EMERGENCIES IN GENERAL PRACTICE

DANGEROUS BRONCHITIS

BY

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The importance of bronchitis as a cause of morbidity and mortality needs no emphasis: in England and Wales in 1950 590,000 spells of incapacity from work and 28,000 deaths were attributed to this cause. With few exceptions,* acute bronchitis becomes a serious illness only in patients with pre-existing impairment of respiratory function—those with chronic bronchitis, emphysema, pulmonary fibrosis, severe chest wall deformity, or heart disease. In such subjects an exacerbation of bronchitis may precipitate acute respiratory failure with generalized impairment of the ventilation of the lung alveoli. Carbon dioxide accumulates in underventilated alveoli, with a consequent fall in oxygen tension. The blood leaving such alveoli is not fully oxygenated and has a high carbon-dioxide tension which causes a shift of blood *p*H toward the acid side. This triad of carbon-dioxide retention, anoxaemia, and acidaemia—which may be demonstrated by arterial blood analysis—characterizes respiratory failure.

Pathogenesis of Respiratory Failure

How does respiratory failure arise during acute chest infections? A complete answer would require a lengthy digression into the realms of respiratory physiology, but, in brief, there are two principal causes.

(1) *Impaired Sensitivity of the Respiratory Centre.*—Respiratory infection may initiate a vicious circle: pulmonary infection→arterial anoxaemia→anoxic damage to the medullary respiratory centre→diminished drive to the respiratory muscles → alveolar hypoventilation → carbon-dioxide retention→further increase in arterial anoxaemia. This sequence of events is particularly apt to occur in the chronic bronchitic or emphysematous subject who—even when free from respiratory infection—is chronically anoxic and shows a diminished respiratory response to inhalation of carbon dioxide. Treatment is based on oxygen therapy, which prevents further damage to the respiratory centre, together with the use of respiratory stimulants.

(2) *Increased Metabolism and Reduced Ventilatory Capacity.*—Increase in metabolic rate may be due, in part, to fever, but more specifically to the greater energy expended by the respiratory muscles working under difficulties. Bronchiolar obstruction (by oedema, spasm, or mucus) and pulmonary consolidation greatly increase the amount of work that must be done to get a given volume of air in and out of the lungs. This increase in ventilatory work causes an increase in metabolism, and thus the lungs have a larger volume of carbon dioxide to excrete—and this requires a greater ventilatory effort. Thus, a point may be reached where the increase of carbon-dioxide production by the increased work of the respiratory muscles begins to outstrip the consequent increase of alveolar ventilation. Further attempts to increase ventilation will then actually increase the alveolar carbon-dioxide tension. Severe status asthmaticus exemplifies this type of respiratory failure. Effective methods of treatment are those that lower the metabolic rate and relieve the obstruction to ventilation: bed rest and chemotherapy will control bronchial infection and lower the temperature; bronchodilators will relieve respiratory obstruction and diminish the work of breathing. In practice, respiratory failure is usually due to a combination of both mechanisms.

*Pertussis and other types of bronchitis in babies and young children will not be considered in this article.

Clinical Picture of Bronchitis with Respiratory Failure

The clinical picture of uncomplicated bronchitis is familiar to all: following exposure to "smog," or after a head cold, influenza, or other infections of the respiratory tract, the patient develops an irritating cough, substernal soreness made worse by deep breathing, wheeziness, and moderate pyrexia. The cough, at first dry, soon becomes productive of purulent sputum. There is little or no dyspnoea; the mucosae show no trace of cyanosis, and mental disturbance (apart from the delirium of pyrexia) does not occur. With the development of respiratory failure, however, new symptoms and signs appear: these can all be attributed to the effects of carbon-dioxide retention, anoxaemia, and acidaemia on the brain, cerebral vessels, lung, heart, and kidneys.

