*Professional article*

# SECOND YEAR RADIOGRAPHY STUDENTS AT THE DEPARTMENT FOR MEDICAL IMAGING AND RADIOTHERAPY IN LJUBLJANA, SLOVENIA AND REJECT ANALYSIS

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## Abstract

***Introduction:*** *The aim of this project was to recognize the reasons for rejects made by the second year radiography students at the Skeleton Diagnostic. Reject rate tells us whether the department works against the recommended standards, if the equipment is properly maintained, if routine tests of equipment are regularly performed and we can evaluate the effect of personnel education.*
***Methods:*** *The data were collected by an observation list prepared in advance with most common causes for rejects as suggested from literature and divided it according to the hours (8 am – 12 am). Five groups of students participated in the research, which was nearly half of them (n= 15), i.e. quota sampling.*
***Results and discussion:*** *506 radiographs were made by students, in total of which 156 were rejected – 30.8 %. After corrections of students' mistakes the reject rate was 4.15%. The most common reasons for students' reject were forgotten anatomical markers and wrong cassette identification. Incorrect exposure factors and patient movement were major reasons for real reject.*
***Conclusions:*** *Radiographers at clinical practice and the radiographers teaching in the skills lab got useful information as to where we should be particularly careful when preparing the students for clinical practice.*

## Introduction, aim and background

*Reject films are the sum of repeat films, which are made due to positioning, motion, technique, etc. and wasted films (Stevenson, 2001). The aim of this project was to recognize the reasons for rejects made by the second year radiography students at the Skeleton Diagnostic in Clinical centre in Ljubljana, which is (mainly) their first experience in practice. The other aim was to reflect on the quality of the "Radiographic positioning" module, which students have in their first year of studies and which combines theoretical lectures and practical work in a skills lab, as a preparation for the work in practice.*

## Why is reject analysis important?

*The main purpose for conducting reject analysis are ethical - reducing patient dose and political - reduction of costs. Wong et al (2000) stated that routine reject analysis is done to »reduce film costs and patient exposure«, which was also emphasized by Arvanitis (1991). Furthermore, we can establish whether the department works against the recommended standards, if the equipment is properly maintained, if routine tests of equipment are regularly performed and we can evaluate the effect of personnel education – if there is a need for additional training, added Gadeholt et al (1989). The more detailed the analysis is, the more effort will be required to collect the data, therefore Finch (2001) suggests it is better to start with a simple analysis and later develop more detailed analysis if it is required. In my opinion the most important factor is the reason why we are doing such analysis. Is it a routine check or are we looking at something specific? I was looking at the quality of student's current knowledge and wanted to find out what could be improved in skills lab to minimize the number of rejects when students come to diagnostic.*

## Legislative and political aspects

*European countries required the implementation of quality assurance program because X–ray departments are expensive to run (Henshaw, 1990) and reject films are costing the health service money they can ill afford. For that, quality assurance in diagnostic radiology is a legal requirement in countries within the European Community, which are required to comply with the Council Directive of 3 September 1984. This Directive determines:*

> *»All installations in use must be kept under strict surveillance with regard to radiological protection and the quality control of appliances.«*

*According to their reject research, Watkinson, Moores and Hill (1984); Goethlin & Alders (1985); Wong et al (2000); Hardy & Persaud (2001) and Clark & Hogg (2003) found that with the results of reject analysis expenses can be successfully reduced. Lewantat & Bohndorf (1997) added that the main approach to reducing costs must be to cut down technical film waste. Hardy & Persuad (2001) estimated that the loss to the NHS (National Health Service, Great Britain) in 1999 was between 3.24 and 4.86 million pounds.*
*In 2002 the Ionising Radiation Protection and Nuclear Safety Act (ZVISVJ) in Slovenia was introduced. Article 3 of ZVISVJ states that the quality assurance program has to include also the quality control of procedures. Item 6 of Article 23 of ZVISVJ determines that in order to provide ionising radiation protection for the exposed workers, apprentices and students during the radiation activity, the employer has to provide »training for the radiographers,*

*apprentices and students using the radiation sources, updating their knowledge...«. With implementation of current analysis and with introduction of the analysis results to radiographers and students this demand for updating the knowledge will be fulfilled.*

