

Flow Meters: What Do You Mean the Flow Rate From One Does Not Equal the Same Flow Rate From Another?

Achieving a stable blood oxygen level in patients who depend on this level of care is arguably determined in part by precise regulation of oxygen flow. The reliance on flow meter accuracy is the cautionary message that is relayed in the paper by Davidson et al in this issue of *RESPIRATORY CARE*.¹ There is limited evidence that defends oxygen flow meter accuracy,² which may account for the lack of awareness, and which takes this concern off the radar screen of many clinical practitioners who administer oxygen to their patients. The few studies that have been reported suggest an association between flow meter accuracy and the deterioration of the device that comes with age.^{3,4} Regardless, the published work in this area suggests that a higher appreciation, which challenges flow meter accuracy, is warranted.⁵

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The perception that flow meters are accurate may be true, especially in the United States. This may be due to the mistaken association of these devices with the reliability of the oxygen supply infrastructure that is expected to deliver stable 50 psi to the patient headwall. If the infrastructure is appropriately alarmed by zone and it is not violated, then it may be mistakenly assumed that proper operation and accurate flow delivery regulated by the flow meter are occurring. Stability of the gas pressure source is only one variable, and it alone cannot assure the clinician that the displayed flow rates are accurate.

Flow meter accuracy is evaluated and discussed in the Davidson et al paper.¹ Even with the assurance that the source pressure is stable, which is a prerequisite for proper flow meter operation, the reader, who may have mistakenly under-appreciated the variability of these devices, is encouraged to consider the authors' findings and the clinical consequences.

In the paper,¹ the clinical practice describes the adjustment of the flow meter and the titration of the flow rate to obtain a targeted S_{pO_2} level. Considering that oxygen-dependent patients are often cared for in more than one location during their hospital stay, unless their original flow meter relocates with them, another meter will be used for oxygen delivery. Introducing subsequent flow meters after initially achieving targeted S_{pO_2} has the possible con-

sequence of not achieving the same blood oxygen level, even when the same prescribed flow rate is set.

Adding to the potential of compromising the care continuum, the oxygen-dependent patient's post-discharge management must be considered as well. Reliance on the pre-discharge flow rate and patient assessment may significantly over- or under-estimate the patient's oxygen requirement unless further S_{pO_2} monitoring is used for guidance. Insufficient or excessive oxygen delivery is a consequence of relying on the original flow meter setting. Setting the originally prescribed flow rate may be an insufficient benchmark in setting the subsequent flow meters used for oxygen delivery.

There are additional variables obligating the provider to question the original flow meter settings for determining adequacy in meeting the patient's oxygen delivery needs. These may include the use of cylinder oxygen and a different regulated pressure than the hospital's source; home oxygen concentrators, where an F_{IO_2} of less than 1.0 is delivered; the accuracy of the concentrator's flow meter; and the possible use of bourdon gauges. All of these may introduce variables that could deliver flow rates (and F_{IO_2}) different than what was originally required to meet the patient's needs. These variables emphasize the need to find a solution to an under-appreciated problem, one that will assure that prescribed S_{pO_2} is achieved and maintained.

In their experiment, the authors regulated the gas source to 50 psi. They found that both new and used flow meters had poor accuracy. This is concerning, because only with additional S_{pO_2} or blood gas monitoring, after achieving therapeutic blood oxygen levels, will the targeted level be assured with each subsequent flow meter that the patient may be managed with. If follow-up monitoring is not used, the patient may be oxygen deprived or be exposed to blood levels in excess of what is targeted.

To assure comparable S_{pO_2} outcomes, the authors wisely recommend that the flow rate be titrated again (after the initial adjustment) with pulse oximetry to achieve the desired level. If source gas pressure variability between patient management locations were the reason for inaccurate flow delivery, then this might explain flow meter inaccuracy. However, as the authors clearly point out in their study, this is not the origin for inaccurate flow rates. Their work might suggest that it is the manufacturer's design or

tolerance indifferences, or possibly quality control that manufacturers should be encouraged to address in their future products to assure flow meter accuracy. Until all flow meters deliver the exact same flow rate at each setting, higher surveillance with more frequent S_{pO_2} measurements should be considered the minimal standard for determining acceptable blood oxygen levels.

There is at least one barrier that must be considered in the post-discharge management of oxygen-dependent patients to assure that their requirements are met. Considering the importance of follow-up monitoring with pulse oximetry, for example, Medicare and the commercial insurer's restrictions to these reimbursable events are limited to no more than once or twice a year.⁶ The measurement of S_{pO_2} this infrequently helps to place the correct emphasis on the subject of this paper, accuracy of flow meters, and the apparent void in safeguards to ensure stable oxygen delivery.

Until there is an assurance that all flow meters are accurate, it is reasonable to ask all clinicians who are responsible for managing oxygen delivery to consider the

limitations of existing flow meters. An S_{pO_2} obtained using one flow meter may, unfortunately, have a different effect when oxygen is regulated with another one. The authors' findings demonstrate that, regardless of the reading, unanticipated flow rate delivery will most likely occur whether the flow meters are new or not. Keeping this important concern in mind will help all clinical staff to assure that safe oxygen administration is practiced.

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The author has disclosed no conflicts of interest.

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DOI: 10.4187/respcare.01900