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FULL PAPER

Current status of cranial stereotactic radiosurgery in the UK

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Objective: To investigate and benchmark the current clinical and dosimetric practices in stereotactic radiosurgery (SRS) in the UK.

Methods: A detailed questionnaire was sent to 70 radiotherapy centres in the UK. 97% (68/70) of centres replied between June and December 2014.

Results: 21 centres stated that they are practising SRS, and a further 12 centres plan to start SRS by the end of 2016. The most commonly treated indications are brain metastases and acoustic neuromas. A large range of prescription isodoses that range from 45% to 100% between different radiotherapy centres was seen. Ionization chambers and solid-water phantoms are used by the majority of centres for patient-specific quality assurance, and thermoplastic masks for patient immobilization are more

commonly used than fixed stereotactic frames. The majority of centres perform orthogonal kilovoltage X-rays for localization before and during delivery. The acceptable setup accuracy reported ranges from 0.1 to 2 mm with a mean of 0.8 mm.

Conclusion: SRS has been increasing in use in the UK and will continue to increase in the next 2 years. There is no current consensus between SRS centres as a whole, or even between SRS centres with the same equipment, on the practices followed. This indicates the need for benchmarking and standardization in SRS practices within the UK.

Advances in knowledge: This article outlines the current practices in SRS and provides a benchmark for reference and comparison with future research in this technique.

INTRODUCTION

Stereotactic radiosurgery (SRS) has been a rapidly evolving treatment since its inception, constantly developing and being used on more patients with various pathologies. It has been identified as an effective treatment approach for a number of indications with low rates of complications. There is evidence showing that it is a useful modality for patients with arteriovenous malformations, brain metastases, trigeminal neuralgia and acoustic neuromas, and it may establish itself as the preferred treatment for more indications in the near future.^{1–4}

The UK was one of the early adopters of SRS, as the first Gamma Knife (GK) unit to be installed in the UK was only the second commercial unit in the world. This was installed at Weston Park Hospital in Sheffield in 1985, and in 1989, the first linear accelerator-based (LB) service in the UK was initiated by St. Bartholomew's Hospital in London.^{5,6} In 2009, CyberKnife (CK) radiosurgery was introduced to the UK for the first time by the Harley Street Clinic.

Recently, there have been efforts put into improving standardization in SRS. The International Commission of Radiological Units has proposed a new report on "Prescribing, Recording, and Reporting Stereotactic Treatments with Small Photon Beams" that is in preparation.⁷ Also, the International Leksell Gamma Knife Society has recently published a report that attempts to standardize the terminology used in radiosurgery. This report deals with the variations in nomenclature and aims to standardize them, not only for GK users but across the field, to facilitate collaborations between radiosurgical technologies.⁸

Alongside these international initiatives, it is an appropriate time to facilitate collaborations and communication nationally. The recently published consultation by National Health Service (NHS) England stated that owing to the inability to determine whether one type of SRS machine produces better outcomes, there is a need for more robust reviews and technology appraisals on SRS in the UK.⁹

The aim of this study was to investigate the current status of clinical and dosimetric practice for SRS and provide a basis for benchmarking and future comparisons. The findings presented will also be useful references to new centres launching their SRS programmes. Moreover, a better understanding of the current practices would facilitate better communication in the UK community and assist in standardizing practices between users of different equipment. The results may also provide relevant information for protocol design in clinical trials. It is also planned to employ the results to help develop a methodology for dosimetry intercomparison for SRS such as has been implemented for other advanced radiotherapy techniques.¹⁰

This study focuses on intracranial practices, and therefore a comprehensive review of all extracranial radiosurgical practices is beyond the scope of this article; however, relevant comments and publications are provided where appropriate.

METHODS AND MATERIALS

The survey was sent as an online questionnaire to the heads of radiotherapy physics at 63 UK NHS trusts (incorporating all radiotherapy and radiosurgery providers) and 7 private providers in June 2014. The survey defined “cranial radiosurgery” as “a single high dose of photon radiotherapy in a small volume within the cranium” and requested that participants submit replies for only intracranial radiosurgery. For respondents who did not have plans to implement SRS in the near future, only a few questions were required to be answered.