## *Professional documents of relevance*

*The 2nd paragraph of Article 2 of the Ethical Code of conduct (2001) explains that »radiographers shall respect the laws and regulations« and the 3rd paragraph says that »radiographers shall constantly develop their professional role, shall get professional education and shall ensure their own personal growth. They shall actively stimulate the professional development and education of their colleagues and students.«*
*Hardy & Persaud (2001) argued whether a radiographer possesses the ability to assess the diagnostic potential of a radiograph. They raised this question because they believe that a decision to reject, repeat or accept the image is in majority radiographers' sphere. Gadeholt et al (1989) and Finch (2001) argued on the acceptance criteria for radiographs, which can be different among various radiology departments; something may be acceptable for one radiologist, but useless according to another.*
*The following authors have decided to present their reject rates, as mentioned bellow:*

- *Total number of rejects (total waste + total repeat) - Watkinson, Moores and Hill (1984); Gadeholt et al (1989); Arvanitis (1991); Bassey et al (1991); Lewentat & Bohndorf (1997); Dunn & Rogers (1998); Weatherburn et al (1999); Wong et al (2000); Peer et al (2001); Clark and Hogg (2003).*
- *By various reasons for rejection – Watkinson, Moores and Hill (1984); Arvanitis (1991); Bassey et al (1991); Lewentat & Bohndorf (1997); Dunn & Rogers (1998) Weatherburn et al (1999); Peer et al (2000); Wong et al (2000); Clark and Hogg (2003); Muhogora et al (2005) .*
- *Time presentation (in weeks, months) – Watkinson, Moores and Hill (1984)*
- *Wastage in surface - Gadeholt et al (1989) or m2 - Arvanitis (1991) .*
- *By different body parts - Watkinson, Moores and Hill (1984); Lewentat & Bohndorf (1997); Dunn & Rogers (1998); Weatherburn et al (1999); Wong et al (2000); Clark and Hogg (2003) .*
- *By examination - Watkinson, Moores and Hill (1984); Gadeholt et al (1989); Arvanitis (1991) .*
- *By examination room - Watkinson, Moores and Hill (1984); Arvanitis (1991); Muhogora et al (2005) .*

*The lowest percentage in reject film analysis was published by Sheung – Ling et al (2004) – 2.1 %. The following percentages were quite high: Venter (1995) – 19.49 %, Peer et al (2001) - 27.6 %, and even 33 % by Clark & Hogg (2003). Stevens (2001) believed that a repeat rate under 3 % is not realistic, but if exceed 10 % action (such as education) should be taken.*
*Stevens (2001) wrote that some authors advocate 2-week analysis every six months and some every quarter.*

## *Social interaction*

*There is no doubt that one of the most important aspects for the analysis to succeed is the cooperation of participants, in our case, the radiographers.*
*Arvanitis (1991) and Finch (2001) stressed the importance of cooperation from the staff department. He discussed the significance of informing and involving as many staff members as possible to ensure positive approach. Clark and Hogg (2003) also emphasized that the compliance of all radiographic staff is necessary for the smooth and accurate course.*
*It is inevitable with such analyses that some anxiety exists amongst the working staff, believed Arvanitis (1991). To avoid this, Stevens (2001) suggested »that staff should be reminded that the repeat analysis is a routine undertaking and should not be viewed as a mechanism for punishing the personnel«.*
*All of the above-mentioned authors agreed that a research cannot take place without cooperation. None of them, however, gives any advice on how to act after completing the analysis of individual diagnostics, in case someone has an extremely high number of repeats.*
*Sapsford and Jupp (1996) mentioned the groups in which the ethical aspect is extremely important, such as prisoners, patients, older people, people from lower social classes, and also students; these are the groups that depend on their superiors. I consider the students to be a member of such group when tutors monitor their work. Benjafield (1994) also describes a group of »students or subordinates« and points out that the researcher has to »take special care to protect the prospective participants from adverse consequences of declining or withdrawing from participation«. When the teacher - a tutor researching his or her own pupils – students »may have a direct power over the future of the people whom he or she wants as research informants. Even if not, there is an existing authority or dependency relationship such that the informants may feel bound to cooperate, however fairly that the request is put« asserted Sapsford and Jupp (1996). The type of research with a subordinate group that depends on its superiors has to be carefully planned and the recommendations of the Ethical guidelines for conducting research (Benjafield, 1994) have to be followed. In Slovenia National Medical Ethics Committee (http://www.mf.uni-lj.si/kme-nmec/) gives ethical approvals to researchers.*

