Use of Anatomical Side Markers (ASMs) during Planar X-Ray Imaging

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DECLARATION

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Use of Anatomical Side Markers (ASMs) during Planar X-Ray Imaging

I hereby declare that I am the legitimate author of this Long Essay/Dissertation/Thesis and that it is my original work.

No portion of this work has been submitted in support of an application for another degree or qualification of this or any other university or institution of learning.

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Date
DEDICATION

I dedicate this dissertation to my wonderful parents, Pauline and Lawrence, who have always provided me with their endless love and support throughout my life.

I would also like to thank all my friends who have supported me during my studies, especially Mario, for his continuous patience and support.
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ABSTRACT

Purpose
The purpose of the study was to evaluate the perception and use of ASMs by radiographers working in a local radiology department in a general hospital in Malta and develop an information leaflet based on the outcomes of the study to promote awareness amongst radiographers highlighting areas of improvement of ASM use.

Methodology
The study was divided into two phases. Phase 1 involving a retrospective observation of radiographs over 5 years, using a self-designed data record sheet and phase 2 the distribution of a self-designed questionnaire to radiographers evaluating their perception of the use of ASMs. Data obtained was analysed using both descriptive and inferential statistics.

Results
In phase 1, 430 radiographs (86%) had evidence of ASM, of which 110 (25.6%) had a pre-exposure ASM and 320 (74.4%) had a post-processing ASM. The remaining 14% of radiographs had no evidence of either a pre-exposure or post-processing ASM. Two hundred and eighty two (282) (56.4%) of the radiographs having either pre-exposure or post-processing ASMs were placed according to stipulated guidelines. In phase 2, 15.4% of respondents stated that they prefer using pre-exposure ASM during practice while 84.6% of the respondents stated that they prefer using post-processing ASMs. Seventy seven percent (76.6%) of radiographers find it often or occasionally time consuming when applying pre-exposure ASMs. The average percentage score of correct answers to find out the radiographers’ knowledge about the guidelines was estimated to be 60.5%.

Conclusion
The study showed non-use and misuse of ASMs by radiographers indicating improvement in some areas. Preference in using post-processing ASMs was shown over the use of pre-exposure ASMs. Both phase 1 and 2 of the study were generally in agreement showing the need of more awareness on the use of pre-exposure ASMs hence the reason why an information leaflet was distributed in the radiology department where the study took place.
TABLE OF CONTENTS

TITLE PAGE .................................................................................................................. i
DECLARATION .............................................................................................................. ii
DEDICATION ................................................................................................................ iii
ACKNOWLEDGEMENTS ............................................................................................... iv
ABSTRACT .................................................................................................................... v
TABLE OF CONTENTS ................................................................................................. vi
LIST OF FIGURES ......................................................................................................... x
LIST OF TABLES .......................................................................................................... xi
ABBREVIATIONS AND ACRONYMS ........................................................................... xii
DEFINITION OF CONCEPTS ..................................................................................... xiii

CHAPTER 1- INTRODUCTION OF THE STUDY ......................................................... 1
1.1. Introduction .......................................................................................................... 2
1.2. Background to the study .................................................................................... 2
1.3. Relevance of the study ...................................................................................... 4
1.4. Research aim and objectives ............................................................................. 4
1.5. Research design ................................................................................................. 5
1.6. Course of study ................................................................................................. 6

CHAPTER 2- LITERATURE REVIEW ......................................................................... 7
2.1. Introduction .......................................................................................................... 8
2.2. Literature search ............................................................................................... 8
2.3. Pre- Exposure Anatomical Side Markers (ASM):
    Definition and use ............................................................................................... 8
2.4. Medico-Legal issues ......................................................................................... 10
2.5. Recommendations regarding the use of ASMs ................................................. 12
2.6. Education and Training .................................................................14
2.7. Issues associated with Pre-exposure ASM use ..................................................15
  2.7.1. A source for Cross-Contamination .............................................15
  2.7.2. A Potential case for Repeat Radiographs .....................................16
  2.7.3. Issues with collimation...............................................................16
  2.7.4. Communities of Practice .........................................................17
  2.7.5. Influences on Practice Methods ...............................................19
  2.7.6. Time Constraints on Image Acquisition .....................................19
  2.7.7. Lack of Patient Co-operation ..................................................20
  2.7.8. Introduction of Digital Radiography .........................................20
2.8. Improving the Use of Pre-exposure ASM .............................................21
  2.8.1. Modification in design of the Pre-exposure ASM .........................21
  2.8.2. Introduction to Continuing Professional Development (CPD) sessions,
         Reject Analysis and Training ......................................................22
  2.8.3. Developing Departmental Protocols .........................................23
  2.8.4. Availability of Pre-exposure ASM ............................................24
2.9. Conclusion .........................................................................................24

CHAPTER 3- METHODOLOGY ......................................................................25
3.1. Introduction .........................................................................................26
3.2. Research Design ..................................................................................26
  3.2.1. Quantitative and Qualitative Elements of the Study .......................26
  3.2.2. Non-Experimental Study ..............................................................27
  3.2.3. Longitudinal Study ........................................................................27
  3.2.4. Retrospective Study .......................................................................28
  3.2.5. Cross-sectional Study ....................................................................28
  3.2.6. Prospective Study ..........................................................................29
3.3. Target Population ................................................................................29
  3.3.1. Sampling Technique ......................................................................30
3.4. Data Collection Tools ..........................................................................31
  3.4.1. Phase 1: Data Record Sheet for Retrospective Data Collection .......31
4.4.2. Radiographers’ knowledge regarding the guidelines associated with the use of Pre-exposure ASMs ........................................73
4.4.3. Collimation and use of Pre-exposure ASMs ........................................73
4.5. Conclusion ........................................................................................................74

CHAPTER 5 – CONCLUSIONS AND RECOMMENDATIONS ..........................75
5.1. Introduction ........................................................................................................76
5.2. Conclusions from the study ................................................................................76
5.3. Recommendations from the study .....................................................................77
5.4. Recommendations for further studies .................................................................78
5.5. Conclusion ........................................................................................................79

REFERENCES ........................................................................................................80
APPENDIX A - Data Record Sheet ........................................................................87
APPENDIX B - Radiographers’ Questionnaire .........................................................89
APPENDIX C - Permissions ......................................................................................106
  MID Approval .........................................................................................................107
  Data Protection Officer Approval ........................................................................109
  Chief Executive Officer Approval .........................................................................111
  University Research Ethics Committee Approval .................................................113
APPENDIX D - Radiographers’ Information Leaflet ..............................................116
LIST OF FIGURES

Figure 2.1a Stencilled pre-exposure ASMs ................................................................. 9
Figure 2.1b Engraved pre-exposure ASMs ................................................................. 9
Figure 2.1c Pre-exposure ASMs with radiographer’s initials ..................................... 9
Figure 2.1d Colour-coded pre-exposure ASMs ......................................................... 9
Figure 4.1 Use of ASMs ............................................................................................ 43
Figure 4.2 Correct use of ASMs ................................................................................. 44
Figure 4.3 Day/night distribution of radiographs over the 5 years ....................... 46
Figure 4.4 Distribution of examinations performed over the 5 years ................. 48
Figure 4.5 Distribution of radiographic projections over the 5 years ............... 51
Figure 4.6 Distribution of patient position over the 5 years .................................. 55
Figure 4.7 Responses on use of ASMs ................................................................. 58
Figure 4.8 Responses on difficulties in the use of pre-exposure ASMs ............ 59
Figure 4.9 Responses on whether it is time consuming to place pre-pre-exposure ASM ........................................................................................................ 60
Figure 4.10 Respondents’ preference of type of ASM used ................................... 61
Figure 4.11 Respondents’ acquisition of knowledge on ASM use ....................... 61
Figure 4.12 Radiographers’ rating of their knowledge of ASM use ...................... 62
Figure 4.13 Respondents’ interest in gaining more knowledge on ASM use .......... 62
Figure 4.14 Preferred method of obtaining knowledge on ASM use ...................... 63
LIST OF TABLES

Table 4.1 Results of chi-square test comparing the use of ASM between day and night shifts ................................................................. 46
Table 4.2 Results of chi-square test comparing the use of pre-exposure and post-processing ASM between day and night shift ......................... 47
Table 4.3 Results of chi-square test comparing the use of ASM in accordance with guidelines between day and night shift ............................ 47
Table 4.4 Results of chi-square test comparing the use of ASM by examination .......................................................................................... 49
Table 4.5 Results of chi-square test comparing the use of pre-exposure and post-processing ASM by examination ........................................ 50
Table 4.6 Results of chi-square test comparing the use of ASM in accordance with guidelines per examination ............................................. 51
Table 4.7 Results of chi-square test comparing the use of ASM per projection ............................................................................................ 52
Table 4.8 Results of chi-square test comparing the use of pre-exposure and post-processing ASM per projection ........................................ 53
Table 4.9 Results of chi-square test comparing the use of ASM in accordance with guidelines per projection ............................................... 54
Table 4.10 Results of chi-square test comparing ASM use per patient position ............................................................................................ 55
Table 4.11 Results of chi-square test comparing the use of pre-exposure and post-exposure ASM per patient position .................................... 56
Table 4.12 Results of chi-square test comparing the use of ASM in accordance with guidelines per patient position ................................. 57
ABBREVIATIONS AND ACRONYMS

AP - Antero-posterior
ASM - Anatomical Side Marker
CPD - Continuing Professional Development
L - Left
PA - Postero-anterior
PACS - Picture Archiving and Communication System
R - Right
DEFINITION OF CONCEPTS

Anatomical Side Marker (ASM) – markers that provide an indication of the patient’s right or left side of the anatomy on planar x-ray images (Long, Frank and Ehrlich, 2013).

Collimation - the restriction of radiation to the area being examined by confining the beam with diaphragms with high radiation-absorption power (Sloane and Whitley, 2010).

Image receptor - a device that changes the x-ray beam into a visible image (Bontrager and Lampignano, 2010).

Post-processing ASM - markers added after x-ray exposure to indicate the patient’s right or left side on planar x-ray images (Hermann et al., 2012).

Pre-exposure ASM - radio-opaque markers that are used during x-ray exposure to indicate the patient’s right or left side on planar x-ray images (Long, Frank and Ehrlich, 2013).

Primary beam - radiation emitted from the x-ray tube (Bontrager and Lampignano, 2010).

Radiograph - an image produced by X-rays used in medical examination to visualise internal anatomy (Ballinger, Frank and Merrill, 2003).

Radio-opaque - structures that block radiation to pass through, such as metal, due to its high atomic mass, causing the structure to appear white on the radiograph (Bontrager and Lampignano, 2010).

Secondary beam - radiation that results from the scattering of the primary beam (Bontrager and Lampignano, 2010).
CHAPTER 1

INTRODUCTION TO THE STUDY
1.1. Introduction

Pre-exposure anatomical side markers (ASMs) are radio-opaque markers visible on radiographs, containing the letters ‘R’ and ‘L’ to indicate the right and left side of anatomy imaged (Ballinger, Frank and Merrill, 2003). For instance, when a radiographer images a patient’s right hand, the ‘R’ pre-exposure ASM is placed on the image receptor, reassuring that the side taken is indeed the right side.

In radiography, use of pre-exposure ASMs is considered ‘best practice’ (The Royal College of Radiologists and the Society and College of Radiographers, 2011). ASMs should be placed prior to exposure and not edited afterwards. It is important to double check that: the correct pre-exposure ASM is used and placed correctly, appearing within the irradiated area and not obscuring essential anatomy (Health and Care Professions Council, 2013).

1.2. Background to the Study

Educational radiography textbooks emphasise on the importance of using pre-exposure ASMs, as many authors including Ball, Price and Chesney (1995), Bontrager and Lampignano (2010) and Easton (2009) classify them as necessary information required on radiographs.
Medico-legal issues associated with the non-use or misuse of pre-exposure ASMs may arise where radiographers and other health care professionals, such as clinicians, have been held responsible and disciplined due to such errors (Platt and Strudwick, 2009). It is essential that pre-exposure ASMs, together with the patient’s name, date, and place of examination are imprinted on radiographs, or else are considered valueless as legal evidence (Parelli, 2009).