The aim was to identify the centres with active SRS programmes and those working towards implementation. The survey also aimed to obtain details of the current issues and variations in clinical practices. The questions were divided into five sections: (1) generic information and experience, (2) pathologies/indications treated, (3) treatment-planning practices, (4) quality assurance (QA) and verification and (5) immobilization and imaging. In Section 1, names, postcodes and contact information were collected, and the questions asked were related to the centre’s experience with SRS in terms of the total number of patients treated, weekly capacity for SRS, equipment and techniques used. In Section 2, the centres were asked to indicate which pathologies they treated, the frequency of each pathology

and their future plans with regard to expansion of SRS provision. In Section 3, centres were asked to give details regarding the imaging modalities used for contouring and planning, structures delineated and prescription regimes used. In Section 4, centres were asked to describe their QA protocols and the equipment and methods used for these. In Section 5, centres were asked to specify the type of immobilization devices used, type of image guidance used (if any) and their acceptable setup accuracies.

The results reported are presented as fractions/percentages of the centres responding to each question owing to the fact that some partial replies were submitted.

RESULTS

Generic information, equipment and experience

68/70 (62 NHS and 6 private) centres responded by December 2014, 6 months after the launch of the survey. 21/68 (17 NHS and 4 private) centres were performing SRS clinically and 5/68 centres were in the process of implementing and planning to be clinical within 1 year. 7/68 centres were planning to implement within 2 years, and the remaining 35/68 centres did not have active programmes, nor did they plan to have one in the next 2 years. Centres were also asked for how long they have been delivering SRS: 13/21 centres indicated that they have been clinical for more than 5 years, 4/21 centres for 3–5 years, 3/21 centres for 1–3 years and 1/21 centres began treating in the past year.

According to the responses, there are 31 radiotherapy treatment machines in total used clinically for SRS in the UK: 16/31 machines are linear accelerators, 6/31 machines are CKs, 7/31 machines are GKs and 2/31 machines are used for TomoTherapy® (TT). The proportion of provision by the private sector is 2/6 CKs and 2/7 GKs, with the remaining provision being NHS facilities.

Figure 1 shows the diversity and number of vendors used in the 21 centres that are currently treating with SRS in the UK.

2/21 centres (both GK) indicated that they have treated over 1000 cases, 5/21 centres (2 GK, 2 LB and 1 CK) had treated 500–1000 cases, 10/21 centres (2 GK, 5 LB and 3 CK) had treated 100–500 cases, with the remaining 4/21 centres (2 CK,

Figure 1. The number of UK centres using equipment from each manufacturer indicated for stereotactic radiosurgery (SRS).

Figure 2. The average number of patients treated per month grouped under three frequencies. The equipment used in each group is also indicated on the chart. CK, CyberKnife; GK, Gamma Knife; LB, linear accelerator based; SRS, stereotactic radiosurgery; TT, tomotherapy.

1 LB and 1 TT) having treated <100 cases. GK centres have the highest patient throughput per month, followed by LB and CK centres, as shown in Figure 2.

The centres were asked if they wished to expand their current SRS programmes; this expansion was differentiated between increasing the indications which they already treat (60% of centres said “Yes”) and the number of cases per week (75% of centres said “Yes”). 40% of centres wanted to expand on both areas, and 5% of centres had no expansion plans. 11/21 centres did not limit the number of cases treated, with the remaining 10 centres limiting them. The reasons indicated as the limiting factors for limiting/not expanding SRS programmes were: resources for delivery (5/10), planning resources (4/10), contouring resources (3/10) and NHS funding (2/10).

All GK centres (6/21) use the GK beam array as a collimation system, and 4/6 CK centres use circular collimators, whereas the remaining 2/6 CK centres use both circular collimators and the CK IRIS system. Six LB and one TT (7/21) centres use only multi-leaf collimators (MLCs), one LB (1/21) centre uses only circular collimators and one LB (1/21) centre uses both. The majority of the centres that use MLCs adopt micro-MLCs (2.5 mm), although there are two centres that use wider MLCs (5 and 6.25 mm). The CK and LB centres that use more than one collimation system stated that the collimation system of choice is dependent on the pathology, its size, its location and its proximity to organs at risk (OARs).

The nominal photon energies used for SRS delivery are cobalt-60 (approximately 1.25 MeV) used by 6 GK centres, 6 MV used by 14/21 centres and 10 MV used by 1 centre. Of the 8 LB centres, 1/8 centres indicated that they use flattening filter-free (FFF) mode (10 MV FFF). 3/8 centres said that they do not use FFF but they plan to within 2 years, whilst 4/8 centres stated that they have no plans to use FFF within the next 2 years. GK, CK and TT do not use flattening filters by default. The most common delivery technique is the use of non-coplanar static fields (89% of respondents use it); however, modulated fields or arcs with MLCs or cones are also being used, but less often (5–21% of respondents).

