PHYSICS IN THE WEST

Medical Physics in Western Australia

R. W. Stanford, Department of Medical Physics, Royal Perth Hospital, Western Australia.

PROLOGUE

The Royal Perth Hospital, having existed under various titles since 1830, is the oldest and, with a current bed capacity of 1051, the largest acute general Hospital in the State. Housed in a variety of buildings of different periods, the main part of the Hospital, built between 1939 and 1958, is now planned for yet a further major expansion. On a not far distant site the Sir Charles Gairdner Hospital is steadily developing as the second general Hospital. When the Medical School of the University of WA was established in 1955 Royal Perth became the major Teaching Hospital. Since 1955 undergraduate and postgraduate teaching has spread to all the five Metropolitan Hospitals each of which has a strong University affiliation.

As the oldest Hospital, the history of physics in medicine in WA stems largely from the Royal Perth where, from 1897 to 1920, W. J. Hancock, DSc, MInst CE, MIEE was the first engineer scientist to be associated with it as Honorary Radiologist. In 1929 a first agreement was signed with the Commonwealth Department of Health whereby some 200 mg of radium was loaned to the Hospital. This, coupled with the almost simultaneous installation of therapeutic X-ray equipment, necessitated physics services which were supplied initially by Professor Ross of the University. From that date until 1958 Professor Ross and, subsequently, Dr J Shearer, continued to supply or supervise the basic measurements of x and Υ ray activity using the classical Victoreen Dosemeter.

Following the foundation of the Medical School the Board of Management of the Hospital resolved to establish a broadly based Department of Medical Physics designed to provide for the needs of all other departments. In 1959 this resolve became an established fact, and until 1971 this Department supplied physics services to all Metropolitan Hospitals. At that date the expansion of the Sir Charles Gairdner Hospital reached the stage which justified the establishment of a second Department that has yet to grow to the size of its predecessor. There follows a brief description of each Department.

ROYAL PERTH HOSPITAL

Organisation and staffing

Partly by natural evolution and partly by design the Department has developed into a series of divisions.

- Physics of Diagnostic procedure
- Physics of Therapeutic procedure
- Scientific computing
- Bioengineering
- Standards and Safety
- Technical Services

These involve a total staff of 8 Physicists, 3 Engineers, 7 Technologists, 15 Technicians and 12 other essential support staff. Each division within the Department operates with virtual autonomy, the Heads of Divisions being responsible for day to day operation and the operation and the professional competence of their group. Departmental policy is determined by the use of monthly management meetings.

Teaching

Although not a part of the University *de jure*, a close association with the University Department of Physics developed at the outset so that Medical Physics has come to be regarded as having *de facto* University standing. Honours and post graduate students may work under supervision in the Department. For some 14 years the courses of Physics for 1st year Medical and Dental students have been given by members of staff as have also specialist courses for 3rd year Physiology and Pharmacology Students. Post graduate specialist medical education courses are run in Bioengineering and Radiology. Regular lecture series are given for undergraduate and post graduate nursing and other students of paramedical disciplines both within the Hospital and at the WA Institute of Technology. These cover such topics as electrical safety, radiation safety, biomechanics in manipulative physiotherapy and the physical principles of operating theatre equipment.

Diagnostic procedures

An early responsibility in the development of physics services was that of carrying out diagnostic procedures with radionuclides and over the years this work has steadily expanded. Automatic equipment for *in vitro* assay of samples was introduced in 1963 and followed in 1965 by the purchaser of a Picker Magna Scanner. For many years physicists in collaboration with their medical colleagues interpreted the findings of these tests, initiated the purchase of new equipment, such as a gamma camera,

and fabricated specialized equipment such as multiprobe mountings and a shadow shield whole body monitor. Clinical responsibilities in this field have now been largely transferred to a Department of Nuclear Medicine. A substantial radiochemical laboratory with suitable infra-structure was established to procure, store, manipulate, prepare and dispense precise activities of radionuclides and radiopharmaceuticals amounting to 100 curies per year and to operate a central counting service for the Hospital, handling some 80000 samples per year. Until recent years this laboratory provided radioactive substances for all other Metropolitan Hospitals and still today supplies a number of other institutions. It is fair to claim that the use of radionuclides in clinical practice in this State owes much to the pioneering work done at Royal Perth Hospital.

