Introduction:
Elevated temperature may actually be helpful in enhancing immune function and improving outcomes from illnesses including sepsis, ARDS, and COVID-19. Increasing clinical data show fever may shorten illness duration, and a recent pilot randomized controlled trial suggests benefit from actively warming patients with sepsis. We evaluated the potential to provide core warming to patients using a commercially available heat transfer device, focusing on the effect of lung density on regional body temperature.

Methods:
Using Comsol Multiphysics, we modeled heat transfer in the body from the device, taking into account ventilator airflow. We considered a patient with initial body temperature of 38°C. The simulation was performed on a simplified geometry of a human body and airway from the pharynx to the lungs. The simulations used a fixed value of blood perfusion rate obtained from prior modeling, and a range of lung density seen in patients with varying degrees of ARDS.

Results:
Heat diffuses from the device by conduction and convection to the nearby tissues, including the air flowing in the airways (Figure). Skin surface is at a lower temperature than the core due to convective cooling in a hospital environment. At the range of blood perfusion modeled, maximum lung temperature ranged from 37.6°C to 38.6°C. The results suggest that changes in the lung density due to ARDS do not impact heat transfer significantly or affect ability to heat the lungs. The average lung plus air temperature was found to be close to 38.02°C with the peak temperature close to 38.4°C

Conclusion:
The provision of core warming via commercially available technology can increase regional temperature of lung tissue and airway passages over a range of lung density to treat conditions increasingly being shown to benefit from hyperthermia, including sepsis, ARDS, and likely also COVID-19. Clinical study is ongoing.
Figure 1. Stationary graphical results. a) Air velocity in the airways, b) Temperature in the airways+lungs and c) Body temperature.