The Future Delivery of Diagnostic Imaging Services in Wales

December 2009
Foreword by the Assembly Minister for Health and Social Services

Perhaps more than any other clinical service diagnostic imaging has been transformed by developments in information technology and digital electronics over the last thirty years. A service then largely based on film, now uses computers to calculate digital medical images for a range of scanner types which literally provide a window into any part of the body, making use of the physical properties of magnetic resonance, x-ray absorption, radionuclide emissions and ultrasound reflection in tissue. This has enabled earlier, more accurate diagnosis and more appropriate interventions for almost all major health conditions. Access to electronic images will help foster collaboration and support seamless care for patients across the primary and secondary care sectors.

It is not surprising that such developments have captured the imagination of the public and that they are now fundamental to clinical practice across the spectrum of health conditions, with in excess of two million imaging examinations per year performed in Wales. Demand for some types of scans has been increasing by 10-15% per year, reflecting the range of clinical information which can now be obtained using the latest technology. I have paid tribute to the hard work and dedication of staff for achieving significant falls in waits for investigations such as MRI, CT and ultrasound in the face of ever increasing demand. NHS staff in imaging services now face the challenge of how best to manage resources to ensure that patients throughout Wales continue to benefit from sustainable technological advance.

The proposals contained within The Future Delivery of Diagnostic Imaging Services in Wales describe our approach to planning at national and more local levels which will need to be integrated into the planning and delivery arrangements for the NHS as a whole. A National Imaging Board has been established to oversee delivery of an integrated Wales-wide approach to high quality imaging services with collaboration across organisational boundaries. This will build on the professional engagement established within the Welsh Assembly Government’s Imaging Modernisation Project.

I will look to our clinicians within diagnostic imaging services, to take the lead in developing first class imaging services for the 21st century.

EDWINA HART MBE AM
Contents

Executive Summary and Recommendations  1

1.  Introduction  5

2.  Imaging Services  5
   2.1  Diagnostic Imaging Modalities  6
   2.2  Other Imaging Applications  6

3.  Strategic Context  7
   3.1  Demographics  7
   3.2  Designed for Life  7
   3.3  Diagnostic Services Strategy  8

4.  Current and Future Delivery of Diagnostic Imaging Services  8
   4.1  Provision of Diagnostic Imaging Services in Wales  8
   4.2  Quality and Safety
       4.2.1  Standards and Accreditation  9
       4.2.2  Governance  9
       4.2.3  Point of Care Imaging  9
       4.2.4  Pathways  10
       4.2.5  Benchmarking  10
   4.3  Planning  11
   4.4  Service Delivery
       4.4.1  Demand  12
       4.4.2  Activity  13
           Table 2: Activity – April 2007 – March 2008  13
       4.4.3  Waiting Times  14
           Figure 2: Radiology waiting list trend (April 2007 – March 2009)  15
   4.5  Funding  15
   4.6  Workforce
       Table 3: Number of Radiologists and Radiographers working in Wales  17
       4.6.1  Clinical Leadership in Imaging Services  18
       4.6.2  Training  19
   4.7  Equipment  19
4.8  Research and Development  20
4.9  Facilities  20
4.10 Patient Care and Service User Involvement  20
4.11 Information Management and Technology  21
    4.11.1 Picture Archiving Communication System (PACS)  22
    4.11.2 Electronic Test Requesting and Results Reporting (TRRR)  23

Appendices
A.  Imaging Modalities  25
B.  Population density in Wales by Unitary Authority, 2006  29
C.  Designed for Life: Imaging Services mapped to the levels of care  31
D.  Current Provision of Diagnostic Imaging Service in Wales  33
E.  Location of Main Imaging Departments and Key Imaging Modalities in Wales  35
F.  Location of CT Scanners in Wales  37
    Location of MRI Scanners in Wales  38
    Location of Plain Film and Computed Radiography Facilities in
    Community Hospitals/Centres in Wales  39

Bibliography  41
Executive Summary and Recommendations

Imaging services play a vital role in the diagnosis, treatment and ongoing monitoring of disease. Imaging should be seen as a key clinical component of healthcare rather than as a “support” service and this needs to be recognised in the planning and delivery of the totality of healthcare if we are to deliver World Class Health and Social Care in Wales.

New delivery models for imaging services need to be developed which ensure imaging services operate to all Wales quality standards required to meet the needs of patients. These standards are described more fully in the National Diagnostic Imaging Framework, which is the companion document to this Future Service Delivery document. The Framework identifies the broader healthcare standards that impact on diagnostic imaging and sets out in detail the quality standards to which diagnostic imaging services are expected to perform.

During recent times, through the Imaging Modernisation Project, there has been increasing collaboration between national and local imaging services and it is vital that this relationship is developed to enable improvements to services to continue.

Demand for services continues to increase year on year. Through a combination of central investment in new scanners, adoption of new methods of working and hard work on the part of staff, waiting times for imaging investigations have been reduced.

The imaging workforce is central to the delivery of efficient and effective services. They have responded to increases in demand placed upon the service by for example lengthening the working day and providing services during evenings and at weekends. New roles have been developed and existing roles extended and these developments need to continue to enable imaging services to respond to future challenges. The availability of training will be essential to support continued progress and ensure that staff are appropriately trained to keep up with rapid developments in imaging technology and practice.

Imaging specialists need to be involved in the development of clinical pathways to ensure that the appropriate investigation is undertaken at the appropriate time, by an appropriate individual. However, it should be recognised that imaging investigations are also undertaken outside formal care pathways to support initial diagnosis and decisions about the management of care.

Investment in diagnostic imaging can often have an impact on the patient pathway, such that resources can be released elsewhere in the system, for example by replacing invasive procedures.

Access to imaging services will be essential for the development of new flexible models of healthcare delivery within rural or primary care settings.

In future, there will be a need to plan at both local and national levels with healthcare organisations collaborating to ensure that services are planned and delivered to comply with relevant standards and that capacity is available to accommodate increases in demand and maintain compliance with waiting times targets. Plans will
need to take into account the physical capacity required to carry out investigations and the clinical capacity needed to ensure that investigations are promptly reported. The availability of integrated Information Management and Technology (IM&T) systems will be a key enabler to the ongoing development of new service models.

The following recommendations are consistent with the planned changes to the NHS in Wales. They provide the basis upon which Local Health Boards can develop more equitable services and a way forward for a continued collaborative approach to the planning and delivery of imaging services in Wales.

### Quality

- Imaging services should strive for continuous improvement through compliance with all relevant standards, including the Imaging Services Accreditation Scheme and appropriate legislation.

- Consideration should be given to the development of a national audit programme for diagnostic imaging.

- National guidelines should be developed for the use of point of care imaging.

- Imaging investigations should be performed to the same standards regardless of location.

- Staff undertaking work outside imaging departments need to be appropriately trained for the range of imaging investigations they undertake.

### Pathways

- The role and timing of diagnostic imaging investigations should be clearly defined within care pathways.

- Decision support for those requesting diagnostic imaging investigations should be developed.

- The results of imaging investigations should be interpreted by appropriately trained and qualified registered healthcare professionals.

### Workforce

- Imaging services should produce workforce plans to support delivery of future service models.

- There should be a national approach to the provision of post graduate and post qualification training.

- The imaging workforce must continue to enhance their skills to support future service models.
Leadership

- Support mechanisms for existing and emerging leaders within diagnostic imaging services should be developed.

Planning

- A national approach to planning will continue through the formation of a National Imaging Board.

- Local networks should be developed where they support integrated service planning and delivery and compliance with standards.

- A model should be developed to enable organisations and networks to monitor and anticipate increases in demand and plan to manage the subsequent impact on service provision.

Service Delivery

- Imaging services should collaborate across organisational boundaries to ensure that the use of facilities is optimised.

- Processes should be developed to share best practice for the benefit of others.

Information Management & Technology

- The use and benefits of standardised Information Management and Technology should be maximised.