## *Hypotheses*

*H1 At the beginning of practical work the students make more mistakes than at the end.*

*H2 The most common cause of mistakes made by students during practice is the wrong setting of the central ray and the wrong position of the examinee.*

## METHODOLOGY

*After examining the reasons for the reject and repeat films in professional literature and after studying the literature on different research methods, I came to conclusion that the best method for obtaining the information on the causes of mistakes made by students is systematic observation with partial participation (more - structured observation). The data were collected by an observation list prepared in advance with most common causes for rejects as suggested from literature and from my last years' reject analysis with students involved. In my research a descriptive method was used.*

### Sampling

*There were 40 students in the second year class and students are placed in groups of three students. Five groups of students participated in the research, which was nearly half of them (n= 15), i.e. quota sampling.*

### Method of data collection – content of the observation list

*The content of the above list was decided after reviewing the literature about reject analysis (books and journal articles).*
*I prepared an observation list of all potential mistakes and divided it according to the hours (8 am – 12 am). Thus I also observed when the reasons for rejections occurred and why. I prepared a new list (see Table 1) for every day and marked the appropriate box for each mistake at a certain time (hour – see Table 3). At the end of the day I counted the mistakes and the exposures made in one day.*

### What are difficulties with observation?

1. *Validity of observation; when the observer distracts the subjects of observation with his/her presence or changes the natural course of events (Sapsford & Jupp, 1996; Mesec, 1997). I managed to avoid this by leaving the diagnostic and returning only when they called me. I was observing them through the window.*
2. *Objectivity issue; in order to avoid subjective judgment I strictly defined the things I was about to observe - reasons for rejects were chosen from literature concerning rejects and reasons for rejects made by students from my previous reject analysis. It would be ethically and professionally inadmissible to exposure the patients due to the mistakes made by students and that could be corrected by the tutor, so I included the corrected mistakes among the mistakes in analysis, which was not always easy, because it is sometimes difficult to determine whether a certain mistake would make the film useless or not.*
3. *Reliability issue was mentioned by Mesec (1997). When the observation is longer, unreliability or non-systematic mistakes can occur, when the observer is inconsistent. Kobeja (2002) discusses that the possible influences are weather, illness, tiredness, or bad mood.*

*The list was divided into two main reasons for rejects; human factors and technical factors.*

*Table 1. Classification of reject films made by students*

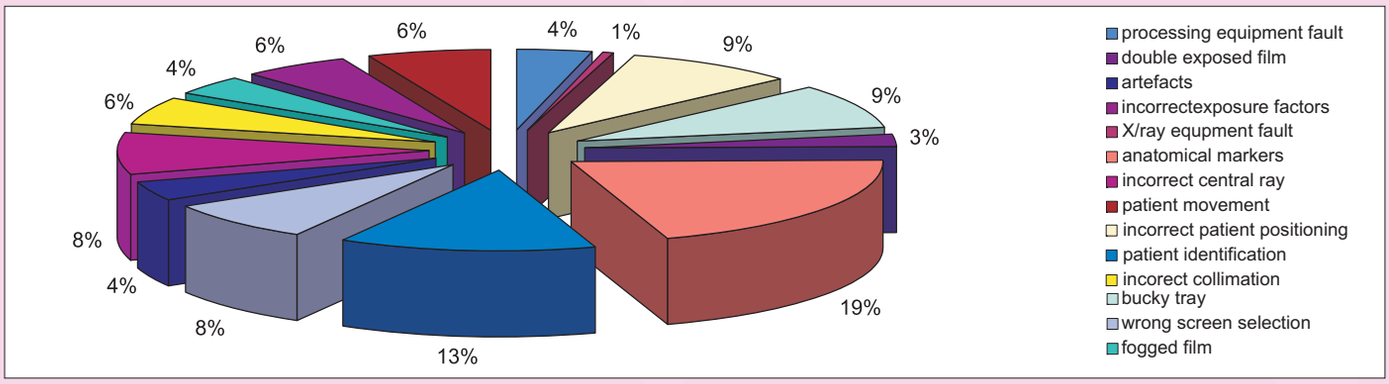
| **REASON/NUMBER** | 8-9 | 9-10 | 10-11 | 11-12 | together | % |
|---|---|---|---|---|---|---|
| **technical factors:** | | | | | | |
| processing equipment fault | | | | | | |
| X–ray equipment fault | | | | | | |
| **human factors:** | | | | | | |
| incorrect patient positioning | | | | | | |
| bucky tray | | | | | | |
| double exposed film | | | | | | |
| anatomical markers | | | | | | |
| patient identification | | | | | | |
| wrong screen selection | | | | | | |
| artefacts | | | | | | |
| incorrect central ray | | | | | | |
| incorrect collimation | | | | | | |
| fogged film | | | | | | |
| incorrect exposure factors | | | | | | |
| patient movement | | | | | | |
| **total numbers of mistakes** | | | | | | |
| **total number of exposures in one day** | | | | | | |

