THORACIC AND LUMBAR SPINE

P A Driscoll, D A Nicholson, R Ross

All lesions of the vertebral column should be treated as unstable until a specialist advises otherwise.

This chapter describes a system by which non-radiologists can analyse the common radiographs taken of the thoracic and lumbar spine and the sacrolumbar junction. The system requires knowledge of the basic anatomy of the vertebral column and an understanding of how it can be injured.

Important anatomical considerations

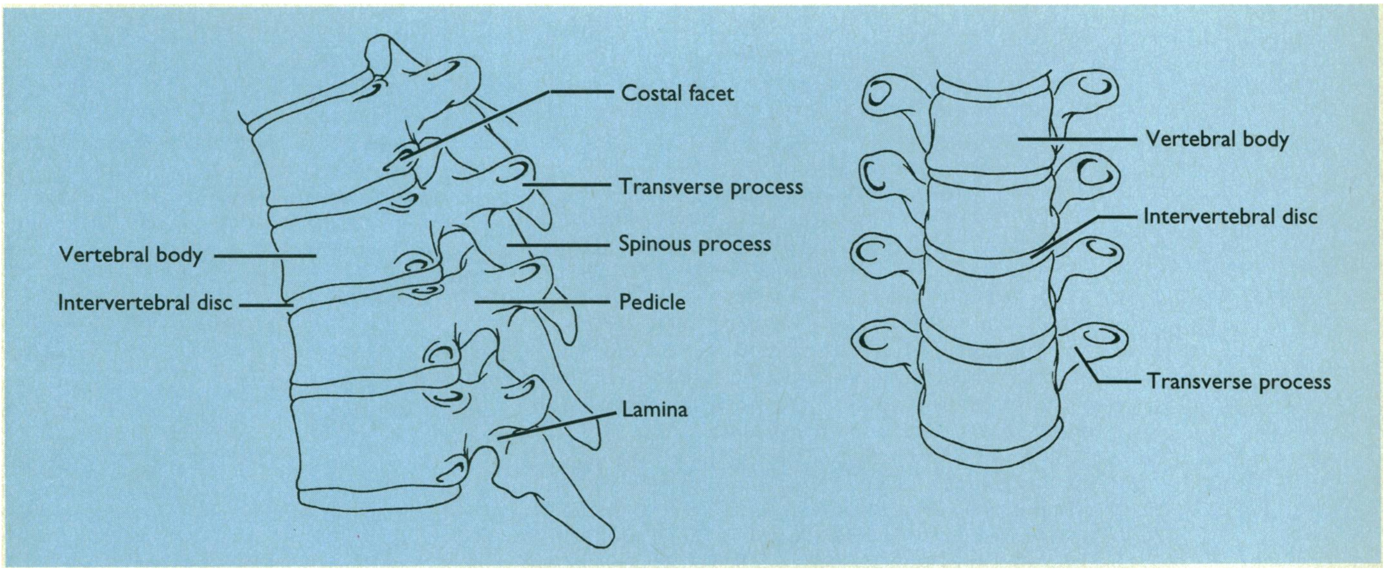

FIG 1—Left: Line diagram showing lateral view of the thoracic vertebral column. Right: Line diagram showing anteroposterior view of the thoracic vertebral column.

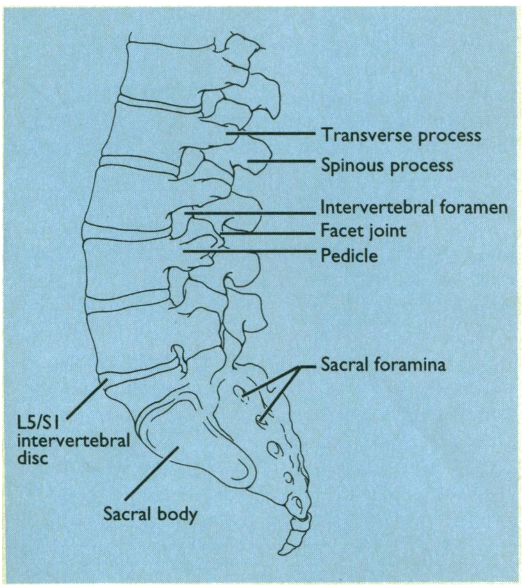

FIG 2—Line diagram of lateral view of the lumbar vertebral column.

