Development of an expert system for automatic chart checking combined with departmental digital chart system

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放射線治療部内デジタル病歴システムにおける自動検証のためのエキスパートシステムの開発

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放射線治療部内電子病歴システムに併用して開発されたモニターユニットの自動検証システムを紹介する．プログラムはデルファイソフトウェアを用いて作成した．このプログラムではモニターユニットを計算し，疾患部位ごとに年間の平均値を蓄積し，個々に計算されたモニターユニットと比較することができる．このシステムでは治療パラメーターを入力し，算出されたモニターユニットに平均値±5%を超える誤差のある場合には，警告のメッセージが発せられる．今後は更に臨床データを蓄積することにより，このシステムの臨床的な意義が評価される必要がある．

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INTRODUCTION

Local tumor control as well as the incidence of complications are known to be closely related to the dose absorbed in the target tissue and the surrounding normal tissue, respectively. In this regard, reviewing treatment parameters contained in radiotherapy charts becomes an important quality-assurance activity. Although chart review by physicists can be considered as a traditional way of assuring quality of radiotherapy treatment, it does not completely eliminate the possibility of the errors associated with radiotherapy treatment. One way of further reducing the errors associated with radiotherapy treatment parameters according to our opinion is to develop and implement automatic chart checking system combined with our departmental digital chart system [1)-3)]. For dosimetric quality assurance purpose, a similar study was performed by Fontenla et al.[4)]. They implemented automatic check system in connection with their information management system. Using this feature they were able to detect the differences between planned and delivered dose greater than 5 %. On the contrary, our system does not involve the type of in vivo measurement, which Fontenla et al.[4)] have used. Our system detects possible errors in the treatment parameters such as field sizes, depth, and energies in the digital chart system. It specifically detects difference between the ratio of monitor units and prescribed dose for average patient (acquired as an annual average) and the ratio for individual patient greater than 5 %. In this paper, we introduce its features and implementation.

DESCRIPTION OF THE SYSTEM

Our radiation information management system (ROIMS) includes as one of its features automatic chart system[1)]. Our automatic chart system was developed based on Delphi 3.0[5)], and implemented with ROIMS. The system is capable of calculating monitor units for the treatment portals using beam

database for the linear accelerators we have in our department and the calculation formula contained in the software. The beam database includes, for all energies used in our department, tissue-maximum ratios, collimator and phantom scatter factors, off-axis ratios, and other factors included in the monitor unit calculation.

The system in its record also keeps the ratios between the annual-average monitor units to prescribed dose and tolerances (5 %) associated with the four categories of treatment (i.e. disease code) such as whole brain irradiation, lung, breast, and cervix. For whole brain irradiation, the system contains the average monitor units corresponding to parallel opposing treatment. For lung, the monitor units correspond to anterior, posterior, and oblique ports, respectively. For breast, the monitor units correspond to tangential ports. Finally, for cervix, the monitor units correspond to anterior, posterior, and lateral ports. Thus, this system can function for most routine treatment protocols taken by radiation oncologists in our department excluding 3-D and other special treatment such as total body irradiation. Table 1 shows some of the treatment conditions of the categories used in this study as average data taken during the past one year. Using these data, the average ratios for each disease categories were obtained.

CLINICAL APPLICATION

Fig. 1 shows the overall operational flow of the expert chart-checking system. The use of the system starts by typing in the disease code and treatment parameters in the menu boxes of the square on the left side of the window (Fig. 2). Then, one can click the "calculation" button enabling the system to calculate the monitor unit, and the result is recorded in the bottom box (i.e. M.U.). One can click the "confirm" button enabling the system to compare the calculated result with the average data, i.e. MU/cGy ratio, stored in it. If the result is within the limit bounded by the tolerance of the average data, then a warning message does not show up, and one can proceed to treatment. If the result is outside of the limit, then the system prompts a warning (i.e. confirm) message and forces one to choose between "override" and "correct" (see the central message box in Fig. 2). One can choose "override" if the warning message is found false or the input parameters are found correct. One can correct the input parameters if the warning message is found true or the input parameters are found wrong.

The confirmation message box in Fig. 2 shows that for the

Table 1 Some average beam parameters used as a basis for the expert system.