***Technical factors:***

- *processing equipment fault – processing error, static error (artefacts), film was not loaded in the cassette, scratched film,*
- *X–ray equipment fault – fall in x–ray tube.*

***Human factors:***

- *Incorrect patient positioning – the patient has not been positioned to show the whole body area or to demonstrate pathology adequately.*
- *Bucky tray – insufficiently pushed tray, no cassette in tray and exposure without cassette – patient positioned correctly but exposed without cassette.*
- *Double exposed film – two superimposed images on one film.*
- *Incorrectly used or forgotten anatomical markers – upside up or down, marker used at wrong body side, no markers on film.*
- *Patient identification – processing without patient identification, wrongly used AP/PA, wrong name.*




*Graph 1: Classification of reject films made by students*

- *Wrong screen selection – students could use regular or fine screen.*
- *Artefacts - jewellery placed in anatomical area, forgotten false teeth, lead protection in exposure field.*
- *Incorrect central ray – because of incorrect central ray anatomy and pathology weren't demonstrated adequately.*
- *Incorrect collimation – because of too narrow collimation the area of interest was not present.*
- *Fogged film – cassette opened by mistake, light leakage.*
- *Incorrect exposure factors – overexposure (too dark), underexposure (too light).*
- *Patient movement – the patient cannot hold body area as it was positioned.*

*Processor cleaning films were not included in analysis.*

## *RESULTS AND DISCUSSION*

*The reject analysis has been undertaken for 20 working days (4 week period) in the Skeleton Diagnostic at Clinical centre in Ljubljana by observing 15 second year students of College*

*Table 2: Classification of reject films made by students In table three the share of rejects done in hours is presented.*

| REASON/NUMBER | 8-9 | 9-10 | 10-11 | 11-12 | together | % |
|---|---|---|---|---|---|---|
| **technical factors:** | | | | | | **4.4 %** |
| processing equipment fault | 2 | 2 | 1 | 1 | 6 | 3.8 % |
| X–ray equipment fault | 0 | 0 | 1 | 0 | 1 | 0.6 % |
| **human factors:** | | | | | | **95.6 %** |
| incorrect patient positioning | 2 | 5 | 5 | 2 | 14 | 9 % |
| bucky tray | 4 | 6 | 4 | 0 | 14 | 9 % |
| double exposed film | 1 | 2 | 1 | 0 | 4 | 2.5 % |
| anatomical markers | 7 | 13 | 7 | 5 | 32 | 20.5 % |
| patient identification | 3 | 6 | 4 | 8 | 21 | 13.5 % |
| wrong screen selection | 2 | 5 | 4 | 2 | 13 | 8.3 % |
| artefacts | 1 | 2 | 2 | 1 | 6 | 3.8 % |
| incorrect central ray | 3 | 6 | 2 | 2 | 13 | 8.3 % |
| incorrect collimation | 0 | 3 | 3 | 3 | 9 | 5.7 % |
| fogged film | 2 | 1 | 3 | 0 | 6 | 3.8 % |
| incorrect exposure factors | 1 | 2 | 4 | 2 | 9 | 5.7 % |
| patient movement | 2 | 1 | 4 | 3 | 10 | 6.4 % |
| **total** | **30** | **52** | **45** | **29** | **156** | **100 %** |