This part of the vertebral column is more stable than the cervical spine because of the nature of the ligaments, intervertebral discs, facet joint alignment, paravertebral muscles, and the upper eight ribs (thoracic). The ligaments are the most important stabilising feature.

In view of these stabilising features vertebral disruption in the thoracic or lumbar area occurs only when a large force has been applied—usually with rotation. This is particularly true in the case of the thoracic vertebrae, which have additional support from the ribs.

Nevertheless, the vertebral column can be damaged, especially where the curvature of the spine alters. The mechanical stresses which result from the change in direction at the thoracolumbar junction (T11-L2) or sacrolumbar junction are amplified by the differing mobility above and below the junction. These areas are therefore common sites of injury when the vertebral column is subjected to abnormal forces.

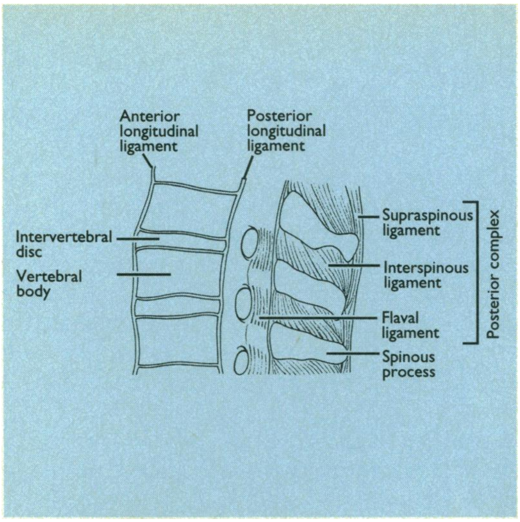

FIG 3—Line diagram of important ligaments in the thoracolumbar spine.

Two thirds of fractures in the thoracic and lumbar region occur between T12 and L2

Spinal canal

The spinal cord and its meningeal coverings run down the spinal canal to the level of the L1/2 disc (adult) or L2/3 vertebrae (new born). Between the bony canal and the dura mater is a potential space that is normally filled with extradural fat and blood vessels. The size of the space varies with the region of the vertebral column and the presence of degenerative disease. For example, in the thoracic area the space is small because the spinal cord is wide. This region therefore has a limited capacity to adapt to injuries that impinge on the spinal canal.

Developmental

Each vertebra ossifies from three centres, any of which can fail to fuse. This gives rise to deformities such as hemivertebra. Spina bifida occulta is caused by a failure of the dorsal parts of the vertebrae to fuse and usually occurs in the sacrolumbar region.

Lumbarisation is incomplete fusion of the upper sacral vertebrae. In sacralisation, the vertebra of L5 is partly or completely fused with the ala (top) of the sacrum.

Mechanism of injury

Common mechanisms of injury

Hyperflexion—Usually occurs at T12-L2 in adults and T4/5 in children. The posterior structures are stretched and the anterior ones compressed. This force usually causes a wedge fracture but if the person is constrained by a lap belt a horizontal fracture through the body, pedicle, and posterior vertebra is seen (Chance fracture)

Shearing—The vertebra is slid anteriorly or posteriorly with respect to the one below. All the intervertebral ligaments can be torn and displacement may be up to 25%

Hyperextension tears the longitudinal ligaments and widens the anterior disc space. It can be associated with avulsion fracture of the anterior superior vertebral corner

Axial compression squeezes the vertebral bodies of T4-L5 together. The intervertebral disc explodes under excessive force, disrupting the longitudinal ligaments

The thoracic and lumbar regions of the vertebral column are damaged by forces that produce extreme movements such as hyperflexion, hyperextension, and axial compression. These forces are usually modified by other forces which cause rotation, distraction, and lateral flexion to occur at the same time. The commonest cause of fractures of the thoracic lumbar spine is hyperflexion with rotation resulting from falls, direct trauma, or road traffic accidents.