71% of respondents stated that the average treatment takes less than 1 h to be delivered (from the point the patient lies on the couch to the point the patient sits up).

Pathologies

The vast majority of centres are currently treating solitary and multiple brain metastases, but many other clinical sites are also being treated. The centres were asked to state the indications currently treated and the number of patients treated with each indication per month. They were also asked about their expansion plans in terms of number of patients treated and indications treated. It is anticipated that there will be an increase for both, as it is shown in Table 1 and Figure 3.

There are differences in the indications treated between equipment groups. GK centres treat the largest variety of clinical indications (mean = 9.2, range = 6–13), followed by CK (mean = 6.5, range = 2–10) and LB (mean = 4.9, range = 1–10). LB is mostly focused on brain metastatic diseases, acoustic neuromas and arteriovenous malformations. The number of indications treated was also found to increase with the experience of the centre, as more-experienced centres treat more indications than less-experienced centres.

Treatment-planning practices

Participants were asked to state the imaging modalities they use for SRS target and OAR visualization and outlining. Multiple answers were allowed, as centres often decide to use a different modality depending on the availability of certain modalities, equipment used and pathology to be treated. The results show that there is a wide range of imaging modalities used, with fused CT and MR being the most common modalities (Figure 4).

The structures outlined are dependent on the location of the target volume as only proximal OARs are usually delineated. The target volume is delineated by all centres at all times. The respondents indicated the following structures as those that are most often delineated: optic chiasm (90%), optic nerves (90%), brainstem (86%), eyes (76%), lenses (71%), cochlea (24%), trigeminal nerve (19%), whole brain (14%), hippocampus (10%), lacrimal gland (5%), pituitary (5%), scalp (5%) and temporal lobe (5%). One centre reported that only OAR contouring is performed retrospectively to the plan and is dependent on the clinician’s judgment on which OARs are to be contoured after reviewing the dose distribution. Half of the centres stated that outlining usually takes less than 30 min with the other half reporting less than 1.5 h. One centre reported that it usually takes over 1.5 h.

Figure 5 shows the range of treatment planning systems (TPSs) used. 6/21 respondents reported that they may not use their TPS for delineation and use different software instead.

All GK centres use a MRI data set in the TPS for defining the target and OARs as well as the stereotactic space and were using the tissue maximum ratio algorithm, which assumes that everything inside the patient has water density, in order to calculate dose distributions. The remaining centres use a CT data

Table 1. The percentage of centres that treat the indicated anatomical sites

Answer options	Not within 2 years (%)	Start within 2 years (%)	Up to 4/ month (%)	5–8/ month (%)	9 or more/ month (%)
Solitary brain metastases	4.8	–	57.1	33.3	4.8
Multiple brain metastases	4.8	4.8	61.9	28.6	–
Acoustic neuromas	23.8	4.8	52.4	9.5	9.5
Meningiomas	28.6	–	61.9	4.8	4.8
Pituitary adenomas	28.6	4.8	66.7	–	–
Arteriovenous malformations	33.3	14.3	47.6	–	4.8
Trigeminal neuralgia	57.1	–	38.1	4.8	–
Primary CNS tumours	52.4	4.8	42.9	–	–
Glomus jugulare tumours	52.4	9.5	42.9	–	–
Craniopharyngiomas	52.4	9.5	38.1	–	–

CNS, central nervous system.

The results are categorized into three frequency groups.

The percentage of centres that are and are not planning to treat these indications within the next 2 years are also presented.

The indications have been sorted with the most common indications at the top and least common indications at the bottom of the table.

set for dose calculation. However, two GK centres indicated that they may use CT for certain pathologies or when the MR distortion is significant.

GK and CK centres only use non-coplanar static fields, and the TT centre only uses coplanar intensity-modulated radiotherapy. There are a variety of techniques used in the eight LB centres, but seven centres employ non-coplanar techniques only, and one centre may also use coplanar techniques. The most common techniques used by LB centres are non-coplanar static fields

(5/8) and non-coplanar dynamic conformal arcs (4/8). Two centres use non-coplanar circular collimator arcs, and only one centre uses volumetric arc therapy.

