Due to WBV



Survey Assessment 2026 Top 10 SMOG Tasks Rated Very or Extremely Challenging Tasks (N = 47)



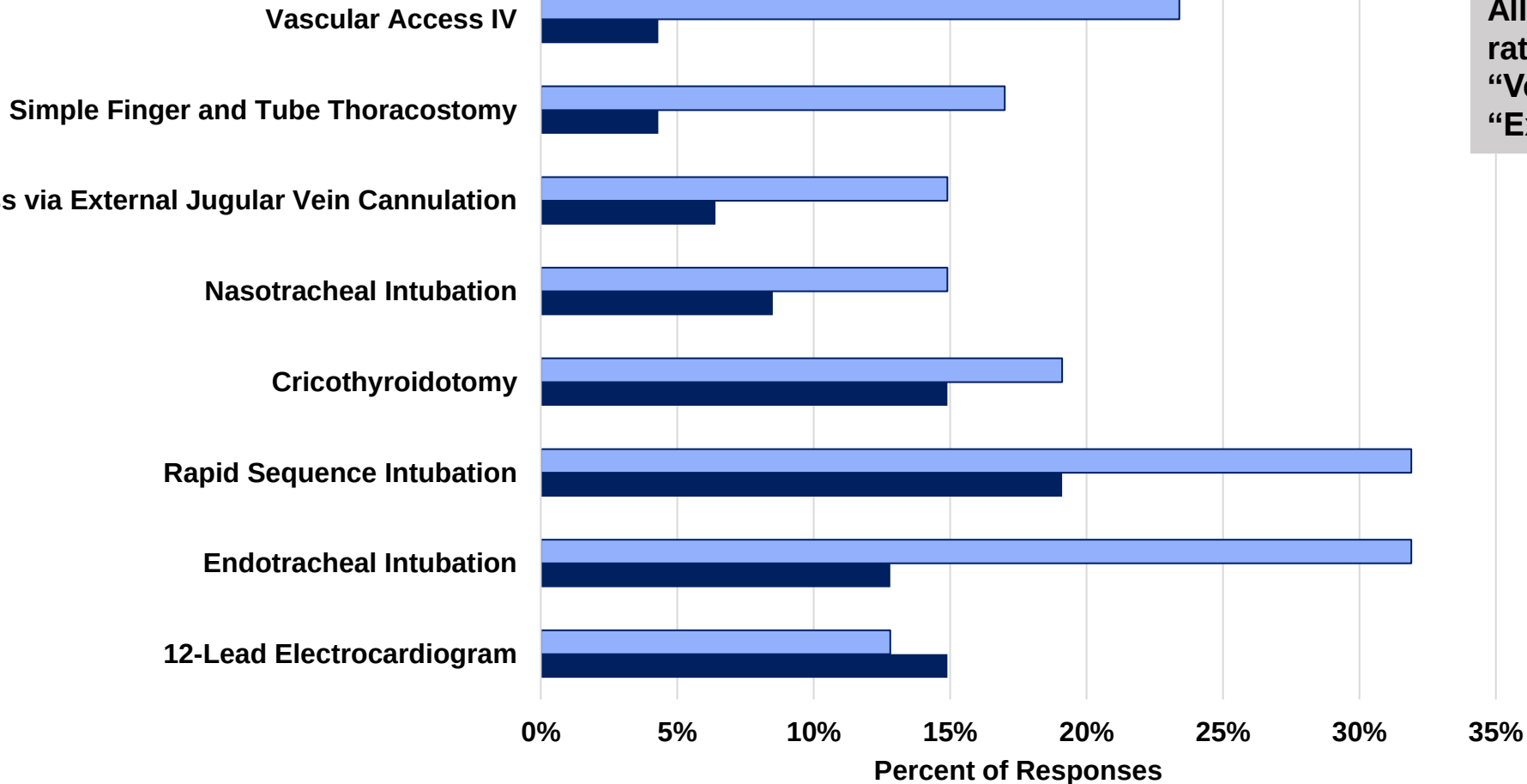


Results: ERCP SMOG Task Difficulty Due to WBV



Survey Assessment 2026 Top 10 SMOG Tasks Rated Very and Extremely Challenging Tasks (N = 47)

Medical Task



All tasks that were top 10 rated in both “Very Challenging” and “Extremely Challenging”

