

The role and development of afterloading brachytherapy services in the United Kingdom

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Foreword

The Royal College of Radiologists (RCR) published *The Role and Development of Brachytherapy Services in the United Kingdom* in 2007,¹ based on the original publication of 2001,² which have been withdrawn. Both documents were based on surveys of brachytherapy practice in the UK which showed that the use of brachytherapy varied widely, although the latter (2005) survey showed greater consistency in practice than the original (1998). The document recommended minimum levels of resources and patient throughput per centre to maintain a safe and effective service with adequate opportunity for training in brachytherapy of clinicians, physicists and radiographers. It also recognised that the role of brachytherapy may change, with new clinical indications, techniques and equipment.

Since 2007 there have been major changes in brachytherapy, with much more widespread use of low dose rate (LDR) interstitial prostate brachytherapy and declining use of brachytherapy in areas such as head and neck cancer. Some applications that were expected to become more common, such as intravascular brachytherapy, have actually become less frequently used with the development of chemotherapy-impregnated intravascular stents. Expected developments in intra-luminal brachytherapy have not progressed as endoscopic laser resection has been developed.

Worldwide, there has also been a widespread withdrawal of LDR remote afterloading systems, sources and of iridium wire. High activity source afterloading systems, such as high dose rate (HDR) and pulsed dose rate (PDR), have largely replaced LDR equipment. However, there have also been technical advances in external radiotherapy techniques, such as the widespread availability of high energy electrons and intensity-modulated radiotherapy (IMRT) which have replaced brachytherapy as the treatment of choice for tumours at some sites.

This change in delivery system from LDR to HDR has been recognised by the RCR and guidelines on how to use HDR brachytherapy in gynaecological cancer have been published (2009).³ These guidelines detail how we can move away from some of the empirical, point-based systems to image-guided brachytherapy and volume-based dosimetry and prescription.

This is a critical time for many centres, where there is a need to review resources for brachytherapy. Account will have to be taken of a centre's case mix, the need for brachytherapy and the capital and revenue costs associated with it. In order that the wellbeing of the patient remains the focus of these decisions, the RCR asked for the 2007 guidelines to be reviewed, and minimum standards set for a brachytherapy service.

I would like to thank Dr Peter Blake for his valuable work in preparing this report.

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1. Introduction

The placement of sealed radioactive sources into, or immediately adjacent to, tumours is the radiotherapy technique described as brachytherapy.

Isotopes used in brachytherapy can be applied directly to the tumour by surface applicators, inserted into body cavities and tubular organs via specially designed delivery systems (intracavitary and intraluminal therapy), or inserted directly into a tumour (interstitial therapy). Interstitial therapy may be by afterloaded sources that are introduced and withdrawn through applicator needles or by permanently implanted sources (commonly Iodine-125 [¹²⁵I] seeds for prostate cancer).

In the treatment of a localised cancer, an advantage of brachytherapy is that it delivers high doses of radiation to the tumour and only relatively small amounts to the surrounding normal tissue. Extensive experience over many years has led to the empirical development of systems giving high local tumour control rates and good functional outcomes. This empirical experience has led to the identification of safe and effective doses on the basis of tumour control probability and normal tissue complication rates.

Improved imaging with reconstructed CT images and MRI scanning has allowed image-guided brachytherapy (IGBT). Some of the principles of volume-based dosimetry used in external beam radiotherapy can now be applied to brachytherapy. This allows a transition from 'point-based dosimetry' (such as the Manchester point 'A' in intracavitary brachytherapy) to volume-based dosimetry as described in the Groupe Européen de Curiethérapie and the European Society of Radiotherapy and Oncology (GEC-ESTRO) guidelines for the brachytherapy of cervical cancer.^{4,5}

Other than for permanently implanted I125 seeds, treatment delivery time is relatively short being days or hours with low dose rate (LDR) systems or minutes with high dose rate (HDR) systems. However, several fractions of HDR are usually required if excessive fraction size is to be avoided. In order to mimic the radiobiological effects of LDR brachytherapy when using HDR sources, pulsed dose rate (PDR) brachytherapy has been developed in which a small dose is delivered by HDR sources in multiple fractions (commonly at one-hour intervals) over a total treatment time similar to that used with LDR systems.

