leads to the proposal that combining a slow release oral theophylline with both an inhaled β_2 agonist and ipratropium may achieve better bronchodilatation.^{9 10} Many patients fail to use a metered dose inhaled properly, despite repeated instruction, so that inhalation through a reservoir device—for example, Nebuhaler, Ventamatic—which ensures most efficient delivery of the inhaled drugs to the lungs,¹¹ also seems sensible. Adding a high dose topical steroid by a reservoir inhaler may yield further bronchodilatation¹² and spare the need for oral steroids—as in patients with asthma.¹³ In patients with severe airflow obstruction 15-7.5 mg/day of oral prednisolone appeared to prolong survival over 14-18 years of follow up.¹⁴ Can a similar benefit be obtained by inhaled steroids, with less risk of side effects? Clearly this polypharmacy (which has not yet been proved by controlled trial) can be justified only if bronchodilatation is shown objectively, as by a rise in peak expiratory flow rate measured four times daily over several weeks.¹²

Much attention has recently focused on respiratory muscle function in patients with chronic airflow obstruction, and it has been proposed that theophylline may improve diaphragmatic contractility and delay the onset of diaphragmatic fatigue.¹⁵ Animal¹⁶ and some human studies¹⁵ report improvements in transdiaphragmatic pressure generation at therapeutic concentrations of theophylline, but other studies do not.¹⁷ Any such effects are, however, less obvious in patients with chronic bronchitis and emphysema: thus in 15 such patients 30 days of theophylline increased maximal transdiaphragmatic pressure and reduced diaphragmatic fatigue, and the mean forced expiratory volume in one second (FEV₁) also rose from 0.6 to 0.8 l.¹⁸ In contrast, in 14 similar patients maximal inspiratory pressures were not changed by theophylline, and the six minute walking distance increased on average by only 6%, but the FEV₁ again rose from 0.8 to 0.9 l.¹⁹ The respiratory muscles are most stressed in exercise, yet most double blind studies using objective assessment of exercise tolerance show no (or only minor) improvement from theophylline in patients with chronic bronchitis and emphysema.²⁰⁻²⁴

Thus an oral theophylline combined with an inhaled β_2 agonist can yield useful bronchodilatation in patients with chronic bronchitis and emphysema, but any improvement in respiratory muscle function²⁵ in such patients is probably only a fringe benefit—and like other such benefits even this may be taxed. Oral theophylline passes into lung lining fluids and can then halve the bactericidal activity of alveolar macrophages.²⁶ As acute exacerbations of respiratory failure most often arise from infection in these patients,²⁷ using theophylline to improve respiratory muscle function in such exacerbations may be unwise.

D C FLENLEY

Professor of Respiratory Medicine,
University of Edinburgh,
City Hospital,
Edinburgh EH10 5SB

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Acetazolamide in acute mountain sickness

During a 1969 Korean expedition to climb Lhotse in the Himalaya most of the climbers were comfortable at 4000 m. Some had mild headache and anorexia, but one man became unconscious and remained so for three weeks. He was my introduction to acute mountain sickness. This story illustrates both the range of severity of acute mountain sickness and its idiosyncratic nature.

About half of those passing through 4243 m on the Everest route experience symptoms of acute mountain sickness: headache, anorexia, nausea, vomiting, insomnia, dizziness, breathlessness, and weakness.¹ Some 4% suffer life threatening disease. As over 5000 visits are made each year to the high Nepal Himalaya² this is an important problem.

The severe forms of acute mountain sickness affect the lungs, the brain, or both. We do not know whether the mechanisms of the mild and severe forms differ in nature or merely in degree.³ Does the headache of acute mountain sickness, for example, represent an early stage of cerebral oedema? Much uncertainty surrounds these mechanisms, though the main underlying cause is hypoxia rather than hypobaria.⁴ Oedema certainly plays a part: in the lungs it has the characteristics of a permeability oedema⁵ and venous pressure is not raised; but in the brain there is no consensus on whether the oedema is vasogenic or cytotoxic.⁴ Impairment of the membrane pump has been postulated,² and vascular changes have been invoked to explain pulmonary⁶ and cerebral⁷ disease. Vascular thrombosis occurs at high

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altitude,^{8,9} and neurotransmitter depletion¹⁰ and membrane depolarisation¹¹ may occur. Fluid shifts^{12,13} and endocrine changes¹⁴ are described, but whether they are cause or effect is not clearly established.

