



European Society for Therapeutic Radiology and Oncology

The logo of the European Union, consisting of twelve yellow five-pointed stars arranged in a circle on a blue background.	<p>EUROPEAN COMMISSION Directorate General Health and Consumer Protection - Europe Against Cancer Programme</p>
<p>ESQUIRE II Project: Education, Science and Quality Assurance for Radiotherapy</p>	
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FINAL REPORT

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TECHNICAL REPORTS

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Publication in the series of European Guidelines for Quality Assurance in Radiotherapy: ESTRO Booklet nr 7

“Quality Assurance of Treatment Planning Systems. Practical Examples for non-)IMRT Photon Beams”
Ben Mijnheer, Agnieszka Olszewska, Claudio Fiorino,
Guenther Hartmann, Tommy Knöös, Jean-Claude Rosenwald,
Hans Welleweerd

Technical Report Part IV

Publication in the series of European Guidelines for Quality Assurance in Radiotherapy: ESTRO Booklet nr 8, 250 pages

“A Practical Guide to Quality Control of Brachytherapy Equipment”
Jack Venselaar & José Pérez Calatayud Editors

Project Starting date: AUGUST 1, 2001 (year 1) – **Project Ending date:** November 30, 2003 (year 2)

ESQUIRE CO-ORDINATION AND MANAGEMENT STRUCTURE

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Complete list of ESQUIRE partners: see p.33

OVERALL ESQUIRE OBJECTIVES

The overall objective of the ESQUIRE Project was to improve the treatment outcome for cancer patients by enhancing the efficacy of radiotherapy, one of the 3 main cancer treatment modalities.

Through a multi-faceted approach articulated in 6 parallel projects, each supported by a network of experts, the ESQUIRE project hopes to have made a substantial contribution to the pursuit of this goal.

The ESQUIRE actions focused on developing the human potential through investment in education and a concerted European approach to the surveillance of the quality of radiotherapy with the aim of pulling clinicians over the confidence threshold for the safe introduction of optimised radiotherapy with better outcome figures without an increased risk to the patient.

Rationale

The number of new cancer patients receiving radiotherapy in the EU is estimated at +/- 50% with a variation from 35% to 60% between the member states. In optimal conditions (as is the case in the US) 60% of all patients should receive radiotherapy. Recent evidence based studies tend to upgrade these figures to more than 70% for some of the most frequent tumours (breast, prostate, colorectal cancer) [1-4]

Earlier detection and gains derived from a multidisciplinary approach and combined modality treatments are contributing to better treatment outcome. Advances in genomics, molecular biology and imaging open the perspective for more effective treatments for a fast increasing disease burden. For the immediate future however an important indent in mortality figures could already be achieved by the implementation into routine clinical practice of existing optimised radiotherapy techniques.

It was demonstrated (Eur J Cancer 2000 Mar; 36 (5):615-20) [5] that every gain in the quality of radiotherapy delivery results in a substantial gain in the uncomplicated cure probability.

In 18% of all patients the local or loco-regional RT-treatments still fail and 5 to 8% of cured patients pay for their survival with largely avoidable late effects that severely affect the quality of their life. The most important reasons for failure are considered to be poor treatments, tumours with difficult location and tumours resistant to currently available radiation beams. Measures suggested to remediate this situation are: improved quality control of radiotherapy, conformal treatments and introduction of hadrontherapy. In the immediate future the most important gains (up to 7% increase in uncomplicated cure rates) can however be expected from a better education of the RT professionals, from the generalised introduction of optimised high precision treatment schedules and from the implementation of stringent quality standards for RT delivery.

There is a steep dose/response relationship in RT. Optimised conformal treatments allow the delivery of higher doses to the tumour target volume while keeping the dose to the normal tissue within tolerance levels. In unskilled hands however, instead of reducing local failure, dose escalation is dangerous and may lead to severe adverse effects.

Thanks to the EU support given for 6 major action lines integrated in the ESQUIRE project, ESTRO has been able to develop a broad strategy to address these issues in a vigorous and co-ordinated way. More than 150 experts have contributed to the project in very active parallel networks. As the 2nd largest cancer society world-wide (6.271 members) and well connected to the national and international scientific and professional RT societies, ESTRO will make every effort for disseminating the results of the project and for encouraging implementation.

Rather than reporting only on the 8 month period not yet covered in the last interim report, this final report will try to highlight the overall performance of the ESQUIRE project over its entire 2 year period (supported by 2 successive 1-year contracts).

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MAIN ACHIEVEMENTS OF THE PROJECT

1. Creation of permanent infrastructures for the external audit of the quality of radiotherapy both for routine practice and for clinical trials.

- Task 1, EQUAL, has set up the EQUAL Laboratory established at the comprehensive cancer centre Gustave Roussy (Villejuif, Paris). The EQUAL network, in cooperation also with the BRAPHYQS Task 6 Network, developed the tools for carrying out a range of dosimetric checks going from the dosimetry in reference conditions to the QA for complex treatments and brachytherapy. The new audit tools were tested within the networks and then made available to the

radiotherapy community at large. In total close to 3.000 beams were checked, covering, in collaboration with some active national networks, more than 70% of all radiotherapy departments in Europe. With a standard deviation of 2.2%, and only 3% of the beams outside the tolerance level of 5% (to be compared to the results of the EC network (published in 1997), in which still 12% of the checked beams showed deviations larger than 5% and the standard deviation was 4,5%), one can only be impressed by the major impact the EQUAL Lab has had on the overall dosimetric accuracy in the European radiotherapy departments.

- Task 4: EQART has developed a methodology for the QA of clinical trials with a radiotherapy ingredient. For clinical studies not only the dosimetric accuracy but the quality in the total RT treatment process needs to be audited.

ESTRO is proud to report that the results of both the EQUAL Lab and Network and of the EQART Institute are about to be consolidated under the joint umbrella of an independent structure called EQUAL-ESTRO asrl which hopefully will achieve total financial independence in the course of 2005. The further scientific development of the structure will be ensured by an ESTRO Supervisory Board, which can still rely on the commitment of the expert networks that were created for the ESQUIRE project.

By supporting the ESQUIRE project, Europe against Cancer has been instrumental in the establishment of a unique and essential European infrastructure for the implementation of EURATOM Directive 97/43. This directive, now in the phase of implementation at the national level, makes it mandatory for member states to organise clinical audits for all radiotherapy departments. A dosimetric audit is considered to be an essential ingredient of such audits. Thus far only the EQUAL Lab can meet the stringent quality standards for the required QA audits. Also the EQART QA services fill an urgent need. Negotiations are under way for carrying out QA audits for several clinical trials. In the pre-ESQUIRE era, trial coordinators were forced to apply for such services in NCI (National Cancer Institute) - supported Institutes in the US.

2. Education

A comprehensive body of European guidance for the basic and continued education and training in the field of RT in Europe was developed and published in a thematic issue of Radiotherapy and Oncology, Volume 70, Issue 2, Pages 103-158. It includes the following Esquire - Task 3 EDRO generated documents:

- Shaping the future: training of professionals for radiotherapy in Europe. Michael Baumann, Christine Verfaillie, Germaine Heeren and Jan Willem Leer, Pages 103-105
- Updated European core curriculum for radiotherapists (radiation oncologists). Recommended curriculum for the specialist training of medical practitioners in radiotherapy (radiation oncology) within Europe. M. Baumann, J.W.H. Leer, O. Dahl, W. De Neve, R. Hunter, R. Rampling, C. Verfaillie, Pages 107-113
- Union of European Medical Specialists: European Training Charter for Medical Specialists, UEMS 1995. Radiotherapy. Chapter 6, Charter on training of the medical specialists in the EU. Requirements for the specialty Radiotherapy. Pages 115-116

- Training Logbook for Radiotherapy. Robin D. Hunter, Boguslav Maciejewski, Jan-Willem Leer, Munir Kinay, Germaine Heeren and the European Board of Radiotherapy (Radiation Oncology). Pages 117-121.
- Guidelines for the infrastructure of training institutes and teaching departments for Radiotherapy in Europe. E. Röttinger, A. Barrett, J.W.H. Leer and the European Board of Radiotherapy. Pages 123-124
- Guidelines for education and training of medical physicists in radiotherapy: Recommendations from an ESTRO/EFOMP working group. Teresa Eudaldo, Henk Huizenga, Inger-Lena Lamm, Alan McKenzie, Franco Milano, Wolfgang Schlegel, David Thwaites and Germaine Heeren. Pages 125-135
- Revised European Core Curriculum for RT's. Mary Coffey, Jan Degerfält, Andreas Ostavics, Judocus van Hedel and Guy Vandeveld. Pages 137-158.

These documents are also downloadable from the ESTRO website.