Calibration facilities for ultrasound equipment in clinical use have been provided for some years. These facilities are in the course of expansion to provide for more precise analysis of the polar distribution of energy from transducers. Also quality control of diagnostic X-ray equipment, more especially with image intensifier/TV chains, is now a routine service task.

Therapeutic procedures

For almost half a century the traditional task of Physicists has related to the provision of precise dosimetry relating to the use of external beams of x and Υ rays of implanted sources of Υ rays for the treatment of cancer. Much of this has long been codified and tabulated for routine work but special needs still arise for shaping radiation fields and for particular treatments. Automatic scanning equipment and computer analysis of otherwise impossibly lengthy calculations are now routinely used. Direct calibration of the quality, and intensity of x and Υ ray beams is a continuing responsibility.

Efforts to improve the accuracy of treatment and to reduce the amount of radiation received by radiotherapists and other staff have been directed towards the use of afterloading techniques, in which an empty container is first placed in position in or on the body and the Υ - ray source is inserted subsequently by remote control. The introduction of new modalities for cancer treatment such as hyperthermia result in a variety of physical measurements. Work is proceeding upon methods for determining the thermal conductivity of healthy and malignant tissue within the body. Accurate estimation of the temperature of deep seated tissues of the body is a problem yet to be solved satisfactorily. Methods of applying heat to the body such as immersion in baths of molten wax, irradiation with nonionising electromagnetic radiation or the application of ultrasound all pose distinct problems of physical measurements or calculation if they are to be applied in a reproducible and measured fashion.

Bioengineering

This word is frequently misused and in this Hospital is defined as the application of mechanical engineering principles to the living body under clinical conditions. Staff of the division work directly with clinicians and patients and the underlying philosophy of this division is to tackle problems of immediate practical concern within this Hospital. A continuing programme of measurement and analysis of stress in metal prostheses used to support bone is in hand allied to metallographic analysis of the implant material and of tissues in the near vicinity of worn prostheses. This is aimed at determining the cause of fracture of these prostheses and the cause of pain at the site of a worn prosthesis. Research into the static and dynamic physical characteristics of spinal cord tissue is part of a programme of work designed to investigate the causation of disabling injury such as 'whiplash'. The hypertrophy of muscle under the influence of strain is a further research area in collaboration with neutropathologists. Much work of immediate practical importance stems from the problems of rehabilitation. Design of wheelchairs, assessment of patient gait and determination of the magnitude and distribution of pressure on various parts of the anatomy of immobilised patients are all practical problems on which work is proceeding. Useful service work has been carried out in the assessment of the strength of various metal prostheses, the stress/strain characteristics of prosthodontic elastomers and similar items which in certain instance have led to a direct cost saving to the Hospital.

Computing

Interest in computers started with the very practical desire to provide a more accurate estimate of the radiation dose to humans being treated with implanted Υ - ray sources. This was followed by the programming of a PDP 12 computer for on line control of, and data analysis from a biochemical autoanalyser. Subsequently a PDP 11/40 computer was acquired for departmental use. Computer use and development in the department has been and continues to be quite separate from Hospital and State facilities designed to deal with accountancy, patient index, requesting and results of laboratory tests and similar activities. Our use has been directed towards the acquisition of data from radionuclide measuring equipment under *in vivo* and *in vitro* conditions, from laboratory equipment used in bioengineering and radiation measurement and from spatial distribution of implanted radionuclide sources. Computation is carried out for radiation dosimetry, isodose curves, radionuclide dosimetry, radiation protection and a variety of mathematical problems. Record keeping of radiation worker dosage, waste radioactive products, divisional work levels and similar data is an increasingly useful function of the PDP 11/40. A steady use of the equipment is in the area of familiarisation of clinical and paraclinical staff with computer facilities and direct service, usually of a methematical nature, to a variety of other clinical departments. It is clear that the use and application of computer techniques in all aspects of clinical medicine and laboratory work is at a very early stage. Full exploitation of the obviously enormous potential will require suitable concentration of medical and physical scientists in medical physics or similar departments.