Research has been carried out to evaluate the use of pre-exposure ASMs in radiology departments:

Titley and Cosson (2014) state that the use of pre-exposure ASMs is a basic competency, however such use was not performed satisfactorily as high levels of error were found, with radiographers finding other factors as an excuse for justifying poor practice.

Platt and Strudwick (2009) noticed how changing from film-based to computerised radiography did not improve the use of pre-exposure ASMs and recommended increasing their use to reach ‘best practice’, where 100% of radiographs show presence of pre-exposure ASMs.

Aakre and Johnson’s study (2006) showed a drastic reduction in error rates involving pre-exposure ASMs after comparing pre-improvement and post-
improvement procedures, where pre-exposure ASMs were enlarged with 1-inch colour-coded ‘L’ and ‘R’ letters.

1.3. Relevance of the Study

During clinical placements in a radiology department at a local general hospital in Malta, variations in the use of ASMs were noticed. As there are no local study findings on this topic, an investigation evaluating the use of ASMs by local radiographers was warranted.

During literature review, the main difficulty encountered was the considerable lack of published material regarding the radiographers’ perception of the use of ASMs. In addition the researcher felt the need to investigate this subject locally.

Through this study, an information leaflet was developed to promote awareness amongst radiographers, highlighting areas of improvement on ASM use.

1.4. Research Aim and Objectives

The aim of the study was to evaluate the perception and use of ASMs by radiographers working in a local radiology department in a general hospital in Malta.
Chapter 1 - Introduction to the Study

The objectives of the study were to:

- Perform an observational study evaluating a sample of radiographs to:
  - Identify the frequency of pre-exposure and post-processing ASM incorporation within radiographs over the last 5 years;
  - Identify the frequency of ASM incorporation according to:
    - time at which the examination took place;
    - examination performed;
    - projection executed;
    - patient positioning;
  - Identify if placement of ASM is according to guidelines;

- Distribute a questionnaire among radiographers evaluating their perception of the use of ASMs.

- Compare the findings of the observational survey to the findings of the questionnaire;

- Develop an information leaflet based on the outcomes of the study to promote awareness amongst radiographers, highlighting areas of improvement of ASM use.

1.5. Research Design

The study was divided into two phases. In the first phase, a non-experimental, longitudinal approach was undertaken through retrospective observation of radiographs using a data record sheet with the data collected being mainly quantitative. The second
phase involved a non-experimental, cross-sectional, prospective study where a questionnaire was distributed to radiographers evaluating their perception of the use of ASMs, where the data collected was both quantitative and qualitative.

Data obtained was analysed using both descriptive and inferential statistics. Similarities and/or differences in the study’s findings were compared to available literature.

Permissions to conduct the study were sought and obtained from: the University of Malta Research and Ethics Committee (UREC) through the Faculty of Health Sciences Research Ethics committee (FREC); the Chief Executive Officer (CEO) and the Data Protection Officer of the local general hospital; and the Manager of the radiology department. Furthermore, informed consent was obtained from radiographers by their voluntary participation in the study by answering the questionnaire.

1.6. Course of Study

This work includes 5 chapters:

Chapter 1 provides an overview of the study covering its background, aim, objectives and methods used for data collection. In chapter 2, relevant literature is presented and reviewed. Chapter 3 discusses the methodology utilised for the study involving the research approach, data collection tools and data analysis. Results from data analysis are presented and discussed in chapter 4. Chapter 5 draws conclusions and recommendations based on the results obtained.
CHAPTER 2

LITERATURE REVIEW
2.1. Introduction

This chapter presents a critical review of the literature related to the subject under investigation. The first part outlines a description of pre-exposure ASMs and their use in radiography. Issues related to the misuse and non-use of pre-exposure ASMs is discussed. The final part of this chapter introduces initiatives that could help to improve the use of pre-exposure ASMs in radiography.

2.2. Literature Search

During literature review, published data were sought from books, internet as well as peer reviewed journals from health-care databases including PubMed, MEDscape and ScienceDirect. The keywords utilised included: radiographer, anatomical-side-marker, X-ray marker, lead markers, image quality, and image labelling. The period of time considered for paper inclusion in the review was ideally of up to 10 years. Whenever possible the use of primary sources was preferred over secondary sources.

2.3. Pre-Exposure Anatomical Side Markers (ASMs): Definition and Use

Pre-exposure ASMs are fundamentally useful in radiography and are known by a number of different names including: lead markers, X-ray markers, and radiographic film identification markers (Jaquith, 2013). Pre-exposure ASMs are placed on image receptors prior to exposure to identify the patient’s anatomical sides and are usually held in place with the use of tape or other means. However, some may place pre-exposure
ASMs directly on the patient, in a region that will not obscure essential anatomy (Long, Frank and Ehrlich, 2013).

Pre-exposure ASMs have a letter ‘R’ for the right and ‘L’ for the left. The radiographer’s initials may also be incorporated on the pre-exposure ASMs to identify the radiographer taking the radiograph (Jaquith, 2013). The letters are either engraved on a Perspex base filled with radiopaque material or incised in a thin piece of metal (Ball, Price and Chesney, 1995). The type of pre-exposure ASM used depends solely on the radiographer’s preference (Figure 2.1a-d).
Incorrect use of pre-exposure ASMs is classified as one of the most common sources of error in radiography (Aakre and Johnson, 2006). Improperly-identified radiographs “result in confusion, wasted time and effort, and perhaps, unnecessary radiation” to patients (Fabian, 2005, p. 19). Thus it is not justified to repeat radiation exposure, but instead post-processing ASMs are edited in the case of digital radiography, or handwritten with a permanent marker in the case of film radiography. However, such alternatives should not be an acceptable substitute for pre-exposure ASMs forming part of the original image (Herrmann et al., 2012). In Platt and Strudwick’s study (2009), 2% of radiographs showed evidence of incorrect pre-exposure ASM placement which were corrected for by adding post-processing ASMs. Additionally, Titley and Cosson (2014) noticed 0.5% of post-processing ASMs added to incorrectly placed pre-exposure ASMs.

Researchers have also demonstrated non-use use of ASMs in their studies. Titley and Cosson’s study (2014) showed an absence of ASM in 40.8% of radiographs.

2.4. Medico-Legal issues

The importance of placing correct pre-exposure ASMs on radiographs is emphasised in the following incidents.

In 2002, two surgeons from Wales were charged for negligence and manslaughter after mistakenly removing a patient’s left healthy kidney instead of his right diseased kidney.
resulting in death. The professional conduct committee stated that the radiographs were put the wrong way round on the x-ray illuminator during surgery and no evidence of pre-exposure or post-processing ASMs were present on the radiographs to distinguish the side of anatomy. The radiographer could also have been held responsible for such an incident as surgeons may rely on the radiographers’ accuracy at work (Dyer, 2002).

Similarly, in Sweden, two infants had been reported to have had treatment for pneumothorax on the wrong side of the chest due to decisions based on radiographs taken with no evidence of pre-exposure or post-processing ASMs, resulting in a fatal outcome in one patient. Prior to this incident, it was normal in some Swedish hospitals to include pre-exposure ASMs on the first radiograph and then dismiss its use on the rest, however, after this incident, a new protocol was introduced to include pre-exposure ASMs on all radiographs (Finnbogason, Bremmer and Ringertz, 2001).

Radiographers must be careful on how to correctly place pre-exposure ASMs. Some radiographs have been reported of having inaccurate placement of pre-exposure ASM that caused confusion and a negative impact on the patient’s treatment. During 2005, a radiographer in Wales repeatedly placed pre-exposure ASMs on incorrect sides. Such practice resulted in the radiographer being suspended for one year by the Health Professions Council (The Society of Radiographers, 2007).

In Forensic Radiography, it is mandatory that all radiographs are presented with evidence of pre-exposure ASMs as they are regarded as legal documents. The
radiographs should also include the date and time of the examination, along with the initials/name of the radiographers performing the examination (The Society of Radiographers, 2005).

2.5. Recommendations regarding the use of ASMs

The use of pre-exposure ASMs is highly recommended by many authorities in radiography.

Bontrager and Lampignano (2010) emphasise that a radiograph taken without ASMs may have to be repeated, resulting in unnecessary radiation exposure to patients, as omission of ASMs is seen as such a risk that a radiologist may refuse to report the radiograph and can request an additional one with the presence of a pre-exposure ASM (Finnbogason, Bremmer and Ringertz, 2002).

Carter and Vealé (2008) state that ever since computed-radiography was installed, marking radiographs with ASMs after exposure has been made easier. Nonetheless, they still strongly recommend that pre-exposure ASMs be used the same way they were used in film systems.

Bontrager and Lampignano (2010) state that it is not acceptable practice to place post-processing ASMs on radiographs because of legal and liability issues due to potential mismarking. Mismarking a radiograph can result into serious implications, thus during
evaluation, a double check should be made to confirm that the pre-exposure ASM corresponds to the correct anatomical side (McQuillen-Martensen, 1996) and in turn matches with the referring clinician’s request (Sloane and Whitley, 2010).

Easton (2009) explains that image annotations such as ASMs, patient identification, date of examination and name of facility must be present and readable on all radiographs. Image annotations are one of the factors affecting acceptable image quality, where an optimum quality image is defined as the ability of “the observer to extract information from the image and make an accurate diagnosis” (Easton, 2009, p. 161).

Ballinger, Frank and Merrill (2003) explain that pre-exposure ASMs present on radiographs should never obscure anatomy nor be placed over the patient’s identification information but should always be placed on the collimated beam edge and outside of any lead shielding present within the beam. They provide specific ASM placement guidelines that radiographers should follow:

1. For AP and PA projections that include the right and left sides of the body, a ‘R’ pre-exposure ASM is used.
2. For lateral projections of the head and trunk, the side closest to the image receptor should always be marked. Pre-exposure ASM are placed anterior to the anatomy.
3. For oblique projections that include both the right and left sides of the body, the side nearest the image receptor is marked.
4. For limb projections, the appropriate ‘R’ or ‘L’ pre-exposure ASM should be used.

5. For limb projections that are done with two images on one image receptor, only one of the projections needs to be marked.

6. For limb projections where both the right and left sides are imaged side-by-side on one image receptor, both the ‘R’ and ‘L’ pre-exposure ASM must be used to clearly identify the two-sides.

7. For AP/PA or oblique chest projections, the pre-exposure ASM is placed on the upper outer corner so that the thoracic anatomy is not obscured.

8. For decubitus positions of the chest and abdomen, the ‘R’ or ‘L’ pre-exposure ASM should always be placed on the side up and away from the anatomy of interest.

9. No matter which projection is performed, and no matter what position the patient is in, if a ‘R’ pre-exposure ASM is used it must be placed on the “right” side of anatomy. If a ‘L’ pre-exposure ASM is used it must be placed on the “left” side of anatomy.

2.6. Education and training

The importance of using pre-exposure ASMs is enforced in students during their course of training. They are taught that critiquing radiographs involves assessing the presence of pre-exposure ASMs and that one must appropriately label the radiograph prior to exposure and prevent adding post-processing ASMs as it is considered “sloppy” (Taylor and Strudwick, 2010). Starc (2008) recognised that a possible reason for student
radiographers to have their radiographs rejected, with a reject percentage of 19%, was due to pre-exposure ASM omission.

2.7. Issues associated with pre-exposure ASM use

A number of issues have been identified with the use of pre-exposure ASMs, including:

2.7.1. A source for cross-contamination

Pre-exposure ASMs may have the possibility of becoming a source for cross-contamination, if not routinely cleaned, thus infection control is an essential part of clinical practice to prevent cross-infection (Ayliffe, Collins and Taylor, 1990) as hospital environments are a potential reservoir of infection (Rhomberg, Fritsche, Sader and Jones, 2006).

