Title: Demystifying the Draeger Perseus A500 Anesthesia Machine's Spontaneous Ventilation CPAP Function
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Background: The Draeger Perseus A500 anesthesia machine has a convenient feature that allows the anesthesia provider to apply a set positive end expiratory pressure (PEEP) i.e. continuous positive airway pressure (CPAP) in the manual / spontaneous ventilation mode. Notably, this feature is relatively flow independent - i.e. the set PEEP is achieved regardless of what the fresh gas flow (FGF) setting is (unlike using the adjustable pressure valve, which develops pressure in the circuit in a flow dependent manner). The Instructions for Use (IFU) describe the use of this CPAP mode and the corresponding alarm "CPAP changed to "Off"" but does not specify what threshold is used to trigger the alarm. Only a general descriptor of the alarm is provided in the IFU: "The set CPAP pressure could not be achieved due to leakage. The system has changed the CPAP setting to "Off"."

Learning goals: What is the leak threshold that triggers the alarm and forces the CPAP to turn off? How does the Perseus A500 generate the set PEEP/CPAP in spontaneous ventilation mode?

Case Presentation: A 3-year-old male is induced under general anesthesia via inhaled induction technique with sevoflurane. The anesthesia mask is secured on the patient's face with elastic mask straps. To minimize atelectasis, the CPAP setting is set to "5cm H2O." With the FGF reduced to 1 L/min, the patient continues breathing spontaneously and the machine measures a PEEP of 5cm H2O. During the procedure, the patient's head is turned, and a small leak develops. After some time, the "CPAP changed to "Off"" alarm is triggered, and the PEEP setting is reset to zero.

Results: Since publicly available materials on the Perseus A500 do not provide additional explanation on the CPAP mode, direct communication with Draeger was initiated, resulting in a fruitful explanation of its design and function. Per their R&D team: "The alarm regarding the forced deactivation of CPAP in Man/Spon is based on the expiratory pressure sensor. The alarm is raised if the pressure reading is below 75% of the set CPAP for more than 10 seconds. We apply some filtering so that 'ok values' are not considered if the 75% threshold is not exceeded for more than one second again. The bottom line is that we cannot say how much leakage is tolerated because the influence on the expiratory pressure reading depends on the location of a leakage and of course the ability of the blower in conjunction with an adequate fresh gas flow setting to compensate for the leakage." Furthermore, they confirmed that the CPAP mechanism in the A500 is generated via compression: "The turbine is compressing the volume which is inside the breathing circuit already. In theory this works just fine without any gas going into the system at all. Of course, you'll need some fresh-gas to account for eventual leakages and patient uptake." Based on these communications, it can be concluded that the CPAP mode deactivation relies on a sustained relative inability to achieve the set pressure instead of an absolute leak threshold. Furthermore, use of the CPAP mode is achieved even in settings of lower FGFs because turbine driven ventilators can pressurize the gasses already in the circuit.

Discussion: Communication and collaboration with anesthesia machine vendors is crucial for the ongoing understanding of new features and unique failure states in modern anesthesia machines. In the case of the Draeger A500, that has the ability to provide CPAP in low FGF states, it is clinically useful to recognize that increasing FGF can help compensate for small leaks, as long as the expiratory pressure remains > 75% of the set PEEP.

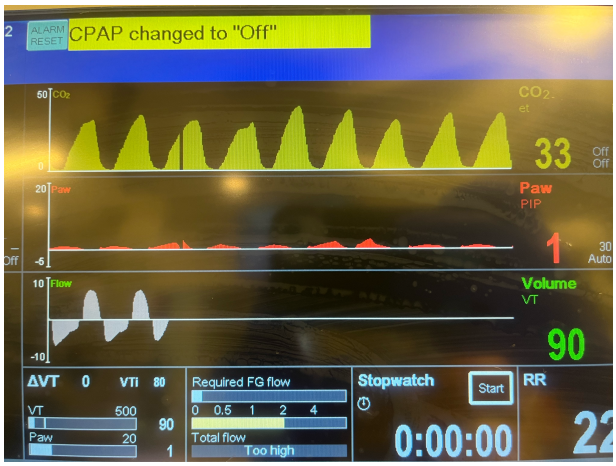

Figure: Draeger A500's main display showing the "CPAP changed to 'Off'" alarm after the set CPAP pressure was not achieved for more than 10 seconds (i.e. < 75% of the set pressure)

References: Instructions for use: Perseus A500: Anesthesia workstation software 2.0n. Draeger. https://www.draeger.com/Products/Content/perseus-a500-sw-203-ifu-9510595-en.pdf

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