การวิเคราะห์การถ่ายฟิล์มซ้ำ ในงานรังสีวิทยา โรงพยาบาลบุรีรัมย์

A STUDY ON RADIOGRAPHIC REPEAT RATE DATA OF BURIRAM HOSPITAL

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ABSTRACT

Objective : The purpose of this study were to determine the repeat rate and causes of film repetition in radiology department of Buriram Hospital, this study provided valuable information to suggest preventive measures to reduce repeats.

Method : A prospective study was analysed monthly between April 2006 and March 2007. The data included the following information : type of examination, room used for examination, number and size of film used, number and size of film repeated, and reason for repetition. The reason for film repetition were classified according to the following : exposure fault, processing fault, patient motion, positioning fault, equipment fault, and others. Descriptive statistics was used to analyse the data.

Result : The total number of examinations is 73,909 using 93,900 films on 6,412 patients. The averae repeat rate was 3.70%. The first 6 months showed a trend of reduction in the repeat rate with an average repeat rate of 4.41% while the last 6 months produced an average repeat rate of 3.54%. This was due to the effectiveness of implementation of routine quality control and attend courses and training workshops for departmental staff. The exposure, and position and processing fault were the foremost contributors for repeats and constitute 38.04%, 27.40% and 16.76% of the total respectively. The highest repetition rate was for chest, 4.14% followed by spine, 3.85%, and skull/face, 3.79%. As per the average repeat rate, the cost of repeat films in the Buriram Hospital per year has been projected to be about 591,260 Baths.

Conclusion : The main cause of repetition film were exposure fault and positioning fault. It was found that human error contributed significantly to this cause. Based on the findings of this study a set of recommendations have been prescribed for the radiology department to reduce the repeat rate and to improve the safety culture.

Keywords : repeat rate ; exposure fault ; processing fault ; patient motion ; positioning fault ; equipment fault

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บทคัดย่อ

วัตถุประสงค์ : การวิเคราะห์การถ่ายฟิล์มซ้ำ ในงานรังสีวิทยา โรงพยาบาลบุรีรัมย์ มีวัตถุประสงค์ คือ หาอัตราและสาเหตุของการถ่ายฟิล์มเสียจากการถ่ายภาพรังสีเพื่อลดและป้องกันการถ่ายฟิล์มซ้ำ

วิธีการศึกษา : เป็นการวิจัยแบบไปข้างหน้า (Prospective study) ระหว่างเดือนเมษายน 2549 ถึงเดือนมีนาคม 2550 ข้อมูลที่ใช้ศึกษาประกอบด้วย ชนิดของการตรวจ ห้องที่ใช้ถ่ายฟิล์ม จำนวนและขนาดของฟิล์มที่ถ่าย จำนวนและขนาดของฟิล์มที่ถ่ายซ้ำ และสาเหตุของการถ่ายฟิล์มซ้ำ โดยแบ่งกลุ่มสาเหตุของการถ่ายฟิล์มซ้ำดังต่อไปนี้ คือ การตั้งเทคนิคไม่ดี (Exposure fault) เครื่องล้างฟิล์มขัดข้อง (Processing fault) ผู้ป่วยไม่ร่วมมือ (Patient motion) การจัดท่าไม่ดี (Positioning fault) เครื่องเอกซเรย์ขัดข้อง (Equipment fault) และอื่น ๆ วิเคราะห์ข้อมูลโดยใช้สถิติเชิงพรรณนา (Descriptive statistics) อธิบายเป็นจำนวนร้อยละ

ผลการศึกษา : ในการศึกษาครั้งนี้มีจำนวนผู้ป่วยทั้งหมด 6,412 ราย จำนวนครั้งการถ่ายฟิล์มเอกซเรย์ 73,909 ครั้ง จำนวนฟิล์มทั้งหมด 93,900 แผ่น พบว่าอัตราของการถ่ายฟิล์มซ้ำพบร้อยละ 3.70 และจากการวิเคราะห์อัตราของการถ่ายฟิล์มซ้ำใน 6 เดือนแรก พบว่ามีแนวโน้มลดลง โดยอัตราของการถ่ายฟิล์มซ้ำเฉลี่ยร้อยละ 4.41 และใน 6 เดือนหลัง พบเฉลี่ยร้อยละ 3.54 สาเหตุที่มีแนวโน้มลดลงเนื่องจากมีการเตรียมและตรวจสอบความพร้อมก่อนการปฏิบัติงาน ตลอดจนมีการพัฒนาความรู้ ความสามารถของเจ้าหน้าที่ผู้ปฏิบัติงาน สาเหตุของการถ่ายฟิล์มซ้ำที่พบมากที่สุด คือ การตั้งเทคนิคไม่ดี รองลงมา คือ การจัดท่าไม่ดี และเครื่องล้างฟิล์มขัดข้อง พบร้อยละ 38.04, 27.40 และ 16.76 ตามลำดับ ส่วนของร่างกายที่ถ่ายฟิล์มซ้ำมากที่สุด คือ ทรวงอก พบร้อยละ 4.14 รองลงมา คือ กระดูกสันหลัง ร้อยละ 3.85 และกะโหลกศีรษะ ร้อยละ 3.79 จากการวิเคราะห์สาเหตุของการถ่ายฟิล์ม จำนวนฟิล์มเสียทั้งหมด คิดเป็นเงินประมาณ 591,260 บาท