In order to reduce staff radiation exposure to the very low limits that are mandatory under *The Ionising Radiation Regulations*,⁶ brachytherapy equipment using remote afterloading of sealed radioactive sources is used in the majority of procedures. Exceptions to this are some iridium wire interstitial implants and the permanent implantation of I125 seeds in the prostate.

Treatments that include brachytherapy are usually curative in intent and the total physical and biological dose may exceed that commonly used with conventional external beam radiotherapy. Consequently, due to potentially serious normal tissue effects, there are issues of risk management that accompany brachytherapy. Particularly, gynaecological brachytherapy remains an area of high medico-legal risk.

The major role of afterloading brachytherapy has been in the management of gynaecological cancers, which may be treated with LDR, PDR or HDR systems. Where brachytherapy is required for head and neck cancers, LDR interstitial implants are usually used. However, the use of brachytherapy in head and neck cancer has reduced as the availability of electrons and intensity-modulated radiotherapy (IMRT) has increased.

The largest growth area in interstitial brachytherapy has been the use of permanent interstitial implantation of I125 seeds in early-stage prostate carcinoma⁷ and the numbers of patients undergoing this treatment in a centre may exceed the numbers of patients with cervical cancer undergoing intracavitary therapy.

2. The purpose of this document

The number of patients being treated with some types of brachytherapy in the UK has been falling for many years.² It may become difficult to maintain the required expertise and resources for complex brachytherapy procedures if the volume of work in a centre, or for any individual in the necessary disciplines, is too low. The risks of treatment failure and morbidity with radical brachytherapy may rise in centres unable to maintain expertise and resources. Also, low patient throughput has serious implications for the financial viability of a service and for education and training of all staff involved.

The rapid growth of 1125 prostate implant services, in some cases in centres not practising any other form of brachytherapy, also poses a risk in terms of local lack of experience in brachytherapy techniques and principles.

Previous documents from the RCR^{1,2} sought to advise on the minimum requirements for a safe, effective and affordable brachytherapy service and on the development of services, allowing new techniques to be introduced. Recommendations were made on equipment, training and patient throughput to maintain such a service with skill and expertise. These recommendations were incorporated and modified in the brachytherapy service standards for the 2010–11 national peer review of UK radiotherapy services.⁸

In the previous RCR documents, in the absence of any other available quality indicators, the maintenance of clinical skill and expertise was equated to patient throughput and the numbers of procedures performed. From 2011, there are formal training courses in brachytherapy with trainee assessment. There are also clinical trials collecting data both retrospectively and prospectively on treatment parameters (EMBRACE and Retro-EMBRACE studies^{9,10}). There is an improved national radiotherapy incident reporting system.¹¹ In addition, outcomes measures will have to be developed both for national service reviews and for personal clinician revalidation.¹²

Therefore, while patient throughput will remain important, it is possible to identify other factors which can be used to assess and ensure the quality and safety of a service.

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3. Sources of advice

3.1 American Brachytherapy Society

The American Brachytherapy Society has published guidelines on the brachytherapy of cervical, breast and prostate cancer. These are clear clinical guidelines as to the indications for brachytherapy, investigations, treatment technique and dose.¹³

Although they fall short of specifying criteria in terms of training, equipment or patient throughput for an effective service, patterns of care studies in the USA have established profiles of how patients are treated with radiotherapy for a variety of common malignancies and have correlated these with outcomes. In the management of cervical cancer, these studies have repeatedly shown a positive correlation between numbers of patients treated, brachytherapy applications and successful outcomes.¹⁴

3.2 UK cancer peer-review standards

As evidenced in previous surveys and earlier national audits,^{1,2,15-17} there is a wide range in the number of cervical cancer patients treated with brachytherapy in centres across the UK. While it is difficult to extrapolate directly from the American healthcare system to that in the UK, it is generally accepted, in many skilled techniques, that repeated practice leads to improved ability, expertise and confidence. This view is accepted in specialist surgery and increasingly in other areas of oncology, with recognition of the need for site-specialisation. It is also recognised that the need for maintenance of skill is not limited to clinicians but is appropriate for all healthcare workers, including those involved in the preparation, calculation and delivery of brachytherapy.