In addition, Esquire gave a powerful impulse to participation to high level training courses at the European level, to professional mobility and training for research. Over a period of 2 years, 231 fellowships for attending one of ESTRO's 13 modular teaching courses were given next to 33 technology transfer grants for short stays in an other department and 12 full year research training fellowships.

An important boost was also given to the further development of a state-of-the-art education system for RT and corresponding teaching material for a medical discipline in a continuous state of mutation, evolving at a breathtaking pace. In this context, the urgency of addressing the need for distant teaching was recognised and the ESTRO education Committee ventured for the first time in a thus far unexplored area which could make the results of its education efforts available to a vast new target group.

All these actions have made an important contribution to a convergence to shared European standards in the field of education for radiotherapy and to a growing cohesion and awareness of a common European space for RT professionals.

3. Safety, QA and Best Practice Guidelines

- Task group 2, REACT, has developed a 3-tier system for evaluating and reporting the outcome of radiotherapy treatments, both for the purpose of routine follow-up and for clinical trials. By giving the patient a central role in the assessment, a simple tool for detecting and recording adverse effects in day-to-day follow-up practice could be developed. The new tool links the patient's perspective to a medical interpretation. It was piloted in the REACT network and was found so user-friendly that compliance in the participating centres went up from 23 to 90%. Also a much needed revision of the existing scales for recording RT outcomes for clinical trials was undertaken. For this task a co-operation was established with the REACT group's American counterpart. Their joint work was endorsed both by ESTRO and ASTRO (the American RT Society).

- The REACT group also carried out an audit of follow up practice in Europe. With growing cohorts of long term cancer survivors, the care of the cured patient is becoming an increasing burden on the strained cancer budgets. For this reason the REACT partners have been investigating whether patient triggered follow up cannot be as effective in detecting relapse and late effects of RT that require medical interventions, as frequent follow up visits and associated costly tests. They developed for this purpose a set of site-specific simple patient questionnaires which could be mailed or used in a telephone contact. Research for establishing the proper timing for such a contact was carried out for a single tumour site and would need to be further investigated for other tumour sites. Also a feasibility study to test for the whole methodology still needs to be carried out. Several publications in peer reviewed journals are forthcoming and guidelines for the optimisation of follow up practice in Europe are in progress.

- The EQART sub-task group ROSIS has developed a web-based incident reporting system. Hundreds of reports on detected incidents (breaks in the QA process of RT departments) are coming in. Such breaks, if allowed to go undetected, can result in accidents which put the lives of single or dozens of patients or their cure at risk. Only a minority of the incidents can be ascribed to technical or software problems. The reports are a graphic description of human failure and vulnerability, of shortcomings in communication, deviations from agreed procedures or just slips in attention. Over a short period of time the ROSIS data library has evolved into an invaluable resource for quality surveillance and an education tool for risk management and prevention in RT.

- The QUASIMODO task group, a network of top experts in the most advanced RT treatments: Intensity Modulated Radiotherapy (IMRT), sharing amongst them virtually all possible machine/ software architectures used in clinical practice, has developed a novel approach to the QA of treatment planning systems (TPS), by selecting a set of essential tests for the quality control and commissioning of TP (software) systems and distributing the responsibility for these tests over the vendors and the users. The result of their work is published in ESTRO booklet nr.7 entitled: "Quality assurance of treatment planning systems — practical examples for non-IMRT photon beams", presently in the hands of the printer but already available on the ESTRO website. They also developed and tested a methodology for the verification and inter-departmental intercomparison of IMRT treatment delivery on the different equipment and software constellations of the group. The experience gained in this cooperative exercise was translated in a set of recommendations which should be of great assistance to those planning to introduce IMRT in their departments . Both the booklet and the recommendations are available on the ESTRO website

- Finally, the BRAPHYQS (Brachytherapy Physics) expert group, not only developed tools for the external audit of the geometric and dosimetric accuracy of brachytherapy (piloted in their group and already made available to the EQUAL Lab), they also drafted an exhaustive "Practical Guide to the Quality Control of Brachytherapy Equipment", published as ESTRO Booklet 8, and made an inventory and analysis of essential tasks still to be carried out for the optimisation of brachytherapy treatments, this in cooperation with clinicians, recruited to reinforce their group.

EXECUTIVE REPORT

TASK 1: EQUAL

A European External **Q**uality **A**udit **L**aboratory

A. Dutreix, Task Leader, on behalf of the EQUAL Laboratory and Network

Introduction-Aims

The results achieved by the EQUAL task Group in the period of the 2 ESQUIRE projects were spectacular: A dosimetric audit was carried out in up to 70% of all the Radiotherapy Centres in Europe. Not only academic institutions but also private hospitals and small centres enrolled for the checks. This result could only be achieved thanks to the very active support of the EQUAL Network which promoted the QA audits each in their own country. While in the first year successively checks for photon and electron beams were introduced, the range of services offered by the lab was extended in year 2 to irregular, wedged and MLC fields and brachytherapy.

One can only be impressed by the improvement in the quality of the results for the reference beam output, with a standard deviation of 2.2%, and only 3% of the beams outside the tolerance level of 5% (to be compared to the study of the EC network in which still 12% of the checked beams showed deviations larger than 5%). This improvement needs to be credited largely to the Europe against Cancer support to the EC Network and to the ESQUIRE Project. Unfortunately the most important deviations appear for the check of the other parameters (depth dose data and beam output using large fields, wedge transmission factors especially for dynamic wedges). In about 50% of the checked centres, some data showed unacceptable deviations outside the 5% tolerance level after the first check. In a 2nd check, most of these deviations didn't appear and had been eliminated. It is assumed that part of the larger deviations still present after a recheck is attributable to the software of treatment planning systems (TPS). This problem was addressed by the QUASIMODO task group which has involved also the suppliers of the dedicated advanced software systems in the development of guidelines for the QA of TPS

Results.

Statistical data concerning the number of participating centres per country, the radiotherapy structure and the treatment units, and the dosimetry methods used in Europe have been compiled, analysed and published. These data correspond for the last 6 months alone, to the checks of about 250 photon beams and about 150 electron beams.. The analysis of the results shows deviations larger than $\pm 5\%$ (generally regarded as the tolerance level) for at least 1 point in one half of the radiotherapy centres (21% of the total number of photon beams and 13 % of the total number of electron beams after a first check), demonstrating the major importance of these external audits. When deviations are observed a second check is immediately proposed. If the cause of the discrepancy is not found and if the deviation persists, an on-site visit is suggested to help the local physics team to improve the accuracy of dosimetry. Strict confidentiality is always observed, but the final results are always sent in parallel to the medical physicist and the medical doctor in charge of the radiotherapy department.

The second goal of EQUAL was to develop an external audit for Multileaf Colimated (MLC) beams in order to answer to the new needs of the centres linked to the set up of modern radiotherapy techniques.

Since June 2003, 107 beams in 44 centres had been checked in the frame of this MLC test. Among all these beams, 7 beams have been rechecked and 20 further checks are at present in progress for a second check.

A new project is also under consideration. It consists of measurements at off-axis points with the modified holder suggested by the International Atomic Energy Agency (IAEA). The EQUAL board has accepted to check the modified holder and to study the feasibility in a few selected centres.

In 2001, the EQUAL board also decided that the measuring laboratory should perform checks of the brachytherapy techniques as recommended by the BRAPHYQS (task 6) network. Since June 2003, 41 brachytherapy centres from 16 countries have applied to perform this check. Among all the geometrical reconstructions checked, 17 % showed deviations outside the tolerance level corresponding to an unacceptable deviation after the first check.

Since 2002 another collaboration project with the BRAPHYQS group is under development at the EQUAL lab. This new project consists in the development of a new phantom allowing to perform a dosimetry check of the brachytherapy system. The methodology has been developed in the EQUAL lab and validated in collaboration with the BRAPHYQS group. The feasibility study was performed in some reference centres and the test has recently been made available to all the brachytherapy centres in Europe. Among the applicants are several US departments, since EQUAL is the only laboratory worldwide that can presently offer this service.

Task 2: REACT

Recording, Education and Amelioration of the Consequences of Treatment

Ö. Ataman and A. Barrett on behalf of the REACT Network.

Introduction- Aims

Insight in the overall effectiveness of cancer treatment depends on the long-term follow-up of patients, not only for recording the tumour outcome but also for recording late side effects of the treatment to determine the therapeutic ratio. However, an optimal follow-up schedule and a widely accepted late side-effects recording system have not been standardised and many variations exist throughout Europe. The REACT group of ESTRO started work in August 2001, building on what had been done previously in the MORQA project. The overall aim was to develop an international consensus on different levels of complexity of recording and reporting RT treatment outcome, using optimised site-specific follow-up schedules. For this purpose the network undertook to study patterns of follow up (FU) care after treatment for cancer, to produce a scale for recording toxicity which could be used in routine practice, to run a teaching course to increase awareness of the late effects of radiotherapy, and to investigate possible ways of intervening to ameliorate these effects. REACT is Task 2 of the ESQUIRE Project.

