

# A Survey of IMRT and VMAT in UK

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**Abstract—Purpose:** This E-survey was carried out to facilitate the implementation and Education of VMAT (Volumetric Modulated Arc Therapy) in Radiotherapy-RT departments and reasons for not using IMRT (Intensity Modulated Radiotherapy). VMAT Skills in demand were also identified. **Method:** E-Survey was distributed to NHS hospitals across UK by email. Thirty NHS and related centres in England, 21 in Scotland, 3 in Ireland and 1 in Wales were contacted. This Survey was intended for those working in RT and Medical Physics and who were responsible for Treatment Planning and training. **Results:** This E-survey have indicated pathways adopted by staff to acquire VMAT skills, strategies to efficiently implement VMAT in RT departments and for obtaining VMAT Education. **Conclusion:** Despite poor survey response this survey has managed to highlight requirements for education and implementation of VMAT that are also applicable to IMRT. Other RT centres in world can also find these results useful.

**Keywords**—IMRT, Radiotherapy, Treatment Planning, VMAT.

## I. INTRODUCTION

THERE are number of reports that suggest that there is a shortage of Radiotherapy and IMRT services in England [1], [2]. Similarly there are reports that show that RT Services in Scotland needs to be improved [3]. In 2005 the estimated difference between present activity levels and optimal treatment levels was about 63% that has been reduced by 13% in 2012. However a huge gap still remains. There is also evidence that there is a gap between access rates and advance Radiotherapy techniques e.g. IMRT that are suitable for the cancer population. Not all patients who need IMRT treatment have access to this advance RT technology. Same case is expected for VMAT (Volumetric Modulated Arc Therapy).

In 2012 it was estimated that at least 33% of radical treatment should be given with IMRT and 24% with inverse planned IMRT. However, only 4 centres in UK were found to be providing treatments in access of 24% [1]. Complexity of IMRT QA, Commissioning and treatment planning and lack of expert staff are one of the main reasons that prohibit implementation and use of IMRT in RT departments across UK. Similarly VMAT QA, treatment planning, delivery and dosimetry are very complex and require special expertise.

VMAT (a rotational form of IMRT) has a number of potential benefits in terms of treatment accuracy, efficiency and speed. However its implementation is also a complicated process and requires special skills. This prompted the researcher to carry out a short survey in March 2014 on VMAT and IMRT implementation and education as well as training in UK. *This is the first Survey in UK* that has focused on determining demand for VMAT skills as well as how to

improve VMAT education level among the RT staff as well as how to improve VMAT (as well as IMRT) implementation in RT departments. All this will eventually help in speeding up the take up of these advance technologies by RT departments across UK thereby increasing patient access to IMRT and VMAT.

**Objectives of the study:** (I) To determine which VMAT skills are required now and in next 5 years.(II) To identify factors that can ensure easy and smooth implementation of VMAT/IMRT in RT departments across UK. (III). To determine how to improve VMAT education and training. & identify most common pathways used by staff to acquire their VMAT/IMRT Skills. (IV) Identify Reasons for not using IMRT. These objectives are shown in Fig. 1.

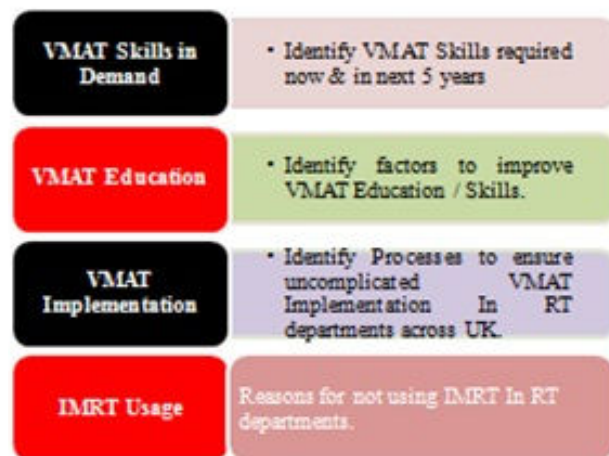


Fig. 1 Objectives and Focus of E-Survey

## II. MATERIALS AND METHOD

E-Survey was distributed to NHS hospitals and centres across UK by email. Almost 30 NHS and NHS related centres were contacted by email in England and about 21 in Scotland. Three centres including Northern Ireland Cancer Network were contacted in Ireland and one centre in Wales.