สรุปและวิจารณ์ : การศึกษาครั้งนี้พบว่าสาเหตุของการถ่ายฟิล์มซ้ำส่วนใหญ่เกิดจากการตั้งเทคนิคและการจัดท่าไม่ดี พบว่าเกิดจากเจ้าหน้าที่ผู้ปฏิบัติงานเป็นส่วนใหญ่ ดังนั้นควรมีการพัฒนาความรู้ ความสามารถของเจ้าหน้าที่ผู้ปฏิบัติงานเพื่อลดอัตราและสาเหตุของการเกิดฟิล์มเสียจากการถ่ายภาพรังสี ตลอดจนเป็นการลดค่าใช้จ่ายให้กับโรงพยาบาลอีกทางหนึ่งด้วย

INTRODUCTION

Medical diagnostic X rays are so extensively used that they represent by far the largest man-made source of ionising radiation received by the members of the general public. It has been estimated that about 21% of the total somatic dose and about 10% of the total genetically significant dose arise from medical procedures, the most important contributor beingdiagnosticradiology[1]. According to UNSCEAR's estimates (1988), the average effective dose equivalent from natural sources is 2-2.5 mSv a^{-1}, to which value an extra 20 to 40% is usually added to reflect the radiation used in medical diagnostic examinations[2]. Diagnostic procedures contribute more than 95% of the medical exposures[3]. The correct interpretation of the image is a condition for further therapy planning. Hence the quality of the image plays an important role in the accuracy of the diagnostic process. When a radiograph is not within acceptable quality limits, it must be repeated which increases the total exposure dose to the patient with an economic impact on the institution. It was reported that one patient in six, undergoing a diagnostic examination has at least one film retaken[4]. Thus it is important to evaluate the frequency of such repeat radiographs and to ascertain the principal reasons for their causes, in order that excess exposure of patients and consequent carcinogenic risk can be minimised. The review on state-of-the-art 'repeat analysis' reflects the wide scope of work that needs to be addressed for an in depth study. Repeat film analysis is a sort of subjective evaluation of image quality, where images judged to be of poor quality are categorised according to their causes. Repeat rate in this study is defined as the ratio of the number of repeated films to the total number of films used clinically during the same data collection period. The purpose of the study is to investigate the repeat profiles and causes in radiology departments of Buriram Hospital. The frequency of repeats and the relationship between repeat rates and examination types are studied in detail. One way of reducing the unnecessary exposure is through a quality assurance (QA) programme, which includes procedures that help to ensure satisfactory performance of radiographic X ray equipment on a day-to-day basis. This type of programme is either absent or not satisfactory in most hospitals in developing countries[5]. The aim of a QA programme is to provide quality that is satisfactory, adequate,dependable and economic. QA in diagnostic radiology is a means of maintaining standards in imaging and working towards minimising patient and staff doses.

Based on the analyses and findings of this study it has been possible to prescribe a set of recommendations to lower the rate of repeats, to improve the safety culture, and to promote QA programmes in X ray imaging practice.

MATERIALS AND METHODS

The study was conducted in radiology department of Buriram Hospital for 12 months from April 2006 to March 2007. All repeated films were collected from each individual X ray room. For each repeated film the radiography technologists had to fill in a standardised information sheet, especially prepared for this study. The data included the following information : type of examination, room used for examination, number and size of film used, number and size of film repeated, and reason for repetition. The most frequently prescribed examination types for investigation were chosen for this study. Details of the film sizes were used to assess excess exposures due to repeat radiographs and to estimate the financial cost of the examination. Data collection was done with the cooperation of the departmental staff. Thecompleted sheets were collected at the end of each day. The reason for repetition is one of the six parameters as defined below.

Exposure fault : Image visible but overall density is high or so low enough that diagnostic information may be obscured or missing due to incorrect selection of exposure factor.

Processing fault : Unacceptable radiograph as a result of faults in the processing cycle, dark room conditions, roller marks, and films stuck together etc.

Patient motion : Poor resolution due to subject movement, respiratory motion, and cases where collaboration with the patient was impossible.