The UK standards⁸ were largely based on the RCR 2007¹ publication and specify clear training, equipment and patient throughput criteria for a service to be recognised.

3.3 RCR guidance on image-guided brachytherapy (IGBT)

Published in 2009, this document³ is specific to the introduction and development of IGBT in the treatment of cervical cancer. The criteria to ensure an effective service are as per 2007 document,¹ but have been extended to include the imaging resources and training necessary for IGBT.

3.4 GEC-ESTRO guidelines

The GEC-ESTRO guidelines^{4,5} on IGBT and volume-based dosimetry specify the resources and training needed for an IGBT service in gynaecological cancer.

3.5 UK and Ireland Prostate Brachytherapy Group

The UK and Ireland Prostate Brachytherapy Group, with input from the RCR, has produced a set of guidelines and quality assurance measures for I125 seed permanent interstitial implants: *Quality assurance practice guidelines for transperineal LDR permanent seed brachytherapy of prostate cancer*.¹⁸

4. Recommendations

4.1 Brachytherapy activity

To determine the minimum number of patients that would justify a brachytherapy service in a centre, the following should be taken into account:

- The cancer network demand for the service, and the availability or need for a similar service in adjacent networks
- The number of patients needed to maintain expertise in each site-specific discipline
- Cost-effectiveness
- The place of such a service in the research and development of brachytherapy.

Brachytherapy services should be cancer network-based and configured to meet the needs of the patients. Each network is expected to provide surgical and non-surgical oncological care according to nationally agreed standards. Some networks contain more than one cancer centre, and some are geographically large with a sparse population. Networks are expected to have cross-network arrangements for the provision of highly specialised treatments that are provided regionally or nationally.

In all cancer networks, it is recommended that a total brachytherapy caseload of more than 50 patients per year is taken as a minimum workload in each centre offering the service. This is for economy of scale and cost-effectiveness, to justify regular access to theatre sessions and to maintain expertise in all members of the team, which should include at least two clinical oncologists. If this is not the case, the service should be concentrated in one centre within the network, or cross-network arrangements should be made.

Brachytherapy should only be carried out at centres with direct access to appropriate surgical oncology expertise for multidisciplinary patient assessment and treatment.

For the purpose of setting standards in workload for the training and maintenance of experience in brachytherapy, it is recommended that brachytherapy be divided into three modality-specialised areas:

- Gynaecological intracavitary brachytherapy
- Interstitial and intraluminal therapy
- LDR I¹²⁵ seed prostate implantation.

4.2 Gynaecological brachytherapy

It is recommended that intrauterine applicator insertion should be carried out by a subspecialty-trained clinical oncologist.

Vault brachytherapy applicators may be inserted by appropriately trained clinicians, nurses or radiographers after assessment by a specialist clinical oncologist and under their supervision. Therefore, to maintain clinical oncologist expertise in intrauterine applicator techniques, recommendations should be separate from those for vaginal vault brachytherapy and there should be a minimum of ten intrauterine applicator insertions per year per centre.

4.3 Interstitial and intraluminal therapy

From previous surveys, other low throughput activities are likely to be head and neck interstitial implants and intraluminal treatments in the bronchus, oesophagus and rectum. While ten patients per year per centre would be a reasonable throughput, individual clinicians would need to ensure continued practical experience. It is, therefore, recommended that oncologists doing brachytherapy either perform or attend more than five applicator insertions and dosimetry reviews per year in each of the low throughput techniques that they practise, including cervical cancer applicator insertions.