**Target Population:** This survey was intended for those working in Radiotherapy, Radiation Oncology and Medical physics fields and who are responsible for Radiation treatment planning and training.

**Survey Design** This survey was anonymous so no personal information was collected. However demographic information was collected. The survey contained 13 questions and was likely to take 5-10 minutes to complete. This survey mostly contained specific questions and a few open ended questions. Fig 6 shows Sample Questionnaire. The Questionnaire was accompanied by an Invitation letter to describe the reasons for

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conducting this survey.

**Survey length:** 3 weeks.

**Statistical Analysis:** superiority of one strategy is determined if considered important by majority of respondents. i.e. by determining percentage of responses for a particular category.

III. RESULTS

Results of this survey are shown in Fig. 2-5. Percentage of filled surveys and different types of responses received are shown in Fig. 2 and Table I. VMAT skills required now and in next 5 years are shown in Fig. 3. Fig. 4 shows results for Improving VMAT Implementation in RT departments. Table II shows the order in which staff acquired their VMAT Treatment Planning (TP) and Commissioning skills. The E-Survey response has been poor. Only 3 filled surveys were returned i.e. two from England and one from Scotland. Four centres (3 from England and 2 from Scotland) replied that they provide no RT service and did not indicate if they want to start RT service provision in future. No responses were received from Wales and Ireland and therefore they are not indicated in results. All respondents had IMRT in their departments so no reasons for not implementing and using IMRT could be identified.

TABLE I  
SURVEY RESPONSES

Total No of Hospitals/cancer facilities contacted	30	21
No of Filled & Returned Surveys	2	1
Response with No RT	2	2
No Response/No Returned surveys	26	8

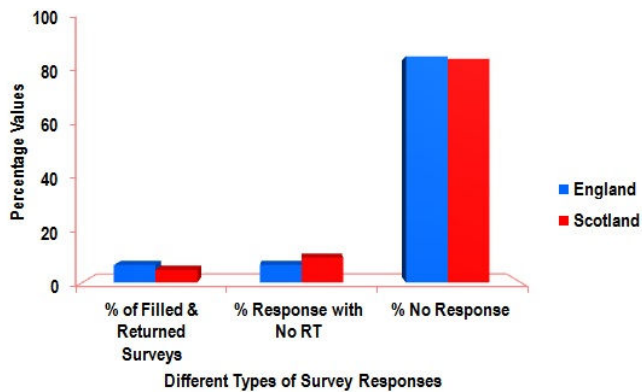


Fig. 2 Characteristics of Survey responses

A. VMAT Skills in Demand

Results for VMAT Skills in Demand now and in next 5 years are shown in Fig. 3.

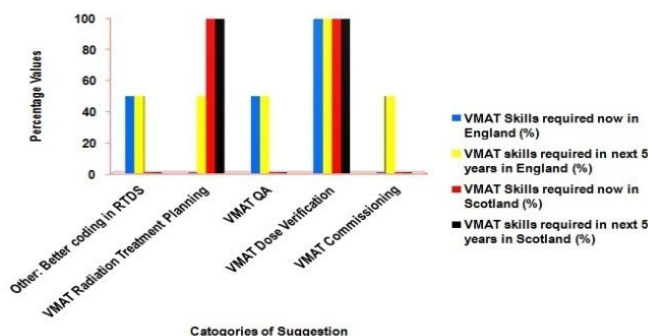


Fig. 3 Graph Showing VMAT Skills In Demand

B. Strategies to Improve VMAT Implementation

Results shown in Fig. 3 indicated ways to improve VMAT Implementation in RT departments across UK.

