

การหาสาเหตุความผิดพลาดของการฉายรังสี ด้วยเอกสารตรวจสอบความถูกต้อง

Radiotherapy error detection by treatment verification sheet

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Abstract

Purpose: This study was undertaken to investigate errors in radiation therapy process using the treatment verification sheet as a medium for error detection.

Materials and methods: Treatment verification sheets were attached to the patient's file folder. Each physicist checked and marked the dosimetric part of the treatment verification sheets of each individual patient before transferring the plan to the treatment room. Technologists verified and marked the treatment verification sheets of all the treatment parameters from the radiation oncologist's prescription chart and treatment plan report before starting the first fraction of treatment. This verification was repeated every week during the whole course of the treatment. All the errors found were corrected immediately, collected and analyzed after the course of treatment had been completed.

Results: From May 2010 to February 2012, 1,136 cases were verified. We detected the treatment parameter errors in 150 cases (13.2%). Seventy-one cases (47.3%) out of the errors were from mismatches between the radiation oncologist's prescription chart and the treatment plan report. However, these errors did not result in significant incorrect dose to the target volume. One case received a 33.7% higher than the intended dose to the skin due to bolus misplacement. There were 2 cases (1.3%) resulted in serious dose errors to the target volumes. These errors were from incorrect dose calculation of Source Axis Distance (SAD) instead of Source Skin Distance (SSD) setting, resulting in maximum dose error of 11.5% under-dosage from the prescribed dose.

Conclusion: The treatment verification sheet is a good method for error detection and correction in radiotherapy process. It is easy to perform and early edited before treatment execution.

Keywords : Errors in Radiation Therapy, Quality assurance, Incident report

บทคัดย่อ

วัตถุประสงค์: การใช้เอกสารตรวจสอบความถูกต้องของการฉายรังสีเพื่อหาสาเหตุความผิดพลาดในกระบวนการฉายรังสี

วัสดุและวิธีการ: เอกสารตรวจสอบความถูกต้องของการฉายรังสีจะถูกแนบไปกับแฟ้มประวัติของผู้ป่วย โดยนักฟิสิกส์การแพทย์จะทำการตรวจสอบปริมาณรังสีก่อนจะทำการส่งข้อมูลแผนการรักษาเพื่อทำการรักษาต่อไป ก่อนเริ่มฉายรังสี นักรังสีการแพทย์จะทำการตรวจสอบข้อมูลต่างๆ เปรียบเทียบกับเอกสารกำหนดปริมาณรังสีจากรังสีแพทย์และแบบพิมพ์แผนการรักษา โดยกระบวนการตรวจสอบความถูกต้องของการฉายรังสีจะทำซ้ำในทุกๆ สัปดาห์ ตลอดระยะเวลาของการฉายรังสี ซึ่งทุกๆ ความผิดพลาดที่พบจะมีการแก้ไขทันทีและเก็บรวบรวมนำมาวิเคราะห์ผลภายหลัง

ผลการศึกษา: ตั้งแต่เดือน พฤษภาคม 2553 จนถึง กุมภาพันธ์ 2555 มีจำนวนเอกสารที่ได้รับการตรวจสอบความถูกต้องของการฉายรังสี 1,136 ราย พบว่า 150 ราย (ร้อยละ 13.2) เกิดความผิดพลาด โดยสาเหตุหลักเกิดจากข้อมูลที่ไม่ตรงกันระหว่างเอกสารกำหนดปริมาณรังสีจากแพทย์และแบบพิมพ์แผนการรักษาเท่ากับ 71 ราย (ร้อยละ 47.3) จากความผิดพลาดทั้งหมด ถึงอย่างไรก็ตามปริมาณรังสีที่รอยโรคได้รับไม่ได้เกิดความผิดพลาด มีความผิดพลาด 1 ราย ผู้ป่วยได้รับปริมาณรังสีที่ผิวหนังสูงขึ้นร้อยละ 33.7 สาเหตุเกิดจากการวางโบล์สผิด และพบผู้ป่วยจำนวน 2 ราย (ร้อยละ 1.3) ได้รับปริมาณรังสีที่รอยโรคผิดพลาดไปจากแผนการรักษามากที่สุดคือ ต่ำกว่าที่วางแผนไว้เท่ากับร้อยละ 11.5 สาเหตุจากการคำนวณปริมาณรังสีด้วยเทคนิค Source Axis Distance (SAD) แต่จัดทำผู้ป่วยด้วยเทคนิค Source Skin Distance (SSD)