Tuqwell and Maddison (2011) verified that pre-exposure ASMs are in fact a reservoir for bacteria. After swabbing pre-exposure ASMs from both radiographers and students before and after cleaning took place using disinfectant wipes and alcohol gels, 92% were contaminated with various organisms including Staphylococcus and Bacillus species. Another study by Eze (2013) showed similar results and suggested that pre-exposure ASMs could be a source of infection to both the radiographer and the society if they are carried out of the hospital environment.
2.7.2. A potential case for repeat radiographs

Pre-exposure ASMs can mistakenly be placed on essential anatomy resulting in the possibility of image repetition. In Titley and Cosson’s study (2014), correct placement of ASM was present on 58.8% of radiographs, of which 54.4% had pre-exposure ASMs within the primary collimation, 5.4% had pre-exposure ASMs within the scattered radiation and 41.2% had ASMs added during post-processing. However, 0.6% of radiographs evaluated had pre-exposure ASMs obscuring anatomy. Bontrager and Lampignano (2010) state that such obscurity is considered as a repeatable error. European guidelines on quality criteria for diagnostic radiographic images emphasise that pre-exposure ASMs “should not obscure the diagnostically relevant regions of the radiograph” (Carmichael, 1996, p. 12). For this reason, radiographers hesitate to use pre-exposure ASMs resulting in additional radiation doses to patients.

2.7.3. Issues with collimation

‘Best practice’ requires correct placement of pre-exposure ASM within the collimation, to ensure its presence on the radiograph (The Royal College of Radiologists and the Society and College of Radiographers, 2011).

Prior to exposure, collimation is modified by radiographers to limit the x-ray beam to the area of interest (Sloane and Whitley, 2010) and avoid unnecessary radiation dose to patients. A conflict of priorities between ‘best practice’ pre-exposure ASM use and
efficient collimation practice may be present amongst radiographers working in a radiology department regarding optimisation of radiation exposure to the patient.

Titley and Cosson (2014) explain that it may not be possible to place a pre-exposure ASM within the primary beam without obscuring anatomy, thus collimation may have to be increased to include pre-exposure ASMs. In Titley and Cosson’s study (2014), collimation was given more importance over having pre-exposure ASMs inclusion. In another study by Adejoh, Onwuzu, Nkubli and Ikekwo, (2014), radiographs were evaluated with 89.0% of the pre-exposure ASMs appearing within the primary beam, while 11.0% of the pre-exposure ASMs appeared outside the primary beam. However, 2.0% of those within the primary beam had some level of obstruction on essential anatomy. Their findings demonstrated that the placement of pre-exposure ASM in the primary beam did not offer any superiority to pre-exposure ASMs placed in the secondary beam as pre-exposure ASMs placed in the secondary beam were clear and aesthetically similar to those in the primary beam. Out of Titley and Cosson’s sample, 25 radiographs demonstrated having pre-exposure ASMs outside collimation, but were acceptable because post-processed ASMs were added, thus rather than adding them to one or other category, they were excluded from the study (Titley and Cosson; 2014).

2.7.4. Communities of practice

Neglect of pre-exposure ASMs may be a result of learning and fostering incorrect practices. Platt and Strudwick (2009) refer to this issue as ‘communities of practice’,
where practice is influenced by how individuals collaborate irrespective of their job
description based on their norms and transform the workplace into a ‘community’ where
colleagues learn from each other (Hughes, Jewson and Unwin, 2007). Therefore the use
of pre-exposure ASMs may only be applied when radiographers think it is justified.

Titley and Cosson (2014) found that radiographers give more importance to pre-
exposure ASMs on AP radiographs compared to lateral projections (where two sides are
superimposed upon each other) as use of pre-exposure ASMs was approximately 7 times
more likely on AP projections (80.3%) than on lateral projections (38.2%). Importance
may be given more in AP projections due to two sides being present with the possibility
of the image being inverted. Use of pre-exposure ASMs was higher on bilateral
examinations, compared to unilateral examinations. Reasons may be because a
pathology affecting unilateral anatomy (e.g. extremities) may be more obvious, or more
easily communicated by the patient, than the precise location of pathology of bilateral
anatomy (e.g. abdomen).

Presence of pre-exposure ASMs was 4 times more likely when patients were in the
supine position in comparison to when patients were erect, where post-processing ASMs
were added. Also, the presence of pre-exposure ASMs was approximately 3 times
higher when using routine techniques compared to when a modified technique (Titley
and Cosson, 2014).
2.7.5. Influences on practice methods

Platt and Strudwick (2009) identify that lack of pre-exposure ASM use may be related to influences brought by radiographers themselves. Poor use of pre-exposure ASMs in a radiology department may influence newly qualified radiographers to follow the example of their supervisors. If pre-exposure ASMs are not used by all radiographers, it is likely that ‘bad habits’, such as adding post-processing ASMs will be passed on. Contrarily, if newly qualified radiographers improved the frequency of use of pre-exposure ASMs, they would pass on ‘good habits’ to other radiographers, thus reinforcing good practice methods.

2.7.6. Time constraints on image acquisition

Platt and Strudwick (2009) explain how radiology departments are under constant pressure to meet their required goals. Presence of students increases the time necessary for each examination due to less experience and more time to engage in each imaging technique. Thus radiographers may feel pressured by time constraints and simple procedural requirements, such as placement of pre-exposure ASMs, may be neglected. In Titley and Cosson’s study (2014), 85.8% of the radiographs were conducted during the day while 14.2% were conducted out-of-hours. However, results showed that time of acquisition were not associated with lack of pre-exposure ASM use. Applying a pre-exposure ASM only takes a moment thus omitting pre-exposure ASMs would not be more time efficient.
2.7.7. Lack of patient co-operation

Every possible effort should be made to include pre-exposure ASMs in the first time round. However distressed patients, especially pediatrics, may be uncooperative resulting in the pre-exposure ASMs being moved or become hidden. If the radiographer has followed the proper process and image quality is satisfactory except for visibility of pre-exposure ASMs, the need of repeating may not be applicable. The Royal College of Radiologists and the Society and College of Radiographers (2011) recommend that the radiographer and the radiologist need to decide together whether a repetition is necessary depending on the radiograph’s diagnostic value. In these instances, the use of post-processing ASMs minimises the number of occasions where image repeats need to take place.

2.7.8. Introduction of Digital Radiography

Digital radiography allows annotations to be added during post-processing to ensure that the correct ASM is visible on the radiograph (Oakley, 2003). However, if a pre-exposure ASM has not been placed, it may not be possible to accurately determine the orientation of the radiograph since it is not uncommon for a radiograph to be flipped or rotated during post-processing without the radiographers’ acknowledgement. Therefore, use of pre-exposure ASMs ensures accuracy in anatomical labelling (Platt and Strudwick, 2009). Herrmann et al. (2012, p 10) state that “electronic annotations of anatomic side
on the image during post-processing are not an acceptable substitute for lead markers captured during the exposure”.

In Platt and Strudwick’s study (2009), presence of pre-exposure ASMs pre-installation of digital radiography was seen in 32% of radiographs while 66% of radiographs had a handwritten or stamped ASM added afterwards. Additionally, 1% of the radiographs had no evidence of ASM to indicate anatomical sides. On the other hand, 25% of digital radiographs revealed having pre-exposure ASM present, while 77% of the radiographs had a post-processing ASM electronically added. No radiographs showed absence of ASM indicating side of anatomy. When comparing radiographs pre- and post-installation of digital systems, a decrease of 7% was identified in the use of pre-exposure ASMs. However Platt and Strudwick (2009) state that this difference does not show significant change in practice, since both pre- and post-digital system installation show poor use of pre-exposure ASMs.

2.8. Improving the use of pre-exposure ASMs

Suggestions have been brought up on how to improve the use of pre-exposure ASMs:

2.8.1. Modification in design of the pre-exposure ASM

Radiographers may find pre-exposure ASMs difficult to read at a glance. Using pre-exposure ASMs with small print ‘R’ and ‘L’ may cause radiographers to “[squint] to
see the font” and may result in “marking the wrong side of the patient by mistake” (Enfinger, 2013).

Aakre and Johnson’s (2006) study showed 2.4% errors among the radiographs analyzed. One of the most detrimental errors involved the non-use or misuse of ASMs. They recommend that pre-exposure ASMs should include enlarged letters with 1-inch ‘R’ and ‘L’ indicators and should be differentiated from each other so that the radiographers “[can] quickly reference which [is] which” (Enfinger, 2013). Aakre and Johnson (2006) advise that each pre-exposure ASM should be colour-coded blue for left and red for right to confirm the correct pre-exposure ASM. These improvements were adapted resulting in a reduction of errors among the radiographs analyzed in the second study down to 0.07%. The results show how such improvements were highly effective in producing radiographs with less probability of labeling-errors.

2.8.2. Introduction to Continuing Professional Development (CPD) sessions, reject analysis and training

Radiographers are required to show a commitment to their continuing professional development (CPD) to sustain their professional standards of competence and provide high-quality service. CPD provides on-going development to shape and evolve the workers’ expertise through professional and personal growth which is beneficiary to both service-users and providers (Clouston and Westcott, 2005). Platt and Strudwick
(2008) recommend introducing CPD sessions in radiology departments, to highlight the risks of non-use or misuse of pre-exposure ASM.

Both Ofori et al. (2013) and Honea, Elissa Blado and Ma, (2002) noticed incorrect use of ASMs on radiographs during reject analysis and recommended consistent training to radiographers.

Honea, Elissa Blado and Ma (2002) state that reject analysis, which is the study of rejected radiographs to evaluate the cause of rejection (O’Toole, 2013), is considered as “an accepted standard of practice for Quality Assurance (QA) in pre-exposure radiology” and must be conducted routinely to provide a basis for in-service training of individual radiographers. The researchers explain that team leaders within the radiological department play an important role to determine whether an individual radiographer or else a group of radiographers need additional training.

2.8.3. Developing departmental protocols

Titley and Cosson’s study (2014) found high levels of error (68%) in the use of ASMs on radiographs and highlighted some ‘latent conditions’ that may have caused such deviation. Latent conditions are defined as inevitable errors that arise and form part of a system that spreads in an organization creating ‘error-producing factors’ within a workplace (Roux and Halstead, 2009).
Possible latent conditions include communities of practice, collimation efficiency, time constraints, patient position and technique used. Titley and Cosson (2014) suggested that these latent conditions must be dealt on ‘an individual departmental basis’ to understand the communities of practice’s beliefs. By adopting a systems approach, they believe that departmental protocols can be adapted within the radiological department where the official procedure of rules governing correct placement of pre-exposure ASM can be carried out. The introduction of departmental protocols was also recommended by Ofori et al. (2013) to improve practice.

2.8.4. Availability of pre-exposure ASM

Platt and Strudwick (2009) state that radiographers should have pre-exposure ASMs in their possession at all times. They also point out that extra pre-exposure ASMs should be purchased to replace lost ones and spare departmental pre-exposure ASMs should be made available to the radiographer.

2.9. Conclusion

The literature reviewed in this chapter shows that ‘best practice’ is not always applied in radiography being a reason to repeat radiographs and cause medico-legal issues. However, if radiographers are encouraged to use pre-exposure ASMs correctly, it may improve the practice considerably. In the following chapter, a description of the research design used in this study will be presented.
CHAPTER 3

METHODOLOGY
3.1. Introduction

This chapter provides an overview of the methodology employed in the study including the research design and the methods adopted. The data collection procedure is discussed along with ethical considerations and limitations relevant to this study.

3.2. Research Design

The methods used to investigate the research question was mainly quantitative but also contained some qualitative elements (Saks and Allsop, 2007). The study was based on two non-experimental phases. The first phase of the study was longitudinal and retrospective with data gathered being totally quantitative in nature through an evaluation of the use of ASM on radiographs acquired previous to the study period. The second phase involved a cross-sectional, prospective data collection of both quantitative and qualitative data through a questionnaire distributed among radiographers evaluating their perception on the use of ASM.

3.2.1. Quantitative and qualitative elements of the study

A formal, objective and systematic process was adapted where numerical data was utilised to obtain information about the use of ASM on radiographs (Burns and Grove, 2005). The researcher gathered empirical evidence based on objective reality through human senses to confirm initial hypotheses (Brink, Van Der Walt and Van Rensburg,
Quantitative methods provide ‘generalisability’ (Polit and Beck, 2013), as results are representative of the generalised population (Johnson and Christensen, 2012).

However, quantitative data cannot reveal the relationship between the cause and effect behind the variations in the variables studied due to lack of contextual information. Combining quantitative and qualitative research techniques together in a study is essential (Gacitúa-Marió and Wodon, 2001) to produce in-depth information, related to the radiographers’ perception on the use of ASM. Hence the questionnaire utilised consisted of both closed and open-ended questions, providing much richer information and identifying the full range of responses given by all respondents (Brace, 2008).

