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THE LARYNGEAL MICROPHONE AS AN AID TO TREATMENT OF BULBAR POLIOMYELITIS

BY

F. D. STOTT, D.Phil.

*Electro-medical Research Unit (Medical Research Council),
Stoke Mandeville Hospital, Aylesbury, Bucks*

In the treatment of bulbar poliomyelitis the prime requirement is the maintenance of a clear airway. Failure to keep the airway free from obstruction results in anoxia and hypercapnia. McDowell and Wolff (1953) have advocated early tracheotomy as a prophylactic measure in bulbo-spinal cases. Galloway (1947) recommends tracheotomy in bulbo-spinal cases, and also in other types of the disease whenever there is difficulty in maintaining a clear airway. The frequency with which tracheotomy may be needed should be much reduced if the technique of detecting and removing obstruction is improved. Ritchie Russell (1952) has stressed the need for a continuous watch over the patient to detect obstruction at the earliest possible moment. If this can be done, and adequate postural drainage in the prone position is used, most cases of bulbar poliomyelitis uncomplicated by failure of respiratory muscles can be kept fully ventilated without tracheotomy.

The first indications of obstruction are not, however, easily detected even by experienced nurses, especially if there is much other noise in the ward. In order to eliminate this source of danger, an instrument has been developed to amplify respiratory sounds so that the slightest obstruction is immediately apparent. It has been tried out in two epidemics and has proved to be of the greatest value.

The instrument, as constructed here, consists of a standard pattern of U.S. Air Force laryngeal microphone,* together with an amplifier and loudspeaker. Details of the construction of two models, one mains-operated and the other battery-operated, are given below.

The method of using both instruments is the same. The microphone is placed over the patient's larynx and held in place by an elastic band. If the laryngeal position is inaccessible, as may be the case when the patient is prone, the microphone may be placed on the back of the neck, over the temple, or even on the occiput, when the sounds will be picked up by bone conduction.

*Type ZA.19734, readily obtainable from many shops dealing in radio equipment, and advertised in *Wireless World*.

Light pressure only is required, just enough to prevent displacement by the patient's movements. The volume is then adjusted until the intermittent rushing sound produced by normal unobstructed respiration is just audible without being obtrusive. Under these conditions the sound caused by obstruction of the airway is loud enough to draw attention from the far end of the ward. The bubbling sound, accompanied by loud rhonchi so produced, is quite unmistakable, and quite distinct from the more clattering or clicking noise produced by swallowing.

Construction of the Instruments

The circuit diagram of the mains-operated instrument is given in Fig. 1, and of the battery model in Fig. 2.

FIG. 1.—Circuit of mains-operated unit. R_1 , 100 KΩ. R_2 , 1,500 Ω. R_3 , 250 KΩ. R_4 , 100 KΩ. R_5 , 100 KΩ. R_6 , 1,500 Ω. R_7 , 1 MΩ. R_8 , 1 MΩ. R_9 , 500 KΩ. R_{10} , 100 KΩ. R_{11} , 100 KΩ. R_{12} , 500 KΩ. R_{13} , 500 KΩ. R_{14} , 500 KΩ. R_{15} , 50 KΩ. T_1 , Microphone input transformer, 100:1. T_2 , Speaker output transformer. T_3 , 300-0-300 V, 5 V, 6.3 V. C_1 , 0.1 μf. C_2 , 0.1 μf. C_3 , 0.1 μf. C_4 , 0.1 μf. C_5 , 0.001 μf. C_6 , 8 μf. C_7 , 8 μf. C_8 , 0.01 μf. V_1 , 6V6. V_2 , ECC 35. V_3 , 6V6. V_4 , 6V6. V_5 , 524. P_1 , 600 KΩ. L_1 , 5H, 100 mA. L_2 , 100H, 5 mA.

FIG. 2.—Circuit of battery-operated unit. R_1 , 30 KΩ. R_2 , 1 MΩ. R_3 , 500 KΩ volume control. T_1 , Microphone input transformer, 100:1. T_2 , Speaker output transformer. V_1 , DF 92 (or 1L4). V_2 , DL 92 (or 3S4). C_1 , 0.002 μf. C_2 , 0.01 μf.

As will be seen, the mains amplifier is a three-stage type, with push-pull output to an 8-in. (20 cm.) loudspeaker. This provides a maximum output volume much greater than is normally needed. The highest and lowest notes are attenuated, as the required diagnostic sounds are mainly in the middle frequency range, from 100 to 2,000 cycles approxi-

mately. Amplification over this range, which is roughly the minimum required for comprehensible speech, is adequate. As the loudspeaker and microphone are usually fairly close together, amplification of higher frequencies is very apt to cause oscillation from acoustic feedback; this will, in any case, happen when the microphone is removed from the patient, and it should always be switched off by the switch, S₁, when not in place on the patient.

The microphone used with this instrument is an electromagnetic type which is particularly robust and reliable, and gives excellent results. The battery model uses a carbon microphone; although this does not give quite the same frequency response, and has a rather higher noise level, it was chosen for this purpose because it gives a much larger output, so that a simpler amplifier, with correspondingly reduced drain on the batteries, could be used. A simple two-valve amplifier, using a DF92 voltage amplifier and a DL92 output valve, is all that is needed.

The same precautions with regard to acoustic feedback are desirable, though the oscillation is not so offensive in the battery model as in the mains one, because the maximum output power is so much less.

An instrument of similar performance and specification to the mains-operated model, but lighter and more compact, is now available from Isis Equipments, Broad Street, Oxford.