4.4 Prostate interstitial therapy

In 2006, the Department of Health recommended the establishment of I125 seed implantation services on the basis of a minimum catchment population of 1.5 million.⁷ To maintain expertise in prostate interstitial permanent implants, a minimum caseload of 25 patients per year per centre and more than five implants per year per clinical oncologist was recommended. However, the UK and Ireland Prostate Brachytherapy Group in its recent publication, *Quality assurance practice guidelines for transperineal LDR permanent seed brachytherapy of prostate cancer*, states that, 'While there is no evidence in the literature with regard to minimum caseload, as it is essential to ensure a suitable infrastructure based on patient throughput, clinical expertise and long-term viability, it is recommended that an implementation plan is in place at

individual centres with the objective of performing 25 cases per oncologist per year within a three-year period. On an ongoing basis, an individual clinician should aim towards performing 25 cases per year'.¹⁸

4.5 Time frame for achieving and maintaining the standards

It is recommended that these workload standards be achieved within three years of introduction of a new service. Failure to do so should result in redesign or discontinuation of the service.

In an established service, failure to achieve the standards for two consecutive years should result in redesign or discontinuation of the service.

In the event of these standards not being met in the recommended time frame, a redesign of the service with those of other brachytherapy specialists and networks should take place within one year.

4.6 Staffing and service resourcing

There should be recognition of designated staff for specific brachytherapy-related roles within centres practising brachytherapy. Co-ordination of brachytherapy services in each centre should be by a lead clinical oncologist for brachytherapy, who should be clinically involved in the provision of brachytherapy services. The co-ordinator should have full knowledge of the brachytherapy services offered within the network and both regionally and supraregionally, and should have close liaison with the lead clinical oncologist for the network.

For patients receiving treatment with external beam radiotherapy by a clinical oncologist other than that providing the brachytherapy, there should be clear protocols, regular meetings and case conferences between the clinicians involved, and the service should be audited in terms of both process and clinical outcomes.

Overall treatment time should not be prolonged outside the RCR guidelines¹⁹ by delay in the provision of brachytherapy.²⁰ These state that radical radiotherapy and brachytherapy should be completed within 56 days for category 1 cervix cancer patients.¹⁹ However, most UK centres are now following the more stringent GEC-ESTRO guidelines for image-guided brachytherapy which specify an overall treatment time of 50 days which allows 28 radiotherapy fractions and 3–4 brachytherapy fractions to be completed without gaps.⁹ Staffing levels and operating facilities should be such as to permit at least one brachytherapy list per week throughout the year. In centres with a large number of patients (more than 100 patients per year), or with patients with tumours at different sites, access to two or more operating lists per week is advocated. Special provision needs to be made to cover holidays, theatre servicing and source replacement to minimise disruption to patients' treatment.

Purpose-built brachytherapy facilities are recommended (see Appendix 1). A brachytherapy theatre suite should include comprehensive facilities for anaesthesia and resuscitation, imaging (both static and real-time) and access to computer planning, in addition to treatment delivery. In the event of additional imaging or advanced simulation being required that is not available at the place of insertion of the applicators, patients should not be transferred over long distances within the centre. This is to minimise the risks of applicator displacement during such transfers. Where CT and MR imaging are both used, it is beneficial to make the time interval between the two imaging sessions as short as possible. Relevant CT/MR imaging protocols for specific brachytherapy technique and applicator type should be developed and used.

Treatment should be in an appropriate environment conducive to reassuring the patient and minimising any discomfort. Every patient should be assessed for analgesia and anaesthesia.

4.7 Standards and accreditation

In developing any strategy for the use of brachytherapy in the UK, there needs to be a mechanism in place to ensure that centres meet baseline standards of quality and experience.

Centres in the UK are implementing quality assurance in radiotherapy (QART) procedures that include brachytherapy work instructions and the monitoring of quality procedures.⁸ In an individual centre, an accepted level in overall service quality assurance can be recognised by achieving standards such as ISO 9001 and standards set as part of the *Manual for Cancer Services*.⁸

4.8 Training and education

Training and education are of particular importance in maintaining and developing clinical, radiographer and physics expertise in brachytherapy.