Methods

An initial survey of follow up practices was undertaken. A major part of the work was a prospective audit of follow up practices which assessed the usefulness of routine FU, its individual components of history taking, examination and investigations, and patient and doctor satisfaction. It also tested the feasibility of using a short scale developed by Professors Dische and Saunders to record side

effects in the setting of the routine clinic. In over 50% of visits patients and doctors reported disease or treatment related problems. There was an attribution bias in patients who, compared to doctors, were more likely to consider their problems related to disease than to treatment. Patients appreciated their follow up care. Routine investigations, not triggered by a specific problem, were found not to be useful. The short scale proved easy to use and increased the recording of side effects from 23% before the study to 90%. A paper, submitted to the journal "Radiotherapy & Oncology, was accepted for publication.

Next an attempt was made to develop a model for optimising follow up on a site specific basis from data contained in large, prospectively collected, data bases such as the CHART bronchus database. The CHART (Continuous Hyperfractionated Accelerated Radiotherapy) bronchus trial compared conventional fractionation to CHART in locally advanced non-small cell lung cancer and collected very detailed follow-up data for more than 10 years. As a result of this work a regimen of follow up was proposed which would match follow up visits more closely to the time at which events of significance were most likely to develop. This methodology can be applied to other similar databases. REACT hopes to continue with the CHART head and neck data. A paper documenting the methodology has been submitted to "Radiotherapy & Oncology".

A one-day teaching course was held at the Prague ESTRO meeting in 2002 and it is hoped that this might be incorporated into the ESTRO Evidence-based Radiotherapy Teaching course in the future.

The REACT group has been represented formally at a Late Effects Criteria and Applications workshop held in Florida in April 2002. This has led to an on-going collaboration in the revision of NCI-CTC3 (Common Toxicity Criteria). The work of the joint working party was officially endorsed by both the American and European Radiation Oncology Societies (ASTRO & ESTRO)

A trial was designed to explore how far follow up after radiotherapy could be triggered by patients, to assess correlation between patient and doctor recorded outcomes and to try to formalise different levels of complexity of toxicity scoring using the simple scale, an intermediate level of site specific outcome measures and the new CTC3 criteria.

16 European centres were involved in REACT studies. One of the strengths of the REACT network was the active participation of 2 bio-statisticians who vetted the methodology of the research and were actively involved in the data-analysis.

The REACT group met 6 times: in Lisboa, Köln, Norwich, Genova, Copenhagen and Montpellier. 4 of these meetings were supported by the ESQUIRE Project.

Results

The survey of current follow-up practices has shown that there are no agreed standards, and follow-up policies are very variable depending on the philosophy in the individual department and the reimbursement system. A methodology for optimising follow up practice was developed.

A 3-tier system for recording and reporting outcome of RT treatments was developed and tested to document treatment outcome for the needs of routine practice and for clinical trials.

A first spin-off of the REACT activities is that the REACT methodology for evaluating treatment outcome was adopted as standard method for the European Tissue Bank and Data Base set up for the ESTRO-EURATOM GENEPI project.

Of 2 papers submitted to a peer reviewed journal, one is already accepted for publication. European guidelines for reporting the outcome of RT treatments and for the optimisation of follow up will be published as soon as the group will have been able to finish its ongoing work.

Since no funding could be secured to continue this work, it will be pursued on a voluntary basis, using the ESTRO annual meeting as an opportunity to meet with the network and continue this collaboration.

Task 3: EDRO

EDucation for Radiation Oncology

Task Leader: Michael Baumann

Introduction

This task had a quadruple aim:

1. Technological developments make a precise delivery of RT and hence a much improved efficacy of the treatment possible. To realise RT's potential for achieving a better tumour control with a minimum of undesirable side effects, the education of the health care professionals needs to keep pace with the growing technological complexity of the specialty. A sustained effort is therefore needed to identify the needs for training, to generate the appropriate training capacity and state-of-the art teaching material at the European level as a template for teaching efforts at the National level. Since RT is numerically a relatively small medical specialty, few European countries can provide alone all the manpower and expertise to provide in all the education needs for the basic and continuous education of their RT personnel, especially for advanced treatments. This has given rise to a European initiative, supported by various EU programmes (ERASMUS, SOCRATES, TEMPUS, Europe against Cancer) to pool expertise for the development of a comprehensive multi-modular education programme. Support for the further development of the programme and incentives to pull in also those countries and sub-groups with limited access to trans-national educational activities remain necessary.
2. Although in principle the freedom of movement of professionals is guaranteed within the EU, in practice, as far as radiation oncology is concerned, it works only for those who received their practical training in centres of excellence with an established and recognised standing in that field. Yet, mobility within Europe to match lack of employment opportunities in some countries to acute staff shortages in others is a growing necessity. True freedom of movement within a common European space will however become a reality only if we are successful in harmonising the standards of education and training across Europe. This can only be achieved through a concerted European effort stimulating national authorities to adopt common European standards.
3. Expertise in the various sub-disciplines within RT is spread over many centres. The exchange of staff between centres, even for short periods, is an effective method for spreading excellence.

4. Research is the only way forward to translate new scientific knowledge in innovative treatments and improved clinical practice. To draw more bright and ambitious young professionals into science and prepare them for teaching positions or a career in research, access to research training needs to be created also for those who trained in institutes without research facilities. In addition, exchange of young scientists between research institutes needs to be encouraged to create the critical mass for progress and to realise a European Research Area also in this field of oncology.

Methods

1. Several teaching modules were totally revamped. Popular courses of which some elements have gradually become integrated in national teaching programmes were fused with less accessible modules in 6-day courses: "Evidence based Radiotherapy" was fused with "Methodology of Clinical Research" and "Basic Clinical Radiotherapy" with "Molecular Oncology". For this reason the course contents needed to be totally rethought and new teaching material created. A new course: "Brachytherapy for Gynaecological Tumours" was introduced and 2 new courses: "Quality, Resource and Risk Management in Radiotherapy" and "Image guided Radiotherapy" are under construction. Also the course "Imaging for Target Volume Definition in Radiotherapy" needed to be thoroughly updated since imaging modalities such as PET and NMR spectroscopy, which till recently were available only in a few centres are fast becoming standard tools for optimised radiotherapy. The course on "Dose determination in radiotherapy: beam characterisation, dose calculation and dose verification" was redesigned to include advanced treatment techniques. At the same time a method for distance pre-course teaching to allow students with different levels of knowledge to start a course from a level playing field, was designed and piloted.

A course fellowship programme was launched to raise the level of ambition of trainees for their own professional development and enhance awareness of education opportunities at the European level.

2. Development of a comprehensive set of European guidelines for the education of RT professionals. The work was distributed over 6 different working parties who collected and analysed material produced in different EU countries and internationally as a basis for aspirational European guidelines.
3. A programme of "Technology Transfer Grants" was created to stimulate young professionals to cross their national borders in a quest for innovative treatment approaches or for familiarising themselves with new techniques or equipment.
4. A network of host training institutes was created and a competition for full year research training fellowships launched.

Results

1. Two new teaching courses resulted from the fusion each time of a basic and an advanced course, 1 new course was developed and 2 new courses are in under construction, to be launched in 2005. Two further courses were totally redesigned to adjust to new developments.

The ESTRO teaching programme now consists of 14 modules with totally new or thoroughly revised teaching material.

231 applicants were selected for an EDRO fellowship to enrol for 1 ESTRO course module.

2. European curricula were developed for radiation oncologists, for medical physicists in radiotherapy and for technologists. A European logbook on basic training and further professional development, downloadable from the web was created. This easily auditable record system will serve as a European passport for trainees or professionals who want to move to an other country in the EU. Also European guidelines for teaching institutes and for continued medical education were drafted. This comprehensive body of European guidance in the field of radiation oncology was presented in an education workshop in Brussels and formally endorsed by 42 national radiation oncology societies after previous discussion in their education boards.
3. The programme of "Technology Transfer Grants" proved to be an outstanding success. The diversity of the topics going from proteomics to advanced algorithms for the verification of IMRT, make for stimulating reading and demonstrate an enormous need for transfer of knowledge on a one-to-one, hands-on, master-apprentice basis. The flows, going in all directions (and no longer exclusively from South to North and from East to West) point to an accelerating convergence to a European knowledge space. As far as radiotherapy is concerned (a specialty receiving little or no support from the pharmaceutical industry) this is mainly thanks to the support received from the European Commission for ESTRO education projects.
4. In total, 12 full year research training fellowships could be awarded. The enthusiastic reports of the fellows show that for them this one-year exposure to research was a mind-expanding experience which has meant a decisive turning point in their choice of career.

