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Abstract

Recent observations suggest that a low surface tension may be an important attribute of the lining of the air passages of the lung.[1-4] The purpose of this paper is to present evidence that the material responsible for such a low surface tension is absent in the lungs of infants under 1,100-1,200 gm. and in those dying with hyaline membrane disease. The role of this deficiency in the pathogenesis of the disease is considered.

Surface tension operates so as to minimize the area of the surface. In the lungs, where the internal surface (the alveolar lining) is curved concave to the airway, the tendency of the surface to become smaller promotes collapse. Although the forces not only of surface tension but also of the elastic tissue tend to collapse the lungs, their behavior differs in one important respect. When the lung contains only a small volume of air, the elastic

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Surface Properties in Relation to Atelectasis and Hyaline Membrane Disease

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Recent observations suggest that a low surface tension may be an important attribute of the lining of the air passages of the lung.[1-4] The purpose of this paper is to present evidence that the material responsible for such a low surface tension is absent in the lungs of infants under 1,100-1,200 gm. and in those dying with hyaline membrane disease. The role of this deficiency in the pathogenesis of the disease is considered.

Surface tension operates so as to minimize the area of the surface. In the lungs, where the internal surface (the alveolar lining) is curved concave to the airway, the tendency of the surface to become smaller promotes collapse. Although the forces not only of surface tension but also of the elastic tissue tend to collapse the lungs, their behavior differs in one important respect. When the lung contains only a small volume of air, the elastic recoil of the tissue is diminished, that is, the less the tissues are stretched, the less are the elastic stresses. In contrast, the contribution of surface tension to the retractive force of the lung is increased. Thus, as the air spaces become smaller and more sharply curved, the "mechanical advantage" of surface tension may be thought of as increasing, promoting the tendency to collapse. Since the air spaces are not uniform in size and are all connected to the airway, the smaller, more sharply curved ones tend to empty their contents into the larger. A high surface tension would favor this phenomenon and predispose to atelectasis, whereas a low surface tension would be a stabilizing influence, diminishing the tendency to collapse. For example, if an alveolus can be thought of as a partial sphere with a radius of 40μ and a surface tension equal to that of plasma (55 dynes/cm.), pressure difference would be 20.5 mm. Hg between the inside and outside of the sphere.* This is the pressure tending to collapse the alveolus. If, however, it had the same radius but a surface tension of only 5 dynes/cm., the pressure tending to collapse it would be 1.86 mm. Hg.

Pattle, and more recently Clements and Brown have focused their attention on the magnitude of the surface tension within the lung. Pattle,[1,2] noting the stability of foam and bubbles arising from the lung,

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concluded that their surface tension must

* This is in accord with the LaPlace relationship, $P=2T/r$, where P is the pressure across the wall of the sphere; T is surface tension, and r is the radius of the sphere.

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