- Imaging services should define the information required to plan, monitor and deliver services in future.

Funding

- A model should be developed which ensures that diagnostic imaging services are accurately, appropriately and consistently costed and funded.

- A benchmarking system should be established to provide comparative information about the economy, efficiency and effectiveness of imaging services.

- Mechanisms should be developed to enable existing resources to be reinvested in imaging services where they are shown to improve patient care, clinical outcomes and pathway efficiency.
Equipment

- Processes should be developed to ensure that there is a co-ordinated approach to the planning and deployment of new equipment.

- Healthcare organisations should ensure that equipment replacement programmes are developed and implemented.

- A National system should be established which enables new technologies to be identified, evaluated and where appropriate, adopted across NHS Wales.

Research & Development

- There should be a co-ordinated approach to the sharing of experience of research and development.
1. Introduction

During recent years there has been increasing recognition that diagnostic imaging is an integral part of modern healthcare. This document provides a vision for the future planning and delivery of imaging services that is consistent with the changes taking place in the organisation of health services in Wales. It describes the role and current organisation of diagnostic imaging, the progress that has been made and considers the challenges the service faces and the solutions that are being implemented to address them.

2. Imaging Services

Diagnostic imaging can be defined as the production of images of the internal structure of the human body that enable the diagnosis and staging of disease and monitoring of the effectiveness of treatment. The diagnostic imaging service encompasses all steps from the request for a diagnostic test to the use of the test result by a clinician or patient to directly inform and influence patient care.

Diagnostic imaging is an integral part of modern healthcare. By providing diagnostic information at critical points in the patient journey, diagnostic imaging services free up healthcare resources by rationalising the need for intervention and targeting it where it will have the greatest benefit.

It is important to recognise that diagnostic imaging is not a technical service, but a clinical service that interprets information and requires the clinical expertise of imaging clinicians, who are increasingly making decisions about the management of patient care. Discussion with clinical colleagues is fundamental, as opinions in respect of imaging are critical and are in increasing demand to support clinical decision making.

Diagnostic imaging plays a role in diagnosing virtually all major illnesses and contributes to the planning of treatment. There is increasing recognition of the need to place imaging early in care pathways to reduce the time to diagnosis and treatment and to improve efficiency and effectiveness.

Most diagnostic imaging is carried out in clinical radiology departments, which deliver a range of services including imaging used purely for diagnostic purposes and interventional radiology (minimally invasive treatments performed while imaging the patient). Interventional radiology requires particularly strong integrated links to clinicians in other specialties. Diagnostic imaging services are also provided in other settings such as cardiology, medical physics and obstetrics.

The diagnostic imaging workforce is both the most important and the most valuable asset of the service. Within radiology departments, it includes Radiologists (who are medically qualified), Radiographers, Assistant Radiography Practitioners, Nurses and Radiology Support Staff. In different settings it includes staff such as other Medical Specialists, Medical Physicists, Clinical Technologists, Vascular Technologists and Clinical Physiologists. Specialised support from medical physics and pharmacy staff is provided in areas such as radiation protection, quality
assurance and radiopharmacy while general support is provided by Portering and Administrative and Clerical staff.

Diagnostic imaging teams work together to deliver services that are technically sophisticated and increasingly dependant on Information Technology (IT). The service is reliant on the availability of imaging equipment which can be expensive, complex and subject to rapid development.

2.1 Diagnostic Imaging Modalities

Whilst Wilhelm Conrad Roentgen’s discovery of x-rays in 1895 revolutionised science and medicine it is thought that x-rays may have originally been produced by William Morgan, a Welsh mathematician, more than a century earlier\(^1\).

The first x-ray equipment in Wales was installed as long ago as 1896 in Cardiff Royal Infirmary when the management board agreed to purchase “apparatus for the utilisation of Roentgen rays” to be installed in the “Electrical Pavilion”, “for a cost not exceeding £50”.

As a result of Roentgen’s discovery, the use of what has become known as plain film or conventional radiography has been utilised and refined and still provides the first line investigation for the majority of patients attending imaging departments.

Scientific developments including those in information technology have revolutionised diagnostic imaging equipment and techniques with the result that a wide range of imaging modalities have been developed. (Appendix A)

2.2 Other Imaging Applications

Whilst this document focuses on diagnostic imaging, it is important to recognise that other imaging applications exist.

Imaging is also used to support other clinical specialties, especially surgery. Examples include the use of planar radiography to confirm the correct placement of artificial joints during orthopaedic surgery and of radionuclide imaging (RNI) to localise sentinel lymph nodes in surgery for breast and other cancers. Developments within imaging services mean that non-invasive imaging investigations can sometimes replace surgical procedures. The increasing use and development of interventional radiology (e.g. performing biopsies, draining fluids, inserting catheters and dilating or stenting narrowed ducts or vessels) has meant that some traditional surgical operations have been replaced by less invasive procedures. This can result in reduced complication rates and shorter stays in hospital.

In many cases, imaging is also an integral part of clinical research involving a wide range of disorders and specialties.

Whilst not yet currently in routine use, the ability of modern scanners to provide dynamic images of the heart and circulation is likely to replace some current invasive diagnostic investigations carried out in catheter laboratories.
3. Strategic Context

3.1 Demographics

In 2006 the population of Wales was 2.97 million, giving an average population density of 143 persons per square kilometre (361 per square mile). Approximately three quarters of the population live in the south of the country, with population density ranging from over 2,500 per square kilometre in Cardiff to 25 per square kilometre in Powys (Appendix B). By 2031 the population is projected to increase by 11% to 3.3 million with the median age of the population rising from 40.6 years in 2006 to 44.3 years in 2031.

3.2 Designed for Life

Designed for Life: Creating World Class Health and Social Care for Wales in the 21st Century, (May 2005) identifies the need to provide appropriate evidence based, quality-assured clinical treatment and care. This requires the development of a more corporate approach in NHS Wales with organisations working together rather than separately.

Designed for Life envisages services being planned and provided at four levels. The modernisation of diagnostic imaging services will be crucial to the successful implementation of future plans at all four levels to ensure that:

- services are accessed whenever they are required;
- services are designed so that patients'/clients' problems are resolved as early in the care pathway as possible;
- the use of technology and telehealth reduce the need for hospital visits;
- assessments and investigations can be conducted locally and results stored electronically so that they do not need to be repeated;
- using the latest technology, diagnostic services will move test requests and results, images and other information from patient to service centres to specialists, so that equipment is used to full capacity and results are available on demand;
- hospitals can develop specialist units for people who have specific long-term conditions, staffed by well trained professionals and backed by high quality diagnostics; and
- waiting times continue to fall with a wait of no more than 26 weeks from GP or dental referral to treatment (including diagnostic tests).

As part of the process to develop the Future Delivery of Diagnostic Imaging Services, imaging modalities have been mapped against the four levels in Designed for Life (Appendix C).
3.3 Diagnostic Services Strategy

Getting Results: A Strategy for Diagnostic Services in Wales\(^{(3)}\) was issued in 2004. It looked to more strategically managed services to ensure consistent, high quality diagnostic provision in all parts of Wales. The Diagnostic Imaging Modernisation Project\(^{(4)}\) was established to implement the recommendations contained in the strategy.

4. Current and Future Delivery of Diagnostic Imaging Services

The increasing use of diagnostic imaging to support diagnosis and treatment has meant that services are under constant and increasing pressure. Despite these pressures, imaging services in Wales are making significant progress in improving and developing services. This has been achieved through the hard work and commitment of staff, combined with investment in services. Continued improvement and development is however needed to enable further progress to be made.

There has been a significant level of involvement from those providing diagnostic imaging services in developing the vision for the future of diagnostic imaging services in Wales. It is their views that have been collated and summarised to shape this document.

The following describes the challenges facing the service and presents a view of how imaging services should be planned and delivered in future, building on the progress that has already taken place across Wales.

From 1 June 2009, six new Local Health Boards (LHBs) were established to replace NHS Trusts (apart from Velindre NHS Trust) and LHBs (apart from Powys LHB).