Rating Scale

1 Not Challenging

2 Slightly Challenging

3 Moderately Challenging

4 Very Challenging

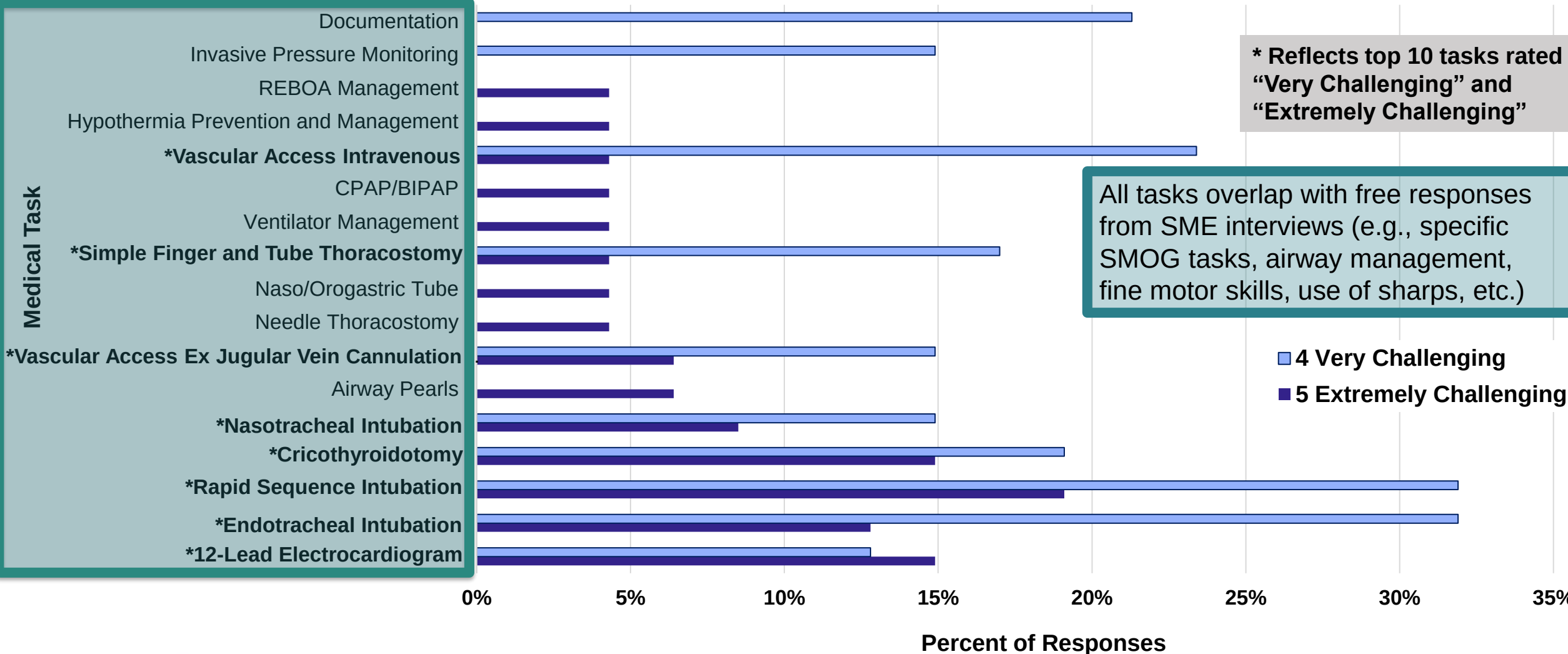
5 Extremely Challenging



Results: ERCP SMOG Task Difficulty Due to WBV



Survey Assessment 2026 Top 10 SMOG Tasks Rated Very or Extremely Challenging Tasks (N = 47)

