THE DYNAMICS OF PULMONARY CAPILLARY BLOOD FLOW

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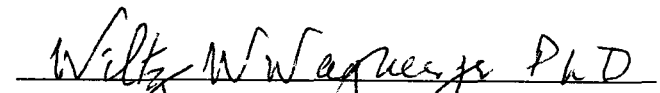

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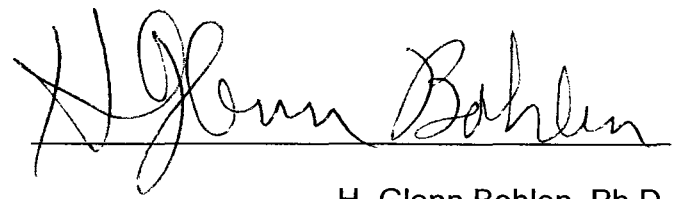

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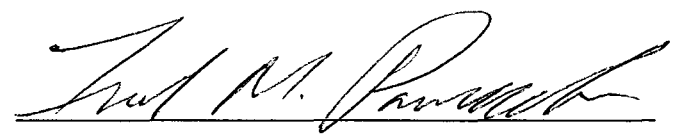

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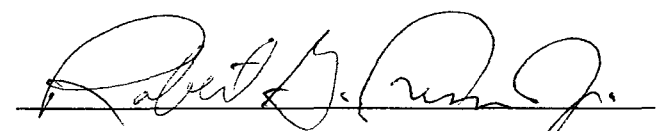

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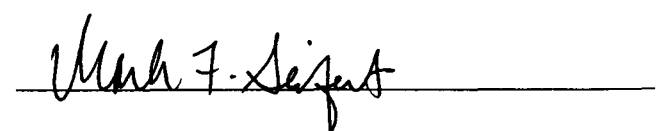

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ABSTRACT

The goal of this research is to determine how blood flow across the capillary bed in the lung is controlled by passive physical forces and active processes. We investigated this by analyzing perfusion patterns of alveolar-capillary networks on the surface of pump-perfused, isolated canine lung lobes using videomicroscopy. Recruitment of capillaries occurs when pressure is raised. First, we hypothesized that levels of recruitment would change in <25 s in response to abrupt blood flow changes. The response to an abrupt increase in blood flow occurred very rapidly (<4 s), while the response to an abrupt decrease in blood flow took ~8 s. These rapid responses were also stable, indicating that the capillary bed responds and equilibrates remarkably fast following abrupt flow changes. Next, we hypothesized that neighboring alveoli would recruit homogeneously with incremental increases in pressure. We found that when comparing one alveolus to its neighbors, the alveoli within a neighborhood recruited heterogeneously. When observing a single alveolus, the pattern of blood flow is highly variable over time, so we then proposed that the pattern may result from individual capillaries having their opening pressure change over time. We determined the stability of these opening pressures by comparing total alveolar capillary blood flow from a long-term, low-pressure observation and a short-term, high-pressure observation which perfused as many capillaries as possible. Significantly more capillaries were perfused at some point during the long, low-pressure observation than during the short, high-pressure observation, suggesting that the opening pressure for those additionally perfused capillaries

had changed during the course of the long observation. Finally, we hypothesized that the variation in the pattern of blood flow was the result of an active process. By comparing perfusion patterns in an alveolus before and after fixation by glutaraldehyde, which eliminated any active process that may be occurring, we observed that the switching of blood flow seen in the normal, healthy lung, continued in the fixed lung. This suggests that blood flow through the capillary bed in the lung is fundamentally controlled passively by the anatomy and structure of the pulmonary vascular tree.

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