Cyanosis is the outward and visible sign of arterial oxygen unsaturation. It is usually impossible to detect cyanosis of central origin clinically until the arterial oxygen saturation has fallen to 80–85%, and anaemia may mask its appearance entirely. Increasing cyanosis during an attack of bronchitis signifies the development of respiratory failure or that bronchial infection has spread to the alveoli, causing patchy consolidation (or, more usually, both these events). Mental disturbance varies from mild disorientation to restless delirium, stupor, and even unrousable coma. An attack of bronchitis may manifest itself as undue drowsiness—the patient falling asleep at work or over his evening meal.

If a chronic bronchitic suddenly develops an acute psychosis with visual and auditory hallucinations or paranoid delusions, an acute respiratory infection is the most likely cause and such patients should be sent to a general hospital rather than an observation ward. Characteristically, the mental state fluctuates from hour to hour, and a patient who was disorientated during the morning may become sufficiently alert to converse rationally when his doctor calls later in the day.

Cerebral vasodilatation causes a rise of intracranial pressure, and the associated throbbing headache may be severe enough to prevent sleep. The retinal veins are always dilated, and frank papilloedema with swelling of the nerve head and flame-shaped retinal haemorrhages may occasionally be seen. Muscular twitching is a characteristic feature of respiratory failure. This consists of coarse, irregular, jerky movements of the fingers, arms, and, less frequently, of the muscles of the face, trunk, or legs. In patients with pre-existing right ventricular hypertrophy and stress, respiratory failure is the commonest cause of congestive cardiac failure. We do not exactly know how this comes about, but it has been shown that anoxia and hypercapnia raise the pulmonary artery pressure by constriction of the pulmonary arterioles; that anoxia and acidaemia increase cardiac output; and that fluid retention and increase in blood volume are a sequel to diminished renal blood flow and increased tubular reabsorption of sodium. Peripheral vasodilatation is recognized clinically by warm hands, large volume pulse, capillary pulsation in the nail beds, and an increased pulse pressure.

Differential Diagnosis

Experience has shown—in both hospital and general practice—that bronchitis with respiratory failure is often misdiagnosed as left ventricular failure with pulmonary oedema. This mistake can have serious consequences, since the administration of morphine—the drug of choice in treating

pulmonary oedema—often proves rapidly fatal when given to a patient in respiratory failure. The main differential points are tabulated below :

Bronchitis with Respiratory Failure	*Left Ventricular Failure*
Previous history of chronic cough, sputum, increasing dyspnoea on exertion, and recurrent bronchitis for 10 or more years.	Chronic cough not usually prominent in the history. Known to be hypertensive or to have other heart disease.
Rapid, shallow, gasping respirations—often irregular in rate and depth—but never periodic. Many deeply cyanosed patients are able to lie flat without discomfort.	Dyspnoea always severe ; unable to lie flat. Respirations often periodic in character (Cheyne-Stokes).
Usually pyrexial (especially if temperature is taken rectally).	Rarely pyrexial.
Purulent sputum ; may be difficult to expectorate.	Frothy, watery, blood-tinged sputum.
Retinal veins dilated ; occasionally papilloedema.	Normal fundus, or changes of hypertensive retinopathy.
Epigastric heave indicating right ventricular hypertrophy.	Apical heave indicating left ventricular hypertrophy.
Warm extremities ; large volume pulse.	Peripheral vasoconstriction with cold hands.
Arm-tongue circulation time normal or even accelerated.	Arm-tongue time much prolonged.
Arterial plasma carbon-dioxide content raised (more than 66 vols.%).	Arterial plasma carbon-dioxide content normal or reduced.

When acute bronchitis precipitates left ventricular failure —as it often does in the elderly hypertensive—it may be exceedingly difficult to decide which is the more important condition. If there is any doubt, it is wiser to withhold opiates and pursue lines of therapy suitable to both conditions.