### 3.2.2. Non-experimental study

Data collection in both phases of the study was obtained without proposing any interventions, thus making it a non-experimental study (Bruce, Pope and Stanistreet, 2008). The researcher observed the consistency on the use of ASM on radiographs and evaluated the radiographers’ perception on the use of ASM.

#### Phase 1

### 3.2.3. Longitudinal study

Longitudinal studies consist of repeated observation of the same variable to examine the way in which it changes over time (Brink, Van Der Walt and Van Rensburg, 2006). In
this study, the use of ASMs on radiographs was evaluated over a period of five years (2010-2014) to demonstrate any changing trends in ASM incorporation.

3.2.4. Retrospective study

Existing data was collected by ‘moving backwards in time’ (Johnson and Christensen, 2012). The researcher located radiographs performed during the last five years to help identify the current situation on the use of ASM.

By using existing data, retrospective research is straightforward requiring less time to complete, inexpensive and a potential to generate hypothesis that can then be tested prospectively (Hess, 2004). However the researcher has limited control over data collection as data gathered may be incomplete, inaccurate, or inconsistently measured. Additionally, retrospective studies are susceptible to information bias, resulting in systematic error due to measurement errors involving different accuracy of information between comparison groups. This decreases the internal validity of the research study which must be carefully addressed and reduced (Song and Chung, 2010).

Phase 2

3.2.5. Cross-sectional study

In cross-sectional studies, data is obtained from multiple groups at a single point of time or during a relatively short time period (Johnson and Christensen, 2012). All data put
forward from the questionnaire was collected during a brief time period of two weeks, from radiographers working in the hospital.

**3.2.6. Prospective study**

Data was collected by measuring variables that occurred during the course of the study involving the radiographers’ perception on the use of ASMs (Brink, Van Der Walt and Van Rensburg, 2006). Prospective studies are considered stronger than retrospective studies since any ambiguity in the findings can be resolved in that specific point in time (Polit and Beck, 2013).

**3.3. Target Population**

The target population consists of a group of individuals/objects that meet the criteria in which the researcher is interested in studying (Brink, Van Der Walt and Van Rensburg, 2006). In this study, two target populations were used involving all radiographs performed in all hospitals in Malta (phase 1) and all radiographers working in Malta (phase 2).

However, the researcher rarely has access to the whole target population, thus a portion of the target population, known as the accessible population, is identified where the researcher can hopefully generalise his/her findings (Polit and Beck, 2013). In the study, the accessible population consisted of all radiographs (n=234,105) performed over the
last 5 years (2010-2014) in a public general hospital and all radiographers (n=35) either in general radiography or in the accident and emergency unit within a public general hospital in Malta.

3.3.1. Sampling Technique

It is difficult to collect data from all the accessible population; therefore a sample was selected (Johnson and Christensen, 2012). Stratified random sampling was used in phase 1 to ensure representation of radiographs from all five consecutive years (2010-2014). The population was split into 5 groups, each representing a year. Cluster sampling was then applied to each year separately, selecting radiographs randomly from 1 particular week from each year (Fox, Hunn and Mathers, 2009). The accessible population was an average of 47,000 radiographs per year. Due to the large population, it was not possible to analyse all the radiographs, however the researcher tried to include as much radiographs in the study as possible during data collection. At the end, a sample size of 500 radiographs were analysed.

In phase 2, all radiographers within the accessible population were invited to take part in the study due to the population size being small (n=35).
3.4. Data collection tools

The researcher chooses the most appropriate data collection tool to obtain data depending on the research question (Khan, 2011). In this study, a data record sheet and a questionnaire were chosen where both data collection tools were self-designed based on published literature regarding the use of ASMs in radiography.

3.4.1. Phase 1: Data record sheet for retrospective data collection (Appendix A)

A self-designed data record sheet was used containing the following parameters: year and time the radiograph was taken, examination and projection executed; patient position and the presence of correct ASM placement (either pre- or post-exposure ASM) on the radiograph.

3.4.2. Phase 2: Radiographers’ questionnaire (Appendix B)

A questionnaire was distributed containing both closed and open-ended questions where instructions were given clearly and questions were written in simple language to refrain uncertainty (Johnson and Christensen, 2012). To boost response rates, the questions were made more appealing by limiting the amount of questions to a reasonable number (n= 30) (Burns and Grove, 2005).
The questionnaire was divided into three sections:

*Use of pre-exposure ASMs:* to evaluate the radiographers’ use of pre-exposure ASMs, their difficulties and level of uncertainty when using pre-exposure ASMs, the availability of pre-exposure ASM in the department and the time expenditure to place pre-exposure ASM during planar x-ray imaging.

*Education and training:* to review how radiographers acquired their knowledge about the use of ASM and what their preferred methods for acquiring information are, and whether the radiographers were interested in gaining more knowledge about the use of ASMs.

*Evaluation regarding use of ASMs:* the evaluation was based on information found from published literature and was formulated to evaluate radiographers’ use of ASMs.

### 3.5. Validity and Reliability of the data collection tools

Validity and reliability produce quality research where results are meaningful, reflect reality as accurately as possible and are replicable. However measurement errors are possible which must be reduced to the lowest possible level (Brink, Van Der Walt and Van Rensburg, 2006).
3.5.1. Validity Testing

Validity calculates “how accurately the measure yields information about the true or real variable being studied” (Macnee and McCabe, 2008, p. 182). Research tools are valid if it measures correctly and accurately what it is required to measure (Macnee and McCabe, 2008).

The four most common types of validity include: content, criterion related, construct and face validity. The type selected depends on the aim and information collected from the study (Brink, Van Der Walt and Van Rensburg, 2006). In both research tools, content validity was carried out since it is concerned with whether the parameters or questions in the tools used are comprehensive and reflect the concept that they are intended to measure (Macnee and McCabe, 2008). Data in the research tool was compared with the literature review by having ‘experts’ evaluate the validity of the tools according to their clarity and relevance to the study. The experts chosen are professionals within the radiography field varying between 7-14 years and are also academics and teach on the undergraduate Radiography course offered by the Department of Radiography at the University of Malta.

The research tools’ were assessed through a content validity index by rating each of the parameters and questions. A rating scale from 1 to 5 was used with, 1 being irrelevant/unclear and 5 being the most relevant/clear (Shrock and Coscarelli, 2007).
An average of the individual validity indexes of both experts was taken and found to be 0.96 for the data record sheet, and 0.87 for the questionnaire. A minimum of 0.8 is required to ensure validity of the tool (Polit and Beck, 2013). Amendments were suggested by the experts involving rewording sentences and changing the tools’ format. After such changes, the tools were re-validated showing the second validity index in both research tools to be 1.

3.5.2. Reliability Testing

Reliability is “where a similar result is obtained in response to a particular question or indicator on repeated occasions” (Saks and Allsop, 2007, p. 195). Reliability enhances the power of the study to determine significant differences occurring in the population under study and involves three aspects, which are stability, equivalence and homogeneity (Burns and Grove, 2005).

Stability was tested in this study, by using the test-re-test method to calculate intra-rater reliability where individuals are asked to fill in the same exact tool at different points in time (Macnee and McCabe, 2008). This indicates the extent to which the tools tested are able to produce stable and consistent results over time (Mitchell and Jolley, 2013). The amount of time allowed between the two points of measures is critical as it should not be too short as the participants may remember the questions, where results would be based upon memory rather than one’s opinion. Contradictorily, if the time interval is
prolonged, there may be a real change among the subject in the way they perceive information, affecting their response to the research tool (Struwig and Stead, 2001).

*Reliability of data record sheet*

A narrow retrospective study was carried out, analysing a small random sample of radiographs (n=10) and recording the information needed on to the data record tool. This procedure was carried out by the researcher at two different points in time separated by a two-week interval using the same radiographs and the same data record sheet to facilitate intra-rater reliability.

A radiographer was asked to perform the same procedure using the same radiographs to calculate inter-rater reliability. Inter-rater reliability provides the ability to generalise measurements to other raters who might use the tool, making sure that the same results are obtained regardless of who is recording the information (Sim and Wright, 2000).

*Reliability of the questionnaire*

Inter-rater reliability could not be applied to the questionnaire as it evaluates one’s own perception and opinion regarding the use of ASM, which could differ from one individual to another. Intra-rater reliability however was carried out by distributing the questionnaire to 10 radiographers from different units to those participating in the study but within the same radiology department, and repeating the questionnaire after 2 weeks.
Reliability findings

The kappa test was deemed appropriate to assess both inter-rater and intra-rater reliability as all the parameters had a nominal categorical scale. The null hypothesis specifies that reliability is poor and is accepted if the \( p \)-value exceeds the 0.05 level of significance. The alternative hypothesis specifies that the reliability is satisfactory and is accepted if the \( p \)-value is less than the 0.05 criterion. Overall, both research tools demonstrated ‘perfect’ agreement levels were all parameters were significant showing a \( p \)-value less than 0.05 (Sim and Wright, 2000).

3.6. Pilot Study

A tentative small-scale study was conducted to evaluate the research tools being used in the main study. This helps the researcher to determine if any modifications are necessary for improvement (McBurney and White, 2010), and to demonstrate the validity and reliability of the selected research tools (Macnee and McCabe, 2008).

Pilot testing of phase 1 was conducted by analysing the same 10 radiographs selected during reliability testing. The time taken to analyse each radiograph was noted (approximately 2 minutes), and the information collected from each radiograph was evaluated in terms of level of clarity and detail. Changes were made to the data record sheet, by removing the column indicating the place where the radiograph was carried out, since such data was unavailable.
In the 2nd phase, the questionnaire’s objectivity and clarity were evaluated. The time taken to complete the questionnaire was also determined (approximately 6 minutes). The same 10 radiographers selected for reliability testing were used, to fill in the questionnaire. The tool was amended by enlarging the radiographs and adding more space to answer open-ended questions.

3.7. Data Collection Method

Data collection describes the technique used to obtain information relevant to the study where the researcher would then be able to analyse the findings (Johnson and Christensen, 2012).

3.7.1. Phase 1: Image evaluation for ASM

Data was collected from the Picture Archiving and Communication System (PACS), where all radiographs carried out in the hospital’s radiology department are archived. Radiographs conducted between the years 2010-2014 were anonymously provided to the researcher from which relevant data was recorded on to the data record sheet during a time period of 2 weeks. The margin of error ($z\sigma_p$) was calculated showing that a sample of 500 selected from a population of 234,105 radiographs guarantees a maximum margin of error of +/- 4.38%, assuming a 95% confidence level (Ramachandran and Tsokos, 2009), therefore the number of radiographs observed was sufficient.
3.7.2. Phase 2: Radiographers’ questionnaire

The questionnaire was distributed to all 35 radiographers working in general radiography or/and Accident and Emergency unit. The respondents were asked to post it in collection boxes situated either in the general radiography quality assurance area (QA area 2) within the radiology department or in the radiographers’ staff room within the Accident and Emergency Unit. The filled in questionnaires were eventually collected by the researcher. A period of 2 weeks was given for radiographers to complete and return the questionnaire.

3.8. Data Analysis

Analysis of data recorded in phase 1 was performed using inferential statistics, while descriptive analysis was used in phase 2 involving the use of numerical, graphical and tabular techniques for the researcher to organise and present the research findings (Saks and Allsop, 2007).

The comparison of results was aided by means of the software program ‘Statistical Package of Social Sciences’ (SPSS) provided by the computing service center department of the University of Malta to compute statistical tests and produce cross tabulations and descriptive statistics. Additionally, Excel was used to create bar graphs for better representation of the data analysed.
3.8.1. Statistical tests:

A statistician from the statistics and operations research department was contacted to assist in the analysis.

*Pearson’s chi-square test*

The Pearson’s chi-square test was used in phase 1 to assess the association between two categorical variables involving the use of ASM depending on the examination performed; time at which the examinations took place; projection executed and patient positioning. The null hypothesis specifies that there is no association between the two categorical variables and is accepted if the $p$-value exceeds the 0.05 level of significance. The alternative hypothesis specifies that there is a significant association between the two categorical variables and is accepted if the $p$-value is less than the 0.5 criterion (Heavey, 2011).

3.9. Ethical Considerations

This study involved the participation of people (radiographers), and also consists of artefacts produced by people (radiographs) (Oliver, 2010), thus a range of ethical considerations were addressed.