TASK 4: EQART

European Institute for **Quality Assurance in Radiation Therapy**

Project Leaders: Dominique Huyskens and Eric Lartigau

Introduction-Aims

The EQART task group (former name: EPOQART) was created to serve as a co-ordinating structure for all the QA initiatives in the field of RT and to develop a platform for the auditing and surveillance of Quality in the total Treatment Process and in Research in RT. Thus far such auditing services were not available in Europe and trial coordinators were forced to call on the US NCI supported institutes.

Methods

1. Starting up EQART: advertising EQART services

To announce the creation of EQART to the radiotherapy community an EQART leaflet was designed and distributed at the annual ESTRO and ECCO meetings. The mission and de services together with the EQART structure and the EQART staff were also published in the ESTRO

Newsletter. This resulted in invited lectures and presentations at different conferences and professional meetings (EORTC Radiotherapy, GETUG, etc.). With on site visits, contacts were established with the American and Japanese counterparts (RPC, ACR, QARC, JASRO). Information about EQART is also available on the ESTRO Website.

2. Starting up EQART: Creation of new methodologies for QA

- **QA database:**
A unique database was developed to collect all the data for chart review of clinical trials. The purpose of this database is to check conformity of data transfer in a treatment unit and to evaluate measured deviations of the patient positioning. This unique database is presently being tested through the Eli Lilly trial.
- **Mailed in vivo dosimetry:**
EQART has developed appropriate build-up caps in order to implement a mailed in vivo dosimetry programme for patients participating in clinical trials. This methodology was tested in the EORTC trial 22922. It was demonstrated that mailed in vivo TLD is a powerful additional means to detect errors in the treatment delivery.
- **Design of humanoid phantoms**
To perform quality assurance measurements for patients treated in the frame of head and neck diseases, a dedicated phantom was designed (Robocop). Robocop contains target volumes (primary tumour and positive nodes) and critical organs (spinal cord, parotid glands, etc.). Robocop is ready to be manufactured if requested by a customer.
- **OPERA for IMRT**
The OPERA phantom was designed to check dose distributions of individual fields for intensity modulated radiotherapy. However, the QUASIMODO expert group considered it unsuitable for the verification of the IMRT treatment delivery at the level of the patient, as required for the GETUG 14 and the EORTC 22991 trials. Part of the QA checks will therefore be handled by one of the other QUASIMODO expert centres that has already built up a considerable experience in the QA of IMRT treatments. .
- **Development of electronic filters**
A first prototype of an electronic filter for prostate treatments has been developed. The prototype is presently tested in the radiotherapy department of the Leuven University Hospital. The next step is to implement the electronic filter in the radiotherapy department of Rouen (GETUG 14 trial, principal investigator).

Results

In just 2 years, EQART has developed the tools and built up the contacts and expertise to offer Comprehensive QA services for radiotherapy in clinical trials. To some extent EQART is a virtual institute with mainly a coordination function for services to be delivered by different centres of expertise.

The contracts for the first 2 trials using the EQART QA services are ready to be signed early in 2004. These contracts describe the tasks to be performed by EQART in the frame of the trial and the funding involved.

- a) *Eli Lilly trial*: EQART will perform the QA part of the Eli Lilly trial (a phase I-II study for thoracic 3D conformal radiotherapy after induction of chemotherapy for patients with inoperable non small cell lung cancers).
- b) *GETUG 14 trial*: EQART will perform the quality assurance programme for the new trial for the GETUG (Groupe d'Etude des Tumeurs UroGénitales). The first pre-approval checks will start soon
- c) For more strategic reasons EQART will be performing the QA part of the IMRT patients treated in the frame of the EORTC 22991 trial. The principal investigator of this trial has decided to transfer a part of the budget foreseen for QA in this investigation to the EQART institute.

It will remain a challenge to keep up the services provided by EQART, without external funding. A lot of research is still needed to compare the efficacy of different RT fractionation schedules for specific tumour sites and tissues. . Also these trials need QA services but there is generally no funding to cover the costs involved.

EQART sub-task ROSIS

Radiation Oncology System for Incident Surveillance

Task Leader: Ola Holmberg (Ireland)

Introduction – Aims

To establish a computerised information system as a support tool in the area of incident prevention in radiotherapy - a European-based database for an inter-hospital approach to preventing incidents.

Cancer is a major cause of morbidity and mortality in Europe. While radiotherapy contributes substantially to cancer cure, the inherent complexity of this treatment modality makes it important to ensure that there exists a well-defined structure for the prevention of incidents. The patient receiving radiation treatment will be exposed to many potential sources of harm throughout the medical procedures. While the probability of harm occurring might be low, the consequences of that harm are potentially grave for the individual patients since they are exposed directly to a very high dose of radiation as part of the treatment.

Curative radiotherapy has the objective to concentrate a high radiation dose to a volume where clonogenic tumour cells are present, in order to cause massive eradication of these cells and permanent tumour control. This volume is usually surrounded by healthy organs, making delivery of a high radiation dose while simultaneously avoiding the risk of severe complications a difficult undertaking. To ensure the accurate delivery of the intended radiation dose to the intended volume, it has to be considered that there are many steps in the treatment chain and that the prescription, preparation and execution of radiotherapy is a complex task with inherent hazards.

The radiotherapy prescription indicates the volume inside a patient that should receive a high absorbed dose and the volumes to avoid irradiating, usually in a computed tomography data set. It also indicates the total intended dose and the dose per fraction. In order to prepare this treatment prescription for clinical implementation, a number of treatment preparation procedures and calculations performed by several categories of staff are required, leading to a group of physical parameter settings for each patient. These parameter settings indicate e.g. the sizes and positions of the irradiation fields and

specific characteristics of the radiation. Each patient has a large number of parameter settings associated with their treatment. These settings must all be correct for the patient to receive the intended treatment.

The importance of realising the prescribed dose and irradiation geometry when treating a patient can be demonstrated by the dose-response relations for tumours and organs at risk, leaving little margin for treatment errors. Clinical dose-response relations have shown that deviating by as little as 5% from the intended dose might cause a clinical impact, while some data suggest that an even higher degree of accuracy is necessary when irradiating close to organs that have steep dose-response gradients for severe complications. Incidents of this magnitude occur frequently in radiotherapy and many of these are entirely preventable. There have also been deaths recorded as a consequence of trivial initiating events, such as forgetting to divide a number by 2 or interpreting 0.3 minutes as 30 seconds.

To reduce the risk of hazards in radiotherapy, the frequency at which they occur and the severity of their consequences should be decreased. There are a number of preventive actions that have the potential of doing this, which can be incorporated into a comprehensive system of quality assurance. An integral part of such a system is to enable the organisation / radiotherapy clinic to learn from mistakes that have been made. By making hazards visible through non-punitive reporting, safe practices have been enhanced in non-medical settings such as the aviation and nuclear industries.

Incident reporting in a radiotherapy setting can be performed both at a local level (within the hospital) and a global level (outside the hospital). Local level incident reporting has previously been the common practice. Given the ready availability of Internet in radiotherapy departments, it is now possible to establish a system whereby information on incidents and prevention can be shared through technology with the wider community. This information can also be accumulated and analysed in a systematic and objective way through a centralised database. The main purpose of either local or global level reporting is for the organisations to learn how to minimise the risks associated with the therapy. Both levels have their own characteristics and advantages, and they complement each other. While local incident reporting has the added value of being specific in relation to the procedures, equipment and organisational characteristics that exist locally, global incident reporting has the added value of opening up a bigger event pool, enabling an incident in another hospital to lead to an identification of a hazard before it is realised in the local setting.

Methods:

ROSI is an acronym for Radiation Oncology Safety Information System, an ESTRO-project on inter-hospital incident reporting in radiotherapy, which was first proposed in early 2001 with some specific objectives:

- To establish an Internet-based system whereby radiotherapy incidents can be analysed in a systematic and objective way, and the information shared through web-access to a centralised database.
- To enable radiotherapy clinics to address safety issues before an accidental exposure occurs and to create a general culture of safety awareness by making information available on details of incidents, near-incidents and corrective actions, submitted on-line by other radiotherapy clinics.

- To define a hazard classification system and perform frequency analysis, leading to the identification of safety-critical steps in the radiotherapy treatment process where errors are likely to occur or be detected.
- To allow current best practice in incident reporting within medical as well as non-medical settings to be utilised in radiotherapy by identifying high-reliability organisations outside radiotherapy and the methods used within these organisations for incident and near-incident reporting, evaluation and feedback.