สรุป: เอกสารตรวจสอบความถูกต้องของการฉายรังสีนี้เป็นวิธีการที่ดีและเหมาะสม เพื่อหาสาเหตุความผิดพลาด และประกันคุณภาพงานในกระบวนการฉายรังสี ความผิดพลาดของผู้ป่วยส่วนมากสามารถแก้ไขก่อนที่จะทำการรักษา

I. INTRODUCTION

A successful radiotherapy treatment is the result of a combination of a good machine, accuracy and precision of planning as well as treatment delivery. According to ICRU report No. 24 recommendation, the aim of clinical dosimetry must be as accurate as possible, with an uncertainty of $\pm 5\%$ ⁽¹⁾ Although all the mechanical

quality assurance (QA) of the machines, treatment planning system (TPS) calculation and dose output are within the acceptable limits, we still cannot be certain that radiation delivered to the patient is correct both in dose and distribution as planned. For example, a radiation oncologist plans to treat a patient with bolus to only a small

specified part of a volume, and the physicist calculates the dose prescribed by the radiation oncologist correctly. If the technologist misread the setup data, placing the bolus to the whole treatment volume, the patient could receive the wrong dose of radiation. In this case, although the TPS calculation and output are correct, the bolus was misplaced resulting in wrong radiation dose to the target volume. This might affect the surrounding normal tissues and show complications afterwards.

Several studies ^(2,3) have shown adverse effects and serious consequences from planning and treatment errors. In order to minimize or eliminate these errors, communication among teamwork members is vital. We realize that in-person communication is the best method to inquire about suspicious information. Nevertheless, in-person communication is difficult to achieve in a large and busy radiotherapy unit consisting of multi-disciplinary team including radiation oncologists, physicists, technologists, and nurses. In addition, the technical aspects of diagnosis, simulation, planning and treatment delivery are complicated and, sometimes, time consuming. An alternative choice of effective communication is using the treatment verification sheet which has been constructed by our physicists since 2010.

This study was undertaken to investigate errors in radiation therapy process using the treatment verification sheet as a medium for error detection.

II. MATERIALS AND METHODS

This study was initiated in May 2010 with the co-operation of the radiation oncologist, physicists and technologists. The treatment verification sheet, developed by our physicists in 2010, contained four parts: radiation oncologist's prescription, pre-treatment evaluation, treatment evaluation, and dosimetric details. Each part contained items of treatment planning and delivery which served as a checklist for both the physicists and technologists. The treatment verification sheet is shown in Figure 1. The treatment verification sheet was attached to the patient's folders until the completion of the treatment.

The planning process started with the radiation oncologist delineated the target volume and contoured the organs at risk on the virtual simulation. Then, the radiation oncologist defined

Treatment Verification Report										Sticker of patient name	
										Dr.	Room.
Doctor prescription (check within first 5 days)											
	Correct	Incorrect	N/A	Note							
1. Total dose, dose/fraction, number of fraction	☐	☐	☐								
2. Machine, energy	☐	☐	☐								
3. Accessories, modifiers (mask, support, bolus, wedge)	☐	☐	☐								
4. Plan modification/ plan order	☐	☐	☐								
Technologist _____	Date _____			Physicist _____	Date _____						
Pre-treatment											
	1 st wk	2 nd wk	3 rd wk	4 th wk	5 th wk	6 th wk	Note				
1. Patient identification	☐	☐	☐	☐	☐	☐	☐				
2. Treatment location	☐	☐	☐	☐	☐	☐	☐				
3. Tx technique	☐	☐	☐	☐	☐	☐	☐				
4. Accessories, modifiers	☐	☐	☐	☐	☐	☐	☐				
5. Gantry survey	☐	☐	☐	☐	☐	☐	☐				
6. Fields verification prior treatment	☐	☐	☐	☐	☐	☐	☐				
Technologist _____	Date _____			Physicist _____	Date _____						
During treatment											
	1 st wk	2 nd wk	3 rd wk	4 th wk	5 th wk	6 th wk	Note				
1. Patient identification	☐	☐	☐	☐	☐	☐	☐				
2. Patient monitoring via OC-TV	☐	☐	☐	☐	☐	☐	☐				
3. Jaws and MLCs movement	☐	☐	☐	☐	☐	☐	☐				
4. Field and number of field completed	☐	☐	☐	☐	☐	☐	☐				
Technologist _____	Date _____			Physicist _____	Date _____						
Dosimetry check											
	1 st wk	2 nd wk	3 rd wk	4 th wk	5 th wk	6 th wk	Note				
1. Plan verification before transfer plan	☐										
2. Weekly plan verification	☐	☐	☐	☐	☐	☐	☐				
Technologist _____	Date _____			Physicist _____	Date _____						

