made of chromium-finished metal. During use pressure in the body of the instrument was raised by means of the hand pump, the spray being controlled by a stopcock at the base. The spray was projected direct into the throat and the fluid accumulating from this was enough for a final gargle. It was found that the treatment could be carried out on a class of fifty ratings in six to seven minutes. This routine was continued daily until the time of their departure from the establishment some five weeks after joining. During these weeks any rating of either class who reported to the medical department with any complaint whatever was seen by me and his condition noted.

	Untreated Group	Treated Group
Number admitted to hospital	13 (26%)	6 (12%)
Complaint	Acute sore throat, 11; common cold, 2	Cerebrospinal meningitis, 1*; acute sore throat, 3; common cold, 2
Number attending for daily treatment	23 (46%)	12 (24%)
Complaint	Sore throat, 18; common cold, 4; suppurative otitis media, 1	Sore throat, 6; common cold, 6

* This case of cerebrospinal meningitis developed on the second day after the entry of the rating to the establishment.

By "acute sore throat" is meant acute streptococcal tonsillitis and pharyngitis, together with marked constitutional symptoms so typical of the 1939-40 epidemic. By "sore throat" is meant a subacute infection of fauces and pharynx, and "common cold" indicates acute coryza with slight constitutional symptoms but little or no throat infection.

Conclusions

The results of this investigation, which are shown in the preceding table, demonstrate clearly that during the five weeks that these two groups remained under observation the incidence of sickness occurring in the treated group was greatly diminished. The total number of patients requiring to be admitted to hospital during this period, as well as those receiving ambulant treatment, was reduced by half in the treated as compared with the untreated group. This diminution was entirely due to the decreased incidence of acute and subacute throat infections, the incidence of "common cold" being more or less equal in both groups. Clinically it was observed that the acute throat infection occurring in members of the treated group was similar in severity and in duration of illness to that occurring in members of the untreated group. This suggests that the use of prophylactic treatment failed to attenuate the virulence of the infecting organisms in those cases in which they were not primarily destroyed.

The favourable results obtained in this small experiment indicate that the use of an antiseptic throat spray is a justifiable prophylactic measure against such common winter ailments as acute and subacute streptococcal throat infections and influenza.

Summary

The incidence of pathogenic organisms in the throat is briefly discussed and a method of destroying them by antiseptic throat spray is suggested.

A comparison is given of the incidence of infection in two groups each of fifty naval ratings during a period of five weeks, only one group receiving prophylactic treatment.

The prophylaxis consisted of a throat spray and gargle of 15 to 20% sodium hypochlorite solution each morning on rising for five weeks.

It is shown that the incidence of acute and subacute throat infection in the group receiving prophylactic treatment was greatly diminished.

The severity of the clinical condition once it has developed is unaffected by the previous prophylactic treatment.

I am indebted to Surgeon Captain J. Bruce Ronaldson, R.N.V.R., for his co-operation and to Sick Berth Attendant J. L. Patterson for his assistance. My thanks are also due to Mr. H. C. Edgell of Milton Proprietary, Ltd., for the supply of sodium hypochlorite solution and pressure atomizers.

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MECHANISM OF PARTIAL REBREATHING IN ANAESTHESIA

BY

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With modern apparatus for gas-and-oxygen anaesthesia rebreathing is always provided for by the use of a bag, and CO₂ is eliminated by absorption or by the use of an expiratory valve. The former method (absorption) will not be considered here. The latter, by which a portion of each expiration is retained and a portion released into the atmosphere, constitutes "partial rebreathing," and may be applied to continuous or to intermittent flow. In either case the ultimate justification for partial rebreathing lies in the fact that the non-alveolar upper air-passages add warmth and moisture to the gases they contain, but take no part in real ventilation, so that any procedure which conserves their contents while still permitting adequate ventilation at a lower level is rational and beneficial, the more so that increased lung expansion and oxygenation are thereby occasioned.