Positioning fault : Selection of the wrong beam limiting cone or diaphragm setting, the film cassette being in an incorrect position while the exposure was made, or failure to push home the cassette tray properly.

Equipment fault : Included tube off-centring itself after positioning and deviation of output from expected results due todifferences between the set and actual exposure factors.

Others : Contained such reasons as items of factor clothing left on the patient, obscuring the areas of interest, for example jewellery on patients, two views in one side, poor bowel preparation, and unintentional folding of the film inside the cassette.

RESULTS AND DISCUSSIONS

The total number of examinations performed during this study period in Buriram Hospital was 73,903 using 93,900 films on 6,412 patients. The total number of repetitions was 3,478 of which 2,014 were for chest, 595 for extremities investigation, 207 for spine, 407 for abdomen/KUB, 178 for skull/Face and 77 for pelvis. A monthly analysis of data gave an average repeat rate of 3.70% for the period. A monthly distribution of repeat rates showed in Figure 1. The first 6 months showed a trend of reduction in the repeat rate from 6.27% in April 2006 to a low of 3.40% in October 2006, with an average repeat rate of 4.41% while the last 6 months produced an average repeat rate of 3.54%. The reduction was mainly due to the effectiveness of the implementation of routine quality control, attend courses and training workshops for departmental staff in order to improve skills and keep abreast with modern techniques.

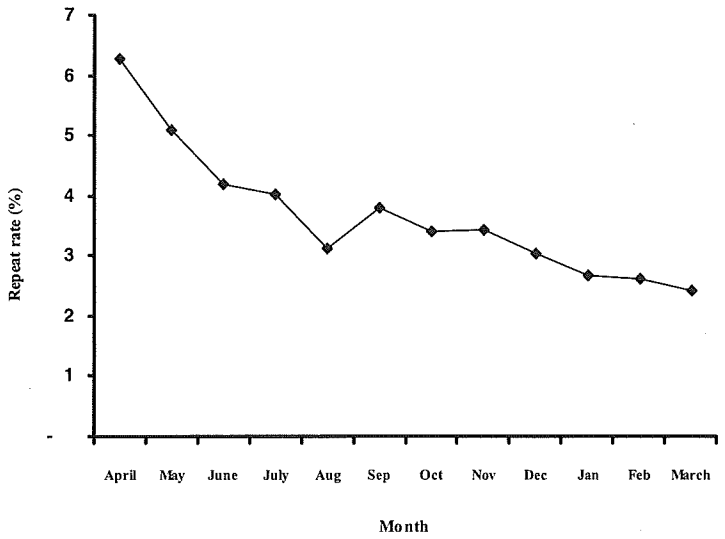

Figure 1. Monthly distribution of repeated films from April 2006 to March 2007.

The repeat rate for various types of examination showed the highest repetition was for chest, 4.14%, followed by spine, 3.85%, and skull/face, 3.79%. The repeat rates of abdomen/KUB and pelvis were also significant high, 3.27% and 3.03%, respectively. The extremities has repeat rate of 2.96%.

Analysis on the repetition showed that exposure fault is the major contributor to the repeat rate. Exposure, position fault and processing fault represent 38.04%, 27.40%, 16.76% of the repetition respectively. Figure 2 shows the distribution of causes for the total number of repeated film in Buriram Hospital. Table 1 lists the high spots of the investigation to demonstrate the most important findings of this study.

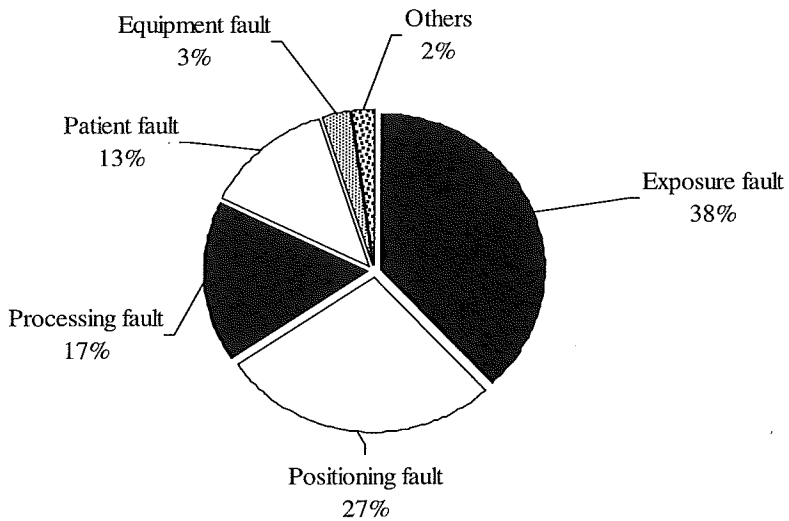

Figure 2. Distribution of causes (in percent) for the total number of repeated films.