The seven LHBs are responsible for planning, designing, developing and securing the delivery of primary, community, in-hospital care services, and where appropriate specialised services for citizens in their respective areas.

The creation of the Local Health Boards supports delivery of the recommendations within this document and will enable imaging services to continue to develop a more integrated and standardised approach to service planning and delivery.

4.1 Provision of Diagnostic Imaging Services in Wales

Diagnostic imaging services are managed and delivered by the Local Health Boards and Velindre NHS Trust, with imaging services provided to Primary and Secondary Care.

The provision of imaging services is described in Appendix D and the location of the main imaging departments and key imaging modalities are shown in Appendix E. The maps in Appendix F show the location of CT and MRI scanners across Wales and the location of Plain Film and Computed Radiography facilities in Community Hospitals and other centres.
4.2  Quality and Safety

It is important for patients to be assured that the services they receive are safe and effective and performed to agreed standards.

Many diagnostic imaging investigations use ionising radiation and for this reason there are a number of quality and safety requirements and legal obligations which directly apply to diagnostic imaging. It is vital to ensure that patients across Wales continue to be imaged as safely as possible and to consistently high standards.

4.2.1 Standards and Accreditation

The National Diagnostic Imaging Framework (NDIF)(5) for Wales is the companion document to this Future Service Delivery document and sets out the standards for diagnostic imaging services in Wales. The accreditation of imaging services will help to ensure safer and more efficient services that are committed to continuous improvement. Patients and Clinicians should expect that diagnostic tests and the mechanism for providing them will be delivered to consistently high quality standards across Wales. This will be evidenced by imaging services striving for continuous improvement through compliance with all relevant standards, including the Imaging Services Accreditation Scheme(6) and appropriate legislation.

Standards based on relevant documents and guidelines should be developed to define both the timescale for diagnostic imaging investigations to be undertaken and the provision of timely reports based on the need to respond to patient and requesting clinician’s requirements.

Improvements in quality and safety require effective team working and communication and it is therefore important that professional communities are maintained and developed. Information is essential to support service improvements and to assure the quality of services and to achieve this, clinical outcome information should be available to Radiology Clinicians. Consideration should be given to the development of a National audit programme for diagnostic imaging.

4.2.2 Governance

Diagnostic imaging services should have clear governance arrangements which define the links with governance structures in their parent organisations. This is particularly important at a time of organisational change.

4.2.3 Point of Care Imaging

To ensure that services are of high quality and consistency, imaging investigations should be performed to the same standards regardless of location.

There has been an increasing use of point of care imaging, i.e. imaging undertaken by personnel outside the remit and management of Imaging Departments. This development has primarily involved the use of Ultrasound and currently there is a lack of guidance to ensure that appropriate governance arrangements exist. It is important to ensure that Point of Care Imaging is used where clinically appropriate
and to support this, **National guidelines should be developed for the use of point of care imaging**. In addition, **staff undertaking work outside imaging departments need to be appropriately trained for the range of imaging investigations they undertake**, working to consistent standards under the supervision of a specialist e.g. Midwives undertaking Obstetric Ultrasound or Vascular Technologists undertaking Ultrasound Blood Flow Imaging Duplex.

As part of the increased use of point of care imaging, demands have been placed on imaging services to provide training to other professionals in the use of point of care imaging equipment. There needs to be recognition of the impact on diagnostic imaging departments to support this training to ensure that delivery of efficient diagnostic imaging services is not compromised.

The Royal College of Radiologists provides guidance on “Ultrasound Training by Radiology Departments for other Medical Specialties”(7) and recognises the need for appropriately resourced additional staff, space and equipment, in order for this training to be carried out effectively.

### 4.2.4 Pathways

To ensure that patients receive the same standard of service, there is a need for a consistent approach to the development of, and compliance with, appropriate pathways.

Access to appropriate and timely diagnostic imaging investigations is vital to ensure that patients are appropriately assessed, diagnosed and treated and **the role and timing of diagnostic imaging investigations should be clearly defined within care pathways**, with investigations requested by the most appropriate registered healthcare professional.

**Decision support for those requesting diagnostic imaging investigations should be developed** to ensure that patients receive appropriate investigations, with the decision to proceed with imaging investigations being undertaken by an appropriate imaging professional. The development of electronic Test Requesting and Results Reporting (TRRR)(8) will prompt referrers to consider the Royal College of Radiologists’ (RCR) Guidelines “Making the best use of Clinical Radiology Services”(9).

It is also vital to ensure that **the results of imaging investigations are interpreted by appropriately trained and qualified registered healthcare professionals**.

### 4.2.5 Benchmarking

There is currently no standard or common system in regular use that enables imaging services to benchmark themselves against others either within or outside Wales.

The most recent All Wales review was carried out by the Wales Audit Office in 2006 as part of The Acute Hospital Portfolio (AHP) review(10). This review measured NHS Trusts’ performance in specific areas of healthcare, with a focus on balancing
value for money with quality of care. Reports were issued to individual Trusts following the review.

A benchmarking system should be established to provide comparative information about the economy, efficiency and effectiveness of imaging services.

4.3 Planning

Historically, planning of diagnostic imaging services has taken place at a local organisational level. In future it will need to take place not only at a local level but also across NHS organisations. Whilst this may be achieved through the development of existing or new local clinical networks, there will also be a need for coordinated planning at a national level. This will be required to ensure efficient and effective use of resources and a consistent approach to service standardisation and integration. To support this, the all Wales approach to planning established through the Imaging Modernisation Project needs to continue. This will be achieved through the formation of a National Imaging Board which will be responsible for the ongoing planning and delivery of diagnostic imaging services.

Supporting local needs will require collaboration between Primary and Secondary care to accommodate local variations, which should be based upon natural geographic regions and patient flows rather than defined boundaries. The creation of Local Health Boards will help to facilitate both this and the integration of imaging services. As a further enabler, Local Networks should be developed where they support integrated service planning and delivery and compliance with standards. This will ensure that safe services are delivered as locally as possible with equity of access and appropriate capacity to meet justifiable demand. Improved planning and increased collaboration will mean that patients and clinicians have access to clinically led imaging services, with diagnostic investigations undertaken at the most appropriate location by a suitably trained person and the results available at the appropriate point in the patient care journey.

4.4 Service Delivery

Increasing demand, an ageing population, advances in technology, patient and clinical expectation, greater emphasis on the use of diagnostic imaging services and limitations on funding, contribute to the increasing pressures faced by diagnostic imaging services. Services will need to respond to these challenges through the continued introduction of improved processes to ensure service efficiency. Service provision should take into account patient and clinical need, access, demand and the use of available facilities. This may require further extension of hours of operation and imaging services should collaborate across organisational boundaries to ensure that the use of facilities is optimised.

The extensive redesign work that has already been undertaken within the service needs to continue to enable further service improvements where possible and processes should be developed to share best practice for the benefit of others.
Evidence of service improvements and optimised use of existing facilities together with demand trends will help to inform the planning of services to ensure that appropriate capacity exists.

4.4.1 Demand

Demand for diagnostic imaging investigations has increased significantly over recent years and at present shows no sign of reducing. Whilst a proportion of this is a result of the drive to reduce waiting times, there are also underlying increases which are due to:

- **Development of Frameworks and Guidelines**, which require imaging services to comply with and implement recommendations contained within them e.g. National Service Frameworks (NSFs)(11), the NHS Cancer Plan(12) and NICE Guidelines(13).

- **Changes in clinical practice and new initiatives** including the development of image guided alternatives to invasive surgical procedures and the introduction of new initiatives e.g. bowel screening. There has also been an increase in the range and number of Multidisciplinary Team (MDT) meetings requiring input from imaging professionals, with Radiologists developing increasing levels of imaging and interpretive expertise in order to respond to the greater levels of precision required in the management of cancer and other clinical conditions.