Trainees in clinical oncology undergoing intermediate and advanced phases of specialist training follow a structured training programme,²¹ which includes brachytherapy theory and practice.

For advanced trainees and for newly appointed consultants wishing to develop a subspecialist interest in brachytherapy, training opportunities in brachytherapy exist in the UK. These include the RCR distance learning module in IGBT²² and the annual GEC-ESTRO course in gynaecological brachytherapy.²³ In addition, there are UK courses in both gynaecological brachytherapy and I125 prostate seed implantation.

Clinical oncologists, radiographers and physicists with a designated interest in brachytherapy should be encouraged and adequately resourced to attend multidisciplinary educational courses and meetings on brachytherapy as part of a co-ordinated programme of continuing professional development. Specific training on brachytherapy dosimetry, source calibration and requirements of CT and MR imaging for IGBT should also be made available to brachytherapy physicists.

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5. Standards

5.1 Staffing levels

Standards should be set for minimal staffing levels to provide an efficient and safe brachytherapy service.

- Networks should have at least two specialist clinical oncologists in brachytherapy, capable of cross-cover and of providing a service without prolonging overall treatment time outside RCR guidelines¹⁹ and national standards.
- Networks should also have at least a consultant or principal physicist with responsibility for brachytherapy (medical physics expert, MPE), a senior physicist for brachytherapy dosimetry, source calibration, quality assurance and cover (MPE) and a third physicist for dosimetry, source calibration, quality assurance and cover.
- Networks should have at least three radiographers experienced in brachytherapy, of which one should be a consultant/advanced expert practitioner with responsibility for brachytherapy (MPE). Two expert practitioners should be present for any HDR treatment.

5.2 Patient throughput

Patient throughput should be sufficient to maintain experience and expertise in all members of the team.

- The minimum throughput of patients being treated in a brachytherapy service should be 50 cases per year.
- The minimum number of patients undergoing intrauterine applicator insertion should be ten per centre per year (and each clinician should attend more than five insertions and dosimetry reviews per year, either alone or with their fellow specialist clinical oncologist).
- The minimum throughput of patients undergoing head and neck implants, or other low throughput practices (such as interstitial, breast, bronchial, oesophageal or rectal implants) should be ten per centre per year (and each clinician should attend more than five insertions and dosimetry reviews per year, either alone or with their fellow specialist clinical oncologist).
- The minimum number of patients undergoing permanent interstitial prostate implants should conform to the recommendations of the UK and Ireland Prostate Brachytherapy Group.¹⁸

5.3 Time frame for achieving standards

It is recommended that these workload standards be achieved within three years of introduction of these standards or of the introduction of a new service. Subsequent failure to achieve the standards for two consecutive years should prompt a redesign of the service with those of other networks.

5.4 Multidisciplinary team (MDT) involvement

Patients should be managed by multidisciplinary teams and organisational structures. Membership and attendance should be subject to peer review audit.

5.5 Audit

There should be an annual audit documenting activity within the centre and by clinician to demonstrate compliance with the standards. It should be presented to the clinical director of the department, the chief executive of the hospital and a representative of the commissioners.

Appendix 1. An example of a brachytherapy service

A. Personnel

All staff are trained in the relevant brachytherapy procedures in line with current radiation protection regulations and the centre's local rules.