The proposed study was accepted by the dissertation panel of the Department of Radiography and the University of Malta Research Ethics Committee (UREC) through
the Faculty Research Health Science Research Ethics Committee (FREC). Permission was additionally sought and obtained from the manager of the radiology department, the data protection officer and the chief executive officer of the hospital (Appendix C).

A written information sheet (Appendix B) was attached to the questionnaire containing accurate and understandable information about the purpose of the study and radiographers were informed whom they should contact in case of any queries they might encounter whilst answering the questionnaire (Lo, 2010).

After completion of the study, all data gathered and signed consent forms were destroyed. To protect the privacy of the participants, anonymity and confidentiality was respected (Oliver, 2010) as there was no contact with the radiographers so that the participant’s identity could not be linked to the data collected. Furthermore, radiographers were assured that participation was voluntary and they could withdraw participation from the study at any time.

3.10. Limitations and Strengths of the study

Limitations are weaknesses in the research that diminish the value of results obtained (Crosby, DiClemente and Salazar, 2006). The limitations and strengths of this study are listed below:

There was limited time to collect data, hence the small sample size in phase 1.
In phase 1, it was assumed that if an ASM is present, it is positioned representing the true anatomical side, as this could be assured only at the time of the examination.

PACS only stores radiographs depending on what was sent to the system by the radiographer. Thus there is a possibility that not all radiographs taken during the examinations are present on PACS, leading to lack of data that might demonstrate the misuse of ASM in radiography.

In phase 2, the use of close-ended questions is straightforward for the respondents to answer and the researcher to analyse the data collected. However, the data is limited which was counter acted by adding open-ended questions to obtain more information.

Regarding the evaluation test in the questionnaire, the radiographers could have discussed the answers between them or looked up the answers from other sources, thus data collected might not reflect the participants’ true level of knowledge. If this was the case, the benefit from this is that radiographers became more aware on the importance of pre-exposure ASM and how to incorporate them in radiography.

3.11. Conclusion

This chapter featured the methodology used by the researcher to obtain the required data in the study. The next chapter will demonstrate how data analysis took place based on the results obtained from the study, and a discussion of the findings will be presented.
CHAPTER 4

PRESENTATION, ANALYSIS AND DISCUSSION OF RESULTS
4.1. Introduction

The following chapter presents an analysis and discussion of the findings from this study.

4.2. Phase 1: Results of survey

4.2.1. Evidence of ASMs

Out of the 500 radiographs observed, 430 radiographs (86%) had evidence of ASM, of which 110 (25.6%) had a pre-exposure ASM and 320 (74.4%) had a post-processing ASM (Figure 4.1). These results were similar to Platt and Strudwick’s study (2009), where presence of pre-exposure ASMs was seen in 33% and 27% of radiographs analysed during pre- and post-Computed Radiography (CR) installation, while the remaining 66% and 77% of the radiographs showed presence of post-processing ASMs.

![Percentage of Radiographs](image)

Figure 4.1: Use of ASMs
However this does not agree with the findings of Titley and Cosson’s study (2014), as the distinction between the use of both types of ASMs was narrower, where presence of pre-exposure ASMs (59.8%) was more than post-processed ASMs (40.2%).

Furthermore, the remaining 14% of radiographs analysed in this local survey had no evidence of either a pre- or post-exposure ASM, which is less than in Titley’s and Cosson’s study (2014) (40.8%) but greater than in Platt and Strudwick’s study (2009) (1% in pre-CR instalment while none in post-CR instalment).

Figure 4.2 shows that 282 (56.4%) of the radiographs having either pre- or post-exposure ASMs were placed according to guidelines as stated by Ballinger, Frank and Merrill (2003).
Titley and Cosson’s study (2014) showed 0.6% of the radiographs having superimposition of pre-exposure ASMs over essential anatomy. In the local study no pre-exposure ASMs were seen to be obscuring essential anatomy. Furthermore, unlike Platt and Strudwick’s (2009) and Titley and Cosson’s study (2014), who showed evidence of incorrect pre-exposure ASM placement which were corrected for by adding post-processing ASMs, no post-processing ASMs were seen to be added on radiographs to compensate for such mistake in the local study. However in the hospital system where this study was done, one can simply crop out the incorrectly placed pre-exposure ASM before archiving the image on PACS. Pre-processed images are not available on PACS for evaluation.

Similar to the previous 2 studies stated above, 3 radiographs (0.6%) showed pre-exposure ASMs placed outside the collimation area; while 1 radiograph (0.2%) had a pre-exposure ASM partially included within the primary beam, cut off by collimation.

4.2.2. Time when radiograph was taken

From the 500 radiographs analysed, 342 of radiographs (68.4%) were taken during the day (from 7am-7pm) while 158 radiographs (31.6%) were taken during the night (7pm-7am). Figure 4.3 shows how in all consecutive years, more radiographs were taken during the day when compared to radiographs taken during the night.
Presence of ASMs showed no significant difference \((p \geq 0.05)\) in radiographs acquired during the day (86.3\%) and during the night (85.4\%) (Table 4.1).

![Percentage of Radiographs](image)

Fig. 4.3: Day/night distribution of radiographs over the 5 years

Table 4.1: Results of chi-square test comparing the use of ASM between day and night shifts

<table>
<thead>
<tr>
<th>Time</th>
<th>Presence of ASM</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Day shift</td>
<td>295</td>
<td>47</td>
</tr>
<tr>
<td>Percentage</td>
<td>86.3%</td>
<td>13.7%</td>
</tr>
<tr>
<td>Night shift</td>
<td>135</td>
<td>23</td>
</tr>
<tr>
<td>Percentage</td>
<td>85.4%</td>
<td>14.6%</td>
</tr>
<tr>
<td>Total</td>
<td>430</td>
<td>70</td>
</tr>
<tr>
<td>Percentage</td>
<td>86.0%</td>
<td>14.0%</td>
</tr>
</tbody>
</table>

\[
X^2 (1) = 0.060, n = 807
\]

However, the use of pre-exposure ASMs was significantly \((p \leq 0.05)\) more evident on radiographs taken during the day (28.8\%) to radiographs performed during the night (18.5\%) (Table 4.2). This contradicts Platt and Strudwick’s claim (2009) that less evidence of pre-exposure ASMs is seen during the day shift. These authors refer that it can be due to the pressure that arises about time constraints. This also differs from Titley
and Cosson’s findings (2014), who noticed no difference in use of pre-exposure ASMs in their study in regards to time of acquisition.

Table 4.2: Results of chi-square test comparing the use of pre-exposure and post-processing ASM between day and night shift

<table>
<thead>
<tr>
<th>Time</th>
<th>Pre-exposure ASM</th>
<th>Post-exposure ASM</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day shift</td>
<td>85</td>
<td>210</td>
<td>295</td>
</tr>
<tr>
<td>Percentage</td>
<td>28.8%</td>
<td>71.2%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Count</td>
<td>25</td>
<td>110</td>
<td>135</td>
</tr>
<tr>
<td>Night shift</td>
<td>110</td>
<td>320</td>
<td>430</td>
</tr>
<tr>
<td>Percentage</td>
<td>18.5%</td>
<td>81.5%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Total</td>
<td>25.6%</td>
<td>74.4%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

$X^2 (1) = 5.156, p = 0.023$

ASMs were shown to be more in accordance to the guidelines on radiographs taken during the day (72.9%), when compared to radiographs taken during the night (68.1%), however this difference was not significant ($p \geq 0.05$) (Table 4.3).

Table 4.3: Results of chi-square test comparing the use of ASM in accordance with guidelines between day and night shift

<table>
<thead>
<tr>
<th>Time</th>
<th>Guidelines</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day shift</td>
<td>A.T.G</td>
<td>215</td>
</tr>
<tr>
<td></td>
<td>N.A.T.G</td>
<td>80</td>
</tr>
<tr>
<td>Percentage</td>
<td>72.9%</td>
<td>27.1%</td>
</tr>
<tr>
<td>Count</td>
<td>92</td>
<td>43</td>
</tr>
<tr>
<td>Night shift</td>
<td>A.T.G</td>
<td>307</td>
</tr>
<tr>
<td></td>
<td>N.A.T.G</td>
<td>123</td>
</tr>
<tr>
<td>Percentage</td>
<td>68.1%</td>
<td>31.9%</td>
</tr>
<tr>
<td>Count</td>
<td>307</td>
<td>123</td>
</tr>
<tr>
<td>Total</td>
<td>A.T.G</td>
<td>430</td>
</tr>
<tr>
<td></td>
<td>N.A.T.G</td>
<td>430</td>
</tr>
<tr>
<td>Percentage</td>
<td>71.4%</td>
<td>28.6%</td>
</tr>
</tbody>
</table>

$X^2 (1) = 1.016, p = 0.313$

Key: A.T.G – According to guidelines; N.A.T.G: Not according to guidelines
4.2.3. Examination performed

The sample involved 212 radiographs showing bilateral anatomy (42.4%), 226 radiographs showing unilateral anatomy (45.2%) and 62 radiographs containing both sides of unilateral anatomy (12.4%). From Figure 4.4, one can notice that in all consecutive years, the examinations performed in the radiology department mostly involved unilateral and bilateral anatomy, while approximately only 1/5 of the examinations observed showed both unilateral anatomy on one radiograph.

![Figure 4.4: Distribution of examinations performed over the 5 years](image)

This study complements Platt and Strudwick’s claim (2009) that placement of pre-exposure ASMs is influenced by ‘communities of practice’, as seen when evaluating radiographs according to examination performed, projection executed and patient positions.
Different from Titley and Cosson’s study (2014) where pre-exposure ASMs was higher on bilateral examinations, compared to unilateral examinations, it was evident in this local study that placement of ASMs was mostly significantly \((p<0.05)\) seen in unilateral examinations (93.8%) and radiographs showing both unilateral sides (98.4%), when compared to radiographs showing bilateral anatomy (74.1%) (Table 4.4).

Table 4.4: Results of chi-square test comparing the use of ASM by examination

<table>
<thead>
<tr>
<th>Examination</th>
<th>Presence of ASM</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Bilateral</td>
<td>157</td>
<td>55</td>
</tr>
<tr>
<td>Percentage</td>
<td>74.1%</td>
<td>25.9%</td>
</tr>
<tr>
<td>Unilateral</td>
<td>212</td>
<td>14</td>
</tr>
<tr>
<td>Percentage</td>
<td>93.8%</td>
<td>6.2%</td>
</tr>
<tr>
<td>Both unilateral</td>
<td>61</td>
<td>1</td>
</tr>
<tr>
<td>Percentage</td>
<td>96.4%</td>
<td>1.6%</td>
</tr>
<tr>
<td>Total</td>
<td>430</td>
<td>70</td>
</tr>
<tr>
<td>Percentage</td>
<td>86.0%</td>
<td>14.0%</td>
</tr>
</tbody>
</table>

\[ \chi^2 (1) = 44.454, p = 0.000 \]

The presence of pre-exposure ASMs, was mostly significantly \((p<0.05)\) seen in radiographs showing both unilateral anatomy (47.5%) when compared to unilateral examinations (28.8%), and radiographs showing bilateral anatomy (12.7%) (Table 4.5).
Table 4.5: Results of chi-square test comparing the use of pre-exposure and post-processing ASM by examination

<table>
<thead>
<tr>
<th>Examination</th>
<th>ASM</th>
<th>Pre-exposure</th>
<th>Post-exposure</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count</td>
<td>Count</td>
<td>Percentage</td>
<td>Percentage</td>
</tr>
<tr>
<td>## Bilateral</td>
<td>20</td>
<td>137</td>
<td>157</td>
<td>12.7%</td>
</tr>
<tr>
<td>## Unilateral</td>
<td>61</td>
<td>151</td>
<td>212</td>
<td>28.8%</td>
</tr>
<tr>
<td>## Both unilateral</td>
<td>29</td>
<td>32</td>
<td>61</td>
<td>47.5%</td>
</tr>
<tr>
<td>## Total</td>
<td>110</td>
<td>320</td>
<td>430</td>
<td>25.6%</td>
</tr>
</tbody>
</table>

$X^2 (1) = 30.188, p = 0.000$

Furthermore, it was noticed that placement of ASM was seen to be within guidelines mostly in unilateral projections (97.2%), while 54.8% of radiographs showing bilateral anatomy were within guidelines. The guidelines recommend the use of the ‘right’ ASM for bilateral anatomy, however in this local study radiographers significantly ($p\leq0.05$) used the ‘left’ ASM more instead.