Results

ROSIIS started a pilot-scheme of the reporting system in Jan'03 together with a participating network of 24 radiotherapy clinics of varying size around Europe. The clinics submit details anonymously regarding incidents and suggestions of corrective actions on-line to an ESTRO-based database. The ROSIS work group reviews these submissions. Once a certain number has been received, they are sent back to all the pilot-participants so that clinics can share experiences and learn lessons from incidents and near-incident in other clinics.

To date, more than 200 of these reports have been submitted to the ROSIS database. The received information includes incident-description, cause, discovery details, severity and suggestions for preventive actions. Reports are continuously assessed for completeness and relevance of the captured information.

In order to make sure that efforts in radiotherapy risk management are not duplicated by different organisations, the ROSIS group has also established links with the Unit for Radiological Protection of Patients at the IAEA to explore synergies that can be achieved by efforts and initiate co-operation on a practical level.

Information technology facilitates the processing of a large volume of information on incidents, and dissemination of lessons learned in a more immediate and accessible manner. It also enables the system to be used as an educational tool.

Task 5: QUASIMODO

QUality Assurance of Intensity **MOD**ulated Radiation **O**ncology

Task leader: Ben Mijnheer

Introduction –Aims

The first aim of the ESTRO-QUASIMODO project was to develop quality assurance (QA) procedures for radiotherapy planning systems and IMRT. In the first part of the project a set of examples of tests was identified for QA of a treatment planning system (TPS), easy to perform by all users of different types of planning systems. By carrying out jointly the task of defining and designing essential tests, the QUASIMODO group wanted to come to the rescue of the physicists isolated in understaffed small RT centres for which it is an uphill struggle to configure and commission new TPS software while coping with their normal work.

The second aim of the QUASIMODO Task group was to design tests and provide guidelines for the verification of IMRT. This second task is not only related to QA of treatment planning systems but includes QA of the treatment delivery as well.

The QUASIMODO group met 5 times: in Sevilla, Heidelberg, Gent, Paris and Brussels to discuss the progress in drafting the booklet and the results of the IMRT planning and verification exercise. The meetings resulted in a division of the tasks in three sub- groups devoted to: 1. Drafting the booklet on QA of TPS; 2. Developing a procedure for a common exercise to plan a prostate cancer patient using IMRT; 3. Analysing the results of the verification of the actual “treatment” of a common phantom simulating such a prostate treatment. The minutes of these meetings are presented as Part II of the Technical Report.

Results

The preliminary results of the work performed in the QUASIMODO project have been presented at several international scientific meetings. Copies of the papers published in the Proceedings of these meetings are presented in Part III of the accompanying Technical Report. In addition, the draft papers describing the results of the planning exercise and the verification of the “prostate” patient IMRT irradiation have been added in Part II of the Technical Report. After some further improvement, these papers will be submitted to a peer-reviewed journal.

The most obvious result of the first part of the QUASIMODO project is the publication of ESTRO Booklet No 7: “Quality assurance of treatment planning systems – practical examples for non-IMRT photon beams”, which will be added as a separate deliverable (cfr. Technical Report Part IV).

From the experience resulting from the second part of the QUASIMODO project, a number of recommendations resulted, which are presented in Part II in the Technical Report. Both Booklet No.7 and the Recommendations will also be available on the ESTRO website.

In ESTRO Booklet No.7 a set of QA tests is described, to be performed by the vendor or by an individual user (or a group of users). The emphasis on the division of these tasks between the vendor and the user is an innovative approach, and discussed in detail. As a consequence a large number of tests can already be performed before the system is installed in the hospital, i.e., before acceptance testing of the system by the user starts. In an appendix each test described in this booklet is assigned either to the category “Vendor Acceptance Tests” or to the category “User Commissioning Tests”. Although a number of tests described in this appendix belong to a “standard” acceptance programme of a TPS, not all results of tests may already be available for each vendor. It may therefore take some time for the vendors to implement this new procedure and to put together the acceptance test materials and data sets.

The other new element in this booklet compared to other documents on QA of treatment planning systems, is the large number of practical examples that is given. These examples show how the tests can be performed in practice, and can be analysed when comparing calculations from a TPS with measurements. Different members of the QUASIMODO group, having different TPSs and using different measuring equipment, have recently performed these tests. These examples are therefore representative for the accuracy of state of the art (non-IMRT) treatment planning systems. They illustrate the enormous possibilities of a modern 3D TPS, but also the limitations of the algorithms of some of these systems.

It is therefore hoped that the booklet will not only provide guidelines for the TPS user to perform a QA programme in the hospital, but that it also becomes part of the user manual of a vendor and will be used

for customer training. Based on the experience of both users and vendors, adaptations of the tests may in the future be necessary.

In the second part of the QUASIMODO project, IMRT techniques of varying degree of complexity for the treatment of prostate cancer were designed and tested. Contrary to the ideas outlined in the original work-plan, it was decided to verify the “end product”, i.e., the complete treatment delivery, and not the dose distributions delivered by the individual fields separately. For that reason it was no longer appropriate to use the so-called multipurpose OPERA (Operational Phantom for European Radiotherapy Audit) phantom. This phantom has a lot of unique features for testing the accuracy of single photon beam dose calculations of treatment planning systems. For IMRT other requirements are more important, making this phantom unsuitable for verification of a complete IMRT delivery.

A new phantom was therefore designed in Gent specifically for this project (the CarPet phantom) to verify IMRT treatments of prostate cancer. Details about the construction of this phantom can be found in some of the publications presented in Part II of the Technical Report. The CarPet phantom, as well as a set of photographic films, was sent to each of the participating centres. Next all institutions were asked to design an IMRT technique using their specific soft- and hardware. Together with the phantom and contour data all centres received a detailed instruction how to perform the treatment planning. It was important that each centre was only allowed to prepare a plan, which was deliverable under the local clinical and technical conditions.

From the experience with the CarPet phantom and with the dosimetry systems a lot of useful information was obtained, not only for the partners in the QUASIMODO project but also for other groups performing IMRT or quality audits. Verification of IMRT delivery by means of a postal service requires a specialised laboratory, having considerable experience in film dosimetry, in handling of output of various treatment planning systems, and in applying dedicated software for 2D/3D data analysis. For instance, film dosimetry, particularly in transversal planes, is extremely sensitive to air gaps. Because some of the earlier phantoms were not completely flat, unexpected problems arose during the film dosimetry measurements. Furthermore, ionisation chamber measurements were performed in only one plane. This resulted sometimes in a rather large uncertainty in the film dose normalisation, and consequently in the (absolute) dose distribution in other planes. These problems have been elucidated in the paper describing the results of the verification procedure.

The development of such an IMRT verification project, including the choice of a common phantom, the use of an accurate film dosimetry method, as well as setting up the data processing and dose comparison procedure, is not a trivial procedure and required a substantial amount of time and manpower. Thanks to the composition of the group of participants, coming from 12 European leading centres in the field, the local expertise could be used to improve continuously the planning and verification procedure. Another advantage of the composition of the QUASIMODO group was that all major accelerator and TPS manufacturers were represented. As a consequence, it was possible to compare most IMRT optimisation/delivery combinations that can be applied clinically.

The work on QA of treatment planning systems is, for the time being, finalised after the publication of ESTRO Booklet No.7. With respect to the IMRT verification part, it is the intention to continue these activities. First the QUASIMODO network will finalise the two scientific papers and the Recommendations, which have recently been distributed to interested members of the group. As a next step the network will continue with pilot studies concerning the use of three phantoms for IMRT verification: (1) an anthropomorphic head and neck phantom for a detailed study of the three-dimensional dose distribution of IMRT of a tumour in that region of the body; (2) an anthropomorphic thorax phantom for the verification of IMRT of lung tumours; (3) a simple non-anthropomorphic phantom for the routine verification of class solutions, i.e. without body contours and tissue inhomogeneities. With some interested centres the further development of more advanced IMRT verification techniques, such as the use of gel dosimetry, dosimetry using electronic portal imaging devices and Monte Carlo calculations will be investigated. The expertise from the QUASIMODO group will in any case be made

available to ESTRO and the radiotherapy community by means of its publications, presentations or otherwise.

Task 6: BRAPHYQS

Development of a **Brachytherapy Physics Quality Assurance System**

Task leader: Jack L.M. Venselaar, The Netherlands

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Introduction-Aims

In contrast to external beam radiotherapy, brachytherapy uses radioactive sources for interstitial, intracavitary or endoluminal applications. Notwithstanding the fact that standards of radiotherapy delivery are considered to be very high in The Netherlands and Belgium, a joint study found in one out of 10 brachytherapy units in these countries deviations outside the tolerance level of 5% in the way in which the source strength was calculated. Geometric inaccuracies, e.g. in the determination of the distance between a source and a dose specification point, can even lead to higher dose deviations: any error made during geometric reconstruction of an implant increases or decreases the dose quadratically with distance. It was therefore considered urgent to develop tools and recommendations to assist brachytherapy departments in checking and improving the accuracy in their procedures through the development of a proper programme of quality control (QC) for sources and equipment.