The centres were asked to indicate the most commonly used prescription isodose (Figure 6). The reported values range from 45–50% to 95–100%, indicating that there are different prescription practices employed by each equipment group. GKs prescribe in the range of 45–55%, CKs within 55–80% and LB with TT within 80–100%.

Figure 3. The number of centres currently treating the indicated pathologies and expected increase by the end of 2016.

Figure 4. The percentage of centres using the indicated imaging modalities for stereotactic radiosurgery target and organ at risk definition (multiple answers were allowed). PET, positron emission tomography.

For the time required to plan, 76% of respondents reported that the average time taken exceeds 1 h, and the remaining 24% stated less than 1 h (these are: 3 GK, 1 CK and 1 LB).

Quality assurance and verification

Participants were asked to state the quantity of patient-specific QA performed. 6/21 participants reported that they do not perform such measurements routinely (5 GK and 1 CK), and 7/21 participants perform measurements on every plan (3 LB, 3 CK and 1 TT). 4/21 participants perform QA measurements for new techniques/sites only (2 LB and 2 CK), and 3/21 participants perform it as part of a regular QA programme (2 LB and 1 GK). 1 LB centre performs QA for <10% of all plans. For the centres that had reduced the amount of patient-specific QA

measurements made, 87.5% centres stated that they reduced it after 10–25 plans. 70% of these centres reduced the amount of patient-specific QA following an experience-based decision, and the remaining centres stated that the main reason for reducing them was insufficient time (15%) and the lack of a suitable phantom/detector (15%).

There is a large range of phantoms and detectors used for QA measurements. These are illustrated in [Figure 7a](#) and [7b](#).

The majority of respondents (13/18) reported that they measure both point doses and dose distributions (4 CK, 5 LB, 3 GK and 1 TT). 4/18 respondents stated that they only measure point doses (2 LB and 2 CK), whereas 1 centre measures only dose

Figure 5. The percentage of centres using each treatment-planning system (TPS) and algorithms (multiple answers were allowed). AAA, analytical anisotropic algorithms; CC, collapsed cone; CCC, collapsed cone convolution; CK, CyberKnife; CSA, convolution-superposition algorithm; MC, Monte Carlo; OMP, Oncentra Master Plan®; SRS, stereotactic radiosurgery; TMR, tissue maximum ratio.

Figure 6. The most common prescription isodoses used in each centre.

distribution (1 LB). The most common time taken for QA or verification procedures was 1–1.5 h.

Immobilization and imaging

The majority of centres (12/21) use thermoplastic masks for the immobilization of patients (6 LB and 6 CK). Two of these centres (both LB) stated that they use the masks in combination with a mouth bite device to provide more robust immobilization. All GKs always use invasive fixed frames (Leksell) to immobilize the patient, and two LB may use masks or frames depending on the indication treated (one centre stated that frames are always used for arteriovenous malformations). Lastly, one centre (TT) uses a non-invasive frame solution with a mouth bite appliance (Gill–Thomas–Cosman frame).

Owing to the GK design, these centres do not perform any imaging guidance for localization before or during treatment. The six CK centres perform orthogonal kV X-rays before and throughout the treatment. The TT centre performs a pre-treatment megavoltage CT scan and no further imaging during treatment. Between LB practitioners, 3/8 centres acquire a cone-beam CT scan before treatment and do not perform any other imaging during treatment. 4/8 centres, all of which use the Novalis ExacTrac® system (Brain Lab, Feldkirchen, Germany), start by taking a set of orthogonal kV X-rays to ensure precise patient positioning and repeat these images after each couch movement and before each beam delivery. Only one LB centre does not perform any image guidance before or during treatment; but, it was reported that they are intending to use cone-beam CT. Figure 8 shows the action level below which setup is considered acceptable.

DISCUSSION

Generic information, equipment and experience

The use of SRS has been steadily increasing since its introduction in the UK in 1985. By 2009, at least 13 centres were active, and

in the past 5 years, the number has increased to 21 centres. The results also suggest that this growth will continue, and almost half the UK's radiotherapy centres will offer cranial radiosurgery services by the end of 2016. The rapid increase over the last few years is mostly attributed to CK and LB radiosurgery, as well as the growing interest in hypofractionated treatment schemes. The survey responses support the evidence that this expansion will continue to occur for both the pathologies treated and the number of cases per month.⁹

Since GK units are dedicated to cranial radiosurgery, it is not surprising that the results showed them having higher patient throughputs. The disadvantage in having a versatile SRS unit (LB) that can be used for other techniques is that it is unable to match a dedicated unit in the number of cases treated per month. This is also reflected in the responses from the five centres who limit the number of patients they treat owing to resources for SRS delivery who are all LB.