- **Demography**: with the predicted increase in the age of the population, demand on the service will continue to increase. Coupled with this is the predicted increase in the prevalence of chronic conditions (such as diabetes) and other diseases, (such as coronary heart disease).

- **Technological advances** have resulted in increases in more complex imaging techniques largely due to the development and use of more accurate cross sectional imaging which has enabled a greater range of investigations to be undertaken. In addition, recently qualified clinicians are more aware of the newer techniques that are available and therefore often request more complex imaging investigations.

“Predicting Future Demand for MRI and CT Scanning in Wales: A Horizon Scan” (2009)(14), compiled by the National Public Health Service (NPHS)(15), was commissioned by the Diagnostic Imaging Project Board as part of the work of the Imaging Modernisation Project to help identify future demand for diagnostic imaging in Wales and to inform service, capital and workforce planning.

The key findings revealed an 82-89% rise in CT scan rates between 2000 and 2007 and up to a 104% increase for MRI in the same period. Data were analysed to predict future trends based on population projection, particularly the impact of the ageing population and expected morbidity from chronic diseases and cancers.

The report projects a minimum of 30% increase in activity for both MR and CT scanning by 2020 based on demographic change alone. However it is anticipated that technological advances and changes in clinical practice will result in even greater increase. Whilst it is difficult to accurately predict future increases in demand,
particularly those due to changes in Technology and Clinical Practice, work undertaken to date indicates that there will be a continued increase in demand. It will therefore be vital to **develop a model to enable organisations and networks to monitor and anticipate increases in demand and plan to manage the subsequent impact on service provision.**

### 4.4.2 Activity

In excess of 2 million examinations are performed within imaging departments across Wales each year. Many patients attend for more than one investigation at each visit, hence the need to collect information about not only the total number of patients attending, but also the total number of investigations performed. This gives a more accurate measure of activity being undertaken.

Although conventional radiography accounts for just under one and half million of the total number of examinations performed, there are still large numbers of specialised investigations undertaken as shown in table 2 below. Whilst the numbers of these specialist investigations are relatively low when compared to plain radiography, they consume disproportionately more resource. The equipment used is often very expensive and requires trained operators with specialist skills and specialist interpretation. A single CT scan, for example can comprise of more than 1000 images.

**Table 2: Activity – April 2008 to March 2009**

<table>
<thead>
<tr>
<th>Modality</th>
<th>Number of patients</th>
<th>Number of examinations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional Radiography</td>
<td>1,227,230</td>
<td>1,455,731</td>
</tr>
<tr>
<td>Ultrasonography</td>
<td>349,987</td>
<td>387,789</td>
</tr>
<tr>
<td>Computed Tomography</td>
<td>133,156</td>
<td>216,551</td>
</tr>
<tr>
<td>Magnetic Resonance Imaging</td>
<td>75,237</td>
<td>91,680</td>
</tr>
<tr>
<td>Screening Mammography</td>
<td>109,412</td>
<td></td>
</tr>
<tr>
<td>Non-Screening Mammography</td>
<td>29,274</td>
<td>42,364</td>
</tr>
<tr>
<td>Nuclear Medicine*</td>
<td>22,982</td>
<td>25,395</td>
</tr>
<tr>
<td>Other**</td>
<td>100,925</td>
<td>105,644</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,048,203</strong></td>
<td><strong>2,325,154</strong></td>
</tr>
</tbody>
</table>

* Including RNI and SPECT

** Including Fluoroscopy, Angiography and Interventional Procedures.

Source: Imaging modernisation team survey of NHS Trusts 2008 (information provided by radiography managers).

In addition, during the same period, nearly 9000 women underwent assessment mammograms and/or ultrasound following screening mammography, and nearly 3000 women needed core biopsies and fine needle aspirations.
At present the collection of consistent activity data is difficult due to variations in coding and the way in which information is collected. The planned adoption of common national codes for imaging procedures and the implementation of a common information system across Wales should greatly help in the standardised collection of relevant data.

4.4.3 Waiting Times

The 2009 Access Project\(^{(16)}\) was established to manage the delivery of the 26 week referral to treatment target across Wales. Imaging services have responded to the need to meet this target in a number of ways, which have included:

- increasing activity using existing capacity through the introduction of service improvements and redesign to improve service efficiency and effectiveness;
- the provision of additional temporary and permanent capacity through increases in operating hours of departments and provision of additional scanning equipment; and
- a more patient-centred imaging service by giving patients more say in arranging the times of appointments.

Imaging services have been supported in delivering these changes by the 2009 Access Team, The National Leadership and Innovation Agency for Healthcare\(^{(17)}\) (NLIAH) and the National Diagnostic Imaging Project.

This work is continuing across Wales in conjunction with the move toward centralisation of booking processes. An example of this is shown below.

The creation of a single central booking office within one new Local Health Board has enabled co-ordination of all out patient appointments, with booking of patients in turn for Radiology services across the organisation. Benefits include standardised booking processes, choice of hospital for patients to attend for their investigation and reduced waiting times.

Figure 2 below shows the reduction in imaging waiting times between April 2007 and March 2009. Since March 2008 no-one has waited in excess of 14 weeks for a diagnostic imaging investigation and by March 2009 there was no-one waiting over 8 weeks.
4.5 Funding

Diagnostic imaging services are funded via block contracts as part of other clinical services and therefore the current funding mechanism is not based on or responsive to changes in activity levels. It is also currently difficult to accurately cost services due to variations in the way that budgets are apportioned. The introduction of standardised codes and data collection will enable more effective comparison within and between imaging departments. This will be strengthened through links with the Financial Information Strategy which will provide standardised costs to support more effective benchmarking. This could also provide the basis for the introduction of a more effective funding mechanism in the future.

Diagnostic imaging departments within Wales have an annual budget in the region of £100 million of which 78% relates to staff costs (Source: imaging modernisation team survey of NHS Trust radiography managers 2008/09).

Diagnostic imaging services are provided in primary, secondary and tertiary care and the current funding model does not enable the cost of services to be clearly identified or for services to be appropriately funded. **A model should be developed which ensures that diagnostic imaging services are accurately, appropriately and consistently costed and funded.**

Mechanisms do not currently exist to reinvest resources in imaging services where they are shown to improve patient care and clinical outcomes or pathway efficiency. **Mechanisms should be developed to enable this in the future.**
4.6 Workforce

The modernisation of the NHS is dependent upon the development of a workforce capable of delivering high quality, patient centred care. Resources within the health service are finite and there is unlikely to be significant additional funding available in the future. This will mean that imaging services will need to continue to review staffing profiles to ensure that resources are used efficiently and effectively. Practitioners in diagnostic imaging are key members of the inter-professional healthcare team. It is therefore essential that they continue to redefine their roles to embrace innovative ways of providing services to the benefit of patients and the service. Whilst this has happened within some imaging services in Wales, there is currently no consistent approach to workforce modernisation across Wales. The creation of larger Healthcare organisations is likely to facilitate further development and this in conjunction with the introduction of the new workforce planning system and Agenda for Change, will provide opportunities for staff development, career progression and the development of new roles necessary for a modernised imaging service.

The Diagnostic Services Strategy in Wales\(^3\) identified that there is an ageing workforce in imaging and a need to develop plans to ensure that the right numbers of people are recruited in the right place, at the right time, with the right skills. To achieve this it is necessary not only to understand demand, but also to understand the profile of the current workforce and be able to accurately predict the skills that will be required and when and where they will be needed.

Workforce plans should take account of the need for roles to be developed to support sustainable future service delivery and to ensure that staff are appropriately trained and skilled to undertake these roles. Workforce planning should therefore encompass the whole imaging workforce.

Whilst one size will not fit all, there should be a consistent approach to workforce development and imaging services should produce workforce plans to support delivery of future service models using the Integrated Workforce Planning System for NHS Wales\(^{18}\).

This will enable a coordinated and comprehensive approach to workforce planning to take place and will identify education and training requirements.