Radiological interpretation of lateral view

Types of view

Lateral
Anteroposterior
Sacrolumbar junction
Oblique

After the patient's name, the date, and the adequacy of the radiographs have been determined the films should be examined by using the ABCs system.

Check the adequacy and quality of the film

Count the vertebrae and make sure that all five lumbar vertebrae, the sacrolumbar junction, and the thoracic vertebrae can be seen clearly.

ABCs system of radiographic interpretation

Alignment
Bones
Cartilage and joints
Soft tissue

Alignment

The anterior and posterior longitudinal lines should be smooth curves which change direction at the thoracolumbar and sacrolumbar junctions. In the lumbar region, there should also be a smooth curve through the facet joints. This is difficult to see in the thoracic region because of the overlying ribs. The transition from the lumbar lordosis to the sacral kyphosis should be smooth. At this junction the upper surface of the sacrum slopes downwards.

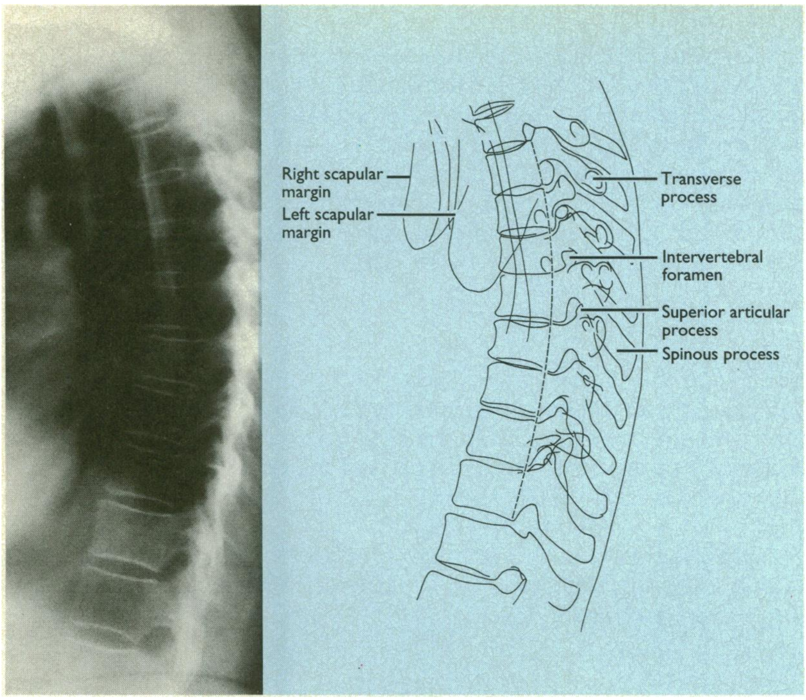

FIG 4—Lateral radiograph and line diagram showing the normal alignment of the thoracic vertebrae.

