An equine anaesthesia Pitot - based flow sensor designed for three - dimensional printing.

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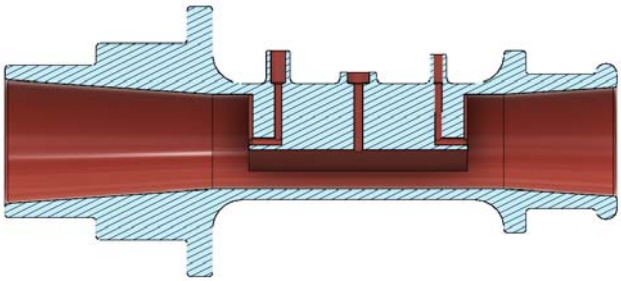
Introduction:

Additive manufacturing, also known as three-dimensional printing, is an emerging technology which allows engineering of individually designed and complex devices. This method seems particularly suitable to develop sensors and adapters used in equine anaesthesia. In this context, three-dimensional printing has been used for adapters like the Flow Partitioning Device (Schramel et al. 2014) and an endotracheal tube connector for a field ventilator (Ritgen et al. 2013).

Aim of the study:

The study aimed to evaluate a re-design of an equine Pitot-based flow meter (H-lite sensor; Moens et al. 2009) including connectors produced by additive manufacturing.

Figure 1 – Cross section of the H-lite3D sensor

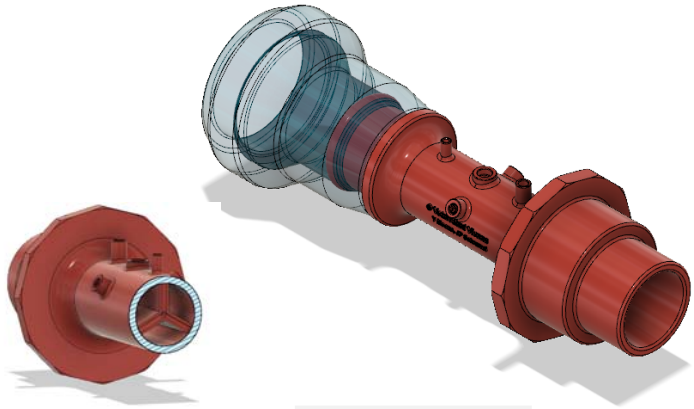


Materials and Methods:

The H-lite was re-modelled with Autodesk Fusion360 (H-lite3D) and manufactured with Selective Laser Sintering of Polyamid.

Conversion factors (CFs) of H-lite and H-lite3D to the original D-lite sensor, (Datex, Finland) were determined using air flows between 180 $Lmin^{-1}$ and 700 $Lmin^{-1}$. A polynomial approximation to the non-linear flow/pressure curve was applied and the CFs calculated by determining the minimum of the squared differences. Deviations < 5.0 % were considered suitable for clinical applications.

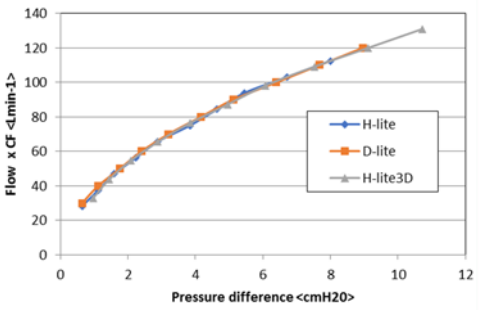
Figure 2 – H-lite3D sensor with bell connector to be inserted between Y- piece and endotracheal tube



Results:

The flow/pressure relationships among H-lite, D-lite and H-lite3D are shown in figure 3. The CFs were 6.32 and 6.15 for the H-Lite and H-Lite3D, respectively (-2.7%). Tuning the CF to an integer value is possible with adjustment screws in the lumen.

Figure 3 – Relationship of flow/pressure curves for H-lite, D-lite and H-lite3D sensors. Flows were multiplied by their respective conversion factors (see text). The non- linear relations of the flow/pressure difference curves were identical for all three sensors and in accordance with the requirements of the Datex monitor.



Conclusion:

Additive manufacturing of sensors for spirometry is an affordable technique that may enhance the availability and application of versatile sensors and adapters in clinical environments. Print data can be provided for non-commercial scientific and research purposes (Open Science License Agreement, Vetmeduni Vienna).

References:

Moens YP, Gootjes P, Ionita JC et al. (2009) In vitro validation of a Pitot-based flow meter for the measurement of respiratory volume and flow in large animal anaesthesia. Vet Anaesth Analg. 36, 209-219.

Ritgen S, Auer U, Schramel JP et al. (2013) A commercial foot pump for emergency ventilation of horses, proof-of-principle during equine field anaesthesia. Equine Vet Educ. 25, 581-584.

Schramel JP, Wimmer K, Ambrisko TD et al. (2014) A novel flow partition device for spirometry during large animal anaesthesia. Vet Anaesth Analg. 41, 191-195.