Only 24.6% of radiographs showing both unilateral anatomy had ASM placed according to the guidelines, as in most cases, only one ASM was used, instead of both ASMs as stated in Ballinger, Frank and Merrill’s guidelines (2003) (Table 4.6).
Table 4.6: Results of chi-square test comparing the use of ASM in accordance with guidelines per examination

<table>
<thead>
<tr>
<th>Examination</th>
<th>Guidelines</th>
<th>Total</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A.T.G</td>
<td>N.A.T.G</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Count</td>
<td>Percentage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Bilateral</strong></td>
<td>86</td>
<td>71</td>
<td>157</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Unilateral</strong></td>
<td>206</td>
<td>6</td>
<td>212</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Both unilateral</strong></td>
<td>15</td>
<td>46</td>
<td>61</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>307</td>
<td>123</td>
<td>430</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$X^2 (1) = 155.628, p = 0.000$

### 4.2.4. Projections taken

During the study, projections analysed included: 117 PA (23.4%), 180 AP (36%), 135 lateral (27%), 20 oblique (4.8%) and 44 special-views (8.8%). Figure 4.5 demonstrates how the three most frequent projections taken in the radiology department in all 5 years were the PA, AP and lateral projections.
In the local study, ASMs were placed most frequently \((p<0.05)\) in the AP (96.6%), PA (95%) and oblique (95.8%) projections, while lateral (68.1%) and special-view (70.5%) projections showed lower use of ASMs on radiographs (Table 4.7).

<table>
<thead>
<tr>
<th>Projection</th>
<th>Presence of ASM</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count</td>
<td></td>
</tr>
<tr>
<td>A/P</td>
<td>113</td>
<td>117</td>
</tr>
<tr>
<td>Percentage</td>
<td>96.6%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Count</td>
<td>171</td>
<td>180</td>
</tr>
<tr>
<td>Percentage</td>
<td>95.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Lateral</td>
<td>92</td>
<td>135</td>
</tr>
<tr>
<td>Percentage</td>
<td>68.1%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Count</td>
<td>131</td>
<td>135</td>
</tr>
<tr>
<td>Percentage</td>
<td>95.8%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Special View</td>
<td>31</td>
<td>44</td>
</tr>
<tr>
<td>Percentage</td>
<td>70.5%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Total</td>
<td>430</td>
<td>500</td>
</tr>
<tr>
<td>Percentage</td>
<td>86.0%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

No significant difference \((p>0.05)\) was seen in the use of post-processing ASMs over pre-exposure ASMs use (Table 4.8). The least shown was in special views, in accordance with Titley and Cosson’s finding (2014) showing that pre-exposure ASMs were more likely to be placed in routine projections rather than in modified techniques.
Table 4.8: Results of chi-square test comparing the use of pre-exposure and post-processing ASM per projection

<table>
<thead>
<tr>
<th>Projection</th>
<th>ASM</th>
<th>Count</th>
<th>Percentage</th>
<th>Count</th>
<th>Percentage</th>
<th>Count</th>
<th>Percentage</th>
<th>Total</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posterior/Anterior</td>
<td>Pre-exposure</td>
<td>35</td>
<td>31.0%</td>
<td>78</td>
<td>69.0%</td>
<td>113</td>
<td>100.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Posterior/Anterior</td>
<td>Post-exposure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anterior/Posterior</td>
<td>Pre-exposure</td>
<td>41</td>
<td>24.0%</td>
<td>130</td>
<td>76.0%</td>
<td>171</td>
<td>100.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anterior/Posterior</td>
<td>Post-exposure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lateral</td>
<td>Pre-exposure</td>
<td>25</td>
<td>27.2%</td>
<td>67</td>
<td>72.8%</td>
<td>92</td>
<td>100.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lateral</td>
<td>Post-exposure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oblique</td>
<td>Pre-exposure</td>
<td>5</td>
<td>25.1%</td>
<td>17</td>
<td>73.9%</td>
<td>23</td>
<td>100.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oblique</td>
<td>Post-exposure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Special Views</td>
<td>Pre-exposure</td>
<td>3</td>
<td>9.7%</td>
<td>28</td>
<td>90.3%</td>
<td>31</td>
<td>100.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Special Views</td>
<td>Post-exposure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>Pre-exposure</td>
<td>110</td>
<td>25.6%</td>
<td>320</td>
<td>74.4%</td>
<td>430</td>
<td>100.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>Post-exposure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$\chi^2$ (1) = 6.202, p = 0.183

The lateral, oblique and special projections showing the presence of an ASM had a significant high ($p \leq 0.05$) percentage of ASM placed in accordance to Ballinger, Frank and Merrill’s guidelines (2003) (Table 4.9). However, a significantly high ($p \leq 0.05$) percentage of radiographs in the posterior/anterior and anterior/posterior projections had an ASM placed not according to the guidelines (Table 4.9). In these instances, the ASMs were either placed in the left side instead of the right side of AP and PA projections showing bilateral anatomy, or the ASM were not reversed in the PA projections as stated in the guidelines.
4.2.5. Patient positioning

From the 500 radiographs observed, 187 (37.4%) patients were positioned erect, 102 (20.4%) were supine/prone, 197 (39.4%) were seated and 14 (2.8%) were in the lateral decubitus position. Figure 4.6 shows how in all 5 years, patients were mostly either erect or sitting at the time when radiographs were taken with the least being in the lateral decubitus position, as seen in all consecutive years.
A significantly high percentage \((p < 0.05)\) of ASMs were seen in most patient positions. In the lateral decubitus position however, presence of ASMs was lower compared to the rest (Table 4.10).

Table 4.10: Results of chi-square test comparing ASM use per patient position

<table>
<thead>
<tr>
<th>Patient’s Position</th>
<th>Presence of ASM</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Supine/prone</td>
<td>82</td>
<td>20</td>
</tr>
<tr>
<td>Percentage</td>
<td>80.4%</td>
<td>19.6%</td>
</tr>
<tr>
<td>Count</td>
<td>155</td>
<td>31</td>
</tr>
<tr>
<td>Sitting</td>
<td>183</td>
<td>14</td>
</tr>
<tr>
<td>Percentage</td>
<td>92.5%</td>
<td>7.1%</td>
</tr>
<tr>
<td>Count</td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td>Decubitus</td>
<td>429</td>
<td>70</td>
</tr>
<tr>
<td>Percentage</td>
<td>86.0%</td>
<td>14.0%</td>
</tr>
</tbody>
</table>

\(X^2 (1) = 16.992, \ p = 0.001\)
The use of pre-exposure ASMs was significantly lower ($p<0.05$) to post-exposure ASM (Table 4.11), especially in the supine/prone, as opposed to what was found in Titley and Cosson’s study (2014) where the use of pre-exposure ASMs was mostly seen when the patient was in the supine position.

Table 4.11: Results of chi-square test comparing the use of pre-exposure and post-exposure ASM per patient position

<table>
<thead>
<tr>
<th>Patient’s Position</th>
<th>Pre-exposure ASM</th>
<th>Post-exposure ASM</th>
<th>Total ASM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count</td>
<td>Percentage</td>
<td>Count</td>
</tr>
<tr>
<td>Supine/prone</td>
<td>10</td>
<td>19.5%</td>
<td>80</td>
</tr>
<tr>
<td>Erect</td>
<td>34</td>
<td>21.9%</td>
<td>121</td>
</tr>
<tr>
<td>Sitting</td>
<td>60</td>
<td>32.8%</td>
<td>123</td>
</tr>
<tr>
<td>Decubitus</td>
<td>0</td>
<td>0.0%</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>110</td>
<td>25.6%</td>
<td>319</td>
</tr>
</tbody>
</table>

$X^2 (1) = 10.736, p = 0.013$

In the lateral decubitus position, no pre-exposure ASMs were evident on all the radiographs evaluated, however post-processing ASMs were used instead and all were positioned according to guidelines. The position of the patient is not statistically correlated ($p \geq 0.05$) with the use of ASMs according to guidelines (Table 4.12).
4.3. Phase 2: Results of questionnaire

4.3.1. Sample size and response rate

Out of the 35 questionnaires that were distributed, 26 (74.3%) were returned. A response rate above 65% is deemed satisfactory (Polit and Beck, 2013), thus in this incidence, such percentage was considered acceptable.

4.3.2. Section A

*Question 1- Radiographers’ own personal pre-exposure ASMs*

The majority of respondents (65.4%) stated not having their own personal pre-exposure ASMs while 34.6% stated that they do have their own personal pre-exposure ASMs in hand.
Question 2- Pre-exposure ASM availability in x-ray rooms

All of the respondents (100%) taking part in the study stated that no pre-exposure ASMs are available in the x-ray rooms.

Question 3- Use of pre-exposure ASMs in the medical imaging department

The responses on the use of pre-exposure ASMs by radiographers are presented in Figure 4.7. The majority of radiographers said that they either often make use of pre-exposure ASMs or rarely make use of them. Only 3.8% said that they never apply pre-exposure ASMs.

Figure 4.7: Responses on use of ASMs

Question 4- Difficulties in using pre-exposure ASMs

The radiographers’ responses of difficulties in the use of ASMs are presented in Figure 4.8. Only 15.4% of radiographers stated that they never find any difficulties in placing pre-exposure ASMs while no radiographer taking part in
the study stated that they often or always find difficulties in placing pre-exposure ASMs. The most frequent answer was ‘occasionally’, as stated by 57.7% of the radiographers.

![Percentage of Respondents](image)

**Figure 4.8: Responses on difficulties in the use of pre-exposure ASMs**

**Question 5- Time consumed when placing pre-exposure ASMs**

A total of 76.6% of the respondents often or occasionally find it time consuming to place pre-exposure ASMs thus agreeing with Platt and Strudwick’s study (2009), while 22.8% of the respondents never find it time consuming to place pre-exposure ASMs (Figure 4.9).
Figure 4.9: Responses on whether it is time consuming to place pre-exposure ASMs

**Question 6- Preference between pre-exposure or post-processing ASMs**

Figure 4.10 presents radiographers’ preference of type of ASM use. Reasons behind the use of post-processing ASMs were due to lack of time, large workload, risk of obscuring essential anatomy and forgetting to use such accessories during practice. Others also answered that the reason for using post-processing ASMs is due to lack of pre-exposure ASMs availability in the room and due to other radiographers’ influence.

Those who prefer using pre-exposure ASMs stated that pre-exposure ASMs make the radiograph more professional and that no excuse is acceptable to prevent adding pre-exposure ASMs. Some respondents also stated that using pre-exposure ASMs makes them legally covered, as stated by Bontrager and Lampignano (2010) where legal and liability issues may arise due to potential mismarking.
4.3.3. Section B

**Question 7 - How knowledge was acquired about the use of pre-exposure ASMs**

Several radiographers chose more than one answer. The majority of respondents said that they acquired knowledge during their radiography course (Figure 4.11)
**Question 8- Perception of own knowledge of respondents about the use of pre-exposure ASMs**

Figure 4.12 presents radiographers’ own rating of their knowledge on pre-exposure ASM use where their knowledge was ranged from ‘just sufficient’ to ‘excellent’, ‘good’ being the most common answer (73.1%).

![Figure 4.12: Radiographers’ rating of their knowledge of ASM use](image)

**Question 9- Interest in more knowledge about the use of pre-exposure ASMs**

The majority of respondents showed interest in gaining more information on the use of pre-exposure ASMs as seen on Figure 4.13.

![Figure 4.13: Respondents’ interest in gaining more knowledge on ASM use](image)
Question 10- Respondents’ opinion about the best method to obtain more knowledge about the use of pre-exposure ASMs

Some respondents chose more than one answer. The majority of respondents, however, prefer printed documents as being the most convenient way to acquire knowledge about the use of pre-exposure ASMs (Figure 4.14).