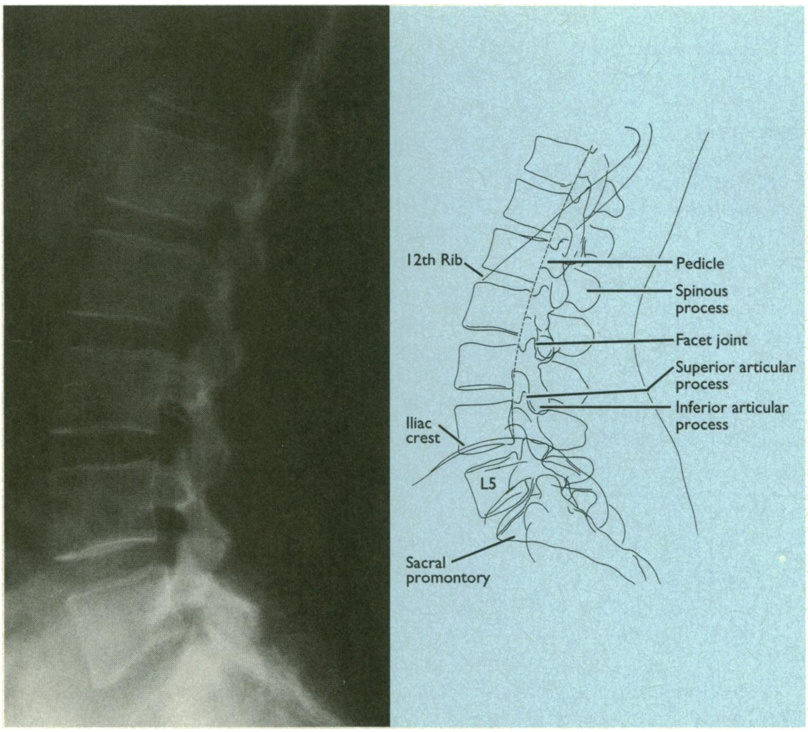

FIG 5—Lateral radiograph and line diagram showing the normal alignment of the lumbar vertebrae and the sacrolumbar junction.

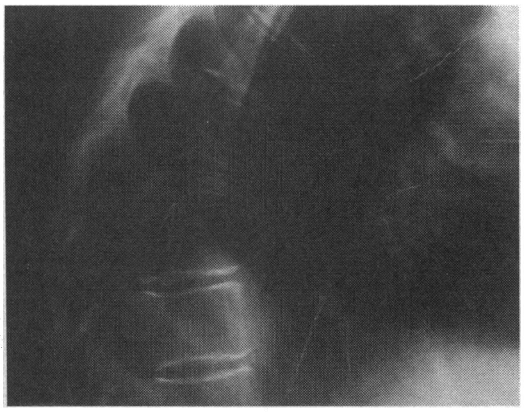

FIG 6—Lateral radiograph of the thoracic vertebrae showing a wedge fracture which is greater than 50% of the vertebral height. The adjacent intervertebral disc spaces are narrowed.

Bones

Each vertebra must be assessed individually. First look at the cortical surface for steps, breaks, or abnormal angulations. Start at the anterior inferior corner of the vertebra and proceed clockwise around the whole of the surface. If you cannot trace out the cortical margins there is usually an overlap of bone. In the upper thoracic region the facet joints, spinous processes, and transverse processes normally cannot be seen because of the alignment of the facet joints and overlying ribs, scapula, and soft tissues. Elsewhere in the vertebral column, loss of cortical margin is commonly caused by a fracture or dislocation.

Look at the rest of each vertebra for alterations in the internal trabecular pattern, lucencies, and increases in density. A discrepancy ≥2 mm between the anterior and posterior height of the vertebral body indicates a fracture except at T11-L1, where these dimensions can exist normally. A 50% discrepancy is always abnormal and suggests serious ligamental damage. This injury is often associated with soft tissue swelling and, in extreme situations, subluxation of the facet joint and widening of the interspinous gaps.

A Chance fracture can usually be seen in the lateral view. The fracture line may extend into the pedicles and lamina and, sometimes, an increase in posterior vertebral height with widening of the posterior disc space is seen.

Reduced height of both the anterior and the posterior surfaces relative to the height in the adjacent vertebra indicates an axial compression force (fig 8). This is commonly associated with soft tissue swelling, anterior wedging, vertical fractures of the spinolamina junctions, and posterior displacement of fragments into the spinal canal.

FIG 7—Lateral radiograph of the lumbar vertebrae showing a Chance fracture of the vertebral body of L2. The posterior vertebral body height is greater than the anterior surface.

FIG 8—Lateral radiograph of the lumbar vertebrae showing an axial compression fracture with disruption of the superior articular surface of L3.

Hyperextension injuries can cause widening of the anterior disc space, fracturing of the laminae and spinous processes, and posterior displacement of bony fragments. Fractures of the transverse and spinous processes can occur in isolation after direct trauma but they are usually associated with other fractures.

Cartilage and joints

Check each intervertebral disc. The discs should be similar and even throughout, with their height increasing progressively down the spine to L4/L5. The disc at L5-S1 is usually narrower than that at L4/L5.

Check the facet joint for alignment. Unilateral or bilateral dislocation of the facet can occur in the lumbar region after trauma but only in association with severe damage to the vertebral body.

Soft tissue

Check the soft tissue shadows around the vertebral column. Disruption of shadows indicates there may be an underlying bony or ligamental injury.