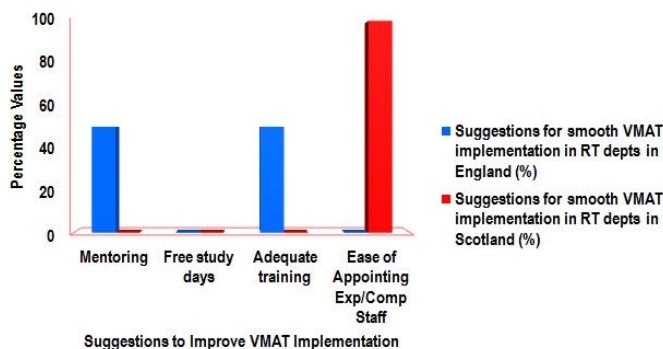


Fig. 4 Strategies to Improve VMAT Implementation in RT Departments

In Fig. 4 Experienced and competent staff is denoted by Exp/comp.

C. Strategies to Improve VMAT Education

Table II and Fig. 4 show results for improving VMAT education and Skills and most common pathways followed by staff to acquire VMAT Skills. In the category of Others National & International courses, support from MPSi, QA groups, peer assessment, mentorship and Training events are indicated.

TABLE II  
VMAT TRAINING ACQUISITION PATHWAY

	Acquisition of VMAT TP skills by staff in order of occurrence	Acquisition of VMAT Comm. skills by staff in order of occurrence
Respondent 1 (England)	E, B, A	E, B, A
Respondent 2 (England)	B, A, C, E	B, A, C, E
Respondent 1 (Scotland)	E, B, A	E

Note: A= In-house training, B=VMAT Treatment planning system, C=University, D=College, E=Others, TP=Treatment Planning, Comm.=Commissioning & QA.

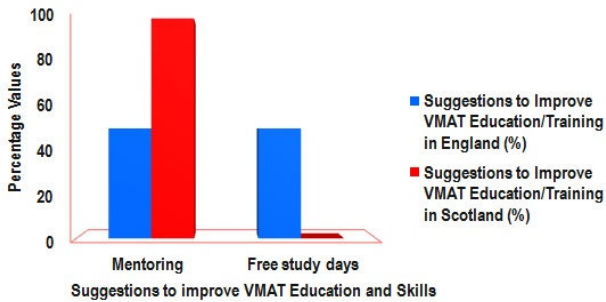


Fig. 5 Strategies to Improve VMAT Education and Skills

#### IV. DISCUSSION

Radiotherapy is gradually becoming more and more complex with inventions of new and complex Radiation treatment techniques. Therefore skills and proficiency of the required workforce needs to be taken into consideration when planning for provision of adequate RT services to cancer patients.

Despite poor response the present study has managed to collect views from three main disciplines of RT i.e. Radiotherapy Manager, Dosimetrist and Medical Physics. Results of this survey have highlighted for first time what VMAT skills are in demand and what strategies are considered important by RT professionals in enhancing their VMAT treatment planning, QA, dose verification and other VMAT skills. This survey has also highlighted the opinions of RT professionals in improving the VMAT implementation in RT departments across UK. The most common pathways taken by RT professionals in acquiring VMAT skills have also been identified. A wide array of methods has been used by RT staff to gain VMAT know-how. Key staff tends to gain their initial knowledge by attending application training from VMAT equipment and software manufacturers. They are then able to cascade this information to rest of the RT staff. It was also noticed that departments acquire VMAT expertise by hiring staff with VMAT knowledge and experience which then acted as a source of information for the rest of the department.

Mentoring came out as one of the most mentioned method for improving VMAT theoretical knowledge and practical skills as well as for improving VMAT implementation in RT departments. Mentoring is considered useful method in educating RT students as it improves confidence, feelings of acceptance and ability to apply class room learned knowledge to practical clinical setting [4]. There is also evidence that employees are attracted to work places that provide mentoring programs [5]. Therefore measures can be taken to improve the availability and frequency of mentoring for RT professionals as well. This can be applicable to IMRT as well.