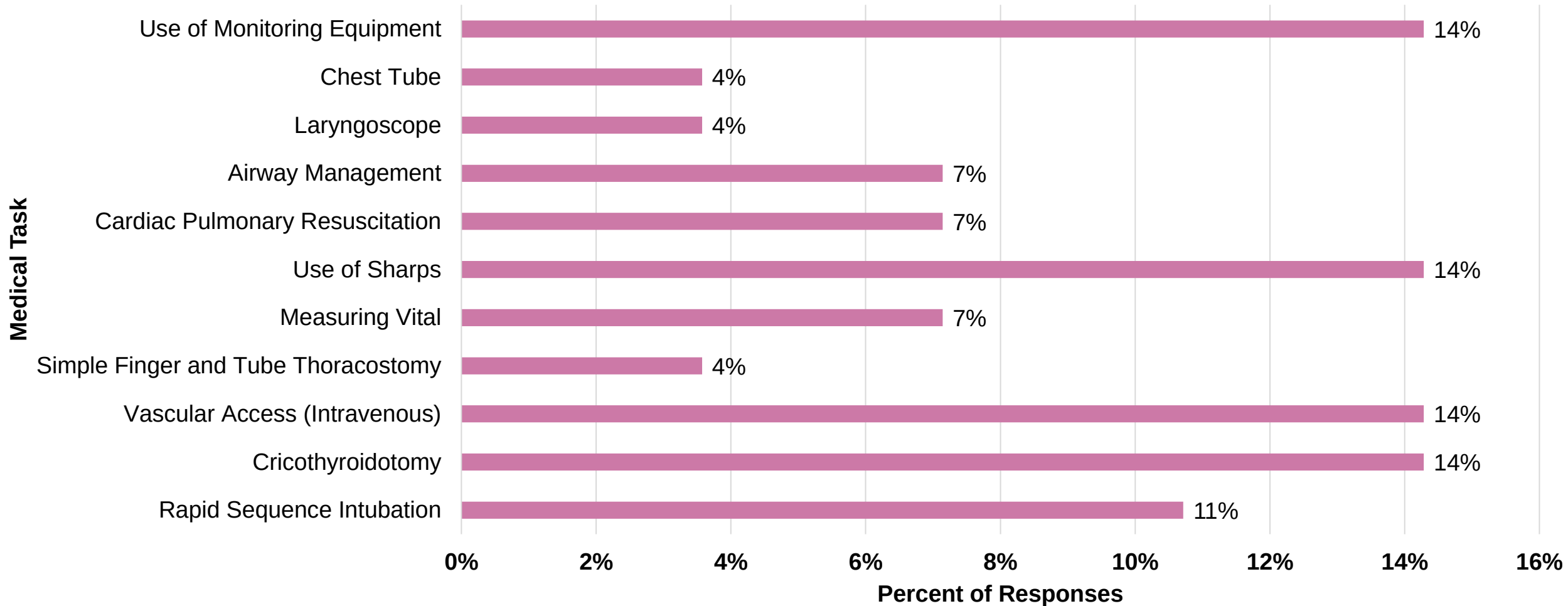




Results: ERCP Tasks Not Performed Due to WBV



SME 2025 Interviews Free Response Tasks Not Performed due to Vibration (N = 21)

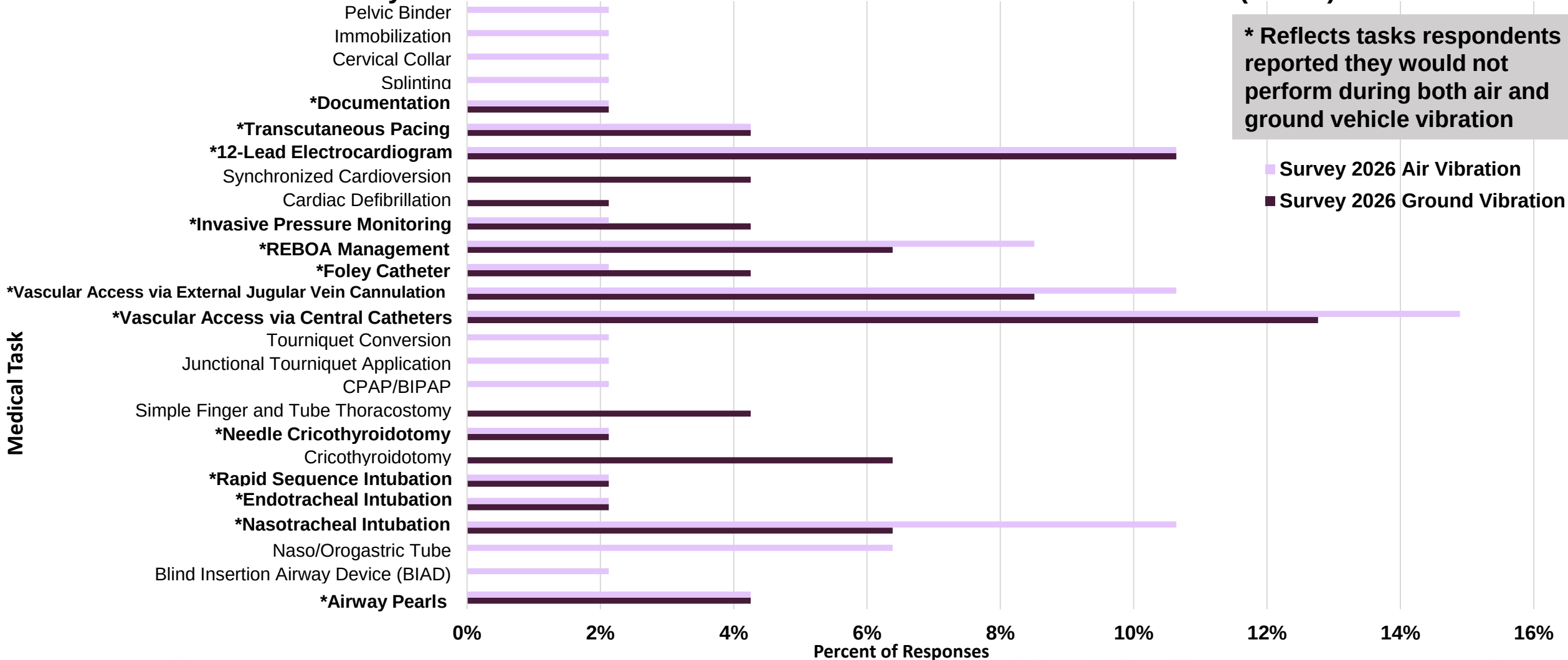




Results: ERCP Tasks Not Performed Due to WBV



Survey Assessment Tasks Not Performed Due to Air or Ground Vibration (N = 47)

