Autonomic Vasomotor Tone in the Pulmonary Circulation

THE BLOOD VESSELS to the lungs, like those of other viscera, are under autonomic control. At least anatomically all the components are there, complete with sympathetic nervous connections to the stellate ganglia and hypothalamus on the one hand and with afferent connections that link systemic chemoreceptors to pulmonary vasomotor nerves on the other. In addition, the pulmonary circulation seems to have a full quota of alpha and beta receptors.

What is unsettled is when, how, and to what extent these autonomic nerves are called into play. Granting that there is little reason to suspect appreciable autonomic activity at rest, a much stronger case can be made for engagement of the pulmonary vasomotor nerves during stress. For example, it would be a bit odd if the pulmonary circulation behaved like a limp bag between the two ventricles during a period of violent exertion. How much more reasonable is the idea that tension of the large pulmonary arteries during a generalized increase in autonomic activity would prevent the withholding of blood from the left ventricle and promote synchrony in the cardiac outputs of the two ventricles. Also attractive is the prospect of improving gas exchange at the apices as pulmonary arterial pressure increases in response to the increase in sympathetic nervous activity.

One limiting factor in these considerations about pulmonary vasoconstriction is that the normal pulmonary circulation is generally pictured as being meagerly endowed with smooth muscle. In essence, the pulmonary vessels lack equipment for vigorous contraction. This is true for normal residents at sea level. But, pulmonary arterial smooth muscle is thicker in native residents at high altitude and in patients who have pulmonary hypertension from a variety of causes. For these patients, a reliable pulmonary vasodilator might be of inestimable value.

All of these considerations seem to apply to the paper by Fahmy et al. in the present issue. These authors administered pentolinium, a ganglionic blocking agent, during nitrous oxide-halothane anesthesia, and found that it caused pulmonary vasodilation. In essence, the pentolinium undid the vasoconstriction caused by the anesthetic [presumably the nitrous oxide]. They attribute the vasodilation, in part, to "sympathetic blockade" by the pentolinium.

The experiments were well planned, carefully executed, and the results are interpreted with proper respect for the experimental setting. The authors are sensitive to the complicated situation that is induced by the combination of anesthesia, systemic hypo-
tension and ganglionic blockade. The situation is certainly right for a barrage of pulmonary vasomotor stimuli to descend upon pulmonary vessels from a stressed heart and circulation. But, the pentolinium somehow intervenes. Where it imposes "sympathetic blockade" remains to be resolved.

But even though the mechanism of action of pentolinium is left unsettled, the sequence of these experiments and the pattern of pulmonary vasomotor response are strongly reminiscent of the way acetylcholine reverses the pulmonary pressor response of acute hypoxia. Although acetylcholine also has no appreciable effect on the normal pulmonary circulation, it does serve to relax vasoconstricted pulmonary vascular smooth muscle, presumably by a direct effect. Whether pentolinium operates in the same way on pulmonary vascular smooth muscle that has constricted in response to nitrous oxide—halothane anesthesia is unknown.

The importance of this paper is twofold: its focus on the autonomic nervous control of the pulmonary circulation and the need for an effective pulmonary vasodilator in pulmonary hypertensive states. With respect to the former, there is indeed a great vista to explore about the operation of the nerves to the lungs, particularly in pulmonary vascular beds that contain hypertrophied and vigorous smooth muscle in their resistance vessels. Much less encouraging is the prospect that pentolinium will prove useful as a therapeutic agent in relieving chronic pulmonary hypertension. Certainly, hexamethonium, to which it is closely related, has been disappointing. Nonetheless, the special interest in the therapeutic implications of pentolinium does underscore the practical rewards that may accompany improved understanding of the role of the autonomic nervous system in regulating pulmonary vasomotor reactivity.

ALFRED P. FISHMAN, M.D.
Cardiovascular-Pulmonary Division
Department of Medicine
University of Pennsylvania School of Medicine
Philadelphia, Pennsylvania 19104

References