QUALITY ASSURANCE IN RADIATION TREATMENT PLANNING. PRINCIPLE CONSIDERATION S AND PRACTICAL PROPOSAL.

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Hile detailed quality assurance based on standard protocols are mandatory in external beam radiotherapy for treatment machines, dosimetry, dose specification and recording, no standard protocols are known for radiation treatment planning. User of treatment planning systems have, to some extent, introduced their own system checks, but usually one relies on hand calculations to verify doses to reference points in a patient treatment plan. Also, there appears to be present a wide-spread belief that the application of treatment planning systems in the daily routine will be sufficient to reveal any deficiencies the system might have. A few attempts have been made to introduce formalized quality control (QC) protocols for treatment planning, and specific investigations in this problem have been reported. Obviously, there is an urgent need for standardizes QC protocols in treatment planning systems.

However, there exist fundamental obstacles to quality assurance in radiation treatment planning systems. Such systems can only reproduce accurately, i.e. within the tolerance limits of the system, the data directly entered into the system, e.g. measured beam dose distributions. Essentially all other calculations of dose distributions are estimates, or rather predictions, in terms of the real dose distribution in the patient or phantom, of what will result from a specific irradiation technique. Therefore, the goal for QC in treatment planning can only be to establish confidence in calculation results which are, in principle, not verifiable. Such confidence is gained by checking out a limited range of results which are verifiable, e.g. by comparison of calculated with measured dose distributions, and by some additional plausibility considerations. In other words, the philosophy for the development of QC protocol in treatment planning needs to account for two basic facts: (i) The number of verifiable treatment planning applications is, in principle, unlimited. (ii) The additional time and personnel needed to run a QC protocol, is very much limited. Therefore, it appears to be reasonable to let a practical QC protocol embody the following test cases: a) regular tests of all local data entered into the system, b) a systematic compilation of a very limited set of carefully selected applications which allow the testing of basic characteristics of the system, and c) a collection of special test situations which are added to the compilation whenever they come up and are considered sufficiently general, or when a need is seen to check out an unusual system behavior.

Quality assurance in treatment planning systems, as generally in other systems too, may be subdivided into four test categories: 1. Pre-acquisition/system comparison checks. 2. Initial system checks (ICRU 42). 3. Repeated system checks (ICRU 42)/Constancy checks. 4. Intermediate system checks. In pre-acquisition checks the future user wants to find out which system might best fit to his or her needs. Such checks usually involve a system comparison. Test categories 2. through 4. are typical in-house checks and have quite different aims than has category 1. According to ICRU Report 42 initial system checks consist of the reproduction of input information, e.g. computation of beams for which data have been entered and the calculation of a set of selected example treatment plans, while repeated system checks consist of the calculation, at regular intervals, of a set of selected examples covering a range of irradiation techniques of the radiotherapy department. ICRU does not mention intermediate system checks which are here considered as important to be run following any system or data modifications, repairs, or service activities. They encompass any subset of the initial system checks from spot checks up to the full test range depending on the nature of the intervention.

According to the two categorial groups described above two different approaches for quality assurance protocols will be presented in detail. For the purpose of pre-acquisition checks and system comparison a data and plan library is under development by a German task group. It consists of a systematic compilation of a strictly limited and carefully selected set of applications which allow the evaluation of basic system characteristics amended by a few typical treatment plans. Beam data consist of a depth dose curve and five profiles as well as an isodose chart. This data is available in graphical, tabular and electronic form. A check of the off-axis calculation is also provided while more sophisticated techniques like 3D conformal

therapy are excluded by purpose. For the clinical cases, to-scale cross-sectional drawings and details of the techniques as well as best-knowledge isodose plans are made available.

For the in-house checks according to categories 2 - 4 a suggestion is made for the range of test cases the user should apply including proposals for the frequencies and range of checks.