Antibiotic Therapy

Antibiotic therapy is the most important single measure in treatment. Before starting treatment a specimen of purulent sputum should be sent for bacteriological examination and the sensitivity to antibiotics of any pathogens isolated determined. Treatment should, of course, be started at once without waiting for the laboratory report. Numerically, *Streptococcus pneumoniae* and *Haemophilus influenzae* are the two most common pathogens, and will be found in from 70–90% of cases ; less common pathogens include *Staphylococcus pyogenes*, β-haemolytic streptococci, *Pseudomonas pyocyanea*, Friedländer's bacillus, *Proteus vulgaris*, and *Bacterium coli*. *H. influenzae* is not (or is only partially) sensitive to penicillin, but is usually sensitive to streptomycin, the tetracyclines, and chloramphenicol.

In uncomplicated bronchitis it is justifiable to give 900,000 units of procaine penicillin daily, and, if necessary, to alter treatment after three to five days if the clinical response is unsatisfactory and sputum culture reveals a penicillin-insensitive pathogen. However, in severe bronchitis with respiratory failure, time is precious, and even 24 hours' delay in controlling the bronchial infection may tip the scales against recovery. Therefore, treatment effective against all the common bronchial pathogens should be started immediately. In hospital practice the treatment of choice is a combination of crystalline penicillin and streptomycin intramuscularly: penicillin 500,000 units and streptomycin 1 g. six-hourly for two days, followed by the same dosage 12-hourly for a further five to eight days or until the sputum has become mucoid. In general practice it may not be possible to arrange for frequent intramuscular injections, but a wide range of oral antibiotics is now available : chlortetracycline, oxytetracycline, and tetracycline—a loading dose of 1 g. followed by 0.5 g. six-hourly for two days, then 0.25 g. six-hourly for a further five to seven days—are all more or less equally effective. The drug of choice is tetracycline itself, since there is evidence that it gives rise to fewer side-effects than the other antibiotics. Chloramphenicol, although highly effective, should not be used in treating acute exacerbations of bronchitis in chronic bronchitic subjects, since further courses of treatment will almost certainly be required at a later date and aplastic anaemia becomes an increasing hazard when a total dose of more than 20–25 g. has been administered.

All the wide-spectrum antibiotics have one serious disadvantage : a fulminating enterocolitis may occur even after small doses and prove rapidly fatal in an ill patient. For this reason I advise a combined course of penicillin and streptomycin whenever facilities for frequent intramuscular injection can be arranged. The toxic effects of streptomycin are less serious : labyrinthine damage may occur in the elderly or in those with renal failure, but is unlikely after only a short period of administration. Clinically, any significant degree of renal impairment can be virtually excluded by the absence of albuminuria and a urinary specific gravity of more than 1020 in a casual specimen. Streptomycin should *never* be given to elderly patients in a dosage of 4 g. a day for more than three to four days and the total amount should not exceed 20 g. *In vitro*, most strains of *H. influenzae* are sensitive to sulphonamides, but the clinical response of *Haemophilus* bronchitis to these drugs is, unfortunately, often disappointing.

Bronchodilators

If respiratory failure is principally due to air-way obstruction intensive and sustained antispasmodic therapy is indicated. Aminophylline should be given by slow intravenous injection of 0.25–0.5 g. at intervals of four to six hours; or as rectal suppositories containing 0.36 g. It is too painful to be administered intramuscularly and usually ineffective when given orally. Solutions of 1:100 isoprenaline, 1:100 adrenaline, or 1:200 phenylephrine are given as an aerosol spray: in hospital from a nebulizer operated by compressed air or oxygen ; and in the home, from a hand inhaler. Inhalations lasting five to ten minutes (with a total dose not exceeding 10 mg.—for example, 1 ml. of a 1:100 solution) should be prescribed at intervals of two to three hours in the acute stage, decreasing to three to four times a day as the patient improves. If signs of overdosage occur—trembling, nausea, vomiting, or palpitations—the dose should be reduced or given more slowly. Isoprenaline is also effective when given sublingually as a 10-mg. tablet at similar intervals. Adrenaline may also be given intramuscularly or subcutaneously as a 1:1000 solution: 0.5 ml. (8 minims) followed by 0.06 ml. (1 minim) every minute until bronchospasm is substantially alleviated. If these measures fail to relieve severe bronchospasm after 24–36 hours, a trial of adrenocortical hormones is warranted : cortisone 50 mg. eight-hourly by mouth, or, alternatively, 20 units of the long-acting corticotrophin gel intramuscularly twice daily. In asthmatic bronchitis benefit is usually apparent within 12–18 hours, and if there is no improvement within 36 hours the drug should be discontinued. If the hormones relieve bronchospasm, treatment should be continued for five to six days, with gradual tailing-off of the dosage.

