I.M. SAFE to P.E.R.F.U.S.E.: Addressing Human Factors in Perfusion Safety

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Before pilots take control of an aircraft, they reflect on a personal checklist: "I.M. S.A.F.E."

> ***I*** *– Illness (Am I sick?)*
> ***M*** *– Medication (Am I taking any medicines that might affect my judgement or make me drowsy?)*
> ***S*** *– Stress (Am I experiencing psychological pressure, anxiety, or financial/family problems?)*
> ***A*** *– Alcohol (Have I been drinking within 8 hours? Within 24 hours? As little as one ounce of liquor can impair flying skills)*
> ***F*** *– Fatigue (Am I tired or not adequately rested?)*
> ***E*** *– Emotion (Am I emotionally upset?)*

It is a quiet oath, an acknowledgment that human performance is inseparable from human vulnerability. If a pilot cannot confidently recite "I'M SAFE" with the above criteria in mind, they cannot fly. Aviation learned decades ago that technology cannot compensate for compromised human performance, because when a pilot is *not* safe, people die.

A heart-lung machine, similar to an aircraft, performs only as safely as the professional guiding it. In perfusion, we do not formally recite such an oath before initiating cardiopulmonary bypass.

We should.

Patient safety isn't just a concept. It is a responsibility measured in seconds, milliliters, and millimeters of mercury. As a perfusion student, I stand at a uniquely critical intersection learning the boundaries of technology with human life. The heart-lung machine does not forgive complacency, and the margin for error is critical to patient outcomes. It is within these silent seconds that patient safety becomes more than protocol; it becomes our purpose.

Consider the initiation of cardiopulmonary bypass: arterial line de-airing incomplete, venous return marginal, perfusion pressures fluctuating. A fatigued or distracted perfusionist may miss subtle warning signs in the first critical minutes. Failure to recognize these warning signs can result in cerebral air embolism, systemic hypoperfusion, or delayed response to oxygenator failure, complications leading to stroke, organ injury, or death. A recent Turkish study surveying practicing perfusionists provides compelling evidence that perfusion safety issues occur frequently in real clinical practice (Sahin, 2025). In the study, 109 perfusionists responded to a detailed survey about perfusion safety and accidents during cardiopulmonary bypass. More than half of surveyed perfusionists reported encountering arterial line bubble events, a high-risk scenario directly associated with embolic stroke and mortality if unrecognized. These are near-miss events, moments in which harm is narrowly avoided not because the system is flawless, but because a vigilant clinician intervenes in time. While 67% believed they could

intervene effectively, this statistic implies that one-third may not feel fully confident managing such crises. These findings underscore that safety threats during bypass are common and rely heavily on rapid human recognition and response. The study also noted that although CPB-related mortality has declined over decades, perfusion accidents remain clinically significant and potentially catastrophic.

While not all complications are preventable, many perfusion-related threats are influenced by human vigilance and decision-making. Competence alone is insufficient without cognitive readiness. Structured safety practices also provide an additional layer of protection against preventable error. Multiple high-quality studies have evaluated the impact of the World Health Organization Surgical Safety Checklist on patient outcomes. In a 2013 systematic review examining the checklist's effect on postoperative adverse events, nine of ten studies that reported complication data demonstrated decreases in overall complication rates after checklist implementation, and 12 of 13 studies found reductions in mortality associated with checklist use (Qaiser, 2024). While not every study found statistically significant results, the preponderance of evidence supports that surgical safety checklists are linked to lower mortality and fewer complications across diverse settings, likely by improving team communication, coordination, and adherence to safety processes during critical points in care. These are the same human-factor domains implicated in perfusion-related near misses.

If structured pauses reduced surgical mortality across diverse systems, then structured self-assessment may similarly reduce cognitive and human errors during perfusion, a field equally dependent on vigilance, communication, and anticipation. The AmSECT Perfusion Checklist meticulously addresses mechanical and system readiness, such as gas supply, electrical backup, and circuit integrity. Yet none of its categories explicitly assess the perfusionist's cognitive readiness, fatigue level, emotional state, or stress burden. In a profession where vigilance is continuous and rescue windows are narrow, human readiness is as critical as mechanical readiness.

Just as aviation embeds human-factor awareness into every takeoff, perfusion should embed it into every initiation of bypass. I propose that a structured pre-bypass self-check, modeled after aviation's IM SAFE, be integrated into perfusion practice as an additional safety mitigator. Integrating cognitive readiness into formal safety culture would acknowledge that the perfusionist is not separate from the system, but a critical component of it. This self-check could be performed silently before pump initiation or incorporated into team time-outs, reinforcing that human readiness is a recognized component of perfusion safety.

Consider this my oath, as I prepare to embark on my clinical rotations and begin practicing behind the pump myself. Before I place a patient on bypass, I will ensure not only that the circuit is safe, but that I.M. S.A.F.E to P.E.R.F.U.S.E.

P *– Prepared (pause outside factors)*
E *– Equipped (verify mechanical safety)*
R *– Rested (shorten cognitive delay)*
F *– Focused (decrease inattentional blindness)*
U *– Up to date (evidence-based practice, protocols reviewed)*
S *– Speaking up (minimize communication failures)*
E *– Engaged (ensure patient safety)*

Because the safest circuit in the world cannot compensate for an unsafe perfusionist.

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