There will also be a need for the imaging workforce to continue to enhance their skills to support flexible working through the ongoing development and extension of their roles.

In order to comply with clinical standards and meet increasing demand, imaging departments will need to review their operational hours. For some departments this may involve the introduction of a shift system and a move to 24 hour working. Consideration will also need to be given to a network approach to the provision of some services.
Radiology departments are led by Clinical Radiologists in partnership with Radiography Service Managers. The role of a Clinical Radiologist includes the use and clinical interpretation of imaging in the diagnosis, treatment and monitoring of disease, a central role in advising on the clinical management of patients through the use of imaging, leadership of the Clinical Radiology Service, and education of healthcare professionals in diagnostic imaging. This places increasing demands on Consultant Radiologists who themselves require high levels of ongoing training and development to keep up to date with the clinical application of constantly evolving technology. Together with Radiographers, Nurses, Administration and Clerical Staff, Radiologists form a team who work together to deliver imaging services.

Table 3 shows the number of Radiologists and Radiographers working across Wales and the % increase since 2003. Nurses, Radiography Assistant Practitioners, Radiography Helpers, Secretarial and Clerical Staff account for a further 200 staff members. (Source: NHS Trusts 2008/09).

**Table 3: Number of Radiologists and Radiographers working in Wales**

<table>
<thead>
<tr>
<th></th>
<th>2003</th>
<th>2007</th>
<th>2009</th>
<th>% increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiologists</td>
<td>141</td>
<td>176</td>
<td>189</td>
<td>34%</td>
</tr>
<tr>
<td>Radiographers</td>
<td>671</td>
<td>838</td>
<td>935</td>
<td>39.3%</td>
</tr>
</tbody>
</table>

The participation of Consultant Radiologists in multi-disciplinary team (MDT) working on more complex investigations and procedures has resulted in increased clinical involvement, advice and expertise. Requests for radiological imaging are clinical referrals and the sophistication of modern imaging techniques is such that clinicians may require guidance in selecting the most appropriate investigation for particular patients and conditions. Within Interventional Radiology increased demands are being placed on Clinical Radiologists as the range and complexity of such procedures continues to grow.

Since 2003, an average of 54 Radiographers have been trained in Wales each year. Radiographers have been able to develop their roles in areas such as reporting with the support of Consultant Radiologists and through the training of Radiography Assistant Practitioners, who are trained to carry out a range of routine investigations. Over 50 students have successfully completed the Assembly funded Radiographer Assistant Practitioner training programme since it was established in 2006.

Examples of areas of workforce development within Local Health Boards include:

- Radiographers trained to perform barium enema examinations now have a lead role in the organisation and delivery of this service.
- Extension of Radiographer roles in techniques such as hysterosalpinography and transurethral ultrasound guided biopsy of the prostate has enabled Radiologists to focus on the delivery of more complex areas of the diagnostic service.
In a number of organisations Radiographers trained in the reporting of the axial and appendicular skeleton are now largely responsible for reporting Accident and Emergency trauma images.

The development of a Radiographer led mammography follow up service. Benefits include reduced time and number of clinic visits for patients and electronic sign off of Radiology reports to alert Consultant Oncologists to abnormal mammogram reports.

The role of the Radiology Nurse has developed considerably over the years. Their exact role varies from department to department and includes the provision of care to patients undergoing both routine and complex imaging investigations. Many are also directly involved in the performance of complex interventional procedures. Increasing demand will mean that the role of Nurses within Radiology will need to continue to develop.

Diagnostic imaging services are also provided by departments other than Radiology, particularly Medical Physics. Some Nuclear Medicine, Bone Densitometry and Vascular Ultrasound services are directly provided wholly or partly in Medical Physics settings. Patient imaging is usually performed by Clinical Technologists although more complex investigations may be carried out by Medical Physicists (who are registered as Clinical Scientists with the Health Professions Council)(20). Medical Physicists and Clinical Technologists are also part of the multi disciplinary teams that deliver Nuclear Medicine and Bone Densitometry services in other settings.

In addition, Medical Physicists provide service management, scientific leadership and advice, teaching and training across the broad spectrum of imaging. They undertake specific statutory roles such as those of Radiation Protection Adviser and Medical Physics Expert. Together with Clinical Technologists they act as Radiation Protection Supervisors and provide a range of imaging support functions such as equipment management (including quality assurance) and radiation safety measurements.

It is anticipated that Modernising Scientific Careers(21) will have a significant impact on the future training of all Healthcare Scientists including Medical Physicists and Clinical Technologists.

4.6.1 Clinical Leadership in Imaging Services

Changes in the Health Service will continue and historically imaging services have responded well to change. It is vital that current clinical leaders are supported in delivering these changes and future leaders identified and developed. To achieve this, support mechanisms for existing and emerging leaders within diagnostic imaging services should be developed.

There will be an increasing need for imaging services to work closely with other clinicians as part of a wider clinical team and with other services. Imaging services need to take a more proactive approach to ensure that they clearly articulate the value of the services that they are able to provide. Whilst this may challenge current clinical practices it could ultimately improve patient care.
4.6.2 Training

Workforce planning will need to take into account the need for post graduate and post qualification training, although pressures on diagnostic imaging services to meet waiting times and increasing demand means that releasing staff to undertake training can be challenging. The development and clinical use of new and complex imaging technology requires additional knowledge and skills for all staff groups and this will need to be factored into training programmes. The provision of ongoing relevant training is necessary to ensure that the clinical benefits of such changes are realised. At present there is limited access to training and disparity in funding for training between medical and non medical staff.

Appropriate training and time to deliver training is needed to meet increasing standards of delivery within postgraduate medical education. These increases place demands upon postgraduate medical education budgets and for clinicians involved in training provision can compete with time needed for service delivery.

Training needs to be available and accessible to those who work within and outside imaging departments as without skilled staff, delivery of the service would not be possible. Increasing workforce flexibility will also require a more flexible and adaptable training system which enables staff to undertake training and gain practical clinical experience. To ensure that this happens, there should be a national approach to the provision of post graduate and post qualification training.

Currently there is a local approach to the provision of a range of further training, e.g. cannulation. This training is not usually transferable; resulting in staff having to repeat the training if they move to work in another organisation. To prevent this duplication, standardised transferable training for the imaging workforce needs to be developed and available at all levels.

4.7 Equipment

The continued operation of diagnostic imaging departments is dependant on the availability of reliable, safe and modern equipment. It is therefore important to ensure that equipment is appropriately maintained. With technologies developing rapidly, imaging services need to evaluate new developments and assess their applicability when looking to purchase new or replacement equipment.

Diagnostic imaging equipment is currently funded from organisations discretionary capital with competing demands. The average current replacement cost for a CT scanner is £600,000 and for a high magnetic field (1.5 tesla) reasonably well configured MRI scanner is £800,000. Maintenance of this equipment is essential with annual maintenance charges costing approximately 10% of the capital cost.22

Four new MRI scanners have been commissioned in Wales since 2007, increasing the number from 15 to 19. This means that all major hospital sites in Wales now have MRI scanners. These scanners were procured using the All Wales Procurement Framework developed as part of the Imaging Modernisation Project, resulting in savings in both equipment and procurement costs. Between April 2007 and March 2009, over £15 million pounds was spent on imaging equipment using the
procurement framework, resulting in savings in the region of £2 million\(^{(22)}\). This figure does not take into account savings made in resources such as procurement costs, timescales for procurement etc.

The availability of diagnostic imaging equipment is central to the provision of Imaging Services. This equipment is costly and therefore processes should be developed to ensure that there is a co-ordinated approach to the planning and deployment of new equipment. Capacity planning and equipment replacement and development plans should take account of the need for a common approach to the shared use of capacity where appropriate.

It is also important to ensure that there is timely replacement of imaging equipment and healthcare organisations should ensure that equipment replacement plans are developed and implemented.

