

This Week's Citation Classic

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West J B & Dollery C T. Distribution of blood flow and ventilation-perfusion ratio in the lung, measured with radioactive CO_2 .

J. Appl. Physiol. 15:405-10, 1960.

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Human volunteers inhaled radioactive CO_2 , labeled with ^{15}O (half-life, two minutes) and counters over the chest measured the rate of removal of the radioactive gas from the lung during breath-holding. The results showed that blood flow increased markedly from apex to base in the upright lung. Regional ventilation was also measured and the topographical inequality of gas exchange in the lung was calculated. [The SCJ[®] indicates that this paper has been cited in over 385 publications since 1961.]

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"During the late 1950s, my colleagues and I were presented with a remarkable opportunity at the Postgraduate Medical School, London. The British Medical Research Council had recently installed the first medical cyclotron in a hospital and it was a relatively simple matter to produce large quantities of ^{15}O by bombarding nitrogen with deuterons. Because ^{15}O has a half-life of only two minutes, large amounts (several millicuries) can be inhaled for a small radiation dose.

"When radioactive CO_2 was inhaled and its rate of removal from the lung was measured with counters over the chest, we were astonished to find the clearance rate from the apex of the lung was much less than from the base. This difference was abolished when the subjects lay supine, and both the apical and basal clearance rates increased during exercise in the upright position. It was clear that we were demonstrating for the first time the enormous topographical inequality of blood flow in the normal lung.

"In the same paper we were able to show that the ventilation of the lower zones of the lung exceeded the upper. This measurement was obtained from the initial increase in

counting rate when the breath of radioactive CO_2 was inhaled. Then, armed with these new data on the inequality of ventilation and blood flow in the lung, we calculated the regional differences of gas exchange. These calculations were subsequently reported in a more sophisticated fashion¹ using better data on the distribution of ventilation obtained with radioactive xenon² but the message was essentially the same.

"The reason why this paper is quoted so often is that it marked the beginning of an extensive research program into the regional differences of function and structure in the lung. It is now known that there are marked regional differences of blood flow, ventilation, alveolar P_{O_2} and P_{CO_2} , intrapleural pressure, alveolar size, and mechanical stresses within the lung.³ Elucidation of the causes of these regional differences has been a very fruitful area of respiratory physiology over the last 15 years. Moreover, these topographical differences have been shown to play a role in a number of lung diseases.

"A note might be added about the laboratory in which this work was done. Space at Hammersmith Hospital at that time was extremely tight. Since we had to have a laboratory near the cyclotron because of the very short life of the isotope, we chose to do the work in a small cottage alongside the cyclotron building, which had previously been used as a house for the hospital engineer. I believe it had been condemned because it was structurally so unsound. However, it suited us well and what used to be the engineer's living room was packed with counting equipment. I still remember the astonishment of American visitors who came to see this exotic research and could not believe that it was being done in such appalling conditions.

"A final note. Since the topographical inequality of blood flow in the lung is caused by gravity, we are anxious to see what happens in the weightless environment of space flight. At the present time, we are working very hard on an experiment to do just that on *Spacelab 4* which will be launched in 1985."

1. West J B. Regional differences in gas exchange in the lung of erect man. *J. Appl. Physiol.* 17:893-8, 1962. (Cited 200 times.)
2. Ball W C, Jr., Stewart P B, Newsham L G S & Bates D V. Regional pulmonary function studied with xenon¹³³. *J. Clin. Invest.* 41:519-31, 1962. (Cited 470 times.)
3. West J B, ed. *Regional differences in the lung*. New York: Academic Press, 1977. 488 p.