intensity of current was adjusted so that neither heart rate nor respiration were markedly affected. In no case was the former decreased more than 5 beats per minute. It is believed that this represented a stimulus of physiological intensity. A tetanizing current so adjusted was applied for 30 minutes after which a second blood sample was drawn, and a third at the end of another hour. In a third series of 8 dogs similar technic was employed except that both vagi were sectioned and the electrodes were applied to the peripheral ends. The composite graphs constructed on a percentage basis are shown in the accompanying figures. With exception of potassium the responses in the individual experiments conformed well with the composite graphs which may, therefore, be considered as type graphs.

It is recognized that the anesthetic is a complicating factor and that these experiments merely demonstrate the modification of the anesthetic graph by vagal stimulation.

The differences observed between peripheral vagal stimulation and intact vagal stimulation may be ascribed to antagonistic reflexes aroused by impulses conveyed centrally from the point of stimulation in the latter group of experiments. A point of some interest is the similarity of all the graphs for calcium to those for potassium.

These experiments demonstrate that, with the possible exception of inorganic phosphorus, the concentration of inorganic salts in the blood may be influenced by the autonomic nervous system, regardless of the immediate mechanism of nervous control.

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Experimental Production of Mucous Plugs in the Bronchi of Dogs.*

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The most commonly accepted explanation for the production of post-operative pulmonary atelectasis is bronchial obstruction, either by a mucous plug or by bronchial secretion. The obstruction of the bronchus or bronchi must be complete so that air can not enter the lung distal to the obstruction. The trapped air or gas in this ob-

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FIG. 1.

Photograph of trachea, bronchi, and lungs of Dog VII, killed 72 hours after introduction of mustard oil into the bronchus of the right lower lobe and 48 hours after plug was seen through the bronchoscope filling that bronchus and extending into right primary bronchus. An idea of the size of the exposed part of the plug can be obtained by comparison with the pins holding the right primary bronchus open.

structed part of the lung is then absorbed by the blood and so the lung collapses or becomes atelectatic.

To study this mechanism, a large variety of foreign bodies have been used to plug the bronchi in dogs such as shot, paper balls, gum arabic,[1] sponges,[2] peas,[3] ligation of a bronchus,[4] rubber balloons,[5]

[1] Mendelsshon, A., *Der Mechanismus der Respiration and Cirkulation*, etc. B. Behrs, Berlin, 1845.

[2] Lichtheim, L., *Arch. f. exp. Path. u. Pharmakol.*, 1878, **10**, 54.

corks,[6] etc. Some investigators[7] have even used tenacious secretions removed from the bronchial tree of a patient with massive atelectasis. It seemed to us that, rather than introduce foreign bodies into the bronchi of dogs, the condition in the human would be simulated more nearly if a mucous plug or tenacious secretion could be produced in the bronchi by irritation. It was found that mustard oil[8] was admirably suited for this purpose.

The dogs were first anesthetized, usually with sodium amytal. Bronchoscopy was performed and the bronchial tree examined to make certain it was normal. A small cotton pledget moistened with mustard oil was then introduced through the bronchoscope into the desired bronchus and held there for 2 or 3 minutes. This area was examined subsequently at frequent intervals through the bronchoscope.

It was found that a bronchial plug of the type shown in the illustration was formed usually in about 24 hours. With one exception there was little reaction in the rest of the bronchial tree. This type of plug was found to extend deep into the finer ramifications and was frequently over an inch in length. There was usually tenacious secretion about the plug. Microscopically the plug consisted either of pure mucous or largely of fibrin and leucocytes. In seven experiments bronchial plugs of the type indicated were successfully produced by the technique described. In one animal a localized bronchial edema occurred at the site of application of the mustard oil. The roentgenographic and pathologic studies on the lungs will be presented in another communication.

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[3] MacCallum, W. G., *Johns Hopkins Hosp. Bull.*, 1908, **19**, 215.

[4] Andrus, W. DeW., *Arch. Surg.*, 1925, **10**, 506.

[5] Coryllos, P. N., and Birnbaum, G. L., *Arch. Surg.* 1928, **16**, 501.

[6] Van Allen, C. M., and Adams, W. E., *Surg. Gynec. and Obst.*, 1930, **50**, 385.

[7] Lee, W. E., Ravdin, I. S., Tucker, G., and Pendergrass, E. P., *Ann. Surg.*, 1928, **88**, 15.

[8] Suggested by Prof. C. D. Leake.