Watson correctly identifies the statistical slight of hand whereby ordinal or categorical Likert scores are mapped onto a linear numerical scale. Watson also correctly points out that Likert score intervals are not necessarily equal or even certain. Fortunately, the Z-score system is based on relative performance and does not use absolute numerical cutoff scores. Although Z-scores are not diagnostic of any particular absolute level of performance, they do provide an excellent method for differentiating relative resident performance among a cohort of residents. This allows us to identify relatively poorer performers, examine the faculty-provided comments for clues as to why the scores were low and, in turn, create performance improvement strategies that often result in performance improvement, as shown in the paper in figure 9.

Van Schalkwyk, Campbell, and Short are primarily concerned with misclassification of a large fraction of residents based on the statistical methodology found in the paper. In particular, they note that as the number of evaluations gets very large, precisely one-half of all residents will be confidently labeled as below average according to the approach used in the paper. They appear to express concern that more than 50% of residents could potentially be inappropriately labeled as problematic or poorly performing, which could have implications for their management and even future careers. Van Schalkwyk, Campbell, and Short appear to have interpreted “below average” as incompetent or problematic. Nowhere in the paper is this inference made. The Z-score system allows relative ordering of residents within a cohort. As correctly pointed out by these authors, the lowest-performing resident in the group may be perfectly competent. The Z-score system relates not to competence but to performance, as stated in the paper. The system correctly identifies relative performance of one resident compared with another and does so with a degree of statistical significance allowing differentiation of levels of performance. The system does not claim that the lowest-performing resident is incompetent. In fact, individual scores are meaningless per se, and it is only in the context of the comments associated with Z-scores that concerning performance attributes are identified and intervened upon. Thus there is no threshold Z-score that identifies a competent versus an incompetent resident. However, as one moves further and further below average, the likelihood of finding concerning or problematic performance gets higher and higher. This is precisely what was found in this study. For example, as mean Z-scores fall further and further below zero, the faculty increasingly checked off clinical-competency boxes relating to significant concerns with performance. This is expected if Z-scores relate to performance. As mentioned in the paper, we tended to find actionable performance concerns associated with Z-scores of about −0.5 and below. When such scores are noted, the comments associated with these scores are examined for diagnostic clues that can explain the lower-than-average performance scores. If we find actionable concerns in the comments, we create interventions, and the resident is tasked with performance improvement in the identified areas. Examples of success using this method were presented in the paper. At times, we also find residents whose average Z-scores are near −0.5 and who do not have any concerning comments related to their below-average Z-scores. Such residents are simply exhibiting performance that is below average for the cohort but is not concerning in terms of competence. Ideally, every resident would have a performance-improvement program, including those with above-average Z-scores. However, given limited resources, we focus on residents having below-average Z-scores with the intent of improving their performance.

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Reference

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High End-Expiratory Airway Pressures Caused by Internal Obstruction of the Draeger Apollo® Scavenger System That Is Not Detected by the Workstation Self-test and Visual Inspection

To the Editor:

High positive end-expiratory pressure (PEEP) buildup during mechanical ventilation is a known complication that may arise from pressure relief valve or scavenging system malfunction.1–5 In Draeger Apollo® (Draeger Medical Inc., Telford, PA), the preuse checkout is performed in two phases. First, the initial Check List Screen displayed by the workstation guides a series of manual check steps. This is followed by an automatic self-test. When successfully completed, the self-test displays a green light indicating proper functioning of the tested components, including the scavenging system. To complete the preuse assessment of the scavenging system, the manufacturer’s manual recommends visual inspection of connecting hoses and verification that the float is within the reference range. We present a case of high PEEP buildup because of an internal obstruction of the scavenger system that has not been reported before. We did not detect failure by applying the workstation preuse self-test and visual inspection of the external scavenger system.

A 75-yr-old woman presented for left carotid endarterectomy under general anesthesia. Following uneventful induction and intubation with a 7.0-mm endotracheal tube, volume control ventilation was initiated. Settings were: tidal volume 500 ml; rate 12 bpm; PEEP, 5 cm H₂O; 50% oxygen/air and sevoflurane; and fresh gas flow of 2 l/min. Shortly...
after initiation of mechanical ventilation, PEEP increased to 10 cm H₂O within few administered breaths, triggering the high PEEP alarm. The reservoir bag, noticed to be under tension, was disconnected, temporarily restoring the PEEP to the set level. Chest compliance was appropriate with manual ventilation. The adjustable pressure relief valve knob was moved through the full range and confirmed to be unobstructed and open. The endotracheal tube was inspected showing no obstruction or kinking, and the correct position was confirmed. The scavenger float was observed to be within the recommended range. PEEP was then set to zero. When positive pressure ventilation resumed, PEEP buildup recurred, triggering the high PEEP alarm. Troubleshooting continued with manual ventilation, using an Ambu-bag® (eMED America Inc, Little Rock, AR) and supplemental intravenous anesthesia.