For the optimal treatment of patients much effort is required after installation of new brachytherapy equipment during the commissioning phase, and afterwards during its clinical life time. The weaker points in the QC of brachytherapy procedures in clinical practice can generally be found:

- in the primary calibration of LDR sources which are rarely replaced; and in the repeated calibration of short-living sources which need replacement at fixed intervals;
- in the seemingly simple steps such as the reconstruction method of an implant for dose calculation in a treatment planning system (e.g. the “orthogonal X-rays”);
- in emergency procedures and safety protocols, which are easily forgotten, of which the parts are lost in the course of time;
- in the steps that need to be taken in case of new releases of software or changes in (parts of) the equipment;
- in the verification of the dose calculation algorithms.

For this reason a network of brachytherapy physics experts was formed. They set themselves 3 goals:

1. to develop a dosimetry check system using a mailed phantom with TLDs as detectors.
2. to develop a geometric reconstruction check system using a dedicated phantom with radio-opaque markers.
3. to draft “European” guidelines for quality assurance in brachytherapy

Methods

It was decided to collaborate for tasks 1 and 2 with the ESTRO-EQUAL Lab as reference and measuring centre and to use their expertise for designing a mailed external audit system which could be made available to all brachytherapy units through the lab services.

1. The dosimetric check would be performed by using a TLD-phantom to be designed for this specific purpose. The investigators would define a prescribed dose to the TLD position. A participating brachytherapy institution would be asked to calculate for this fixed geometry the treatment time and to irradiate the TLD material accordingly. All materials should then be sent back to the reference centre. The TLD is read out and results are reported back to the participating institution. Results are reported as a deviation between the stated and measured dose value.
2. For the *geometric check* another dedicated phantom would be tested in which a number of marker points are inserted at well defined positions. The phantom can be mailed to the participating institutions. The institutions are asked to apply the standard technique of geometric reconstruction to the phantom, Next, the reconstruction must be performed on the treatment planning system. In the reference centre the data are compared with the actual values and results are expressed as deviations of the distances between the points.
3. For drafting "A practical guide on QC of brachytherapy equipment" the network would be subdivided in 2 working parties of 5 to 7 members each. Publication as an ESTRO Booklet, would guarantee to the recommendations a wide acceptance by the radiotherapy community at large. One sub-group has to prepare a guide for checking the outcome of treatment planning system dose calculations for brachytherapy. The most important task to be carried out by the second sub-group would be drafting a set of recommendations and QC forms, which include the items recommended for QC of equipment, e.g. separated for HDR (high dose rate), PDR (pulsed dose rate, LDR (low dose rate) applications. Tolerances and action levels need to be given. A short description of how to perform the checks of the items must be included.

Results of the studies will be published in the open literature and during oral and poster presentations at national and international meetings.

Results

Topic 1: A preliminary phantom was designed at the ESTRO Equal Lab in Paris. A lot of technical problems had to be overcome. By October 2003 the feasibility of the TLD measurement technique was tested at two network members' institutions. Subsequently the test was repeated at the site of 5 other centres. A final phantom design was decided on. A procedure for reporting results to participating centres (optimal, tolerance and emergency levels) was agreed upon. The documents for applying for the check and a manual to accompany the mailing material with instructions for use of the phantom and for reporting results were drafted. Some technical problems still had to be solved, such as the acquisition of a range of catheters for connecting the phantom to the different types of high dose rate afterloading machines. Eventually an external company was commissioned with the production of a set of phantoms so that the check could be launched and other centres in Europe could be invited to participate. At the time of drafting this report a first series of external audits have already been carried out. The new QA check was welcomed with great enthusiasm and a lot of applications, some from overseas, were received because for the first time, Europe has been able to offer an exclusive service available nowhere else worldwide .

Topic 2: The pathway for the selection of a phantom for checking the accuracy of the geometrical reconstruction was less problem- riddled. The system was already available in November 2002. The dedicated "Baltas" type phantom has been tested and the system is now in routine use. Accompanying

documents and forms for reporting results were tested and were found suitable. Two network members were selected to help the Equal lab in case of results showing major deviations. Whenever these occur, the experts mediate between the participating centre and the lab. A mailing to a selected group of centres/physicists was carried out to encourage participation to the test. The response was first slow but quickly gained momentum. A summary of first results was available via the ESTRO desk at the ESTRO Physics meeting in Geneva, September 2003. A short paper was prepared for the ESTRO Newsletter.

Topic 3: The book on QA procedures is subdivided into 2 parts. One is on steps for the general quality control of afterloading equipment, peripheral devices and on infrastructure. The second part is on data needed for the evaluation of the quality of treatment planning systems, with the emphasis on presenting numerical data of widely used source types for implementation into brachytherapy treatment planning systems. The production of the guidelines in such a short time frame has cost the network partners involved almost all of their free time and weekends. Notwithstanding a thorough review by external readers and the ESTRO physics Committee, the publication has come from the press just in time to be added to this final report. As is the case for all ESTRO guideline booklets, this booklet 8 will also be made available in downloadable format on the ESTRO website.

An impressive list of oral and poster presentations on the BRAPHYQS project at national, European and international meetings and written reports in journals and newsletters bears testimony to the high marks given by the radiation oncology community to the pioneering work delivered by the BRAPHYQS group.

BRAPHYQS' links to other European and international initiatives

Jack Venselaar, Task Leader and Germaine Heeren, senior staff member at the ESTRO Office are involved in the work of the EMIR Network. This network of JRC Petten, the European nuclear medicine and radiotherapy societies and the producers of radionuclides is collecting data to document the use, need and availability of radionuclides for medicine. There is a combined interest in these data, on one hand to gain insight in the workload, resources and level of training and education at the brachytherapy (the interest of the GEC-ESTRO brachytherapy committee) and the nuclear medicine departments. On the other side hand is a wish to develop a survey of the prospective use of radionuclides to ensure the required production capacity (the EMIR interest). The data may help in the development of educational programmes and in decision-making. A proposal for a web-based questionnaire system was prepared and after the presentation of the project at the European brachytherapy meeting in Lübeck data collection was started. Data will be shared among the participants in the project. Many BRAPHYQS network partners are actively involved as national co-ordinators of this exercise.

Heiki Tölli, till recently physicist in the Human Health Division at the International Atomic Energy Agency (IAEA), participated in the Braphyqs meetings as an observer and initiated a project for the inter-comparison among 4 standard laboratories (IAEA, PTB, NMI and ADCL) of their calibration facility for the widely used ^{192}Ir brachytherapy sources. The N_k calibration factor for the tedious spectrum of this source is to be determined for 4 different ionisation chambers, after which the results will be compared. The results were presented during the regular 6th Braphyqs network meeting in Vienna, October 2003. A further analysis among the participants is needed before it can be presented formally.

Plans for the future

In a first step, several experts, who had started within their own country or institute projects related to the techniques of prostate implants, were invited to explain the status of their work. The different approaches were evaluated for their possible application on a wider (preferably European) scale. The subgroup included Mangili (Milano), Siebert (Kiel), Salembier and Rijnders (Brussels), Kirisits (Vienna),

Debrabandere (Leuven), Venselaar (Tilburg) and representatives of the ESTRO Office and the ESTRO-Equal Lab. Proposals were further prepared and discussed during the regular Braphyqs meetings.

The Braphyqs Network met 6 times respectively in Sevilla, Paris, Valencia, Oslo, Lübeck and Wien. During the meeting in Lübeck, May 14-17, 2003, several subgroup meetings were organised. The 6th and final Braphyqs Network Meeting took place in Vienna, October 17-19, 2003. Practically all network members were present during these meetings, plus a number of invited observers.

The General Meetings were meant to monitor and receive reports on the progress of the work. It was agreed that the work of the Braphyqs group should be extended to cover also the need of QA procedures for prostate implants. For this purpose a group of clinicians were recruited to join the network as experts. These invited experts participated in the discussions at both the Lübeck and Vienna meetings.

EUROPEAN IMPACT AND INTERNATIONAL DIMENSION

Thanks to this project new benchmarks were set for the standards of education and quality assurance for Radiotherapy (RT) in Europe.

ESTRO has more than 6200 members representing the vast majority of European RT professionals and a deep penetration worldwide with 1350 members from outside Europe. Networking all the European teaching departments and maintaining excellent relationships with European National RT Societies and International bodies such as the Human Health and Radiation Protection Divisions of the International Atomic Energy Agency (IAEA), ESTRO is ideally placed to contribute to standards at the international level and to have the guidelines developed in this project implemented both at the national level and the European level.