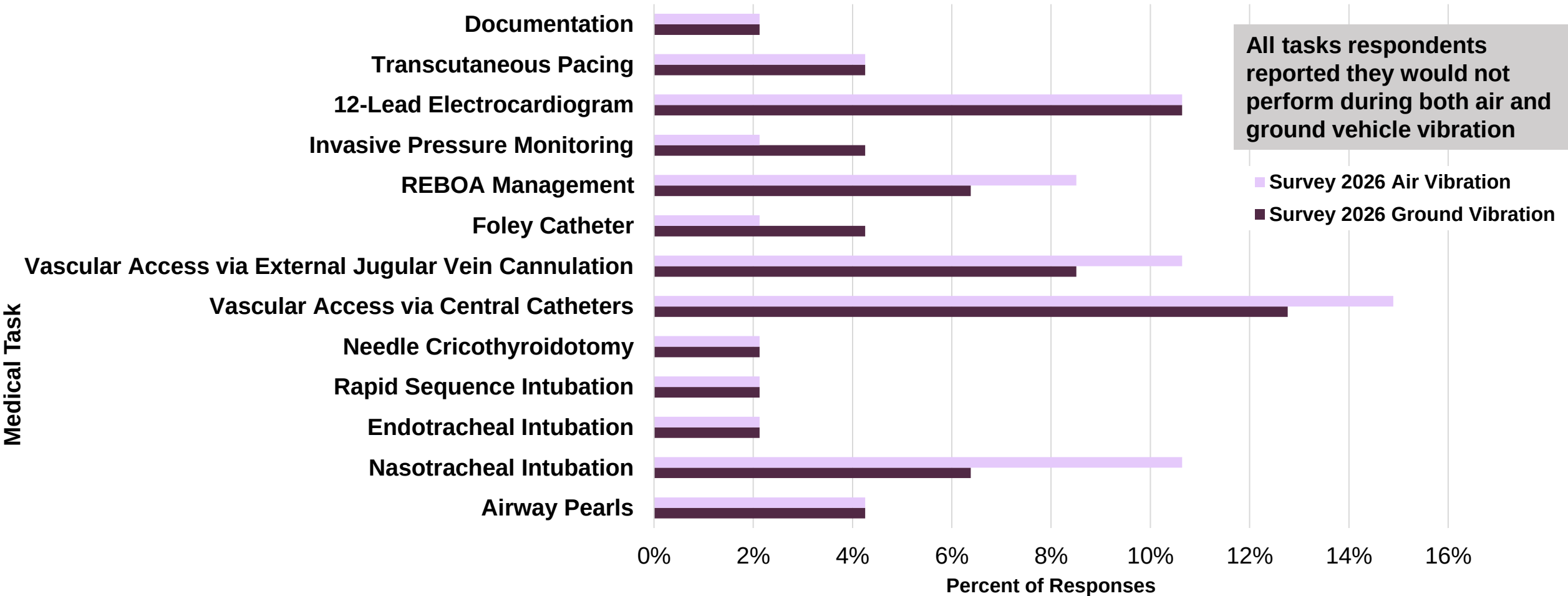




Results: ERCP Tasks Not Performed Due to WBV



Survey 2026 Assessment Tasks Not Performed due to Air & Ground Vibration (N = 47)