Beam direction	Energy (MV)	Depth (cm)	Field size (x) (cm)	Dose (cGy)	MU
Whole brain Lateral	4	8±1	20±1	150	172±3
Pelvis Ant/Post	10	10±2	16±1	90	100±3
Pelvis Lateral	10	16±1	10±1	90	124±13

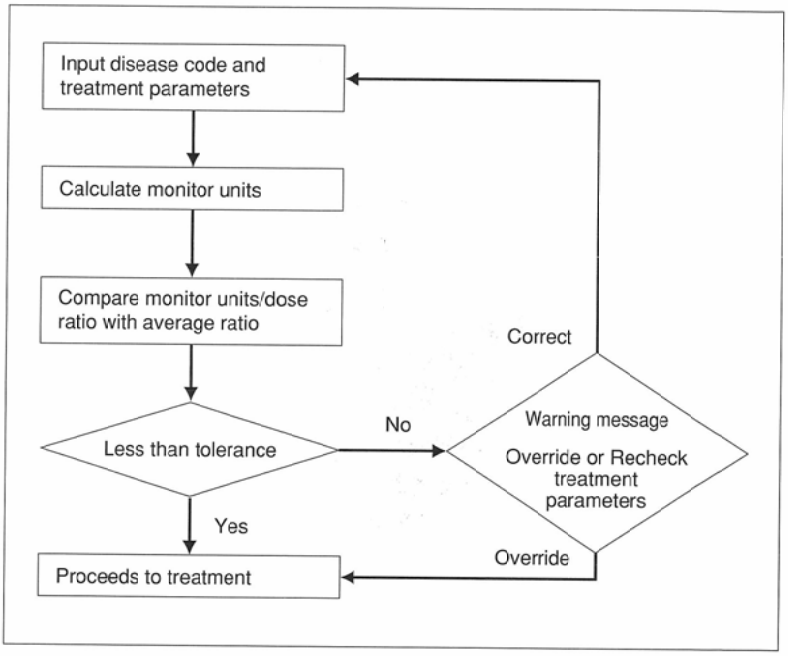

Fig. 1 The operational flow of expert auto-chart checking system.

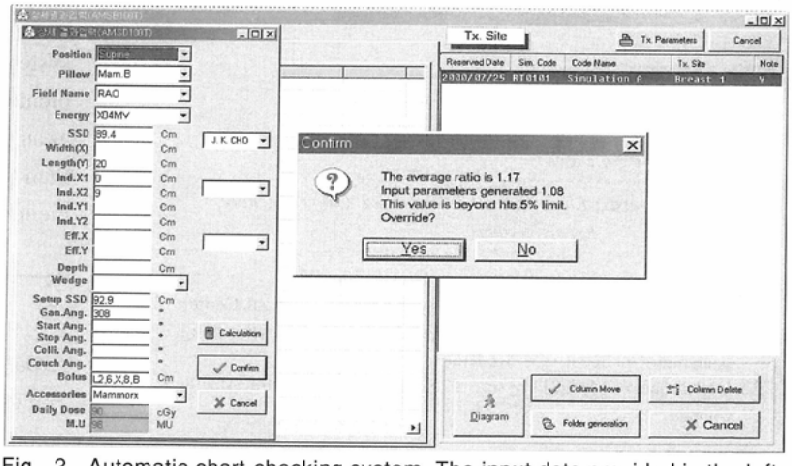

Fig. 2 Automatic chart-checking system. The input data provided in the left-hand side of the figure are treatment parameters. The warning message is generated in the central part.

tangential breast irradiation with a right-anterior-oblique field the calculated value of MU/cGy is 1.08 violating the 5 % limit of the average value of 1.17, the stored value in the system. In our clinical practice, we routinely use this system for the aforementioned cases and those which are based on manual calculation of monitor units.

DISCUSSION

Macklis et al.[6] reported that errors are much more common in routine medical practice than previously believed. Their report stated that a comprehensive record-and-verify system seems to prevent the occurrence of many types of errors in clinical radiotherapy. Similarly, Klein et al.[7] investigated the change a modern record-and-verify system brings to the clinical radiotherapy department. One of the major contributions was the reduction of errors. Besides the application of record-and-verify system to radiotherapy, the system is also believed to reduce errors in other application such as pharmacy[8]. Most computerized record-and-verify systems as previously discussed verify the correct execution of the planned treatment process. In this regard, one of the distinctive characteristics of our system is the ability to check the treatment parameters and monitor unit calculation by comparing the parameters with the corresponding annual-average data.

We are in the process of accumulating statistical summary on how the system has changed our practice of radiotherapy and improved it. The developed system needs more sophisticated algorithm to implement 3-D treatment and real-time auto-checking feature of treatment parameters as well as delivered dose.

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