The ESQUIRE Task Groups pool the top experts in Europe for each of the areas concerned. We were allowed to include a few experts from the new member states although there was no provision made for this in the Programme. Experts from the IAEA participated in several task groups and a close collaboration was established for tasks 2 and 6 with the American Radiation Oncology Society (ASTRO) and the American Medical Physics Society (AAPM). Thanks to this broad platform and the many dissemination tools, the Society has its disposal, the ESQUIRE project will have a vast impact not only in the EU member states but also at the international level.

DISSEMINATION ACTIVITIES

With a top ranked scientific journal, a newsletter, an active website and an average of 18 to 20 seminars, workshops, scientific meetings and teaching courses every year, ESTRO has a choice of instruments at its disposal for the dissemination of project results. The long list of publications and presentations hereafter illustrates the unique impact the project has had also at the national and international levels. Unless stated otherwise we will not list again in this section the numerous dissemination activities already reported on in previous progress reports.

ESTRO Website

All the outputs of the project, are made available through the ESTRO website under the buttons guidelines, education, publications, projects.

Under "Projects" the interim and final reports are posted. Most of the ESQUIRE task groups use FTP sites, usually hosted by the web server of the network coordinator's university, as a common workspace. For this reason there was no need to post meeting reports and other work documents. However, for the purpose of dissemination, some of the presentations given by partners at network meetings or at open scientific meetings are made available for free use and reproduction.

Also the popular "European Handbook for Radiotherapy" and the booklets 7 and 8 published in the series of Guidelines for the Quality Assurance of Radiotherapy in Europe" are available for free on the ESTRO Website in PDF format.

ESTRO News, the Newsletter of ESTRO

For messages aimed at health Care workers in Radiotherapy, the ESTRO Newsletter is an excellent vehicle. It is circulated to the Society's 6174 members, the vast majority of RT professionals in Europe. All the actions within the ESQUIRE project are primarily aimed at this target group. For this reason the Newsletter has been used on a regular basis to report on progress in the ESQUIRE Task groups and to advertise the availability of new QA checks in the EQUAL Lab, of new publications and guidelines. ESTRO News also reaches an international audience since 20% of ESTRO members live outside Europe.

ESTRO News 55 – Summer 2003: Pages 10 to 12; 22-27 (Copy annexed)

ESTRO News 56 – Winter 2003: Pages 7 to 12 and 16 to 19(Copy annexed)

Task 1: EQUAL

This list not only includes papers in peer reviewed journals, abstracts of oral or poster presentations or articles in proceedings books generated during the project ESQUIRE project but also those resulting from the preceding EAC MORQA project that constructed the basis for the EQUAL lab and made its rapid development possible.

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Task 2. REACT

O. Ataman, A. Barrett: Patient Identification and Recording of Adverse Treatment Effects (PIRATE). Paper accepted for publication in "Radiotherapy & Oncology"

Özlem U. Ataman^{a,b*}, Ann Barrett^{a,c}, S. Davidson^d, S. Dische^e, B. Dubray^f, IM. Grillo^g, D. deHaas-Cock^h, A. Kramarⁱ, C. Haie-Meder^j, K. Hideghety^k, J. LeVay^l, J. Maher^e, RP. Muller^m, C. Reguerioⁿ, MI Saunders^e, I. Turesson^o, P. Van Houtte^p, V. Vitale^q and G.Heeren^r: Audit of effectiveness of follow-up clinics after radiotherapy for cancer . A report of the ESTRO REACT Network. Paper submitted to peer reviewed journal

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Task 3: EDRO

A comprehensive body of European guidance for the basic and continued education and training in the field of RT in Europe was developed and published in a thematic issue of Radiotherapy and Oncology, Volume 70, Issue 2, Pages 103-158. It includes the following Esquire - Task 3 EDRO generated documents which are also downloadable from the ESTRO website:

- Shaping the future: training of professionals for radiotherapy in Europe. Michael Baumann, Christine Verfaillie, Germaine Heeren and Jan Willem Leer, Pages 103-105
- Updated European core curriculum for radiotherapists (radiation oncologists). Recommended curriculum for the specialist training of medical practitioners in radiotherapy (radiation oncology) within Europe. M. Baumann, J.W.H. Leer, O. Dahl, W. De Neve, R. Hunter, R. Rampling, C. Verfaillie, Pages 107-113
- Union of European Medical Specialists: European Training Charter for Medical Specialists, UEMS 1995. Radiotherapy. Chapter 6, Charter on training of the medical specialists in the EU. Requirements for the specialty Radiotherapy. Pages 115-116
- Training Logbook for Radiotherapy. Robin D. Hunter, Boguslav Maciejewski, Jan-Willem Leer, Munir Kinay, Germaine Heeren and the European Board of Radiotherapy (Radiation Oncology). Pages 117-121.
- Guidelines for the infrastructure of training institutes and teaching departments for Radiotherapy in Europe. E. Röttinger, A. Barrett, J.W.H. Leer and the European Board of Radiotherapy. Pages 123-124
- Guidelines for education and training of medical physicists in radiotherapy: Recommendations from an ESTRO/EFOMP working group. Teresa Eudaldo, Henk Huizenga, Inger-Lena Lamm, Alan McKenzie, Franco Milano, Wolfgang Schlegel, David Thwaites and Germaine Heeren. Pages 125-135
- Revised European Core Curriculum for RT's. Mary Coffey, Jan Degerfält, Andreas Ostavics, Judocus van Hedel and Guy Vandeveld. Pages 137-158.

Task 4 EQART

Ans Swinnen, Jan Verstraete, Dominique Pierre Huyskens: The use of a multipurpose phantom for mailed dosimetry checks of therapeutic photon beams: "OPERA" (Operational phantom for external radiotherapy audit). Radiother.Oncol. 64 (2002) 317-326

Ans Swinnen, Jan Verstraete, Dominique Pierre Huyskens: Feasibility study of entrance dose measurements with mailed thermoluminescence detectors (Article submitted for publication)

Ann Van Esch, Tom Deopuydt, Dominique Pierre Huyskens: The use of an aSi-based EPID for routine absolute dosimetric pre-treatment verification of dynamic IMRT fields (Article submitted for publication)

Task 4: EQART Sub-task ROSIS

Biennial ESTRO Meeting on Physics and Radiation Technology for Clinical Radiotherapy. Topical session on ROSIS: the Radiation Oncology Safety Information System, Geneva, 17 September 2003.

Presentations:

- Rosis Pilot Study
- Rosis Incident Profiles
- Rosis Partner Profiles

Meeting of the UK Medical Physics Society (IPEM) 2003. Oral presentation Ola Holmberg, Mary Coffey: Radiation Oncology Safety Information System (ROSI): An ESTRO Project.

Task 5: QUASIMODO

Ben Mijnheer, Agnieszka Olszewska, Claudio Fiorino, Guenther Hartmann, Tommy Knöös, Jean-Claude Rosenwald, Hans Welleweerd: QUALITY ASSURANCE OF TREATMENT PLANNING SYSTEMS - PRACTICAL EXAMPLES FOR NON-IMRT PHOTON BEAMS. In print as Booklet nr. 7 in the series of ESTRO European Guidance Booklets for Quality Assurance in Radiotherapy. Will be available at the end of March

IV. Recommendations for the verification of IMRT following from the QUASIMODO project. Document of 24 pages, final draft circulated to Quasimodo network for feedback.

Gillis S., De Wagter C., Bohsung J., Perrin B., Williams P., Mijnheer B.J.:
IMRT treatment planning. An inter-centre quality assurance network for IMRT using film dosimetry: preliminary results of the European QUASIMODO project. (draft version still to be discussed in the QUASIMODO network and to be submitted to "Radiotherapy & Oncology" in 2004)

Quality assurance of treatment planning systems: how to express deviations between measurements and calculations?

Recommended tolerances δ , given as the confidence limit, for a dose deviation for the various regions in a photon beam. (Adapted from ESTRO Booklet 7, 2004). The confidence limit is defined as the absolute value of the average deviation plus 1.5 times the standard deviation.

(Abstract accepted for oral presentation at the 2004 meeting of the American Association for Physics in Medicine (AAPM))

Paper IAEA-CN-96-121 presented at the IAEA Symposium on Dosimetry, Vienna, November 2002/ QUASIMODO: An ESTRO project for performing quality assurance of treatment planning systems and IMRT. B.J. Mijnheer^a, C. De Wagter^b, S. Gillis^b, A. Olszewska^{a,c},

Paper presented at the Education Post Universitaire, Paris, March 2003: Contrôle de Qualité des TPS et de la dose délivrée. Programme QUASIMODO, Carlos De Wagter¹, Sofie Gillis¹, Agnieszka Olszewska², Ben Mijnheer²

Paper to be presented at the International Conference on the use of Computers in Radiation Therapy, Seoul, March 2004: Quality Assurance of Treatment Planning Systems: the ESTRO – QUASIMODO project*. Ben Mijnheer¹, Agnieszka Olszewska¹, Claudio Fiorino², Guenther Hartmann³, Tommy Knöös⁴, Jean-Claude Rosenwald⁵, Hans Welleweerd⁶

An inter-centre quality assurance network for IMRT using film dosimetry: preliminary results of the European QUASIMODO project. (Draft 14/04 - To be submitted to Radiother. Oncol. 2004. Gillis S., De Wagter C., Bohsung J., Perrin B., Williams P., Mijnheer B.J.