The only LB centre that currently uses an FFF beam is also the only centre that uses 10 MV. This is perhaps less striking when considering the fact that an FFF beam is softer (*i.e.* has a lower average energy) than a filtered beam of the same nominal energy. As more LB centres switch to FFF beams (four centres are intending to), in order to benefit from faster delivery times, it will be interesting to see if 10-MV beams are adopted by more of these centres.

The time taken to deliver a treatment may vary significantly depending on the technique, pathology, procedure in use and experience of the centre. The centres were asked to state an average time for this, which did not reveal a clear consensus. However, the majority of centres that agreed on a treatment duration of 30–45 min come from different equipment groups (four LB, three CK and two GK), have varying levels of experience, use different image-guidance protocols and all treat a range of pathologies.

Figure 7. Phantoms (a) and detector systems (b) used for quality assurance (QA) measurements. GK, Gamma Knife; IMRT, intensity-modulated radiotherapy.

Pathologies

The results suggest that the most commonly treated pathologies are brain metastases and acoustic neuromas. The treatment of these pathologies is likely to increase, as new centres launching their programmes in the near future will probably take on these indications first. There is a general intention to increase the number of pathologies treated and the number of patients treated for each pathology. It was highlighted that expanding

SRS programmes to other indications may require access to specialist support and services (*i.e.* angiograms, MRI etc.), which pose more complications for their implementation.

Ongoing research is investigating the use of SRS for functional and behavioural disorders.^{3,11,12} Parkinson's disease, epilepsy and obsessive compulsive disorder may join the list of indications routinely treated with SRS in the future.

Figure 8. The reported values of setup accuracy below which treatment is considered acceptable. The different equipment groups are indicated.

Treatment planning

The participants were allowed to submit multiple answers for the imaging modalities used routinely for outlining. The majority of centres use fused CT and MRI followed by a group of centres that use MRI alone, which by design is used in all GK centres. Also, there are four centres (two GK and two CK) that may use positron emission tomography or fused CT and positron emission tomography in some cases.

There are a variety of outlining and planning practices which make it difficult to assess the average time taken to perform these procedures. Also, as OAR outlining is highly dependent on the location of the target volume, the number of structures outlined and the time taken differs for each patient. Torrens *et al*⁸ (2014) recommend that OAR contouring should be performed by all centres using appropriate imaging sequences. They highlight that standardized and consistent contouring practices are a “key step” to advancing SRS.

The results show that the most popular delivery techniques are non-coplanar static fields and non-coplanar arcs (including dynamic conformal arcs, volumetric arc therapy and circular collimator arcs). With the exception of the TT centre, which is limited owing to the system design, no other centre is employing intensity-modulated radiotherapy for SRS. Moreover, none of the LB centres have reported the use of hybrid arcs. This is indicative of the fact that these techniques yield inferior treatment plans in comparison with the popular techniques. Therefore, some standardization could be recommended by the use of only certain techniques for SRS. This will create a more cohesive approach to SRS, but will also prevent upcoming centres from undertaking timely investigations in assessing the suitability of a range of techniques.

Figure 6 illustrates that the most commonly used prescription isodoses differ between equipment groups. These survey replies have not been reported with a percentage of target coverage. Also, the centres were not asked to indicate whether any target margins are being used in these prescriptions. If target coverage and margins are taken into account, this distribution may change, as these parameters influence the prescription isodose. It should be noted that the variation in prescription isodoses presented is an indication of the differences in prescription practices. For example, the homogeneity of dose in the target volume is not standard. Typically, LB radiosurgery adheres to International Commission of Radiological Units practices and aims for homogeneous dose distributions within the target volume. On the other hand, some dose inhomogeneity in the target volume is acceptable for CK users, and it is actively sought in GK radiosurgery. The large variation in prescription practices requires discussion and perhaps indicates that it will benefit from regulation/standardization.