Some Important Factors

In examining the mechanism of this process, consideration must be given to the following factors: (1) the "spirometer gradient"; (2) the total minute-flow of the anaesthetic mixture; (3) the total minute ventilation of the respiration and its relation to the gas flow; (4) the metabolic needs of the patient.

The "spirometer gradient" depends on the fact that the CO₂ content of the expired air increases until about 800 c.cm. has been released, the content then reaching a maximal value, which is taken as representing the common concentration of CO₂ in the alveolar field. The actual form of this gradient is shown in Fig. 1, and is of import-

FIG. 1.—Showing the actual form of the "spirometer gradient." The horizontal co-ordinates represent depth of expiration in hundreds of c.c.m.

ance in the mechanism of rebreathing. It will of course vary slightly in different individuals or from time to time in the same individual. The curve here given is based on Haldane's figures.

The extent of rebreathing is determined by the relation between respiration and gas flow. Thus if respiration amounted to 12 litres per minute, and in the meantime

6 litres of new gas had flowed into the apparatus, the difference—6 litres, or 50%—would have been rebreathed.

The effects of the process are indicated in Figs. 2-5. In Fig. 2 it is supposed that a tidal respiration of 400 c.cm. is modified by "50% rebreathing." The point

FIG. 2.—Schematic representation of 400 c.cm. tidal respiration, with 50% rebreathing. The white area enclosed under the curve at A represents the amount of CO_2 rebreathed, and the black area at B the amount of CO_2 exhaled into the atmosphere.

during expiration at which the valve opens is indicated by "V," and the end of expiration by "W." It will be seen that the upper dilute portion of the expiration, O-V, is retained for rebreathing, while the lower more concentrated portion, V-W, is released through the valve. The effective release of CO_2 is in this case performed by 200 c.cm. of deeper expiratory air. Figs. 3 and 4 make clear

FIG. 3.—The effect of an increase in tidal respiration to 800 c.cm., with a fixed continuous flow. There is a large increase in the amount of CO_2 rebreathed, and a relatively small increase in that exhaled into the atmosphere.

FIG. 4.—The effect of the same increase with intermittent flow. The amount rebreathed is constant, and the whole increase of tidal respiration carries CO_2 in much greater amount into the atmosphere.

the essential difference between the mechanism in continuous flow, where the volume of effective release, V-W, though movable, remains constant for a given frequency of respiration, and in intermittent flow, where it is the volume rebreathed, O-V, which remains constant.

The patient's metabolic needs must now be considered. As Guedel (1937) has pointed out, many factors tend to modify the oxygen intake and CO_2 output of the patient who reaches the operating table; but in hospital conditions these will be depressed to a minimum by resting conditions and premedication. Gesell (1939) gives for an average adult B.M.R. in the lying position an oxygen intake of 234 c.cm. per minute, representing 1.14 calories, so that if a respiratory quotient of near 1 be assumed, 250 c.cm. per minute can be regarded as a likely *maximum* for CO_2 elimination in the average adult. Now, however deeply respiration is maintained, this cannot be expired at a concentration greater than that of alveolar air, which is 5 to 6%; and if, for example, it is released in the form of a 5% mixture the real ventilation will have to be in the neighbourhood of 5 litres a minute. The volume

released into the atmosphere must needs be nearly equal to the flow of gas into the apparatus; and these figures correspond with clinical experience that in using continuous-flow apparatus a gas flow of some 6 to 7 litres a minute generally ensures good results, but that if the flow is restricted much under 5 litres the patient develops signs of CO_2 accumulation.