Bronchial obstruction is often due to viscid, tenacious sputum which the patient finds great difficulty in coughing up. An effective method of liquefying sputum would be of great value, but unfortunately a specific mucolytic enzyme preparation is not available. The effect of synthetic detergents and proteolytic enzymes by aerosol is currently under investigation, and no firm opinion on their clinical value can yet be given. Some patients find that a steam tent or inhalation of friars' balsam gives considerable symptomatic relief. After the inhalation of a bronchodilator, postural drainage with percussion of the chest wall will help clear the bronchial tree of secretions. There is a widespread belief that mixtures containing potassium iodide or ammonium carbonate liquefy sputum and aid its expectoration. Careful studies of these so-called " expectorants " have failed to confirm this belief, and their administration should be confined to those patients who feel that they would benefit from a bottle of " cough mixture."

Oxygen Therapy

Oxygen equipment can be prescribed on Form E.C.10. For the administration of oxygen in the home, the inexpensive light-weight plastic " polymask " (made by British

Oxygen Company) can be highly recommended. Most patients tolerate this extremely well, and a tent will be required only for the occasional patient who persists in removing his mask.

Oxygen should never be administered continuously in high concentrations to patients with respiratory failure. If anoxia is completely relieved the main stimulus to respiration is abolished, ventilation falls, and the alveolar carbon-dioxide tension rises still higher. Finally the rising carbon-dioxide tension and acidaemia cause coma, falling blood pressure, and irreversible medullary depression. Carbon-dioxide narcosis can often be avoided by administering oxygen by either of two techniques: (*a*) continuously at low rates of flow (1–2 litres per minute)—the flow rate should be adjusted so that the nail beds and mucosae still show the faintest tinge of cyanosis; or (*b*) in high concentrations intermittently. This may be done by giving oxygen at 6–8 litres per minute by tent or mask for 20 minutes, and then allowing the patient to breathe room air for 15 minutes. By this means, carbon dioxide retained during the period of breathing oxygen will be washed out again as ventilation increases on breathing air, and a progressive rise in the arterial carbon-dioxide tension is prevented. The careful use of oxygen therapy will prevent many bronchitic patients dying from the effects of severe anoxaemia.

Management of Heart Failure

Minor degrees of congestive cardiac failure need no specific treatment, since, if the bronchial infection can be brought under control and respiratory failure reversed, raised venous pressure and oedema will disappear spontaneously.

If the venous pressure is very high or oedema persists despite adequate treatment of the bronchitis, digitalis in full dosage, mercurial diuretics, and a diet low in sodium should be prescribed. Mersalyl, 2 ml., should be given intramuscularly on alternate days; albuminuria is not a contraindication to its use, since this usually disappears with improvement of the heart failure. Repeated venesection of one to two pints (0.6 to 1.1 litres) may be helpful in the rare cases in which chronic congestive failure is associated with polycythaemia.