Acknowledgment is made to Dr. W. H. Kelleher for his assistance in testing this instrument in clinical use at the Western Hospital, Fulham, and to Dr. W. Ritchie Russell and the staff of the poliomyelitis unit, Stoke Mandeville Hospital, for carrying out extensive trials during the 1952 epidemic.

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Medical Memorandum

Felty's Syndrome Treated by Splenectomy

Felty's syndrome is the name given to a rare but characteristic triad of arthritis of rheumatoid type, splenomegaly, and leucopenia, with which generalized lymph-node enlargement and hepatomegaly may be associated. The leucopenia has been regarded as a hypersplenic manifestation, and since it may give rise to disabling symptoms a number of patients have been treated by splenectomy. Hutt, Richardson, and Staffurth (1951) report four cases, two of which had corneal ulceration, and a third chronic leg ulcers. After splenectomy there was a continued improvement in the neutrophil count in all and a significant increase in the haemoglobin percentage in three. The ulcers healed, and one patient had lasting improvement in his arthritis.

CASE REPORT

A male radiographer now aged 35 first noticed joint pain in 1937. In 1940 he joined the R.A.M.C. and remained in the regular Army until he was invalided out with a diagnosis of Felty's syndrome in June, 1950. He had first come under medical supervision in 1943 when a diagnosis of rheumatoid arthritis with leucopenia was made. In 1950 his joints became worse and the investigations which led to his discharge revealed, in addition to the leucopenia, a spleen enlarged to 6 in. (15 cm.) below the costal margin.

He first attended hospital on November 6, 1950, for a blood count. He became unwell a few days later, and was admitted to hospital critically ill with a right upper lobe pneumonia. He was treated with large amounts of penicillin, but response was very poor. On the third day in hospital his temperature was still very high and there were signs of massive consolidation, but his leucocyte count was only 1,800 per c.mm., with 79% neutrophils (see Table). Streptomycin and aureomycin were given in full doses, and his temperature and clinical condition slowly improved. A

Leucocyte Counts

	Hb %	W.B.C. per c.mm.	Neutros. %	Eosins. %	Lymphs. %	Platelets per c.mm.
6/11/50 ..	76	1,700	33	4	61	
15/11/50* ..	72	1,800	79	2	17	
18/11/50* ..	70	5,500	82	2	13	130,000
28/11/50* ..	67	2,650	62	—	30	
18/12/50 ..	68	2,000	44	5	44	
30/3/51 ..	70	1,500	15	7	74	175,000
2/4/51 ..	75	1,450	9	4	85	144,000
3/4/51 ..	Splenectomy; 3 pints (1,700 ml.) blood transfused					
4/4/51 ..	90	13,000	88	—	9	
22/5/51 ..	95	7,200	54	1	44	465,000
24/7/51 ..	88	6,400	41	8	44	
25/9/51 ..	97	9,900	52	3	42	380,000
1/12/52 ..	91	11,900	64	1	34	280,000

* Counts taken during course of pyogenic pneumonia.

leucocyte count of 5,500 was recorded on one occasion, coinciding with some clinical improvement, but consolidation appeared in the left lower lobe soon after. Folic acid did not affect his condition. Three weeks after admission his temperature had settled and he was much better, but there were still signs of consolidation, and radiologically there was cavitation. The only organisms isolated from his sputum were *Proteus vulgaris* and *Bact. coli*. The signs gradually cleared over the following month, but some residual fibrosis remained. During convalescence transfusion of 1 pint (570 ml.) of fresh blood did not affect his white-cell count.

He was discharged in January, 1951, and readmitted two months later for splenectomy, with a view to correcting his neutropenia, to which the severity of his pneumonia was attributed. He was then a rather pale man with rheumatoid changes of moderate degree in his joints, ulnar deviation of his fingers, and a spleen which extended below his umbilicus. There was no lymph-node enlargement, his liver was not palpable, he was not pigmented, and there was no ulceration of skin or mucous membranes. Red-cell fragility was normal, reticulocytes 2%, and liver function showed abnormal flocculation reactions, while his serum albumin was 3.6 g. and globulin 3.7 g. per 100 ml. Splenectomy was performed by Mr. J. R. M. Whigham. The spleen, which measured 29 by 12 by 9 cm., was removed fairly easily, there being only a few adhesions. Sections showed congested sinusoids, increase of reticular tissue, and heavy plasma-cell infiltration. Biopsy of liver showed no significant histological abnormality. Bone-marrow biopsy at operation showed slight increase of erythropoiesis over leucogenesis and evidence of delay in polymorph maturation. Recovery from operation was uncomplicated. Since operation his joints have shown little or no improvement, his E.S.R. has remained high, and the abnormal liver function is unchanged. However, the leucocyte count is at normal levels, his haemoglobin is significantly improved, and he looks and feels much better.

COMMENT

Hutt and his colleagues noted an improvement in the general well-being of their patients. One was described after operation as "full of pep and working better than for years." A very noticeable feature of the present case was a change of disposition. Before operation he was a morose and taciturn man who appeared to care little whether he improved or not. He seems to have acquired a new zest for living, and for the first time shows interest in his future progress and in finding a job.

I am greatly indebted to Mr. J. R. M. Whigham and Dr. D. W. G. Smith for permission to publish this account and to Dr. Louis Steingold for the pathological reports.

FRANK RACKOW, M.D., M.R.C.P.,
St. Andrew's Hospital, London, E.3.

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