Safety and Standards

Whilst the problems of radiation safety have been recognized and handled for many years the price is, as always, eternal vigilance. Upgrading and changing of clinical radiation areas and the introduction of new

techniques provides a constant demand for radiation safety assessments. Much of the tedious calculation required is now computerized and presents little or no problem. The increasing use of radionuclides for diagnosis continues to pose dosage problems to patients which, because of the lack of precise knowledge of metabolic processes cannot always be satisfactorily evaluated. Supervision of staff safety demands the ability to predict likely damaging situations such as the dose to fingers from syringes containing radionuclides and to assess levels of dose. Other radiations possibly of a damaging nature are being steadily introduced. International agreement on acceptable levels do not always exist and value judgements must often be made. In this category laser light and microwaves are current examples. The vast increase in electronic equipment used on patients also poses problems in respect of microshock. Whilst controls can readily be applied in a physical sciences laboratory the extension of these in such a mixed society as a Hospital calls for more than simple scientific knowledge.

With the single exception of the classical ionization chamber the calibration of measuring devices and the holding of such standards in physics departments is a neglected area. Only now are steps being taken to rectify the omission and to remind ourselves that the physical scientists is of little value unless he can make measurement with a known degree of accuracy.

Technical Services

For many years the Hospital used clinical equipment until it broke down and then arranged for repair. This was satisfactory for purely mechanical items used in operating theatres. In recent years the vast increase in electronic equipment demonstrated the inadequacy of this policy first in that such equipment whilst still functioning could give misleasing indications and second in that commercial repair facilities in this State are very limited. Inevitably also the nature of a Teaching Hospital demands the provision of facilities to develop equipment for research and for unusual clinical applications. By coalescing a small surgical instrument workshop of long standing with an equally small electronics workshop of long standing a new division has been created. This is charged with the task of, where appropriate, installing, commissioning, modifying, repairing and maintaining all clinically orientated instrumentation. Commercial repair facilities are used where available but in many areas this is a decreasing possiblity. Additionally the division contains the ingredients of sections devoted to instruments and electronics development and the division contains the ingredients of sections devoted to instrument and electronics development and the inspection and quality control of the performance of all apparatus in routine use. Slowly schedules of preventive maintenance are being introduced covering this work in three echelons namely user maintenance, technician maintenance *in situ* and maintenance in workshops. For those concerned, the difficulties of achieving a high standard of maintenance and repair are obvious.

Many users however, are unaware of the vast range of equipment and skills needed to cope with such diverse tasks as sharpening scissors used in microsurgery, overhauling hydraulic gear on operating theatre tables, cleaning and repairing watchmaker type gearing, cleaning contacts and tracing a fault on a printed circuit board containing perhaps a hundred integrated circuits. Staff must be competent at all precision engineering, hydraulics, pneumatics, digital circuitry, microwave to video circuitry, transducers and a variety of other skills. Always they must maintain good relations with users ranging from trainee nurses to senior doctors.

SIR CHARLES GAIRDNER HOSPITAL

History

Dr J L Black was appointed as Hospital Physicits in late January 1971. This was a Hospital rather than a Departmental appointment but, in practice, Black worked virtually full time in the Department of Nuclear Medicine, co-operating with the Head of that Department in establishing a newly created Hospital Department of Nuclear Medicine.

After 12 months, the Hospital Board of Management created an independent Department of Medical Physics and, soon after, Black was appointed as Head of that Department.