Effect of forces on joint space

Hyperflexion—anterior narrowing
Hyperextension—widening
Axial compression—total disruption

Anteroposterior view

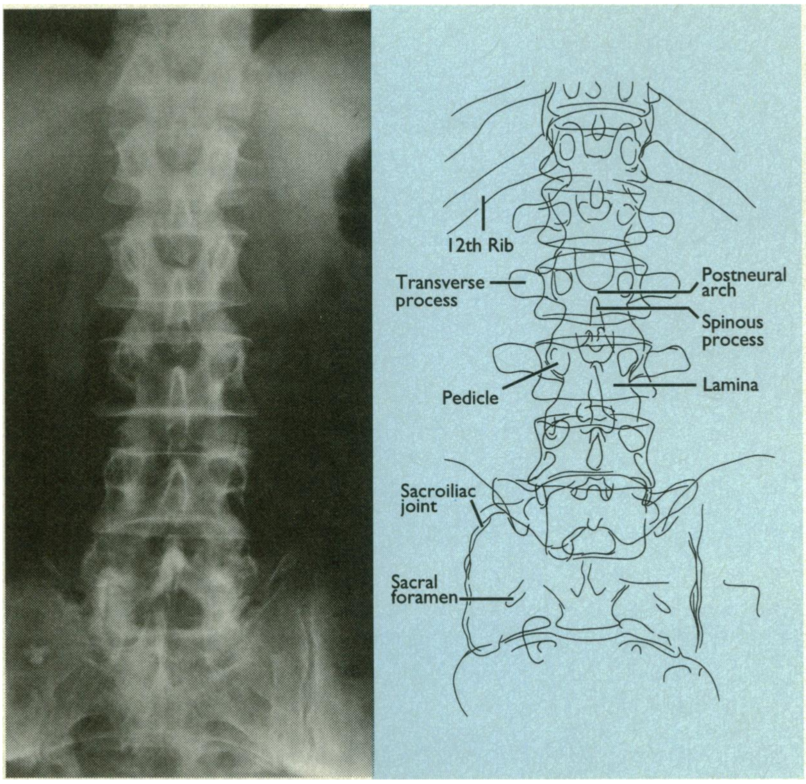

FIG 9—Anteroposterior radiograph and line diagram showing vertical alignment of the spinous processes and the gradual increase in width of the lumbar vertebrae and the interpedicular distance.

The anteroposterior radiograph should be examined with the same system described for the lateral radiograph.

Alignment

Check the vertical alignment of the spinous processes. The width of the vertebrae and interpedicular distance increases progessively down the vertebral column (fig 9).

Malalignment may indicate a fracture of the lateral articular surface. In these cases the spinous processes rotate to the side of the injury.

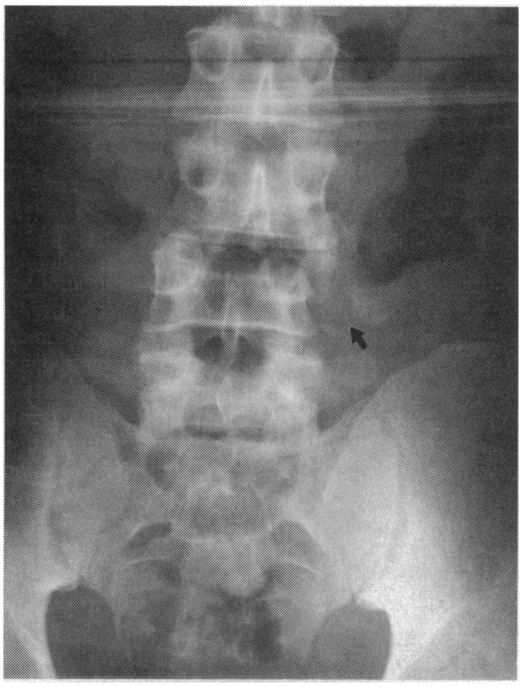

FIG 10—Anteroposterior radiograph of the lumbar vertebrae showing a crush fracture of L4 with rotation of the spinous processes of L2 and L3 to the right. There is also a fracture of the transverse process of L4.