It was found that the major repeats were due to exposure and position fault. It is understood that these faults include the combined effects of equipment malfunction and human error. The two independent findings are consistent and support each other.

Table 1. Analysis of the repeated film in Buriram Hospital.

Examination	Number of examinations	Number of films	Exposure fault	Positioning fault	Processing fault	Patient motion	Equipment fault	others	Total
Chest	44,696	48,696	639	603	338	319	69	46	2,014
Skull/Face	3,389	4,701	71	25	44	30	4	4	178
Abdomen/KUB	10,460	12,460	142	122	67	55	8	13	407
Spine	2,690	5,375	87	76	20	14	5	5	207
Pelvis	2,511	2,541	45	6	17	7	1	1	77
Extremitie	10,163	20,127	339	121	97	23	5	10	595
Total	73,909	93,900	1,323	953	583	448	92	79	3,478
% Cause of repeat			38.04	27.40	16.76	12.88	2.65	2.27	100

Table 2. Distribution of repeated films in different X ray rooms of Buriram Hospital with the cause for repetition.

Rooms	Repeat	Exposure	Position	Processing	Patient	Equipment	Others
	Rate (%)	(%)	Fault (%)	Fault (%)	Motion (%)	Fault (%)	(%)
1	3.66	40.69	27.05	16.11	10.76	2.68	2.44
2	3.74	35.30	27.73	17.37	14.87	2.62	2.12

The repeat rates among the examination rooms and with respective reasons are presented in Table 2. Such variations have previously been observed by Rogers et al[4]. In the present study the variations in repeat rates in rooms may be due to the frequency distribution of examinations within rooms, and the presence of new radiographers undertaking examinations within a room with which they had no familiarity and experience. A persistent or recurrent machine fault in a particular room, the lack of equipment maintenance, and the absence of routine quality control checks are also partially responsible for the variations.

The cost of repeats

Table 3. Projected annual repeat cost in baths.

Months	Average number of films used	Number of repeat films	Cost of the repeats in bath
April	9,100	571	97,070.00
May	7,200	366	62,220.00
June	8,700	364	61,880.00
July	7,200	290	49,300.00
August	7,700	240	40,800.00
September	7,500	285	48,450.00
October	8,100	275	46,750.00
November	7,700	265	45,050.00
December	8,000	242	41,140.00
January	7,700	205	34,850.00
February	6,700	175	29,750.00
March	8,300	200	34,000.00
Total	93,900	3,478	591,260.00

The cost of repeat per film has been estimated to be 591,260 baths, which includes the cost of film, chemicals, and equipment depreciation. The cost is relatively lower than some reference values[6,7]. Table 2 shows the estimated cost of the repeat films per year in baths. The cost to the general members of the public is even graver considering the excess radiation dose they buy with this money.

CONCLUSION AND RECOMMENDATIONS

An analysis of radiographic repeat data in diagnostic radiology in Buriram Hospital provided valuable information to suggest preventive measures to reduce repeats. The study showed that repetition due to exposure and position error are the major reasons for repeats. It was found that human error contributed significantly to these causes. Based on the findings of this study the following recommendations are prescribed for the radiology department to reduce the repeat rate and to improve the safety culture.

(1) The X ray facility should comply with the operational aspects the medical practitioner, the technologist, or other imaging staff should select the relevant parameters such that their combination produces an acceptable image quality to meet the clinical purpose of the examination.

(2) The case of paediatric X ray should be treated with special care and technique.

(3) Proper dark room conditions and

procedures, adequate image processing factors, e.g., developer temperature and image reconstruction algorithms should be strictly followed.

(4) The job distribution of the technical staff should be done carefully considering relevant skill and competence to reduce human error.

(5) Quality assurance and quality control programmes of imaging should be implemented to ensure that for diagnostic uses of radiation a requirement of standards is fulfilled with the advice of a qualified expert in either radiology or medical physics. Through a quality assurance programme, the function of each portion of an X ray system should be routinely checked. Proper collimation and filtration, optimisation of kVp, tube current, and exposure time can contribute significantly to improve the film quality and reduce repeats.

(6) A repeat analysis programme, like the current study, should be undertaken periodically which could identify the causes and suggest ways to reduce repeats that result in cost savings and a reduction in patients and personnel exposure dose. An analysis can provide feedback to individual technologists and can help to improve their professional skill and competence, and also the film quality.

(7) The facility, the equipment or practice should have a licence from an appropriate authority on the basis of safety and protection, financial resource, human resource, and compliance with all requirements of the applicable rules of practice.

It is expected that this study will contribute significantly to an improvement of the safety culture and QA programme of the concerned hospitals. This in turn will contribute significantly to reduce the rate of repeats.

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