![Percentage of Respondents](image)

Figure 4.14: Preferred method of obtaining knowledge on ASM use

4.3.4. Section C1

Question 11- Placement of pre-exposure ASM during planar x-ray imaging

All respondents (100%) chose that the placement of pre-exposure ASMs should be within the collimated x-ray beam, thus agreeing with Ballinger, Frank and Merrill’s guidelines (2003).
Question 12- Placement of pre-exposure ASM when more than one projection is taken of the same body part

This question was answered by 92.3% of the respondents stating that a pre-exposure ASM should be present on all projections even though the same body part is being imaged as recommended by Ballinger, Frank and Merrill (2003). The rest of the respondents (7.7%) stated that a pre-exposure ASM should only be placed on the AP/PA projections if the same body-part is being imaged and omitted in other projections, as seen in Titley and Cosson’s (2014) and Platt and Strudwick’s study (2009). Such practice was also seen in Sweden before a new protocol was introduced to include pre-exposure ASMs on all radiographs as stated by Finnbogason, Bremmer and Ringertz (2001).

Question 13- Placement of pre-exposure ASMS in PA/AP projections of bilateral anatomy.

Most of the respondents (92.3%) stated that the use of either the right or left pre-exposure ASM does not make any difference when imaging bilateral anatomy, while only 7.7% of the respondents agreed that the right pre-exposure ASM should be used instead. This was also reflected in the findings of the local survey showing that most radiographers are not aware of Ballinger, Frank and Merrill’s guidelines (2003) when imaging PA/AP projections of bilateral anatomy.
Question 14- Placement of pre-exposure ASMs in lateral projections of the head and trunk

Some respondents (3.8%) indicated that the pre-exposure ASM should be placed posterior to the anatomy while others (73.1%) stated that it does not make any difference if an ASM is placed anterior or posterior to the anatomy as long as it is on the correct side. Only 23.1% stated that the pre-exposure ASM should be placed anterior to anatomy as indicated in Ballinger, Frank and Merrill’s guidelines (2003).

Question 15- Marking of pre-exposure ASMs in lateral projections of head and trunk

Most of the respondents (73.1%) stated that the anatomical side closest to the image receptor should be marked agreeing with Ballinger, Frank and Merrill’s guidelines (2003). However, 26.9% of radiographers stated that no pre-exposure ASM should be used in lateral projections of the head and trunk.

Question 16- Placement of pre-exposure ASMs in oblique projections that include both the right and left sides of the body

The majority of the respondents (61.5%) agreed that pre-exposure ASMs should be placed on the side closest to the image receptor as stated in Ballinger, Frank and Merrill’s guidelines (2003). Twenty seven percent (27%) answered that the pre-exposure ASM should instead be placed on the side away from the image receptor, while 11.5% did not know the answer.
Question 17- Placement of pre-exposure ASMs in limb projections where both the right and left sides are imaged side-by-side on one image receptor

Sixty nine percent (69.2%) of the respondents stated that either a right or left pre-exposure ASM can be placed on the correct side, while only 30.8% of the respondents stated that both the right and left pre-exposure ASM should be used to clearly identify the two sides, as written in Ballinger, Frank and Merrill’s guidelines (2003).

Question 18- Placement of pre-exposure ASMs in AP, PA or oblique chest projections

All the respondents answered that a pre-exposure ASM should be placed on the upper-outer corner of the x-ray beam as written in Ballinger, Frank and Merrill’s guidelines (2003).

Question 19- Placement of pre-exposure ASMs in decubitus projections of the chest and abdomen

The majority of respondents (67.2%) answered that the pre-exposure ASM should be placed opposite the side laid on and away from the anatomy of interest. Meanwhile, 11.4% answered that a pre-exposure ASM should be placed opposite the side laid on and near the anatomy of interest. The rest of the respondents (21.4%) did not know the answer.
Question 20- Repetition of radiograph

Eighty five per cent (84.6%) of radiographers stated that a radiograph should be repeated when the pre-exposure ASM is obscuring essential anatomy as stated by Bontrager and Lampignano (2010). Additionally, 11.5% radiographers disagreed and stated that a repeat is necessary when the wrong pre-exposure ASM is seen on the radiograph, while 3.8% of radiographers did not know the answer.

Question 21- Best practice regarding the use of ASM

The majority of the respondents (73.1%) agreed with the Royal College of Radiologists and the Society and College of Radiographers (2011) that best practice is reflected when one makes use of a correct pre-exposure ASM during planar x-ray imaging and ensure its presence on the resultant radiograph. However, 23.1% of the respondents stated that it does not make any different whether a pre-exposure ASM or a post-exposure ASM is used as long as it is identifying the correct side. The remaining radiographers (3.8%) stated that best practice is when one places a correct post-exposure ASM during planar x ray imaging to limit the time of acquisition.

4.3.5. Section C2

Question 22- Limiting beam collimation is of more importance during planar x-ray imaging over having pre-exposure ASM included within the primary beam (true or false)
Eighty nine percent (88.5%) of radiographers agreed that limiting beam collimation is of more importance over having pre-exposure ASMs included within the primary beam as seen in Titley’s and Cosson’s study (2014) where they classified it one of the latent conditions that provokes non-use of pre-exposure ASMs. The rest of the respondents (11.5%) did not agree with this statement.

**Question 23- In forensic radiography, it is a necessity that all x-ray images must be presented with evidence of pre-exposure ASM as the images are regarded as legal documents (true or false)**

All respondents (100%) agreed that this is true as the images are regarded as legal documents as stated by the Society of Radiographers (2005).

**4.3.6. Section C3**

**Question 24- Image 1**

The majority of respondents (88.6%) stated that there is correct placement of pre-exposure ASM on the radiograph showing a left pre-exposure ASM placed on the left side of the abdomen. However Ballinger, Frank and Merrill’s guidelines (2003) states that a right pre-exposure ASM should be used. Thus only 11.4% of the respondents answered that there is incorrect use of pre-exposure ASM giving the reason that a right pre-exposure should be used and
placed on the right side of the anatomy. Those that responded correctly stated that no repeat is needed as a post-exposure ASM can be used to fix it.

**Question 25 - Image 2**

All respondents (100%) agreed that there is incorrect use of pre-exposure ASM, giving the reason that the pre-exposure ASM is obscuring essential anatomy and that a repeat of exposure is necessary as stated by Bontrager and Lampignano (2010) since the pre-exposure ASM cannot be removed after exposure has taken place. None realised that a right pre-exposure ASM should have been used instead of a left pre-exposure ASM, when imaging bilateral anatomy, as stated in Ballinger, Frank and Merrill’s guidelines (2003).

**Question 26 - Image 3**

Eighty nine percent (88.5%) of the respondents agreed that the use of pre-exposure ASM is incorrect as there is no ASM seen on the radiograph. The remaining 11.5% did not know whether the radiograph showed correct or incorrect use of ASM. Those stating the radiograph being incorrect explained that no further repeats are necessary as one can add a post-processing ASM as stated by Herrmann et al. (2012) to prevent unnecessary dose to the patient.

**Question 27 - Image 4**

The majority of the respondents (73.1 %) agreed with Ballinger, Frank and Merrill’s guidelines (2003) and stated that there is correct use of ASM on the
radiograph showing the pre-exposure ASM placed anteriorly to the anatomy, while 19.2% of the respondents said that there is incorrect use of pre-exposure ASM, some explaining that it should be placed posterior to anatomy while others stated that no ASM should be used in the lateral projection to prevent obstruction of essential anatomy. The remaining 7.7% stated that they did not know the answer. Those that stated that the use of pre-exposure ASM is incorrect stated that no repeat is necessary unless there is evidence of obscurity on essential anatomy.

Question 28 - Image 5

Sixty five percent (65.4%) of the respondents stated that pre-exposure ASMs visible outside of the collimation was incorrect but that no repeat is needed since a post-processing ASM can be inserted instead, as observed in Tittley and Cosson’s sample (2014) where they were not considered as being incorrect but excluded from the study instead. The rest of the respondents (34.6%) stated that this is still correct as the pre-exposure ASMs is still visually seen and clearly identified thus agreeing with Adejoh, Onwuzu, Nkubli and Ikegwuonu’s study (2014) demonstrating that pre-exposure ASMs placed in the secondary radiation field, very close to the collimation field, were clear and aesthetically similar to those in the primary field.
Question 29- Image 7

Seventy seven percent (76.9%) of the respondents stated that there is correct use of pre-exposure ASM on the radiograph showing only the left pre-exposure ASM where both feet are imaged. Contrary to this, 19.2% of the respondents however identified that there is incorrect use of pre-exposure ASM and stated that a right post-exposure ASM should also be included as recommended in Ballinger, Frank and Merrill’s guidelines (2014), but no repeat of exposure is necessary. The remaining 3.8% of the radiographers did not know the answer.

Question 30- Image 8

The majority of the respondents (76.9%) stated that such use of pre-exposure ASM was still correct as it is still identifiable as being the ‘R’ pre-exposure ASM even though it is partially cut off, while 19.2% of the respondents disagreed and stated that a post-processing ASM should be added to compensate for this mistake. The remaining 3.8% of respondents stated that they did not know the answer.

4.4. Comparing the findings of the two phases of the research

4.4.1. Use of ASMs

‘Best Practice’, as stated by the majority of the respondents (73.1%), is when pre-exposure ASMs are being used during planar x-ray imaging (Question 21). However
from phase 1, this was not found to be the case. A strong alignment is seen between the findings of the two phases in regards to the use of ASMs, as both presented low usage of pre-exposure ASMs in the medical imaging department. In the survey, the researcher found only 25.6% of radiographs having evidence of pre-exposure ASMs. This is complemented in the questionnaire, as only 15.4% of the respondents stated that they use pre-exposure ASM during practice (Question 6), thus providing a reason why there are a low percentage of radiographs having pre-exposure ASMs.

Low use of pre-exposure ASMs can be linked as well to the lack of pre-exposure ASM availability in the x-ray rooms and that only 34.6% of the respondents claimed to have their own personal pre-exposure ASMs in hand (Questions 1 and 2). Contrary, the use of post-processing ASMs was seen dominant in the survey (74.4%) which is further backed up in the questionnaire as 84.6% of the respondents stated that they prefer using post-processing ASMs (Question 6) and 76.6% of radiographers find it often or occasionally time consuming when applying pre-exposure ASMs (Question 5).

Absence of ASMs was seen only in 14% of the radiographs evaluated during the survey. This is reflected in the questionnaire where 92.3% of radiographers agreed on the importance of using ASMs in all projections (Question 12).
4.4.2. Radiographers’ knowledge regarding the guidelines associated with the use of pre-exposure ASMs

Similarities were found in both the survey and questionnaire demonstrating the radiographers’ knowledge on the guidelines related to the use of pre-exposure ASMs during planar x-ray imaging. In the questionnaire, the average percentage score of correct answers was calculated to find out the radiographers’ knowledge about these guidelines. The resultant score was estimated to be 60.5%. Correspondingly, the retrospective study demonstrated that 56.4% of the radiographs evaluated were within the stipulated guidelines. When comparing the results from both tests, it was evident that the radiographers lacked knowledge mostly in the guidelines related to how to place pre-exposure ASMs on bilateral PA/AP projections, lateral projections of the head and trunk and on radiographs showing both sides of unilateral anatomy (Questions 13, 14 and 17).

4.4.3. Collimation and use of pre-exposure ASMs

In the questionnaire, all radiographers agreed that the placement of pre-exposure ASMs should be within collimation (Question 11). However, during the retrospective study, 3 radiographs were found to have a pre-exposure ASM placed outside collimation. In the questionnaire 65.4% of the respondents stated that such placement of pre-exposure ASM is incorrect while the rest of the respondents disagreed (Question 28). Having the radiograph with the pre-exposure ASM partially cut off due to collimation was
considered still correct by 76.9% of the respondents (Question 30), and in fact 1 radiograph was noticed to have a pre-exposure ASM partially cut off due to collimation.

Most radiographers (88.5%) agreed that limiting the beam collimation is more important over having pre-exposure ASMs included within the primary beam (Question 22). However, from the retrospective study it was noted that despite the lack of use of pre-exposure ASMs on radiographs, the collimation of most radiographs having no pre-exposure ASMs was still quite broad, where a pre-exposure ASM could have been easily added without changing its collimation.