The "Critical Flow"

This "critical flow," which if diminished is followed by CO_2 accumulation, is exactly determined in each individual by (1) his rate of elimination of CO_2 , and (2) the percentage of CO_2 normal for his individual alveolar system. Since in Figs. 2, 3, and 5 the "effective release," V-W, remains constant, respiratory adjustment will take place by a shift of this fixed line to right or left, and a consequent alteration in the height of the black column and the area contained by it, which represents CO_2 . It will be seen that there is a limit to the effectiveness of hyperpnoea, indicated in Fig. 5, and if this "limiting

FIG. 5.—The "limiting value" with continuous flow. No matter how far the curve is produced to the right (by increased depth of respiration) the black area will not increase.

value" of CO_2 release does not account for all the CO_2 liberated in the alveoli the latter will begin to accumulate. Altered frequency of respiration will accomplish nothing, for the volume V-W is equal to the gas flow divided by the frequency, and will become contracted in inverse proportion to the latter, so that no increase in total elimination over a given period will result.

It will be seen that in partial rebreathing with continuous flow the natural respiratory mechanism is considerably modified by the apparatus to which the patient is connected. The ventilation per minute is arbitrarily limited, and the patient's efforts to modify it alter only the *depth* within the respiratory system at which the fixed ventilation takes place, this depth being *mechanically* limited by the maximum tidal exchange of which he is capable, but *physiologically* limited by the depth (about 800 c.cm.) of respiration after which no further increase in CO_2 percentage occurs.

This is in contrast to conditions prevailing in normal respiration or open anaesthesia, where increased respiratory movements at once increase both the depth and volume of real ventilation. It is also in contrast to the means of rebreathing employed in the intermittent-flow machine (for example, McKesson), in which it is the volume to be rebreathed which is arbitrarily set beforehand, and in which hyperpnoea causes an immediate increase in real ventilation, by drawing on an increased flow of gases. In this latter method the design of the bag is important. With continuous flow it matters not for this purpose how large the bag is, for it will expand sufficiently to operate the valve, and thereafter contract only by the amount of rebreathing determined by the relation between respiration and gas flow. In an intermittent-flow machine working without pressure, however, the patient must empty the bag entirely before he can draw on new gas; and provision must therefore be made for limiting its capacity to a known small amount.

Conclusions

Partial rebreathing is justified in so far as it promotes lung expansion and oxygenation, and retains the warmth and moisture of the upper respiratory contents while permitting adequate ventilation below.

Its extent is modified in the continuous-flow machine by adjustment of the gas flow, and in the intermittent-flow machine by adjustment of the bag capacity.

The patient's effective alveolar ventilation is controlled, as always, by the alveolar CO_2 concentration.

For continuous-flow machines there is a "critical flow" in the neighbourhood of 5 litres per minute for each individual, which if diminished will lead to CO_2 accumulation, but which if exceeded allows equilibrium to be attained.

Continuous flow is dangerous with a flow below the critical level; intermittent flow is dangerous with an unlimited bag capacity.

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LAURENCE-MOON-BIEDL SYNDROME, WITH TETANY

BY

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The following interesting case, considered to be an example of the Laurence-Moon-Biedl syndrome without polydactyly or mental deficiency, seems to merit publication.

Case History

A young woman aged 25 was admitted to Westminster Hospital in October, 1938. Her immediate complaint was of pain in the left loin that had been present for a week. The features which had actually led to her admission were blindness—present from birth—and attacks of tetany. These attacks dated from the age of 10, and had been occasional until nine months before. From that time they became more frequent, and just before her admission were occurring about twice a week. During the last two years she had also complained of pain in her back, for which she had been given a spinal jacket at another hospital. A report from this hospital stated that radiographs of the bones seemed normal. There was no history of vomiting. She had at one time been rather fat; with the onset of tetany she had gone to the opposite extreme, but recently she had returned more or less to normal. Her menstruation had been irregular and infrequent from the onset at 11, but the intervals had steadily increased from the minimum of three months, her last period having taken place four years ago. A further sixteen sibs of this patient had been born, of whom only five are now alive. Four of these sixteen were blind at birth, and only one is living. No abnormal fatness, tetany, or mental deficiency had affected any sibs; a sister with unaffected vision, however, had had six toes on either foot—she died early in life. The mother suffered from diabetes, but otherwise she and the father were healthy; they were unrelated.