The surgeons were notified of the equipment failure, and surgery was paused. The breathing circuit was replaced with no effect. Biomedical engineering technicians assisted in changing the breathing system (which houses flow sensors and inspiratory, expiratory, and scavenging system valves) without resolution. A replacement workstation was then delivered to the operating room, checked, and connected to the patient, providing normal ventilation without excess PEEP. The remainder of the surgery and recovery were uneventful.

The malfunctioning workstation was removed from service and examined by the biomedical engineering technicians. The failure was caused by a small piece of plastic film (12.5 × 4 cm) (fig. 1) partially obstructing the anesthetic gas scavenger system cone located behind the breathing system drawer (fig. 2). The exact origin of the plastic film could not be determined.

A simple experiment replicating the intraoperative scen-
the Check List Screen (full opening of the APL valve) this step would detect a persistent positive circuit pressure with this type of obstruction.

The events resulting in the obstruction of the anesthetic gas scavenger system cone remain unknown. We hypothesize that an opportunity presented when the ventilator drawer was opened during changing of the reusable carbon dioxide absorbent canister. A space (0.7 cm) above the ventilator drawer (fig. 3) allows for small debris to pass through and fall behind the ventilator drawer. Opening and closing the drawer may allow debris to be forced into the anesthetic gas scavenger system cone. We have recently replaced the reusable absorbent canister with a disposable CLIC canister (Amsorb Plus Universal Bubble Can Absorber; Armstrong Medical Ltd., Coleraine, Northern Ireland). One advantage of the disposable canister is that its replacement does not require opening of the breathing system drawer.

The described internal obstruction of the scavenging system presents a new mechanism of anesthesia workstation malfunction resulting in potentially dangerous levels of PEEP. This obstruction was not detected by following manufacturer’s recommended procedures. This case illustrates the shortcoming of relying only on the automatic check test, as underscored by the 2008 American Society of Anesthesiologists Recommendations for Pre-anesthesia Checkout Procedures. This report should raise awareness of anesthesia providers and the manufacturer of this potential malfunction and reinforce the importance of adopting comprehensive workstation-specific checkout procedures.

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In Reply:

Draeger Medical GmbH (Lübeck, Germany) would like to thank the authors Vannucci et al. for bringing this to the attention of the anesthesia community.

The authors describe a situation where the internal connection between the breathing system and the outlet to the scavenger system of the Draeger Apollo was blocked. This occlusion caused a high positive end-expiratory pressure buildup in the breathing system and at the patient.

In the schematic of the breathing system (fig. 1), you can see how the gas mixture is circulating through the breathing system. The excessive gas, which is not necessary for ventilating the patient, is led out of the breathing system via the anesthetic gas scavenging system connector (it is important to note that this outlet is used in both manual and spontaneous ventilation modes and in all mechanical modes).

In the situation of a complete occlusion in the scavenging line, both manual and spontaneous ventilation modes and mechanical modes would not be possible. As soon as excessive gas cannot be let out of the breathing system and the internal breathing system pressure as well as the airway pressure of the connected patient starts to increase, the Apollo’s safety system alerts the user via acoustic and visual alarms (table 1). After 6 s, the alarms “continuous pressure” and “high airway pressure” appear, and, after the opening of the MV2 internal safety valve, the “pressure relief” alarm appears. In addition, the user will see the manual breathing bag expansion in both manual and spontaneous ventilation and in mechanical ventilation.

As a backup and safety function, the Apollo is equipped with the MV2 internal safety valve integrated into the breathing system interface, which opens to ambient air in case of high pressure or negative pressure.

The check-out procedure on the Apollo anesthesia workstation is designed in two parts:

The first part is the manual test performed by the user according to the device checklist displayed on the screen after startup. In the manual check-out procedure, the user is asked to set the adjustable pressure limitation valve to