The most urgently needed scientific services required by the Hospital at that time were in the areas of electronics design and construction and these were the areas which were developed first and to which the first department staff were appointed.

After a further period the Department was formally divided into four divisions: Clinical Physics, Bioelectronics, Bioengineering and Medical Computing. Each division has a Senior Officer in Charge, who communicates directly with the Head of Department. The Bioengineering division was formed by dissolution of a prexisting Surgical Instruments Department. At the same time as the above major reorganization was occurring, the name of the Medical Physics Department was changed to Biophysics Department, to allow the Department's activities to cover all aspects of the physics of biological systems.

Service

A full range of scientific services is provided to the Sir Charles Gairdner Hospital, University Departments on the Perth Medical Centre site and some services to the State Health Department. In addition to maintenance services, the Bioelectronics and Bioengineering Divisions have design and construction subdivisions which meet an important need at the Centre. These subdivisions design and construct equipment which cannot be purchased commercially or make modifications or additions to commercial equipment to meet the specific needs of Heads of Clinical Departments.

The Clinical Physics and Computing Divisions work closely together, largely in uses of on-line dedicated computing facilities in diagnostic medicine and monitoring. These divisions are actively engaged in diagnostic clinical work in cardiology (vector cardiography for cardiac pacemaker assessment), neurophysiology (wide range of tests involving averaging techniques), ophthalmology (mostly electro-retinography), nuclear medicine and pulmonary physiology

and are also working in the intensive care/ventilation areas. All of this work is carried out in close collaboration with Clinicians.

The Clinical Physics Division is also responsible for isotope therapy and radiation protection.

Total staff of the Department is at present 17, including Physicists, Engineers, Electronics Technicians, Mechanical Instrument Technicians, a Laboratory Assistant and a Secretary.

Services are being further developed in all areas. The scientific equipment explosion in medicine, which has largely occurred over the last 5 years, has made it absolutely vital to provide broad based scientific services to a large, sophisticated Medical Centre with diagnostic and therapeutic techniques of international standard.

EPILOGUE

Advances in medicine have become increasingly associated with the contributions made by scientists and engineers who can rightly claim to be essential members of the total team. The number of major hospitals in the country which sustain broadly based departments concerned with the physical sciences is distressingly small. With a few notable exceptions, such as raiotherapy, medicine in Australia has been slow to recognise the value of such scientists and to accord them proper status. Equally the physical scientists themselves have been dilatory in establishing levels of excellence in the form of professional standards to be applied to the profession. There are an increasing number of such scientists who have now come to recognize the need for these standards and the next five years are likely to determine whether or not the profession will continue to attract men and women of high quality. It would be a tragedy to health care in this country if the physical scientists were to disappear from the scene. Unless the profession sets its own high standards, and those responsible for structuring Hospitals in particular, follow the lead given by the Boards of Management of the Royal Perth Hospital and the Sir Charles Gairdner Hospital, the worthwhile and challenging work of a physical scientist in hospitals will decline and fall.

In front the sun climbs slow, how slowly, But Westward look, the land is bright!

National Association of Testing Authorities, Australia

Noise Symposium

A symposium on the causes, effects, prevention and measurement of industrial noise will be held in the Executive Building, 100 George Street, Brisbane on Wednesday, 31st March, 1976.

Hearing Conservation in Industry – Dr G. W. Chalk
Measurement of Noise – Mr W. C. Middleton
Control of Industrial Noise – Mr R H Rumble
Industrial Noise and the Community – Dr R. J. Hooker
Noise Control in Sugar Mills – Mr D. Macey
Noise Control in the Mining Industry – Dr V Mason

The symposium will be held at an opportune time in view of the intention of the Queensland Government to introduce legislation on noise control during 1976.

Registration brochures and other information on the symposium are available from NATA, 191 Royal Parade, Parkville, Victoria (Telephone: Melbourne 347 1166) or by telephoning Mr. Warren Middleton at Queensland Institute of Technology (Telephone: Brisbane 221 2411, Ext. 328).