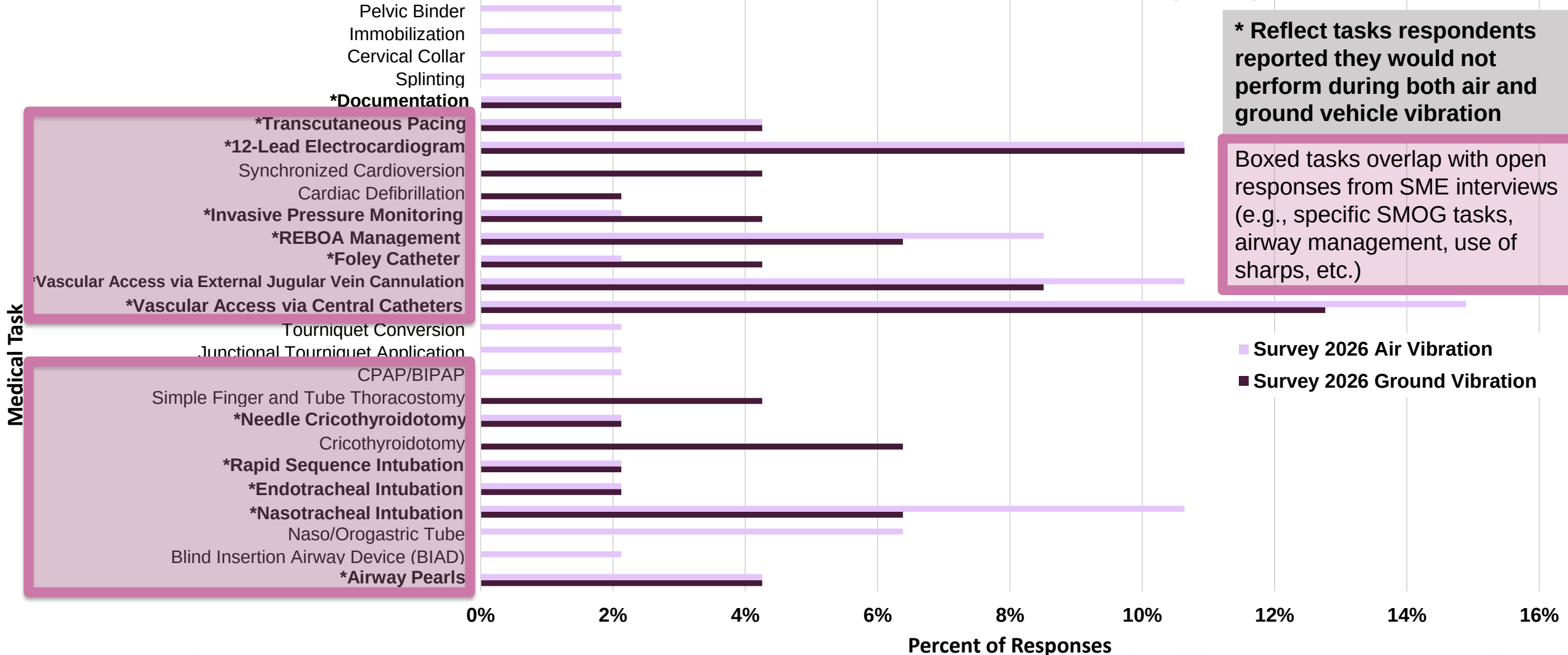




Results: ERCP Tasks Not Performed Due to WBV



Survey Assessment Tasks Not Performed due to Air & Ground Vibration (N = 47)





Results: ERCP Susceptibility & Patient Detriment Due to WBV



SME Semi-Structured Interview 2025

- Respondents rated SMOG tasks based on level of susceptibility and patient detriment if care was delayed

Susceptibility and Detriment Scale 1-3

- 1- Little to no effect on task
- 2- Moderate effect on task
- 3- High effect on task

Survey Assessment 2026

- Respondents rated SMOG tasks based on level of susceptibility and patient detriment if care was delayed