Technology is developing rapidly and in future it will be important to be aware of new technologies that are being developed and to make sure that they are properly evaluated. A national system should be established which enables new technologies to be identified, evaluated and where appropriate, adopted across NHS Wales.

**4.8 Research & Development**

Imaging services play an important part in research both alone and in collaboration with other clinical specialties. Preservation of the academic component of imaging departments is needed to continue to attract high quality consultants and registrars. Research capacity needs to be built on by development of academic training in imaging to promote increased grant income, publications and research activity. There is significant scope for creative collaboration with non-medical academic disciplines such as computer science and the opportunities provided by new imaging research facilities such as the PET/CT facility in Cardiff\(^{(24)}\) need to be fully exploited. Universities across Wales are enhancing facilities for the development of clinical and translational research and it is vital that the imaging service plays its role by thinking of research and academic development as an integral part of its development in Wales. In future there should be a co-ordinated approach to the sharing of experience of research and development.

**4.9 Facilities**

Diagnostic imaging services must be provided in an environment that is supportive of the varying needs of patients for whom a visit for an investigation may be stressful. Services need to be planned and delivered in a way that takes into account the needs of patients, with an holistic approach to the planning of facilities, to ensure that privacy and confidentiality are maintained.

**4.10 Patient Care and Service User Involvement**

All care should be centred on the patient, with the patient being an active participant in the process, having been provided with all the relevant information related to their care. Patients requiring appointments with imaging services should be involved in choosing the date and time of the appointment.
Service User representatives should participate as fully integrated and valued members of the team with their views incorporated at all stages of any redesign of services.

Equally important is the role of patients in assessing the quality of the service provided by diagnostic imaging departments in Wales. This can be undertaken in a number of ways but the central aim of any form of assessment should be explicitly aimed at identifying what can be improved.

### 4.11 Information Management & Technology

Information Management and Technology (IM&T) is at the heart of modern diagnostic imaging services and imaging data is a major component of the patient record. Ongoing clinical engagement has facilitated the development of computerised systems which are helping to revolutionise the delivery of diagnostic imaging services in Wales. As developments progress there will need to be continued collaboration with clinicians, service providers and users to ensure that systems are fit for purpose.

Advances in information technology can enable changes in service delivery. For example, the ability to transfer images electronically over large distances offers significant benefits such as the ability to access remote sub specialist opinion, e.g. in Paediatric Radiology and Neuro-radiology.

Radiology Information Systems (RIS) were first introduced about 20 years ago and are now used universally within modern healthcare settings. The systems perform many functions, such as patient scheduling, resource allocation and diagnostic reporting.

Increasingly, a wide variety of management information is required as part of delivering an effective imaging service across NHS Wales. This includes retrospective analysis of the utilisation of resources and performance against key performance indicators; the generation of standard central returns and activity and demand data to support forward planning to predict levels of demand and future capacity requirements.

There are currently 13 Radiology Information Systems in use across Wales provided by two suppliers. All Local Health Boards use the RadIS system apart from the former Swansea NHS Trust, (now part of Abertawe Bro Morgannwg University LHB). RadIS is maintained and supported by Health Solutions Wales(25) who originally developed the system during the late 1980’s.

The systems have historically been locally configured, are not integrated and have not operated to common definitions and coding standards. This has hampered collection of consistent data for strategic planning; and hindered the sharing of and access to information between LHBs and the integration of services. The lack of standardisation has also prevented any meaningful benchmarking in terms of efficiency and effectiveness of services.
This also affects the ability of NHS organisations to share electronic images using Picture Archiving and Communications Systems (PACS) which in turn has a direct impact on patient care.

Plans developed as part of the Imaging Modernisation Project in partnership with Informing Healthcare\(^{(26)}\), have led to the implementation of RadIS2 and the introduction of common national imaging codes. Once the codes have been adopted across Wales, collection and comparison of information will be more robust and will enable imaging services to **clearly define the information required to plan, monitor and deliver services in future.**

Plans are also being progressed to ensure that information systems are integrated both with each other and with Picture Archiving and Communications Systems (PACS) across NHS Wales. Development of these plans involves close working with clinicians to ensure that the current and future needs of the service are incorporated.

Integration of Radiology Information Systems and PACS across Wales will enable increased use of remote reporting of investigations within aspects of services such as those provided within a rural setting or tertiary centre or where specialist radiological opinion is required.

In future this will mean that information and images will be available to clinicians as required and ensure that decisions about diagnosis and treatment are not delayed due to the lack of appropriate information.

Breast Test Wales (BTW) uses the National Breast Screening System software (NBSS) developed and maintained by the English NHS Breast Screening Programme\(^{(27)}\), with support and local additions provided by Health Solutions Wales. Electronic data is sent to and returned from mobile screening units on portable media and uploaded onto the main systems. A project is underway to provide normal results and non-attendances to GPs electronically.

The breast screening service is delivered via film based technology, however Breast Test Wales (BTW) is currently managing a project to procure and implement digital mammography in breast screening (Modernisation of Mammographic Services for Breast Screening projects).

High quality Information Management and Technology is a key enabler of improvements in service delivery and the development of new service models and **the use and benefits of standardised Information Management and Technology should be maximised.** The future reliance of imaging departments on such technologies requires that the resilience of networks crucial to such systems is ensured.

**4.11.1 Picture Archiving Communication System (PACS)**

PACS are computer systems dedicated to the storage, retrieval and distribution of medical images. The use of PACS systems across Wales means that images no longer need to be stored on film. Medical images on PACS are linked to patient information and clinical reports held on Radiology Information Systems.
PACS provides the potential for off-site viewing and reporting. It supports many functions such as teleradiology, which enables the transfer of patient images from one location to another for the purposes of clinical interpretation at a different site from the one where the investigation was undertaken. It also enables remote reporting of images by specialists; multi-disciplinary teams (MDT’S) to view images when discussing patient management decisions; and can enable urgent clinical decision making in emergency situations such as head injury.

PACS also provides opportunities for a network approach to reporting to enable timely reporting of images. With teleradiology enabling the transmission of images from a PACS to a remote reporting facility, a range of benefits may be realised such as enabling a Radiologist to remotely report images from home. This can potentially enhance patient care as well as being a more efficient use of resources. However, there will still be a need to ensure that clinicians can directly access reporting Radiologists to discuss interpretation and choice of diagnostic imaging investigations and to guide further investigation or treatment.

Many departments now use digital dictation and voice recognition software for the transcribing of the reports of imaging investigations and other documents. Benefits of these systems include the streamlining of the reporting and validation processes.

Whilst at present there is little integration between the separate PACS systems in Wales, plans being implemented to integrate Radiology Information Systems and PACS systems will be key in supporting improvements in patient care and effective work flow management and will enable services to become more efficient. This integrated approach will require collaboration to ensure that appropriate information is available to support effective patient care.

4.11.2 Electronic Test Requesting and Results Reporting (TRRR)

Electronic test requesting and results reporting is currently being developed in Wales as part of the Clinical Portal(28). TRRR will enable clinicians to request imaging investigations electronically and view the investigation report, enabling a move to a paperless system and speeding up the requesting and reporting process. Users will be provided with on-line advice on appropriate investigations and there is potential for integration with clinical pathways. Requesters (and potentially patients) can monitor the status of their request and know when they can expect to receive the result. Other benefits will include the ability to ensure that investigation results are available where patients are attending outpatient clinics.

As technology rapidly changes and develops, diagnostic imaging will need to keep pace with developments as robust, integrated IT systems with appropriate connectivity are vital to underpin and enable the ongoing planning and delivery of diagnostic imaging services in Wales.
Appendix A

Imaging Modalities

**Fluoroscopy** – provides real time (‘live’) images of internal body structures and the position of inserted medical instruments. Like radiography, it is a planar (or projection) method in which body structures are superimposed upon each other in the images.

**Mammography** – the technique for imaging breast tissue, which has been undertaken on dedicated equipment since 1969.

The application of computers has revolutionised diagnostic imaging equipment and techniques with the result that newer imaging modalities have been developed.