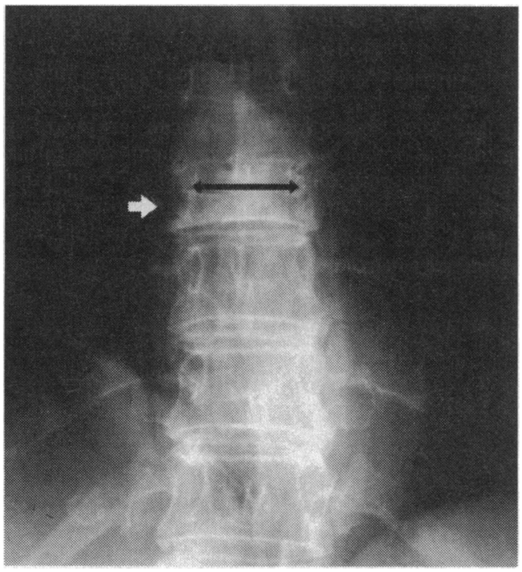

FIG 11—Anteroposterior radiograph showing a crush fracture of T8 with widening of the interpedicular space.

Bones

Assess each vertebra, starting with the cortical margin and finishing with underlying trabecular bone. The superior and inferior surfaces of the vertebral body should be parallel. A compression injury, which causes bursting of the vertebral body, can be detected in the anteroposterior view. In these cases there is loss of trabecular pattern, overlapping of bone fragments, and widening of the interpedicular distance (fig 11). Interpedicular widening usually denotes a very serious bone and ligamental disruption.

Examine the upper thoracic vertebrae carefully because they cannot be seen clearly in the lateral radiograph. Occasionally lateral wedging of the vertebral bodies occurs due to lateral flexion and rotation.

The transverse processes must also be inspected carefully. Depending on the quality of the film you may need a bright light to assess the tips of the processes in the lumbar region (fig 10). Fractures in this area usually result from muscular contraction. However, they can be caused by direct trauma and so damage to the overlying viscera should be looked for. Features of the sacrum seen in the anteroposterior radiograph are covered in the article on the pelvis (9 October; 927-31).

Cartilage and joints

The intervertebral disc space should be examined as in the lateral view. The facet joints overlying each vertebral body should have a similar shape and position.

Soft tissue

Changes in the soft tissue after fracture of the upper thoracic vertebrae can mimic a ruptured thoracic aorta. Changes are best seen on a plain anteroposterior view of the chest. The psoas shadow and its importance is described in the article on the abdomen (20 November; 1342-6).

Soft tissue signs resulting from fractures of upper thoracic vertebrae

Left apical capping
Paravertebral haematoma
Mediastinal widening (80% of cases)

Special views

Special views are rarely required in emergencies. They should be requested only after resuscitation has been completed and after consultation with the specialist in charge of long term management of the patient

Oblique views enable assessment of the intervertebral foramina, the pedicles, and the facet joints. They may also be requested when spondylolithesis or unifacet dislocation is suspected.

Sternum and ribs—Injury leading to the damage of the upper eight thoracic vertebrae can also fracture the sternum or ribs. This increases the chances of the thoracic injury being unstable. Radiographs of the sternum and relevant ribs should be taken.

Computed tomography enables specialists to assess the extent of the injury accurately. For example, it is routinely done to determine the degree of cord compression and the position of the bone fragments after axial compression.

Catches to avoid

Summary

Adequacy and quality

Ensure that all the vertebrae are visible

Alignment

Assess the contours of the thoracic and lumbar regions

Assess the change in curvature at the thoracolumbar and sacrolumbar junctions

Bones

Check each vertebra for shape, height, fractures, and interpedicular distance

Cartilage and joints

Check the facet joints

Check the intervertebral disc spaces

Check the interspinous distance

Soft tissue

Check the paravertebral spaces

The upper thoracic vertebral column is difficult to see in the lateral view because of the overlying shoulder girdle. Computed tomography should be requested if injury to this area is strongly suspected.

Make sure that all the required vertebrae are seen. Ask for further views if necessary.

The forces required to fracture the upper thoracic vertebrae are so great that there are often injuries elsewhere in the vertebral column.

Half of the patients with compression fractures have injuries elsewhere in the vertebral column.