Susceptibility Scale 0-3

- 0- Not Susceptible
- 1- Low Susceptibility
- 2- Medium Susceptibility

- 3- High Susceptibility

Detriment Scale 1-5

- 1- Not Detrimental
- 2- Slightly Detrimental
- 3- Moderately Detrimental

- 4- Very Detrimental
- 5- Extremely Detrimental

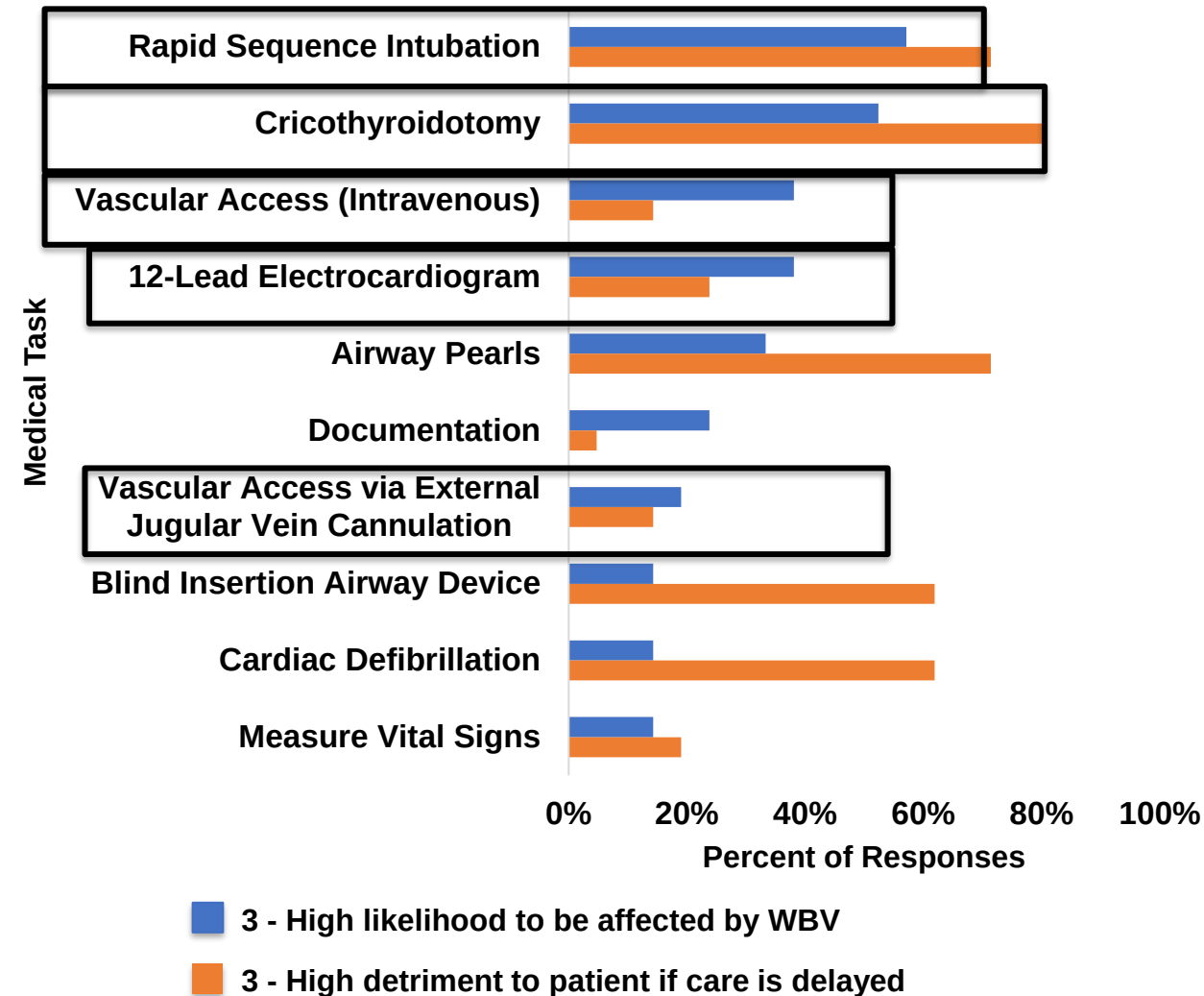
Comparison of tasks rated a 3 in SME interviews to the top 10 tasks rated 3 (susceptibility) and 5 (detriment) in the survey assessment.



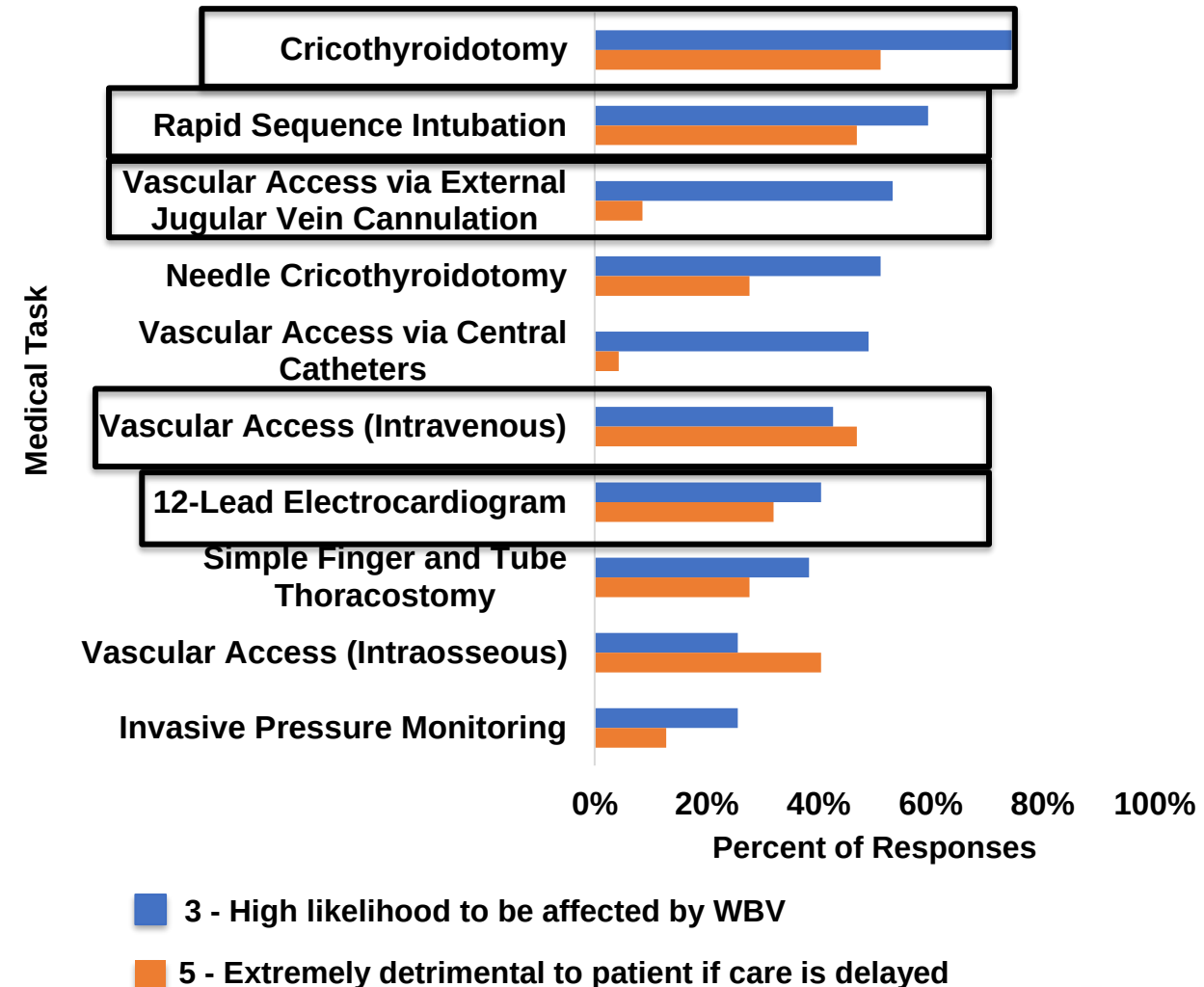
Results: ERCP Susceptibility & Patient Detriment