Medical (minimum two people)

- Lead clinical oncologist in brachytherapy
- Specialist clinical oncologist in gynaecological brachytherapy
- Specialist clinical oncologist in other site-specific brachytherapy
- Second specialist clinical oncologist in brachytherapy for cover during brachytherapy treatments

Physics (minimum two people, three if both gynaecological and prostate brachytherapy performed)

- Consultant or principal physicist with responsibility for brachytherapy (medical physics expert, MPE)
- Senior physicist for brachytherapy dosimetry, source calibration, quality assurance and cover (MPE)
- Second physicist for dosimetry, source calibration, quality assurance and cover. (NB: If afterloading includes prostate brachytherapy, then two physicists are 'expert' in this field)
- Sufficient, informed physics cover for 'on-call' rota during brachytherapy treatments

Radiography (minimum three people, two to be present for each high dose rate [HDR] treatment)

- One consultant/advanced expert practitioner radiographer with responsibility for brachytherapy (MPE)
- Two expert practitioner radiographers to complete HDR treatment team

Nursing (minimum two people per service)

- Designated nurse for HDR brachytherapy
- Designated ward nurse for low dose rate (LDR) brachytherapy who also acts as MPE
- Designated ward nurse for interstitial implant and iodine seed brachytherapy patients

Relevant information

All brachytherapy services comply with national and local radiation protection recommendations. There are:

- Defined and readily available treatment emergency procedures
- Clearly identified 'on-call' physics and medical staff at all times (including during the day), supplied with a list of emergency contact numbers
- Independent dose-rate meters, regularly checked and available for use in areas where sources are implanted and used

B. Operating theatre for HDR, iodine seed and iridium implantation procedures

General accommodation

Treatment room/theatre incorporating the appropriate shielding in its construction conforming to radiation protection regulations. It should contain:

- Sufficient space for attendance of some or all of the multidisciplinary team if needed
- Treatment couch with facilities for locating tools for imaging and incorporating an applicator clamp
- Image acquisition facilities (eg, C arm (referring to the shape), X-ray unit, computed radiography [CR] acquisition)
- Local anaesthesia, general anaesthesia and resuscitation equipment
- Image viewing facility, with correct light levels for screen viewing (digital images/picture archiving and communication system [PACS] etc)
- If fluoroscopy and film imaging are used, facilities for film developing should be close by with a CCTV link and audio link with the treatment room

Applicator cleaning, preparation and storage area

- Clearly defined and effective cleaning and sterilisation procedures in place, to allow quick turnaround of applicators (manufacturer-approved to avoid unnecessary damage)
- Documented contents (photographs) of 'applicator packs' if sterilisation takes place off site
- Close to application room

Treatment planning and dosimetry area

- Ideally near to the treatment room (though not in the control room) with an audio link
- Access to a computed tomography/magnetic resonance (CT/MR) scanner (with flat-topped couch) for imaging if required
- Developed and agreed imaging protocols, suitable for CT and MR scanning of brachytherapy patients with applicators in situ
- Treatment planning system (TPS) for brachytherapy available for exclusive use during brachytherapy sessions
- Clinician-friendly visual representation of dose distributions

Waiting room for outpatients adjacent to treatment room, containing:

- Lockable changing cubicles
- Toilet
- Quiet, pleasant sitting area/interview room/patient preparation area

Auxiliary equipment

- Bladder catheters, plastic tubes, sterilised rulers, patient markers, contrast etc
- Inventory of equipment and status (e.g., 'under repair' or 'used for teaching') kept and regularly updated
- Logbook of clinical usage and of applicator use for dosimetry or research

HDR afterloading

HDR machine in treatment room, with suitable security for source when not in use, as specified by the recommendations produced by the National Counter Terrorism Security Office (NaCTSO).²⁴

Control room containing:

- Machine control unit
- Sufficient space for all staff to be accommodated during exposure
- Image viewing facilities
- Intercom to treatment room
- Audio link with treatment planning and dosimetry room

LDR afterloading

Accommodation, ward-based or adjacent to a ward.

Treatment rooms, with suitable shielding in their construction

- Single rooms, separately served by the treatment machine (to reduce interruption time when treating two patients)
- Pleasant and quiet (away from compressed-air generator)
- With an outside window if possible
- Applicator cleaning, preparation and storage area near to treatment room
- Ventilated cupboard for compressed-air generator
- Cupboard/room for treatment machine separate from patient treatment rooms

Equipment: HDR and LDR

Remote afterloading HDR or LDR machine, appropriately accommodated.