The use of digital imaging techniques commenced in the 1970s with the introduction of Computed Tomography (CT) scanning. These techniques have also impacted on conventional radiography with electronic image receptors replacing radiographic film, enabling the image to be displayed on a computer screen rather than viewed on a light-box. Such Digital or Computed Radiography systems have largely replaced film-based systems in Welsh hospitals. One of the biggest advantages of digital imaging is the ability of the operator to post-process images for optimal diagnostic quality. It also allows the electronic transmission of images so that many people can share the information and assist in the diagnosis. Digital imaging is environmentally friendly since it does not require chemical film processing. Radiation dose reduction is also a benefit derived from the use of digital systems.

**Computed Tomography (CT)** provides cross-sectional (or ‘slice’) views of internal body structures, thus overcoming the problem of superimposed structures that is inherent in plain film radiography and fluoroscopy. During a CT scan, x-rays are passed through the body from multiple directions and high-speed computing is used to produce a series of transverse (along the head to toe axis of the patient) images. The computer can reformat these to show slices in the sagittal (side to side) or coronal (front to back) planes or to display the data as a three-dimensional image. Although CT was first developed over thirty years ago, significant advances continue to be made in this imaging modality with modern multi-slice scanners being fast enough to ‘freeze’ the motion of the beating heart. The constantly improving capability of CT provides opportunities to explore new imaging techniques and to improve patient care; however, CT is regarded as a relatively high radiation dose technique.

**Dual Energy X-Ray Absorptiometry (DXA)** is a specialised and low radiation dose form of planar digital radiography used for measuring bone mineral density. It is used primarily for the diagnosis of osteoporosis, estimating fracture risk and monitoring the effect of treatment. Modern DXA scanners incorporate the ability to acquire digital radiographic images of the spine in order to indicate the presence of vertebral fractures.

Diagnostic imaging has developed to include the following imaging techniques that do not use ionising radiation.
Ultrasound Imaging is the application of echoes from high frequency sound waves to visualise internal organs of the body. It produces cross-sectional ‘live’ images which can be used for diagnosis or to guide the positioning of inserted medical instruments e.g. for taking tissue biopsies. By utilising the Doppler effect (the change in frequency of sound waves when they are reflected by moving structures), it is possible to measure the flow rate of blood in arteries and veins. Ultrasound imaging is considered a relatively safe procedure compared with methods that use ionising radiation (such as x-rays).

Magnetic Resonance Imaging (MRI) is a non-invasive diagnostic method which uses a high magnetic field, radio waves and a computer to produce detailed images of internal body structures. MRI provides much greater soft tissue contrast than CT, making it especially useful in neurological, musculoskeletal, cardiovascular and oncological diseases. Images are directly acquired in any plane and no ionising radiation is used. One of the most recent developments with MRI is the use of magnets of higher strengths e.g. 3T machines, which can give markedly increased quality images of certain parts of the body.

Another major development in diagnostic imaging has been the application of pharmaceutical contrast agents or contrast media to help visualise organs and blood vessels with more clarity and greater image contrast. They are often referred to as ‘dyes’ and are administered orally or via intravenous injection. Pharmaceutical contrast agents are now very much part of many diagnostic imaging investigations, particularly fluoroscopic, CT and MRI procedures. Physical contrast agents have also been developed for ultrasound imaging.

A further group of imaging techniques involves the administration of short-lived radioactive materials (called radiopharmaceuticals) in order to demonstrate the function of an organ or system. The radiopharmaceutical is chosen so as to be appropriate to the clinical condition of the patient and is usually administered by intravenous injection. It accumulates in the organ or body system of interest and emits gamma rays (which are similar in nature to x-rays). Radiopharmaceuticals require specialised facilities for their production.

In Radionuclide Imaging (RNI), the gamma radiation emitted by the target body organ or system is detected using a gamma camera which shows the distribution of the radiopharmaceutical within the body. Like radiography and fluoroscopy, it is a planar technique and involves ionising radiation, although radiation doses are usually relatively modest. It is part of the speciality of Nuclear Medicine which also encompasses the use of radioactive substances for treatment.

Single Photon Emission Computed Tomography (SPECT) is a “slice” imaging nuclear medicine technique whose relationship to radionuclide imaging is similar to that between CT and planar radiography. It is performed by rotating a gamma camera around the patient and using a computer to generate cross-sectional images. SPECT scanners may also be used for planar RNI although radiation doses in SPECT imaging tend to be higher than those associated with planar imaging (because the administered radioactivity is greater). Modern SPECT scanners are often combined with an x-ray CT scanner to give a SPECT/CT image. SPECT and CT images may be ‘fused’ (superimposed) for greater diagnostic accuracy by
enabling the functional SPECT image to be matched against the detailed anatomical information in the CT scan.

**Positron Emission Tomography (PET)** is a more sophisticated type of nuclear medicine slice imaging technique. It uses very short-lived radioactive materials attached to biological molecules to allow the visualisation of metabolic processes in the body by producing images of the distribution of the radiopharmaceutical. Like other nuclear medicine imaging techniques, PET gives functional information about the biological behaviour of tissues and the activity of disease processes. However, PET scanners utilise a ring of gamma radiation detectors and are dedicated for this purpose. As with SPECT, when combined with an x-ray CT scanner (PET/CT), as is now generally the case, functional and anatomical images can be acquired at the same time and fused to display the anatomical site of a functional abnormality.

The first PET/CT facility in Wales, which is a joint venture between Cardiff University and the Cardiff and Vale NHS Trust, is planned to become operational on the University Hospital of Wales site in spring 2010. The project includes an on-site cyclotron for the production of short-lived radioactive nuclides and radiochemical laboratories for the synthesis and testing of PET radiopharmaceuticals. A strategic paper prepared by the All-Wales PET Group\(^{(29)}\), but not formally adopted by the Welsh Assembly Government, recommended a further three scanners across Wales. The timing of the installation of these will be dependent on capacity and demand and the availability of funding.

The fusion of PET and MR images is possible once the images have been generated creating the potential for the first generation of commercial PET/MRI scanners to be developed.

**Other Imaging Applications**

Radiotherapy is the treatment of diseased areas through exposure to gamma rays or x-rays; it is an important and widely used method of treating cancer. For many years, planar radiographic images have been used for radiotherapy treatment planning and simulation to ensure that a high radiation dose is delivered to the tumour site while minimising the dose to surrounding healthy tissue. In many centres, dedicated CT scanners are now used for these purposes while MRI and, to some extent, PET images have an emerging role in treatment planning. In addition, treatment machines are being provided with facilities for planar or slice imaging in order to confirm treatment plans.
Appendix B

Population density in Wales by unitary authority, 2006

Source – Welsh Assembly Government
## Designed for Life: Imaging Services mapped to the levels of care