Abnormal fusion during development can produce deformities such as symptomless joints that can be mistaken for fractures. In these cases the breaks in the cortex usually have a defined sclerotic margin.

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The line drawings were prepared by Mary Harrison, medical illustrator.

The ABC of Emergency Radiology has been edited by David Nicholson and Peter Driscoll.

OBITUARY

Sir Harold Himsworth, by John Ward

Sir HAROLD HIMSWORTH

MD, FRCP, FRS

Sir Harold Himsworth was an outstanding secretary of the Medical Research Council. The only practising clinician to have held that office, he had a remarkable breadth of vision, which enabled him to encompass the whole range of the medical sciences from the molecule to the community.

In his early work at University College Hospital, Himsworth concentrated on diabetes: he was the first to distinguish insulin sensitive and insulin insensitive types of the disease. In 1939 it was no surprise to his colleagues when he was chosen to become professor of medicine. As a teacher he had an infectious enthusiasm and inspired many students to distinguished careers in academic medicine. Always interested in nutrition, he now turned his research to the possible role of a lack of essential amino acids in the aetiology of liver disease. Though his experiments on rats, conducted with L E Glynn, were promising, it became clear that in this instance humans did not behave like rats.

In 1948 Himsworth was appointed a member of the Medical Research Council, having already served on many of its special committees, and a year later he was invited to become the secretary of the council. Harry, as he was universally known, was an inspired choice for the appointment. With his aquiline features and patrician manner he would no doubt now be regarded as an unashamed elitist, but he soon showed that he was a remarkable talent scout, seeking out the best in British biomedical science and giving support unreservedly.

His encouragement of the world famous Laboratory of Molecular Biology in Cambridge, with its cluster of Nobel laureates, was unstinting. At the same time he promoted clinical research, particularly in newer disciplines such as epidemiology and statistics. After the NHS was set up he ensured that the Medical Research Council, in cooperation with the Ministry of Health, set up a clinical research board, in which he played a major part. During his secretaryship a regular annual increase in the budget allowed the council to create more than 80 new research units. Most of these were located in universities, and about half were dedicated to clinical subjects.

Himsworth was a highly successful mandarin in the corridors of power, yet he always remained friendly and approachable, enjoying cordial relationships with the directors of the council's units. His particular brainchild, the Clinical Research Centre, was a dream first proposed in 1929 by his colleague and friend, Sir Thomas Lewis. The centre was established at Northwick Park in 1970 but is now, sadly, scheduled for closure, Himsworth's successors lacking both his vision and his understanding of how research may best be carried out by full time research workers in a clinical environment.

After his retirement Himsworth was for some years chairman of the London School of Hygiene and Tropical Medicine, subjects that had been of particular interest to him during his time as secretary of the council. He chaired an inquiry into the medical and toxicological uses of CS gas after its use in Londonderry in 1969. But his later years were mostly spent quietly at his home in London. He never lost his enthusiasm or his love of stimulating conversation. He continued to write and in 1986 published *Scientific Knowledge and Philosophic Thought.* He concluded that mankind's material benefits had accrued more from the activities of scientists than from the musings of philosophers. He had a deep interest in military history and was an accomplished fly fisherman.

His wife, Charlotte, died after more than 50 years of marriage. He is survived by two sons, one of whom, Richard, is a professor of medicine.—CHRISTOPHER BOOTH

Harold Percival Himsworth, secretary of the Medical Research Council 1949-68, died 1 November aged 88. Born Huddersfield, 19 May 1905; educated King James' Grammar School, Almondbury, Yorkshire, and University College London and University College Hospital (MB, BS 1928). Assistant (1930-6), deputy director (1936-9), and director (1939-49) of medical unit of University College Hospital. Also professor of medicine in University of London 1939-49. Beit memorial fellow 1932-5; Goulstonian lecturer 1939; Harveian orator 1962. Awarded numerous honorary doctorates and honorary FRCR (1958), FRCPEd (1960), FRCS (1965), and FRCPath (1969). Knighted 1952. Made FRS 1955. Chairman of board of management of London School of Hygiene and Tropical Medicine 1969-76. Prime warden of Goldsmiths Company 1975.

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