Analeptics and Sedatives

From time to time the practitioner will be called to a patient *in extremis*: deeply cyanosed, comatose, with shallow, ineffective, gasping respiration. This emergency demands immediate treatment: 10 ml. of nikethamide and 0.5 g. of aminophylline should be given intravenously, and oxygen by mask at 6–7 litres per minute. The effect will be dramatic: within ten seconds the patient sits up, recovers consciousness, and coughs vigorously. The effect wears off in 20–30 minutes, but nikethamide is metabolized extremely rapidly and a similar dose can be repeated at intervals of one to two hours until the patient is out of danger. Nikethamide is ineffective when given by mouth.

On no account should opiates or barbiturates be administered to these patients. This point cannot be emphasized too strongly. Even 100 mg. (1½ gr.) of butobarbitone may cause severe respiratory depression with prolonged coma, while 10 mg. (1/6 gr.) of morphine may be fatal. The depressant effect of morphine, methadone, and pethidine can be immediately reversed by the intravenous injection of 10–20 mg. of nalorphine. No emergency bag should be without this useful drug. If sedation of an extremely restless patient is required, the drug of choice is paraldehyde, which has only a slightly depressant effect on the respiratory centre. The dose is 5 ml. intramuscularly; it should not be repeated.

Respiratory failure is a serious complication of bronchitis and is best treated in hospital. However, during periods of fog or epidemics of influenza a hospital bed may be unobtainable and the practitioner will be required to treat these patients at home to the best of his ability. An understanding of the basic disturbances of respiratory physiology will make this task easier.

Next article on Emergencies in General Practice.—"Coma in Hypopituitarism," by Professor H. L. Sheehan.

OSLER MEMORIAL AT OXFORD

The Osler Club has placed a memorial plaque on the outer wall of the house at Oxford (13, Norham Gardens) which was occupied by Sir William Osler during his 12 years as regius professor of medicine and in which he died in 1919. It was unveiled on October 8 by the regius professor-designate, Professor G. W. Pickering, before an assembly which included many distinguished physicians and surgeons.

Mr. V. B. Green-Armytage, president of the Club, said that he was one of the diminishing band who knew Osler; 50 years ago, almost to the day, he received a prize at his hands. The Osler Club in London was founded in the 'twenties by six of his students. Before the second world war the Club had a difficult time, although people of the eminence of Lord Horder, Sir Farquhar Buzzard, Sir Walter Langdon-Brown, and others came to address it, but after the war, in 1947, it was revived, thanks to the efforts of three men, Dr. L. Carlyle Lyon, Dr. A. White Franklin, and its present secretary, Dr. W. R. Bett. It now had 152 members.

Time for the Young

Professor Pickering said that it was just 50 years ago that Osler came to Oxford from Baltimore. The house in which he lived was intended to be the residence of regius professors of medicine, but for one reason or another none of his successors had lived there. Perhaps some of them felt that a house of 14 bedrooms was beyond the needs of an ageing professor. But thanks to the efforts of Professor A. D. Gardner, who was still acting regius professor, Osler's original purpose was to be in part fulfilled. The house was to be converted into flats, in one of which the future regius professor would live.

Why was Osler commemorated in Oxford? Undoubtedly his great work was accomplished on the North American continent. He served successively McGill, the University of Pennsylvania, and Johns Hopkins. If he was not the creator of Johns Hopkins Medical School, he was the chief instrument in its creation. The Johns Hopkins Hospital laid down a pattern for a teaching hospital and medical school that was destined to be followed by every teaching institution in the United States. Probably no other institution in the world had had such a direct effect on medical education. It was in North America, too, that Osler did his great scientific work, carrying out original and valuable researches on diseases of the spleen and blood and infections of the heart, and it was there he wrote his textbooks in which the facts of clinical medicine were set out in so orderly a manner.

Osler was 56 when he came to Oxford, and, judging from his letters, he had no intention of working at the same pace. But the Medical School gained distinction under his leadership, and he was also curator of the Bodleian Library, delegate of the University Press, and participant in many aspects