Top 10 Task SME Interview (N = 21)



Top 10 Task Survey Assessment (N = 47)

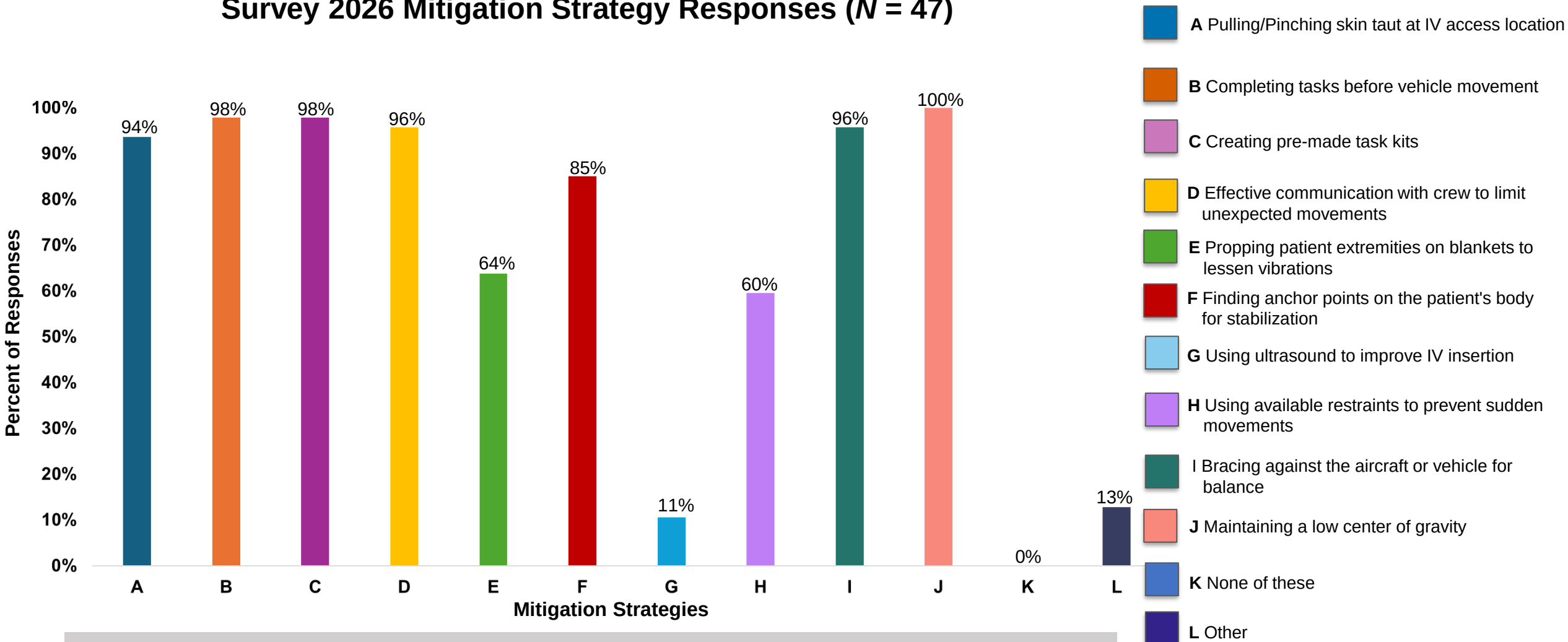




Results: ERCP Mitigation Strategies



Survey 2026 Mitigation Strategy Responses (N = 47)