Acute mountain sickness usually occurs during the first few days at altitude, before respiratory acclimatisation is complete.¹⁵ During this time renal and perhaps other mechanisms partly correct the respiratory alkalosis that initially limits the ventilatory response to hypoxia.¹⁶ Herein lies the rationale for prophylaxis with acetazolamide, a sulphonamide that inhibits renal carbonic anhydrase causing bicarbonate diuresis and extracellular acidosis. Though it was possible to acidify the blood with ammonium chloride and produce in the alveoli a higher partial pressure of oxygen and lower partial pressure of carbon dioxide,¹⁷ there was no symptomatic benefit.¹⁸ Acetazolamide has, however, been shown repeatedly to lower blood pH, improve blood gases, and improve symptom scores for acute mountain sickness.¹⁹⁻²⁴ It produces striking improvements in sleep hypoxaemia and quality of sleep,^{25,26} reduces proteinuria,²⁷ improves exercise performance, and reduces loss of muscle mass,²⁸ probably by improving oxygen supply to the tissues. It is not useful in treating established acute mountain sickness.

Doses used have varied from 250 mg to 1 g daily, and probably 500 mg daily as a sustained release preparation begun in the 24 hours before ascent is adequate. Methazolamide appears equally effective.²⁹ Side effects from acetazolamide are irritating rather than serious: paraesthesia is common but tolerable; fizzy drinks taste flat; and "beer tastes awful."³⁰ Sensitivity to sulphonamides is a contra-indication. There are advocates of dexamethasone³⁰ and those who prefer spironolactone in prophylaxis.^{31,32}

Should we recommend general acetazolamide prophylaxis for acute mountain sickness as recently proposed?³³ Minor symptoms are reduced and performance is improved, but there are many recorded cases of severe acute mountain sickness in those taking acetazolamide.^{22,34,35} We lack proof, but freedom from minor symptoms probably encourages people to go "too high too fast" and so be attacked by severe disease without warning. The mainstay of prevention should be sensible rates of ascent that are modified further if symptoms occur. Those who make emergency ascents on rescue missions and those who have previously suffered acute mountain sickness at reasonable ascent rates are candidates for drug prophylaxis. Many, however, are unwilling to pay the "price of acrophilia,"^{35,36} and the demand for drug prophylaxis is likely to remain high.

J G DICKINSON

Consultant Physician,
Queen Elizabeth Military Hospital,
London SE18 4QH

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Overexposure to radiology

Three factors contribute to the excessive use of ionising radiation in radiology: inappropriate examinations, an excessive number of films per examination, and repeat exposures during an examination. A working party of the Royal College of Radiologists as well as the World Health Organisation have taken leading roles in publishing guidelines on the first of these.^{1,3} Recently a Cardiff group closely aligned to the working party has reported on the frequency with which radiographers at different hospitals repeat films.⁴ The overall repeat rate was 10%, though nearly half the departments exceeded this. One department repeated almost one in five of all films.

What are the reasons for the high repeat rate, which (together with rejected films) may cost £3-4m a year? Poor exposure due to errors by the radiographer or the machine accounts for most of them. Student radiographers have overall repeat rates twice as high as that of trained ones, whereas expensive devices for automatic exposure control can halve them.⁴ Nevertheless, even where these devices are installed they seem to be little used,⁴ and much simpler measures such as exposure charts in each room and calipers to measure the size of the patient may be just as effective.⁵

More importantly, however, the question of repeat rates should be considered in the context of the overall use of ionising radiation in diagnostic radiology. Indeed, the Cardiff