A number of typical attacks of tetany with carpo-pedal and facial spasm were observed during the patient's stay in hospital. Chvostek's and Trousseau's signs were positive and

could be elicited at any time with ease. Her veins were abnormally irritable: none were visible and no blood could be obtained from any of them, not even after cutting down and exposing them, as they went into intense spasm on the prick of the needle. Eventually blood had to be taken by needle from the femoral artery. The nursing staff had not observed any hyperpnoea. Mr. E. F. King examined the patient's eyes, and important findings are as follows: No light perception; pupils inactive to light; posterior cortical complicated cataracts; both retinæ show gross primary degeneration with secondary narrowing of the retinal vessels and optic atrophy. "The picture is somewhat like retinitis pigmentosa, though the size and distribution of the pigmentation are not typical, and of course the history of blindness from birth is atypical." The patient was plump but hardly obese; polydactyly was not present. Her breast development and hair distribution were healthy. She appeared quite intelligent. She was tender in both loins and the urine contained albumin.

Special investigations gave results as follows: Serum calcium 9.2 mg., 10.9 mg., and 9.3 mg. per 100 c.cm.; plasma phosphorus 3.8 mg. and 4.2 mg. per 100 c.cm.; serum phosphatase 11 units; alkali reserve 61 c.cm. carbon dioxide %; blood urea 19 mg. per 100 c.cm. Radiographs of lumbar and dorsal spine disclosed nothing abnormal. The urine contained *B. coli*. An intravenous pyelography failed to reveal abnormality. The basal metabolic rate was +14%. The glucose-tolerance curve was normal, and the Wassermann and Kahn reactions were negative. A full blood count was normal.

The patient was put on three-quarters of an ounce of calcium lactate and 50,000 international units of vitamin D daily. Dr. G. A. Tuck, her medical practitioner, reports that she is greatly improved and that she has had only one attack of tetany in the last three months. It is interesting that her veins are now readily visible.

Discussion

Both the cause of the tetany and the diagnosis of the case are obscure. The investigations appear to rule out any of the accepted causes of tetany. An explanation was somewhat tentatively advanced by Dr. Raymond Greene. It runs as follows:

"Obesity has been present at one time; this and the amenorrhoea might be of pituitary or hypothalamic origin. A parathyrotrophic hormone is to be found in the pituitary. The increasing intervals between the periods and the variation in the obesity suggest an alteration in the level of pituitary secretion over a period of years. If the secretion of the parathyrotrophic hormone at some earlier time was high but has now sunk to normal levels (as indicated by present normal blood calcium and phosphorus figures) then it is possible that the tetany of this case is a consequence of the body's failure to adapt itself, as yet, to the relatively low calcium level."

The result of treatment with calcium and vitamin D supports an explanation along some such lines. No other hypothesis has been suggested.

We believe this case to be an example of the Laurence-Moon-Biedl syndrome. Admittedly polydactyly and mental deficiency are absent, but this has been so in other accepted cases. The absence of obesity is unusual, though Cockayne and co-workers (1935, 1939) have found records of this in a few cases; further, obesity was at one time present in this case. The menstrual disturbance supports the diagnosis. The obesity and amenorrhoea of the syndrome have usually been taken to indicate a pituitary or hypothalamic lesion. A lesion of such a nature in this case is further suggested by the tetany. Cockayne, Krestin, and Sorsby (1935) say, in connexion with atypical retinitis pigmentosa in this disease, that "typical retinitis pigmentosa would appear to be the exception." The affection of four other sibs, the parents being unaffected, is suggestive of a recessive mode of inheritance, and this is consistent with what is known of the syndrome (Cockayne and co-workers, 1935, 1939). The appearance of poly-