Question selection options A-J were directly derived from SME Interviews 2025 free form responses

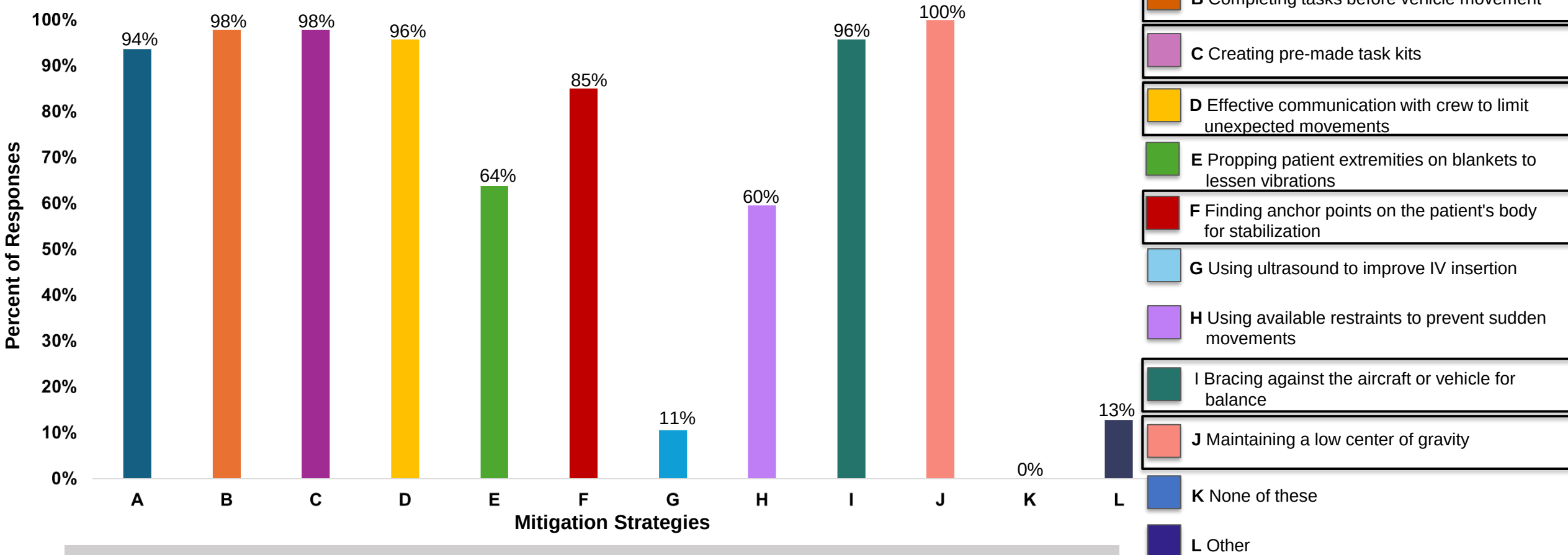


Results: ERCP Mitigation Strategies



Survey 2026 Mitigation Strategy Responses (N = 47)

Mitigation Strategies selected by at least 80% of respondents



Question selection options A-J were directly derived from SME Interviews 2025 free form responses



Discussion



- Understanding challenges ERCPs experience conducting tasks during medical transport missions is necessary to optimize performance as well as improve delivery of medical interventions.
- The SME interviews provided initial insight into ERCP tasks that may be affected by WBV. The follow-up survey, completed by a larger population of ERCPs, expounded on the previous work by allowing the identification of specific SMOG tasks that WBV exposure may hinder or negatively affect.
- Findings from the survey and previous SME interviews reiterate that ERCP tasks requiring fine motor control, use of sharps, and precise visual perception are most likely to be more difficult to complete, be more susceptible to negative effects, and have detrimental effects to patient if care is delayed due to WBV.
- Survey and SME interview outcomes also demonstrated a consistent consensus regarding ERCP use of strategies to mitigate risks associated with WBV while performing tasks.
- Survey data outcomes can be used to support future research to inform recommendations for training, policies, and strategies to improve ERCP performance and patient safety during medical transport missions.



QUESTIONS?