University courses and other international courses also helped RT staff in gaining VMAT Specific knowledge. Therefore efforts can be made to provide VMAT and IMRT specific training courses at University and/or college level. This will certainly assist not only current RT professionals in enhancing their current level of VMAT education and skills but will also encourage other professionals to enter into this

field. This is one way to deal with current shortage of IMRT and VMAT staff and expertise.

Other countries also are experiencing shortage of competent RT staff. Deficiency of RT staff and capital costs for setting up RT facilities are concerned two main challenges in guaranteeing satisfactory RT services [6]. In Australia according to a 2009 report there is shortage of RT workforce and there is a gap in RT service delivery whereby about 36% of newly diagnosed cancer patients received RT between 1996 and 2006 [6]. This figure is below the required bench mark of 50% which requires that at least 50% of newly diagnosed cancer patients should receive RT. Cancer Council New South Wales (NSW), Australia has taken steps to fill the gaps in educational and training services for RT staff. Number of vocational training places was increased for radiation therapists [6]. One of the recommendations of the Report was to enhance funding for staffing level and work practices. Cancer Council NSW recommended a synchronized recruitment and retention plan for RT workforce that increases overall workforce capacity while targeting areas with specific shortages<sup>6</sup>. Therefore it is not uncommon to take steps to enhance educational and training facilities, funding and improve hiring process in order to reduce RT staff shortage. However the report focused only on increasing education and training at college and University level. Our present study on the other hand provides information on use of other strategies to improve Education and training for RT professionals such as mentoring.

There is a need to develop VMAT/IMRT courses that focus on current demand of IMRT/VMAT skills. For example someone with Master's degree in Medical Physics or Radiography should be allowed to attend VMAT/IMRT treatment planning or QA courses available at college and university level. Currently there is extreme shortage of such courses at national and regional level thereby increasing dependence on Manufacturer's-developed courses. The problem with manufacturer's developed courses is that they usually offer such courses only to people who are currently working in departments where their equipment is being used. By providing open access to VMAT/IMRT courses staff shortage can be dealt with and there will be less dependence on using manufacturers. Other strategies to improve VMAT knowledge and skills included QA groups, Training Events and peer-assessment. In future studies the impact of mentoring and other strategies to improve VMAT know-how and implementation can be assessed. Peer support and education via tele-health, case reviews and multidisciplinary meetings, possibilities for professional staff to carry on research activities and attend conferences are considered crucial in attracting and keeping staff [7]. Cancer Research UK in its latest report on improving Radiotherapy services has recommended continued investment by government in first-class equipment and staffing [8]. Thus government support and funding can be utilized to facilitate provision of strategies that this E-survey has identified. Better coding of VMAT in National Radiotherapy Data Set (RTDS) is one of the factors that was identified in the category of VMAT Skills in

Demand. All RT providing facilities in UK are required to fill in and return Radiotherapy Data Set [9]. RTDS serves many functions some of which includes provision of RT activity data, linking patient record with geographical area and helping in standardization of Oncology Management Systems, helping in determining current disease and treatment trends and identifying research opportunities. Therefore better coding skills for VMAT in RTDS are no doubt essential.

The present study was also intended to identify factors that are prohibiting and in many cases delaying the uptake of IMRT services in UK. However due to poor survey response, this survey could not identify these factors. All the respondents of this survey are already using IMRT.

It is well documented that IMRT QA and commissioning is a lengthy and complicated process. Same is the case with VMAT. For VMAT QA and commissioning special tests are required that determine its rotational accuracy as well as MLC speed and dose rate. VMAT QA and Dose verification are currently long processes and they need to be made fast and efficient. Skills in quicker VMAT QA and dose verification seem to be in demand. In Scotland the focus was on improving ability of Radiographers to perform VMAT dose verification and treatment planning. Eventually all VMAT processes need to be streamlined. In Scotland uncomplicated hiring of competent and skilled staff is also considered one of the ways to ensure smooth and uncomplicated VMAT implementation in RT departments. Low and middle income countries around the world face hurdles in the delivery of RT services due to shortage of equipment, work force and education and training facilities [10]. Shortage of well trained staff results in improper and under utilization of RT resources [10]. Hence many other centres around the world can find the results of present E-survey useful in expanding the capacity of their RT services with particular emphasize on modern techniques such as IMRT and VMAT.

