

seeking to resolve the question of clinical practice by laying down principles, it may be wiser for individual employing authorities to adopt a flexible attitude. Just as many community physicians have been encouraged to negotiate academic sessions, so should those who wish to do so be free to negotiate clinical sessions. They would need to have had training in the clinical specialty in which they work, and the sequence of training posts leading to recognised competence in both community and clinical medicine would also have to be carefully planned.

The issue of clinical practice within community medicine is important, for the success of the specialty does not rest solely on skilful application of management, epidemiological, and other techniques learnt during the training courses. As Professor Acheson comments, it depends also on the degree to which the community physician's work meets his or her professional aspirations and "is seen to leaven medicine from within rather than to belabour it from without."

<sup>1</sup> Donaldson, R J, and Hall, D J, *Community Medicine*, 1979, 1, 52.

## Muscle compartment syndrome

In 1941 Bywaters and Beall<sup>1</sup> described the fate of four victims of air raids who had been crushed by debris for some hours before their rescue. They had swollen limbs, shock, oliguria, and dark discoloration of the urine, subsequently found to be due to myoglobin.<sup>2</sup> All four died in renal failure. The syndrome became known as the crush syndrome.

In their original paper Bywaters and Beall commented that less severe renal damage might occur in patients with crushing injuries with the patient's subsequent full recovery. After the war the syndrome became recognised in severely injured civilian casualties after road and mining accidents. More recently a similar syndrome has been reported in patients who have not suffered massive trauma: alcoholics, drug addicts, victims of accidental poisoning (especially those gassed with carbon monoxide), and even patients operated on in the knee-chest position have all become victims. At first reports concentrated on the local damage to muscles, without renal impairment, that could follow prolonged compression; but in 1975 Mubarak and Owen<sup>3</sup> linked these various conditions together, believing that they represented a range of a single disease.

The term compartmental syndrome is now used to describe patients with local damage, ischaemia, and contracture of muscle resulting from oedema and increased pressure within an osteofascial compartment. The term crush syndrome refers to the systemic effects of the compression, including myoglobinuria, renal failure, shock, acidosis, and hyperkalaemia. Though local anoxia, tissue necrosis through poisoning, and hypovolaemic shock play a part, local pressure appears to be the most important mechanism in the pathogenesis of both syndromes; and research workers have sought methods of measuring the pressure within the muscles. At first needles were introduced directly into the muscle, but these blocked

and the results proved inaccurate. With the development of the wick catheter, however, the problems have been overcome, and Owen and his colleagues<sup>4</sup> have recently reported results obtained in human volunteers.

The wick catheter consists of a piece of Dexon suture that has been unravelled and pulled into the end of a flexible polyethylene catheter. The fine filaments protruding from the end of the catheter increase the surface area and prevent the tissues blocking the orifice. The catheter is filled with heparinised saline, and the pressure of this fluid is allowed to reach equilibrium with the tissue fluid. The apparatus is connected to a pressure transducer and recorder. The whole apparatus can be introduced easily into the compartment under local anaesthesia with a 14-gauge needle cannula unit. The normal resting pressure has been found to be 4+4 mm Hg.

Owen inserted wick catheters into 10 forearm flexor compartments and 10 anterior tibial compartments of 17 normal volunteers, and placed them in positions in which victims of drug overdose are commonly found. These were prone with the head or ribcage resting on the forearm, on the side with the forearm compressed by the body or one leg by the other, and in the squatting position with the subject's legs folded. The surgical knee-chest position was also simulated, and in all the positions the tests were done on both soft and hard surfaces. Pulses distal to the compression were palpated.

The results showed a dramatic rise in intracompartmental pressure, especially when the volunteer was lying on a hard surface. The compression of the forearm by the ribcage gave the highest readings, five individuals showing pressures of over 200 mm Hg. The knee-chest position produced pressures of 105-240 mm Hg in the anterior compartment of the leg. Foam padding reduced the pressure by 16% in the leg and 23% in the forearm. Peripheral pulses remained palpable except in some persons in the ribcage-forearm and the knee-chest positions. In few positions, and then only on padded surfaces, were the pressures reduced below 30 mm Hg. Most authors agree that pressures of 30-50 mm Hg are sufficient to cause ischaemia and subsequent necrosis if maintained for several hours, so that these experiments show how easily a compartmental syndrome can be initiated.

Drug-induced coma is now a common cause of this syndrome, and the wick catheter technique should prove a useful diagnostic aid. In alert and co-operative patients the diagnosis is obvious, but in the comatose the only clue may be swelling of a limb and tenderness in a compartment. The presence of peripheral pulses is of no help. If the limb function is to be preserved and renal damage avoided urgent decompression of the compartment and excision of the necrotic muscle are essential. Owen *et al* recommend immediate pressure measurements with a wick catheter and urgent radical surgery if the compartmental pressure exceeds 30 mm Hg. When this technique is not available surgeons must take care to think of the compartmental syndrome in comatose patients; and if there is any suspicion they should be prepared to operate as soon as possible to decompress.

<sup>1</sup> Bywaters, E G L, and Beall, D, *British Medical Journal*, 1941, 1, 427.

<sup>2</sup> Bywaters, E G L, *et al*, *Biochemical Journal*, 1941, 35, 1164.

<sup>3</sup> Mubarak, S, and Owen, C A, *Clinical Orthopaedics and Related Research*, 1975, 113, 81.

<sup>4</sup> Owen, C A, *et al*, *New England Journal of Medicine*, 1979, 300, 1169.