*Table 3: Classification of reject films made by hours After corrections of students' mistakes the reject rate was 4.15 %. Details are presented in Table 4.*

| time | 8-9 | 9-10 | 10-11 | 11-12 | **together** |
|---|---|---|---|---|---|
| total | 30 | 52 | 45 | 29 | 156 |
| **%** | **19.2 %** | **33.3 %** | **28.8 %** | **18.7 %** | **100 %** |

*Table 4: Classification of reject films after students' mistake were corrected by tutor*

| REASON/ NUMBER | together | % |
|---|---|---|
| **human factors:** | | |
| patient identification | 2 | 9.5 % |
| artefacts | 2 | 9.5 % |
| fogged film | 2 | 9.5 % |
| incorrect exposure factors | 9 | 43 % |
| patient movement | 6 | 28.5 % |

*for Radiographers in Ljubljana.*
*For 20 days I was observing them in clinical practice from 8 am – until 12 am. In that time 506 radiographs were made by students, in total of which 156 were rejected – 30.8 % (see Table 4).*
*The overall reject rate was 31 % and it can be compared with Clark & Hogg (2003) with 33 %. The above authors have also reported to have a lot of young radiographers and students working at the time of their research. In this study following the tutor's correction of students' mistakes the overall reject rate was 4.15 %, which can be compared with Gadeholt et al (1989) and Arvanitis et al (1991). Major reasons for rejects were exposure factors and incorrect positioning in both compared analysis.*

***Reasons for "student's reject rate"***

***Anatomical markers:*** *Although paying a lot of attention in skills lab to placing markers to the cassette this is still the leading problem that students have and has to a large extent contributed to the reject percentage with 19 %. Some students have problems with left and right when patients change positions (legs where the head was with previous patient). Further problems with markers were when they managed to find the right side but did not turn it correctly (AP instead of PA or the other way). As we are trying to be*

*strict with students in order for them to learn properly I also considered it to be a mistake when markers were turned upside up or down. None of the authors mentioned this problem, so I think this problem is a "student specific" one.*
***Patient identification:** 13 % of reject was caused by patient identification. Either students forgot to identify the cassette or to change from AP to PA when identifying the cassette. In one occasion they managed to make a real reject. There were three patients for Waters projection, one after another, and students did not identify them correctly. We found out the name of the last patient but had to make the other two once again.*

***Reasons for "real reject rate"***
***Incorrect exposure factors** are being reported as one of the major factors for rejects by many authors (Watkinson, Moores and Hill (1984); Gadeholt et al (1989); Arvanitis (1991); Weatherburn et al (1999); Peer et al (2001); Clark and Hogg (2003) and was our major reason in "real" reject rate.*
*Though we have updated exposure list, as suggested by Watkinson, Moores and Hill (1984) there are still situations where over and under exposures cannot be avoided. In reject analysis teamwork is in my opinion most important. Each radiologist does not require the same density or same position of radiograph for the same diagnosis and if a radiographer thinks his/her radiographs will be reported by the radiologist no. 1 he/she will make different radiographs then for the radiologist no. 2. If the radiologists change for any reason, there is a number of rejects because of that. In this case it would be worth explaining the situation to the radiologist and try to get the radiologist to come into line for the good of the patient.*
*The reject rate could be even lower if the radiologists were present at diagnostic when radiographs are being made, which was also suggested by Gadeholt et al (1989). This refers to the over and under exposed films. We had 9 such films and as the radiologist was not present we decided to repeat those and to make new ones as we were not sure if the already made radiographs would be excepted. Presence of a radiologist might reduce this number even to zero.*

***Patient movement** as a reason for rejects has been mentioned by nearly all authors who did their analysis by reason. Although patients are told to be still or hold their breath, some of them did not understand and moved while exposing the film. The problem was not that they could not keep still, but that they did not understand the instructions (to keep still) or that the students did not explain them well enough.*

***CONCLUSION***
*The most common reasons for student's reject was forgotten anatomical markers or wrong cassette identification. The results have unambiguously pointed out problems that students have with imaging at the Skeleton Diagnostic, which was also the purpose of this research. Thus, the radiographers at clinical practice and the radiographers teaching in the skills lab got useful information as to where we should be particularly careful when preparing the students for clinical practice, or what particular points we should point out at the beginning of each day at clinical practice.*

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