A number of recommendations have been derived in view of the results of this survey. Section V lists recommendations and future directions.

#### V. RECOMMENDATIONS AND FUTURE DIRECTIONS

Recommendations for improving present services have been generated by analyzing the results of this survey which can be further tested in future studies.

- It is recommended to improve integration of VMAT RT data in RTDS. In this case two essential steps are required: (i) ensure the RTDS data entry form/process is compatible and suitable for adding VMAT RT data (ii) assisting in acquisition of better VMAT/IMRT coding skills in RTDS. In future studies relevant staff can be enquired what features they find difficult and/or unnecessary when inputting VMAT data in RTDS and what features can be implemented that can result in better coding in RTDS. This recommendation is in line with NRIg recommendation that RTDS needs to be developed so as to provide consistent and well-timed response of benchmarking data on proportions of patients receiving

IMRT and IGRT (Image guided Radiotherapy). However NRIg did not mention VMAT and therefore what should happen is to improve coding for VMAT in RTDS thereby making it easy for RT professionals to enter VMAT data and also include features in RTDS that can provide VMAT –compatible data i.e. how many VMAT attendances are being given in UK or how Implementation/use of VMAT has resulted in patient through-put etc

- Improve hiring process by making hiring of competent staff an easy and uncomplicated process.
- Provision of mentoring from other hospitals (across the country and around the globe) and MPSi needs to be increased as it is seen by staff as an effective means to gain Treatment planning and commissioning skills as well as for improving implementation of VMAT in RT departments.
- Improve the availability of VMAT/IMRT specific QA groups and national courses by scheduling them more often across the country along with the availability of allowance/support to attend international courses. Organizing more training events based around current demand e.g. Training events emphasizing VMAT Treatment planning, QA and dose verification. The effectiveness of various modes can be determined in future studies.
- It is suggested to arrange a multi-disciplinary meeting to collect ideas that can make VMAT QA and Dose verification a fast and efficient process. This can be done through future studies.

#### VI. LIMITATIONS OF THE STUDY

One of the limitations of the present study is poor survey response. However even this has resulted in the generation of important data that provides direction for future studies. Co-operation from national bodies and hospital staff needs to be improved so that better participation in filling surveys can occur which in turn can result in more accurate results. Ignoring surveys and questionnaires that are designed to ultimately improve RT services is a poor practice and staff must be encouraged to fill such surveys.

#### VII. CONCLUSION

Despite poor response, results obtained from this E-Survey are based on the opinions of respondents representing 3 main disciplines in RT i.e. RT manager, Dosimetrist & Medical Physics.

In terms of VMAT skills in demand 100% of respondents from both England and Scotland consider better Dose verification skills are required now and in next 5 years. 50% of respondents feel fast QA Skills and better coding in RTDS (National RT Dataset) is required currently and in coming years. In Scotland emphasis was on improving treatment planning & Dose verification skills among Radiographers. To achieve smooth and easy implementation of VMAT in RT 100% of respondents from Scotland deem that hiring process

of competent and experienced VMAT staff needs to be made simple and uncomplicated where as in England Mentoring and Adequate training of current staff is deemed more important. Mentoring was seen as an effective means to improve VMAT Education & Training skills by all respondents followed by free study days. Results for improving VMAT implementation and education can be generalized to IMRT i.e. same strategies are likely to be successful for improving IMRT education and Implementation. Due to poor response reasons for not using IMRT cannot be identified.