Fig. 1 The detail of treatment verification sheet

printed out for verification and the treatment was ready to commence.

Table 1. Classification of errors detection from the treatment verification sheet

Errors detection	Number of cases	Percent
1. Misread information	85	56.7
• Mismatch of radiation oncologist prescription and treatment plan report	71	47.3
• Simulation data incomplete	14	9.3
2. Treatment planning	14	9.3
• SSD/SAD	3	2.0
• Bolus	4	2.7
• Wedge	3	2.0
• Cone factor	3	2.0
• Energy	1	0.7
3. Plan transfer	27	18
4. Patient setup	24	16
• Bolus	4	2.7
• Wrong patient	3	2.0
• Wrong plan	2	1.3
• Change position	9	6.0
• Gantry rotation	6	4.0
Total	150	100

discrepancy was noted down in the treatment verification sheet.

III. RESULTS

During the study period, 1,970 treatment verification sheets were analyzed. 1,136 cases (57.7%) were verified for inaccuracy. The rest, 834 cases (42.3%), was excluded because of increasing workloads and its importance was not realized. We detected errors in 150 cases (13.2%). These errors, normalized to 150 cases, were misread information (85 cases, 56.7%), treatment planning (14 cases, 9.3%), transfer plan (27 cases, 18.0%) and patient setup (24 cases, 16.0%). The classification of errors detection from the treatment verification sheet is shown in Table 1. Most errors were minor mistakes and did not cause discrepancies in the target or organ doses. For example, incomplete simulation and transferred plan data which has been corrected before the first treatment was started. The major errors found were bolus calculation and placement. There were 4 cases (2.7%) of bolus misplacement, one case received a 33.7% higher than the intended dose to the skin. There were 3 cases (2.0%) of planning errors, planning two dimension breast tangential fields with Source Skin Distance (SSD) using setup information from that obtained from a Source Axis Distance (SAD) technique. Two of three patients had been treated to 20 fractions before the errors were discovered, resulting in an 11.5% under-dosage to the target volume. The dose errors to target volume are shown in Table 2. However, only one error was detected in each patient.

IV. DISCUSSION

Radiotherapy is a highly sophisticated and complex treatment. It required multidisciplinary teamwork, utmost accuracy in planning and dose delivery. Any error might result in severe complications. Utilizing the treatment verification sheet, developed by our Unit, was able to detect the serious errors in 3 cases. However, there were 42.3% of the patients not being verified. This reflected the vital importance of this process not being realized by both physicists and technologists. Other causes of failure could be due to the increasing workloads, redundant process and repetitive items in the treatment verification sheet. In spite of these drawbacks and inconvenience, it is a feasible method to detect sources of errors. This treatment verification sheet has to be revised, making it more precise while maintaining the vital parameters for verification. Radiation treatment and delivery need professional teamwork, its essence has to be installed into every personnel's mind.

Table 2 The target dose errors detection from the treatment verification sheet

Cause of errors	Target dose errors (%)
1. SAD/SSD	-11.5 - 1.8
2. Bolus	0.2 - 1.0
3. Cone factor	-4.6 - 0.1
4. Wrong plan	0.7
5. Wrong patients	1.6

V. CONCLUSIONS

Treatment verification procedure is an important process in radiotherapy. The treatment verification sheet helps to detect and edit errors before patients are irradiated. The process does not take time and interrupt patient service. Our study showed that utilizing the treatment verification sheet for error detection is feasible.

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