Over the last few years, interest has been shown in the use of brain volumes receiving specific doses ($V_{10\%}$, $V_{25\%}$ and V_{12Gy}) as predictors of radionecrosis.^{13–15} These dose–volume limits are becoming more regularly used as metrics of assessing plan quality and may have a role to play in standardizing SRS prescription practices. Also, the recent International Leksell Gamma

Knife Society recommendations are aiming to improve plan quality reporting, regardless of the technology used for delivery.⁸

Quality assurance and verification

The number of patient-specific QA measurements performed by each centre suggests that some centres have more confidence in their method of treatment delivery than others. The predominant reason for reducing the amount of QA was an experience-based decision, and the reduction was mostly introduced after 10–25 treatment plans. Interestingly, some experienced centres continue to perform QA on every plan, whereas some less-experienced centres have reduced their QA. Also, the majority of GK centres do not perform measurements routinely, which indicates higher confidence, possibly owing to the simpler design of the system with fewer moving parts and the well-known activity-related output of the sources.

The detectors and phantoms in use are diverse, with the exception of GK users who follow similar practices. Solid-water blocks are used by the majority of centres, and ionization chambers are the most commonly used detectors despite limitations in small-field dosimetry capabilities.¹⁶ Some evidence of recognition that these limitations exist is seen, as some centres are using other detectors such as Gafchromic film, diodes, diamond and thermoluminescent detectors in their practices.

Lastly, the time taken to complete a measurement-based QA procedure is not consistent throughout the respondents owing to the range of practices, techniques, delivery times and experience. It is difficult to draw any conclusions with regard to the time required for QA; nevertheless, the majority of centres (72%) state that it usually takes more than 30 min and less than 1.5 h.

Immobilization and imaging

The results illustrate the wide range of immobilization devices and image-guidance protocols used by the SRS community. Consequently, a range of acceptable setup accuracy levels are in use, as shown in Figure 8. LB and TT centres assess acceptable positional accuracies *via* integrated imaging systems, but, this is not possible for GK centres owing to the lack of an imaging system. The answers reported by GK centres on their acceptable positional accuracy are reflections of the accuracy believed to be achievable by their units based on their QA measurements and empirical knowledge. CK centres are also able to assess the setup accuracy *via* the integrated imaging system; however, there was no consensus on the reported levels. It should be noted that four out of six CK centres submitted their replies to this question with additional commentary that allows some insights into the reasons behind the large spread of the levels reported. These four submissions commented on the nature of the CK system that automatically repositions the patient after each pair of kV images is acquired. The machine therefore “corrects” misalignments above an action level set by the user; however, there may still be some inherent positioning errors.

LB centres generally agree and report a level of 1 mm, with the exception of one centre reporting a level of 2 mm. Responses from GK users range between 0.2 and 1 mm. The largest range is

seen in CK responses, which vary from 0.1 to 1.5 mm. The spread of the reported acceptable setup accuracies also indicates benefit from standardization. With only two centres reporting a setup accuracy above 1 mm, this suggests that a reasonable national level for SRS setup accuracy could be <1 mm.

CONCLUSION

SRS in the UK has undergone a rapid increase since its introduction in 1985. This is particularly the case with LB radiosurgery, which is now overtaking GK and CK in terms of number of units and patients treated. This increasing trend will continue in the coming years, not only for the number of patients treated but also for the range of pathologies treated. There is variation in the practices followed between different centres for most aspects of radiosurgery. Radiosurgical treatments are also becoming more common outside the cranium, adding complexities which will need to be taken into consideration. Moreover, proton radiosurgery will be possible in the near future in the UK, which will require special considerations. Any comparison between treatments carried out with different techniques will need to consider these differences, and clinical trials using the different technologies will need to standardize approaches.

In this survey, we have quantified the current SRS provision in the UK, stated the expected increase in SRS provision and provided the demographics of the SRS community. We also

provide a benchmark of current practices showing the need for standardization in order to create a more cohesive national approach to SRS provision. The study assesses the areas of similarities and differences between the different SRS techniques and approaches and considers where standardization may be possible. Outlining practices, delivery techniques, prescription regimes and acceptable setup accuracies are some of the areas where standardization could be performed. These will facilitate the initiation of clinical trials and the production of national protocols which can subsequently answer research questions regarding the efficacy of SRS in different clinical subgroups. It should be noted that NHS England is seeking to procure the provision of intracranial SRS and stereotactic radiotherapy as part of an integrated neurosurgical and neuro-oncology service to patients in England from 01 April 2016, and this is likely to facilitate a more cohesive approach in England.¹⁷

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