<table>
<thead>
<tr>
<th>Care Level</th>
<th>Modality</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level 1 – Primary and community based care</strong></td>
<td>Service delivery will largely depend upon the configuration of clinical services, but could include the following which may be either site-based or mobile services:</td>
</tr>
<tr>
<td></td>
<td>• Plain film or Computed Radiography (CR). CR has largely replaced plain film radiography and its use allows digital transfer of images for remote reporting and support.</td>
</tr>
<tr>
<td></td>
<td>• Ultrasound Imaging.</td>
</tr>
<tr>
<td></td>
<td>Other mobile services could include:</td>
</tr>
<tr>
<td></td>
<td>• Magnetic Resonance Imaging (MRI).</td>
</tr>
<tr>
<td></td>
<td>• Bone Densitometry.</td>
</tr>
<tr>
<td></td>
<td>• National Screening Services e.g. Mammography.</td>
</tr>
<tr>
<td></td>
<td>Imaging would be undertaken by site-based operators (e.g. CR/plain film) where there is a critical mass of staff or by visiting operators where there is less demand or where specialist tests are undertaken (e.g. MRI and Screening Services).</td>
</tr>
<tr>
<td><strong>Level 2 – Local acute services</strong></td>
<td>Service delivery may be site based or mobile depending on the configuration of clinical services and may include:</td>
</tr>
<tr>
<td></td>
<td>• Plain film or Computed Radiography (CR).</td>
</tr>
<tr>
<td></td>
<td>• Ultrasound Imaging.</td>
</tr>
<tr>
<td></td>
<td>• Bone Densitometry.</td>
</tr>
<tr>
<td></td>
<td>• CT.</td>
</tr>
<tr>
<td></td>
<td>• MRI.</td>
</tr>
<tr>
<td></td>
<td>• Fluoroscopy.</td>
</tr>
<tr>
<td></td>
<td>• Radionuclide Imaging (RNI) including Single Photon Emission Computed Tomography (SPECT) or SPECT/CT.</td>
</tr>
<tr>
<td></td>
<td>• National Screening Services.</td>
</tr>
<tr>
<td></td>
<td>Imaging would be undertaken by site-based operators (e.g. CR/plain film) where there is a critical mass of staff or by visiting operators where there is less demand or where specialist tests are undertaken (e.g. MRI and Screening Services).</td>
</tr>
</tbody>
</table>
Images would be reported on site, or transferred to Level 3 centres for reporting and/or specialist imaging opinion. Appropriate access to 24 hour imaging services should be available.

<table>
<thead>
<tr>
<th><strong>Level 3 – Major centres dealing with complex cases</strong></th>
<th>The full range of site-based imaging modalities should be provided including:</th>
</tr>
</thead>
</table>
|  | • Plain film or Computed Radiography.  
|  | • Bone Densitometry.  
|  | • Ultrasound Imaging.  
|  | • CT and MRI.  
|  | • RNI including SPECT or SPECT/CT.  
|  | • Fluoroscopy (including facilities for Interventional Radiology).  

Facilities could also include specialised cardiac imaging, visiting mobile imaging units and PET/CT. Appropriate access to 24 hour imaging services should be available.

| **Level 4 – Tertiary care/Highly Specialist Centres** | The full range of site-based imaging modalities should be provided (which could include PET/CT). Appropriate access to 24 hour imaging services should be available. |
Appendix D

Current provision of Diagnostic Imaging Service in Wales

North Wales

The Betsi Cadwaladr University Local Health Board (LHB) serves a population of approximately 750,000. The LHB has Imaging Departments at its three acute sites. A wide range of imaging services are also provided at Llandudno General Hospital including general and obstetric ultrasound and mammography. Limited services are also provided from a number of community based satellite departments.

South East Wales

There are three LHBs and one NHS Trust in South East Wales:

Cardiff and Vale University LHB serves a local population of around 450,000 and currently hosts departments on two hospital sites, providing an extensive range of services and also providing tertiary services more widely across Wales.

Aneurin Bevan LHB serves a population of around 600,000, and hosts three main hospital imaging departments. Imaging services are also provided at some of the Community Hospitals.

Cwm Taf LHB provides services to around 330,000 people. There are two main hospital imaging departments, both providing an extensive range of services. Imaging services are also provided at a number of the Community Hospitals.

Velindre NHS Trust comprises a variety of divisions, including Cancer Services (Velindre Cancer Centre) which provides diagnostic imaging.

Velindre Cancer Centre provides specialist cancer services to 1.5 million people living in South East Wales. It is one of the 10 largest cancer centres in the UK, with over 5,000 new cancer referrals and around 50,000 outpatient appointments each year. It provides a comprehensive range of diagnostic imaging services.

Screening Services Wales is part of Public Health Wales and consists of antenatal, breast, cervical, bowel and newborn hearing screening services.

Breast Test Wales (BTW) was established in 1988 to deliver the National Health Service breast screening programme in Wales. BTW is divided into three geographical divisions with centres in Cardiff, Swansea and Llandudno (plus an additional satellite centre in Wrexham). Ten mobile units work across Wales to support these centres, visiting over 100 sites in every three year round of screening, with some screening and all assessments undertaken at its four static centres.

The South East Wales Regional Imaging Network was established in 2006 to facilitate dialogue between imaging service providers, Local Health Boards (LHBs), the South East Wales Regional Office and the Imaging Modernisation Project team to explore and develop ways to improve the planning and delivery of services across
the region. Initial work consisted of sharing of current experience and identification of areas where increased collaboration between service providers has the potential to secure tangible improvements in the near future e.g. interventional radiology.

**Mid and West Wales**

There are three Local Health Boards in Mid & West Wales providing services to a population of approximately 1 million.

Abertawe Bro Morgannwg University LHB supports a population of around 600,000 people covering Swansea, Neath, Port Talbot, Bridgend and the Western Vale of Glamorgan. Imaging departments within the LHB provide a comprehensive service. In addition to the main hospital sites, satellite imaging departments are located at Maesteg Community Hospital and Gorseinon Hospital.

Hywel Dda LHB is responsible for delivering healthcare to a population of over 350,000 people across Carmarthenshire, Ceredigion and Pembrokeshire. The LHB has responsibility for four acute hospitals, providing an extensive range of imaging services, - Bronglais General Hospital, Prince Philip General Hospital, West Wales General Hospital and Withybush General Hospital, the only site within the LHB providing Nuclear Medicine services, - as well as community, mental health and learning disabilities services. Imaging services are also provided at a number of the Community Hospitals.

Powys Teaching LHB is responsible for the provision of diagnostic imaging services within Powys. Conventional radiology is provided in their 9 Community Hospitals together with Ultrasound and Fluoroscopy in some of the larger centres.
## Appendix E

### Location of Main Imaging Departments and Key Imaging Modalities in Wales (30)

<table>
<thead>
<tr>
<th>LHB/Trust</th>
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* Note: these figures are for diagnostic CT scanners and do not include CT scanners dedicated to radiotherapy applications

** There is one SPECT/CT scanner at both of these sites, with the CT component having full diagnostic capability

Each of the main departments has at least 1 MRI and 1 CT scanner, whilst provision of Radionuclide Imaging (RNI) is variable.
Appendix F

Location of CT Scanners

Source: Welsh Health Estates
Location of MRI Scanners

Source: Welsh Health Estates
Location of Plain Film and Computed Radiography Facilities in Community Hospitals/Centres in Wales

1. Ysbyty Ystwyth
2. Colwyn Bay Community Hospital
3. Royal Alexandra Hospital
4. Holywell Community Hospital
5. HM Stanley
6. Denbigh Community Hospital
7. Flint Community Hospital
8. Deeside Community Hospital
9. Mold Community Hospital
10. Ruthin Community Hospital
11. Clwyd Community Hospital
12. Flint Memorial Hospital
13. Bron y Garth Hospital
14. Ysgo Tyifr
15. Bryn Eryl Hospital
16. Dolgellau & Barmouth District Hospital
17. Tywyn & District War Memorial Hospital
18. Brodredy Community Hospital
19. Victoria Memorial Hospital
20. Montgomery County Infirmary
21. Llandinwood Hospital
22. Bullan Wells Cottage Hospital
23. Bontnewydd Hospital
24. Brecon War Memorial Hospital
25. Llandrindod Wells Hospital
26. Cardigan & District Memorial Hospital
27. South Pembrokeshire Hospital
28. Amman Valley Hospital
29. Ystradgynlais Community Centre
30. Hafan Community Hospital
31. St. Tydfil’s Hospital
32. Mountain Ash General Hospital
33. Pontypridd
34. Barry Hospital
35. St. David’s Hospital (Cardiff)
36. CRI West Wing
37. St. Woolos
38. Abertillery & District Hospital
39. County Hospital
40. Tredegar General Hospital
41. Ebbw Vale Hospital
42. Blaenau Gwent Hospital
43. Ebbw Vale Health and Social Care Facility
44. Monmouth Community Hospital
45. Newport Hospital
46. Ebbw Vale Hospital
47. Bala Health Centre

Source: Welsh Health Estates
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