Connectors and applicators

- Sufficient to allow there to be one full set per patient, one in cleaning and one in store
- CT/MR compatible gynaecology applicators wherever possible
- Whole system (including applicators and TPS) having been subjected to benchmark quality assurance and testing before use

- Where possible, dummy source trains for each applicator type for dosimetry available (and tested and checked regularly) or an alternative robust method of source and applicator reconstruction
- There should be a rolling programme of applicator replacement in line with manufacturers' recommendations, so that enough applicators are available to provide a robust clinical service at all times. Applicator replacement should be included in brachytherapy equipment service agreements.

Specific accommodation: interstitial implantation procedures (iridium wire) and iodine/palladium seed preparation area

- Trained operator for ordering, receipt, preparation and disposal of sources
- Dedicated 'hot-lab' area for preparation, measurement and storage of sources
- Approved source loading, cutting and heat sealing equipment if needed
- Mobile, shielded, labelled container for source transport, with lockable security for source when not in use; handling tools available
- Isotope calibrator for verification of source strengths (air kerma rate, AKR)

Iridium wire: patient accommodation for treatment

- Suitably protected single room with an integral toilet
- List of recommended 'nursing times' provided to support safe practice

Applicator removal

- Analgesia or anaesthesia available
- Soaking or cleaning area available for applicators close to the treatment room

Equipment: iridium interstitial

Applicators, plastic tubes and accessories

- Range of applicators and systems to allow flexibility in treatment
- Sufficient number to allow application of multiple needles, with sufficient spare for accidents (eg, bending needles and/or tubes, de-sterilisation etc)
- MR/CT compatible templates and applicators, where relevant
- Applicators and dummy sources subjected to benchmark quality assurance and testing before use
- Where possible, dummy source trains for each applicator type for dosimetry available (and tested and checked regularly) or an alternative robust method of source and applicator reconstruction

Specific accommodation: iodine/palladium seed implantation of the prostate

Operating theatre available for implantation. In addition to the general requirements, this includes:

- Theatre couch with facilities for locating stirrups and space around sufficient for at least ten people
- Transrectal ultrasound machine with associated template and stepper, quality assured prior to procedure and available within operating theatre
- Personnel skilled in transrectal ultrasound scanning of the prostate
- If remote afterloading system used for iodine/iridium/palladium source positioning, it should be ensured that this is 'clean' and available within the operating theatre complex

Treatment planning area

- TPS for prostate brachytherapy, available within the theatre at all times during the theatre procedure
- A networked link to the treatment planning area away from theatre is useful to facilitate plan checking

Equipment

Needles and templates

- Sufficient to allow there to be one full set per patient, with sufficient needles spare for accidents (eg, bending needles, de-sterilisation etc)
- MR/CT compatible applicators where required
- Whole system (including seed AKR check, seed delivery and TPS) subjected to benchmark quality assurance and testing before use

C. Brachytherapy treatment planning

Planning system provides:

- Rapid planning for individualised treatments
- Clinician-friendly presentation of dosimetry
- CT/MR/ultrasound-based fusion, volume definition and planning tools
- Analytical evaluation of 3D dose distributions
- Tools within TPS to assist in reconstruction of applicators and sources
- Regular quality assurance performed according to a quality assurance management protocol (eg, ISO 9000)
- Clear reference and identification of manufacturer input parameters affecting dosimetry
- Viewing, at least, of source parameters used in TPS for verification and commissioning, and preferably access to controlled editing of source data by experienced personnel
- Possibility to input known properties of applicators and sources which contribute to dosimetry (eg, absorption)

D. Quality assurance and audit

A quality management system that:

- Identifies serious untoward incidents, near misses and non-conformance to protocol
- Provides comprehensive and relevant quality assurance on the whole system, from imaging and planning to delivery and verification
- Regular and recorded servicing, calibration and quality assurance of all equipment used for brachytherapy
- Regular external audit by approved bodies and groups

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