phosphate concentration was low than when it was high; 6, in many individual experiments there was little or no correlation between changes in reaction and in phosphate concentration; 7, the average phosphate concentration was higher in achlorhydria, possibly due to the small hourly volume of urine excreted, than it was in a short control series.

It seems probable, therefore, that the phosphate concentration produced in the course of ordinary metabolism modifies the urinary reaction as do the variations produced by various experimental methods.[4] The relationship between phosphate concentration and the urinary reaction is not, we believe, an essential one. High concentrations of phosphate tend to decrease, and low ones to exaggerate variations in the urinary reaction due to various causes. Part of this buffer effect is almost certainly concerned in the changes in the reaction of the urine which take place after it is voided, but what proportion of the relationships noted should be attributed to this cause cannot be decided. It seems probable that variations in the phosphate concentration may explain some of the unusual findings noted in our studies upon the alkaline tide in urine; it seems possible, also, that the high degree of constancy of urinary reaction frequently found in patients with achlorhydria may result, not only from the relative constancy of the acid-base metabolism in these subjects, but also from the fact that the phosphate concentration in their urine tends to be high.

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Experimental Production of Cervical Cellulitis Resembling Ludwig's Angina.

DAVID T. SMITH. (Introduced by S. Bayne-Jones.)

From the New York State Hospital for Incipient Tuberculosis, Ray Brook, N. Y.

Infections in the floor of the mouth may extend into the deep facial planes of the neck and produce a cellulitis which has a decided tendency to terminate in gangrene or abscess formation. Ludwig originally described the condition as a gangrenous induration of the neck; Vincent refers to the disease as a foetid para-buccal abscess. The primary focus occurs about the teeth in most in-

[4] Rannenberg, E., *Arch. f. d. ges. Physiol.*, 1925, ccxii, 601.

stances (Muckleston,[1] Van Wagenen and Costello,[2] Ashhurst[3]). These observers, among others recovered an aerobic streptococcus from the cervical lesion, more rarely staphylococci or other aerobic organisms, which they regarded as presumably the causal agent. However, no reference is made to anaerobic studies. Melchoir[4] found fusiform bacilli and cocci in 4 cases; fusiform bacilli alone in one case; spirochetes, fusiform bacilli and cocci in another case. More recently, Hansen* told me he observed a fatal case of Ludwig's angina in which he found fusiform bacilli and spirochetes in large numbers.

It has been demonstrated that local lesions about the teeth generally harbor fuso-spirochetal organisms. These organisms produce a foul abscess or gangrene when introduced into the tissues of animals.[5, 6, 7] It therefore seemed reasonable to infer that Ludwig's angina might be due to a fuso-spirochetal infection.

The scrapings from the teeth of patients with pyorrhea were inoculated into the inner margin of the gum of the lower posterior teeth in 25 guinea pigs. Each of 5 pigs received 0.25 cc. of pyorrhea material. Four animals remained normal, the fifth, after 5 days, developed an enlarged gland deep in the neck immediately below the mandible. The gland gradually enlarged during the following week and the infection spread to the surrounding cellular tissue. At necropsy on the twelfth day a large amount of foul pus was found in the neck which contained innumerable spirochetes, fusiform bacilli, vibrios and anaerobic cocci. The purulent material from this animal in the amount of 0.25 cc. was inoculated into the inner margin of the gums in each of 10 normal guinea pigs. Seven of the 10 pigs developed a unilateral brawny induration in the tissues of the neck which appeared at 24 hours and rapidly grew in size and firmness until the fourth day. Five of these animals died between the sixth and tenth day, and at necropsy showed a gangrenous cellulitis which had dissected back and by pressure closed the glottis. The infection subsided by resolution in one animal and one other recovered after spontaneous rupture and drainage.

[1] Muckleston, *Ann. Otol. Rhin. and Laryn.*, 1928, xxxvii, 711.

[2] Van Wagenen and Costello, *Arch. Surg.*, 1928, lxxxvii, 684.

[3] Ashhurst, *J. Am. Med. Assn.*, 1929, xcii, 500.

[4] Melchoir, *Berl. Klin. Wochenschr.*, 1917, xxix, 695.

* Personal communication from Dr. Oscar C. E. Hansen of the Department of Medicine at the Johns Hopkins Hospital.

[5] Kline, *J. Inf. Dis.*, 1923, xxxii, 481.

[6] Pilot and Davis, *Arch. Int. Med.*, 1924, xxxiv, 313.

[7] Smith, *Am. Rev. Tb.*, 1927, xvi, 584.

The experiment was repeated with 10 other animals and 9 of these likewise developed a cervical cellulitis resembling Ludwig's angina.

Thomas[8] collected 106 cases of Ludwig's angina from the literature and found that the mortality was 40%. Van Wagenen and Costello have shown that with earlier diagnosis, earlier and more prompt surgical interference, the mortality is reduced. The administration of neo-arsphenamine or sulph-arsphenamine in the initial stages of fuso-spirochetal infections of the lung has been helpful in treatment[9] and therefore arsenical therapy would appear to be indicated in those cases of Ludwig's angina due to a fuso-spirochetal infection.

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Some Metabolic Changes Occurring in Prolonged Diathermy Treatments.

E. S. NASSET AND S. L. WARREN. (Introduced by J. R. Murlin.)

From the Department of Vital Economics, and the Division of Radiology of the School of Medicine and Dentistry, University of Rochester, Rochester, N. Y.

Studies on the respiratory exchange and the sugar, non-protein nitrogen, chlorides and carbon dioxide content of blood, were made on anesthetized (morphine + amytal) dogs. Tracheotomy was done and connection made to a Benedict universal apparatus. Blood analyses were done by standard methods. The high frequency current had the following characteristics: wave length—200 meters, relatively high voltage, currents from 500 to 1000 milliamperes. Electrodes were placed on the left upper arm and right thigh, or on either side of the head. Treatment continued from 1 to 3 hours. Temperature measurements were made with thermocouples and mercury thermometers.

The respiratory metabolism invariably increased—in some cases 150%. Body temperatures were elevated 5 to 7°C. When blood sugar was initially relatively high there was a gradual depletion during diathermy; in cases of low initial concentrations a preliminary rise was noted followed by a fall. The end result was a marked hypoglycemia (30 to 50 mg. per 100 cc. blood). Non-protein nitrogen was in some cases increased to 200% of normal. Chlorides

[8] Thomas, *Ann. Surg.*, 1908, xlvii, 161.

[9] Smith, *J. Am. Med. Assn.*, 1930, xciv, 23.