It seems that primary mode of acquisition of VMAT skills especially by key staff is either via attending manufacturer's application training or via other methods such as attending National & International courses, support from MPSi, mentorship, training events, peer assessment and QA groups. The key staff is then able to cascade training to other staff members in form of In-House training. Similar training acquisition pathways can be expected for IMRT as both technologies (IMRT, VMAT) are similar in some aspects and one is advancement of the other. Other RT centres in world can also find these results useful.

## APPENDIX

### A. Survey of IMRT and VMAT in UK

This survey identifies the education/training level for VMAT (Volumetric Modulated Arc Therapy) and IMRT (Intensity Modulated Radiotherapy) Radiation treatment planning and implementing these technologies in UK hospitals. It is a mainly multiple choice questionnaire and I would greatly appreciate if you could take time to complete it. Please select your responses by choosing from given options and typing it in the space provided after each question (e.g. to answer Q1 you may chose to type A if you are RT manager). Do not forget to save your responses in word before emailing the survey back.

Return the completed survey to: [ast97@my.open.ac.uk](mailto:ast97@my.open.ac.uk) by 4th March 2014.

#### Demographic information:

Q.1. In what role you are employed?

- A. Radiotherapy Manager
- B. Medical Physics Head
- C. Radiation Treatment Planning Head/manager
- D. Training Manager
- E. Dosimetrist
- F. Radiographer
- G. Treatment planning Physicist
- H. Other

(You can type your answer here)

Q.2. What is the geographical location of your hospital?

- A. England
- B. Scotland
- C. Wales
- D. Northern Ireland

(You can type your answer here)

#### Education and Training Information:

Q.3. Do you use any of the following technologies? Please select all those applications that you use in your department to treat cancer patients

- A. Forward IMRT
- B. Inverse IMRT
- C. VMAT
- D. IGRT
- E. Adaptive RT

(You can type your answer here)

Q.4. If you do not use IMRT what are the reasons?

- A. Inadequate IMRT and VMAT training facilities
- B. Unavailability of funds
- C. Shortage of competent staff
- D. Complex commissioning and QA process
- E. Other (Please specify):

(You can type your answer here)

Q.5. If you do not use VMAT what are the reasons?

- A. Inadequate IMRT training facilities
- B. Unavailability of funds
- C. Shortage of competent staff
- D. Complex commissioning and QA process
- E. Other (Please specify)

(You can type your answer here)

Q.5. Do you have plans in place to start VMAT in next-

- A. 6 months
- B. 12 months
- C. 24 months

(Please type your answer here)

Q.6. Do you have staff with VMAT treatment planning skills?

- A. Yes
- B. No

- A. In-house training
- B. VMAT Treatment planning system manufacturers (e.g. Philips, Siemens etc)
- C. University
- D. College
- E. Others (Please specify)

(You can type your answer here)

Q. 8. Do you have staff with VMAT Commissioning and QA skills and experience?

- A. Yes
- B. No

Q. 9. If answering yes to question 8 where did they get their training?

- A. In-house training
- B. VMAT Treatment Planning System manufacturers (e.g. Philips, Siemens etc)
- C. University
- D. College
- E. Others (Please specify)

(You can type your answer here)

Q.10. In your view what VMAT skills are required now?

- A. VMAT Commissioning
- B. VMAT QA
- C. VMAT Radiation Treatment Planning
- D. VMAT Dose verification
- E. Other (Please specify)

(Please Type your answer here)

Q.11. In your view what VMAT skills are required in next 5 years?

- A. VMAT Commissioning
- B. VMAT QA
- C. VMAT Planning
- D. VMAT Dose verification
- E. Other (please specify)

(Please Type your answer here)

Q.12. How do you think the education and training for VMAT can be improved?

(Please Type your answer here)

Q.13. What can be done to make Implementation of VMAT in your department an easy and smooth process?

(Please state your answer here)

Thank you again for answering these questions.

Fig. 6 Appendixes A - Sample Questionnaire

## ACKNOWLEDGMENT

Special Thanks to National Health Services in Scotland for providing email contacts to send the survey to hospitals in Scotland.

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