Draft IMRT treatment planning -A comparative intersystem and inter centre planning exercise of the QUASIMODO group (Joerg Bohsung, Charité, Berlin et al.

Task 6 : BRAPHYQS

J.L.M. Venselaar, J. Pérez-Calatayud, editors: "A practical guide to quality control of brachytherapy equipment" Authors: M. Bidmead, E. Briot, J. Burger, I. Ferreira, E. Grusell, C. Kirisits, P. Kneschaurek, M. Malgorzata-Kawczynska, C. Marchetti, T. Paulsen-Hellebust, J. Pérez-Calatayud, A. Rijnders, N. Teixeira, H. Tölle, J. Venselaar

Published as Booklet No. 8 in the series of ESTRO Guidance Booklets on Quality Assurance in Radiotherapy, Brussels (B), 2004 (Book)

Braphyqs: development of a brachytherapy physics quality assurance system

J.L.M. Venselaar

Meeting on Quality Assurance, EC-Network, June 30, 2001, Leuven (B) (Oral)

Quality Assurance in Brachytherapy

J.L.M. Venselaar

Course: Innovazioni in Brachiterapia, Associazione Italiana di Fisica in Medicina, November 12-14, 2001, Como (It) (Oral)

Esquire Task 6: Braphyqs. Development of a Brachytherapy Physics Quality Assurance System

J.L.M. Venselaar

ESTRO News 50 (Winter 2001) 7-8 (Paper)

The ESQUIRE BRAPHYQS program as a contribution to a system of quality assurance in Europe

J.L.M. Venselaar, I.H. Ferreira

Annual GEC-ESTRO meeting, May 9-11, 2002, Antalya (TK) (Oral)

Das ESQUIRE BRAPHYQS Programm als Teil eines Qualitätssicherungssystems für Strahlentherapie in Europa.

C. Kirisits, P. Kneschaurek, J.L.M. Venselaar, I.H. Ferreira

ÖGMP/DGMP/SSGMP meeting, September 8-11, 2002, Gmunden (AU) (Oral)

Quality Assurance of Brachytherapy Systems

J.L.M. Venselaar

Fourth NCS Lustrum Symposium on: Dosimetry, Perpetual Alertness Especially in the Digital Era

November 15, 2002, Delft (NL) (Oral)

QUALITY ASSURANCE OF BRACHYTHERAPY SYSTEMS

J.L.M. VENSELAAR

Klinische Fysica 2002/2+3, 29-33 (Paper)

The European Project BRAPHYQS

Janez Burger

Radiology&Oncology 2002, 36 (3):000-0) (paper)

ESTRO launch of the geometrical check for BT

J.L.M. Venselaar

ESTRO News 53, p11-12, (Winter) 2002 (Paper)

Quality Assurance of Brachytherapy systems

J.L.M. Venselaar

Brachytherapie Refereerdag 2003, Nucletron, Feb 28, 2003, Soestduinen (NL), (Oral)

First results of the geometric checks with the Baltas phantom in the ESTRO ESQUIRE Braphyqs project

A. Roué, I.H. Ferreira, J. Venselaar, A. Bridier, F. Bongeot, A. Dutreix

Annual GEC-ESTRO meeting, May 15-17, 2003, Lubeck (D) (Oral)

The Physics involved in a European programme for quality control in brachytherapy

N. Teixeira, J. Venselaar, P. Ferreira, A. Carvalho, A. Roué

BIOENG 2003 - 7th Portuguese conference on Biomedical Engineering.

June 26-27, 2003, Lisbon (P) (Oral)

Development of a TLD calibration system for ¹⁹²Ir HDR and PDR sources for the ESTRO ESQUIRE Braphyqs project

A. Roué, I.H. Ferreira, J. Venselaar, A. Bridier, L. Farhat, A. Dutreix

Annual GEC-ESTRO meeting, May 15-17, 2003, Lubeck (D) (Poster)

Developments in brachytherapy treatment planning

L.M. Venselaar

Annual GEC-ESTRO meeting, May 15-17, 2003, Lubeck (D)

(Invited teaching lecture)

BRAPHYQS: a European project for quality assurance in brachytherapy
N. Teixeira, J.L.M. Venselaar, I. Ferreira, J. Pereso, A. Carvalho, P. Ferreira
EFOMP Congress, May 20-23, 2003, Eindhoven (NL) (Oral)

Controllo di qualita in brachiterapia

C. Marchetti:

Meeting Semestrale di Gruppo di Studio di Brachiterapia,
Bologna, May 09, 2003 (Oral)

Il programma Esquire Braphyqs come contributo ad un sistema di garanzia di qualita in Europa

C. Marchetti

[First Mediterranean Meeting on Medical Physics 2003](#)

Agrigento, Sicily June 28, 2003 as part (Oral)

The Esquire Braphyqs program as a contribution to a system of quality assurance in Europe

C. Marchetti

1st Austrian, Italian and Slovenian Medical Physics Meeting,
Udine, November 7-8, 2003 (Oral).

BRAPHYQS: Un proyecto europeo para la garantia de calidad en braquiterapia

J. Pérez-Calatayud, J.L.M. Venselaar, I. Ferreira

Bi-annual Meeting of the Sociedad Española de Física Médica, SEFM, June 17-20, 2003 Vigo (Es),
(Oral)

ESTRO activities regarding brachytherapy: the BRAPHYQS program

J.L.M. Venselaar

Kring RKF van de Nederlandse Vereniging voor Klinische Fysica
Oct 30, 2003, Rotterdam (NL) (Oral)

Geometric and dosimetric audits to European brachytherapy centres

N. Teixeira, J.L.M. Venselaar, A. Roué, I. Ferreira, H. Tölli, M. Bidmead, P. Ferreira

ICRS-10 – RPS 2004 Conference, Madeira Island (P)

May 9-14, 2004 Oral)

A prostate phantom for quality control of postimplant seed reconstruction

M. De Brabandere, C. Kirisits, S. Lang, J. Venselaar, D. Georg, D. Huyskens

Annual GEC-ESTRO Meeting, May 14-16, 2004, Barcelona (ES) (abstract)

Design of a web page with dosimetric TG-43 parameters for all different models of Cs-137 and Ir-192 sources used in brachytherapy

J. Pérez-Calatayud, F. Ballester, M. Lis, E. Casal, D. Granero, R. Cases, J. Venselaar

Annual GEC-ESTRO Meeting, May 14-16, 2004, Barcelona (ES) (abstract)

Pitfalls in the use of TG43 in brachytherapy treatment planning, some examples

R. van der Laarse

Joint GEC-ESTRO/ABS/GLAC Brachytherapy Meeting, May 14-16, 2004, Barcelona (ES)
(abstract)

Results of the PCBE questionnaire-2002 in the Netherlands
J.L.M. Venselaar, F. Guedea, B.J. Slotman, T. Ellison, R. Nisin
Joint GEC-ESTRO/ABS/GLAC Brachytherapy Meeting, May 14-16, 2004, Barcelona (ES)
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TASK 6. BRAPHYQS

BRAchytherapy **PHYS**ics **Q**uality **S**ystem

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New Brachytherapy partners year 2- sub-group QA of permanent prostate implants

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ESQUIRE – FINAL REMARKS

The ESQUIRE Project has meant a giant leap forward for the quality assurance and education for radiotherapy. Notwithstanding the outstanding achievements of the project partners, as reflected in the reports of the Task Leaders, a lot of work still needs to be done. A continuity in support would be necessary, adding financial strength to moral leadership and the selfless commitment of dedicated professionals, to stay on top of developments and to give scientific societies like ESTRO the means to translate spectacular progress in science and technology into tangible gains for the cancer patient at the grass roots level.

However, even in the absence of funding, the meanwhile tightly knit groups of experts are not planning on complacency in the face of the enormous work still ahead. A complete and detailed action plan for tasks that need to be carried out in the future for achieving further progress in the quality of radiotherapy delivery, was drafted. The commitment to further contribute their expertise for a better outcome of

radiotherapy treatments is mirrored in all the ESQUIRE task groups. Without the possibility to meet on a regular basis, progress will be slower but the huge impetus given by the Europe against Cancer Programme to their work will definitely outlast the 2-year life span of the ESQUIRE project.

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