4.5. Conclusion

This chapter presented a discussion and analysis of the findings obtained from the study. The next chapter concludes the dissertation by providing the main conclusions and recommendations drawn based on this chapter.
CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS
Chapter 5 – Conclusions and Recommendations

5.1. Introduction

This chapter presents a summary of the conclusions and recommendations derived from the study and provides suggestions for further research.

5.2. Conclusions from the study

In phase 1 of the study, results showed errors of non-use and misuse of both pre- and post-exposure ASMs in 43.6% of radiographs observed, mostly in bilateral AP/PA projections, lateral projections of the head and trunk and radiographs showing both sides of unilateral anatomy. This was reflected in phase 2 of the study, as results showed that the radiographers have adequate knowledge on the guidelines that should be followed when applying pre-exposure ASMs but need further improvement in the same areas mentioned above in regards to the use of ASMs.

Additionally, in phase 1, the use of pre-exposure ASM was minimal on radiographs (25.6%) as radiographers’ showed more preference in using post-processing ASMs (84.6%), compared to using pre-exposure ASMs (15.4%) in phase 2 of the study. Use of pre-exposure ASMs was seen to be influenced by factors such as time of image acquisition, projection executed, and patient positioning. Collimation was seen to be of more importance to radiographers over placement of pre-exposure ASMs, however this was not the case when
observing the radiographs. At the end, it was noted that respondents are interested in learning more about the use of ASMs in radiography mostly through printed documents, hence the reason why a leaflet was constructed (Appendix D).

5.3. Recommendations from the study

With reference to the findings of this study, the following recommendations are brought forward to improve the use of ASMs in radiography.

- Departmental pre-exposure ASMs should be made available to radiographers in every room during planar x-ray imaging, as currently no pre-exposure ASMs are available.

- Use of pre-exposure ASMs should be given more importance during the education and training of student radiographers.

- More education and training is crucial to improve the radiographers’ knowledge on the use of ASMs as from the results obtained in the study, education on this matter was lacking.
• Written departmental protocols on the use of ASM should be made available so that the radiographers can follow them and improve their practice.

• Reject analysis should be conducted routinely as an accepted standard of practice for Quality Assurance (QA) to provide a basis for in-service training of radiographers on the use of ASMs.

• The use of continuous professional development (CPD) by radiographers may further enhance and improve knowledge to staff about the use of ASM.

• Periodic evaluation in the department involving the use of ASMs by radiographers to identify deficiencies in knowledge and provide training as necessary.

5.4. Recommendations for further studies

Recommendations that could be used in future research involving an evaluation on the use of ASM include:

• Further retrospective research such as the one made in phase 1 of the study, is done with a larger radiograph sample size to investigate the use of ASM. A larger sample size allows researcher to evaluate clearly and more precisely the use of ASMs in the radiology department and reduce the maximum
margin error (4.38% in this study). This was not possible in this study due to the limited time frame present during data collection.

- Since phase 2 of this study made use of questionnaires, the data obtained may not truly reflect the radiographers’ knowledge, as they can look up the answers. Thus another method of data collection such as face-to-face interviews is recommended for further research studies.

- Further research can be carried out to identify whether the lack of pre-exposure ASM is linked to the absence of such markers in the department and few radiographers having their own personal pre-exposure ASMs.

- A similar research should be carried out in the future to see if there is any improvement on the perception and use of ASMs after leaflets have been distributed in the radiology department following the results from the study.

5.5. Conclusion

More awareness and education should be brought forward regarding the importance of using pre-exposure ASMs among radiographers as results from phase 1 and phase 2 of the study demonstrated room for improvement and radiographers willing to learn more on the use of pre-exposure ASMs. For this reason an information leaflet has been distributed by the researcher in the radiology department where the study took place.

Word count: 11,369
REFERENCE LIST


Table A1. Data record sheet used in phase 1 of study

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<th>Year and time of Examination</th>
<th>Examination Performed</th>
<th>Projection Taken</th>
<th>Patient Position</th>
<th>Evidence of ASM* on x-ray image</th>
<th>Remarks</th>
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</thead>
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<td>Year</td>
<td>Time</td>
<td>PA</td>
<td>AP</td>
<td>Lateral</td>
<td>Oblique</td>
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</tr>
</tbody>
</table>

Key concepts:
- ASM—Anatomical side marker that provides an indication of the patient's right or left side of the anatomy on planar x-ray images
- Pre-exposure ASM refers to radiopaque 'R' and 'L' letters that are placed on image detectors during exposure to indicate the patient's right or left side on planar x-ray images
- Post-processing ASM refers to 'R' and 'L' letters added after x-ray exposure to indicate the patient's right or left side on planar x-ray images
- A.T.G—According to Guidelines
- N.A.T.G—Not According To Guidelines
APPENDIX B

RADIOGRAPHERS’ QUESTIONNAIRE
RADIOGRAPHER QUESTIONNAIRE

Use of Anatomical Side Markers (ASM) during Planar X-Ray Imaging

Dear Radiographer,

I am a 4th year student undertaking an undergraduate course leading towards a B.Sc. in Radiography with the University of Malta. This entails a research study which has to be submitted during the final year of the course. The aim of this study is to evaluate the use of anatomical side markers (ASM) by the radiographers working in a local Medical Imaging Department.

Kindly fill in the attached questionnaire and when finished, post it in the boxes provided situated either in the PSX QA area 2 within the Medical Imaging Department (MID) or else in the radiographers’ staff room within the Accident and Emergency Unit (AandE).

Your involvement in this study is voluntary and you may choose not to participate or to withdraw participation at any time. The data collected will be treated with strict anonymity and confidentiality and in such a manner that it cannot be traced to you.

I would like to express my gratitude for your patience and consideration. If you have any queries about this research study, please do not hesitate to ask me. You may contact me using the information provided below.

You are required to fill in and post the questionnaire by not later than noon, Friday 20th February 2015.

Thanks
Stephanie Attard
Student Radiographer
Definition of key concepts:

*ASM - Anatomical side markers that provide an indication of the patient’s right or left side of the anatomy on planar x-ray images

**Pre-exposure ASM - refers to radiopaque ‘R’ and ‘L’ letters that are placed on image detectors during exposure to indicate the patient’s right or left side on planar x-ray images.

***Post-processing ASM - refers to ‘R’ and ‘L’ letters added after x-ray exposure to indicate the patient’s right or left side on planar x-ray images.
Appendix B - Radiographers’ Questionnaire

A. Use of Anatomical Side Marker (ASM*)
   Kindly tick the appropriate box.

1. Do you have your own personal pre-exposure ASM**?
   
   □ Yes    □ No

2. Are pre-exposure ASM** readily available in the x-ray room where you work?
   
   □ Yes    □ No

3. How often do you make use of pre-exposure ASM** in your practice?
   
   □ Never    □ Rarely    □ Occasionally    □ Often    □ Always

4. How often do you encounter difficulties in placing a pre-exposure ASM**?
   
   □ Never    □ Rarely    □ Occasionally    □ Often    □ Always

5. Do you consider it time consuming for you to position a pre-exposure ASM**?
   
   □ Never    □ Rarely    □ Occasionally    □ Often    □ Always
Appendix B - Radiographers’ Questionnaire

6. Which ASM do you most frequently use?
   □ Pre-exposure ASM**
   □ Post-processing ASM ***
   □ None
   Provide a reason for your choice of ASM*

B. Education and training in the use of pre-exposure ASM*. Kindly tick the appropriate box.

7. How did you acquire knowledge about the use of pre-exposure ASM**? (you may include more than one choice)
   □ During radiography course
   □ From other radiographers
   □ Work experience
   □ Own-study
   □ Other __________________________

8. Please rate your knowledge regarding the use of pre-exposure ASM**?
   □ Poor   □ Incomplete   □ Just sufficient   □ Good   □ Excellent

9. Would you be interested in learning more about the use of pre-exposure ASM**?
   □ Yes   □ No   □ Not sure
10. What would be the most convenient method for you to acquire knowledge about the use of pre-exposure ASM**? (you may include more than one choice)

- Printed documents
- Online sources
- Seminars
- Not sure
- Other ________________________

C. The aim of this section is to evaluate the learning needs on the use of ASM*. Please use your own knowledge to answer the questions without any help from other information resources so that the evaluation will be valid.

C1. Only indicate ONE option.

11. During planar x-ray imaging, the pre-exposure ASM** should be placed:

- outside the collimated x-ray beam
- within the collimated x-ray beam
- on or near essential anatomy
- I do not know

12. When more than one projection is taken of the same body part, the pre-exposure ASM** should be placed:

- only on the AP projection
- on the standard projection only
- on all projections taken
- I do not know
13. For AP and PA projections that include both the right and left sides of the body (head, spine, chest, abdomen, and pelvis):

- a ‘R’ pre-exposure ASM** should be placed on the correct side
- a ‘L’ pre-exposure ASM** should be placed on the correct side
- does not make any difference if a ‘R’ or ‘L’ pre-exposure ASM** is placed as long as it is on the correct side
- I do not know

14. For lateral projections of the head and trunk, pre-exposure ASM** are typically placed:

- anterior to the anatomy
- posterior to the anatomy
- does not make any difference if anterior or posterior to the anatomy as long as it is on the correct side
- I do not know

15. For lateral projections of the head and trunk (e.g. head, spine, chest, abdomen, and pelvis), always mark:

- the side furthest to the image receptor
- the side closest to the image receptor
- no pre-exposure ASM** should be placed on the image receptor
- I do not know
16. For oblique projections that include both the right and left sides of the body (spine, chest, and abdomen), always mark:

- the side furthest to the image receptor
- the side closest to the image receptor
- both pre-exposure ASM** (R and L) should be placed on the image receptor
- I do not know

17. For limb projections where both the right and left sides are imaged side-by-side on one image receptor:

- either a R or L pre-exposure ASM** should be placed on the correct side
- both the R and L pre-exposure ASM** should be used to clearly identify the two sides
- no pre-exposure ASM** should be used
- I do not know

18. For AP, PA or oblique chest projections, the pre-exposure ASM** is placed:

- on the upper-outer corner of the x-ray beam
- on the lower-outer corner of the x-ray beam
- does not make any difference if upper or lower corner of the x-ray beam
- I do not know
19. For decubitus projections of the chest and abdomen, the right or left pre-exposure ASM** should always be placed:

- closest to the side laid on and away from the anatomy of interest
- opposite the side laid on and away from the anatomy of interest
- opposite the side laid on and near the anatomy of interest
- I do not know

20. An x-ray image may need to be repeated if:

- the pre-exposure ASM** is present in the secondary beam
- the pre-exposure ASM** is obscuring essential anatomy
- the wrong pre-exposure ASM** in seen on the x-ray image
- I do not know

21. Which of the following statements reflect best practice regarding the use of ASM*?

- a correct pre-exposure ASM** placed during planar x-ray imaging and ensuring its presence on the resultant radiograph
- a correct post-exposure ASM*** be placed during planar x ray imaging to limit the time of acquisition
- a correct ASM*, whether it is a pre-exposure ASM** or a post-exposure ASM***, be placed during planar x ray imaging since it makes no difference
- I do not know
C2. Please state whether each of the following statements are TRUE or FALSE

22. Limiting beam collimation is of more importance during planar x-ray imaging over having pre-exposure ASM** included within the primary beam.
   - True   - False

23. In forensic radiography, it is a necessity that all x-ray images must be presented with evidence of pre-exposure ASM** as the images are regarded as legal documents.
   - True   - False
C3. Please state if the following x-ray images are **CORRECT** or **INCORRECT** regarding the use of ASM*. If incorrect, indicate what the mistake is and if a repeat of exposure is needed.

24.

☐ Correct use of pre-exposure ASM

☐ Incorrect Use of pre-exposure ASM

☐ I do not know

*If incorrect:
Why?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

Is a repeat of exposure necessary?  ☐ Yes  ☐ No

Why?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
25.

☐ Correct use of pre-exposure ASM
☐ Incorrect Use of pre-exposure ASM
☐ I do not know

*If incorrect:*
Why?
_________________________________________________________________________
_________________________________________________________________________
_________________________________________________________________________

Is a repeat of exposure necessary?  ☐ Yes  ☐ No
Why?
_________________________________________________________________________
_________________________________________________________________________
_________________________________________________________________________
26.

☐ Correct use of pre-exposure ASM
☐ Incorrect Use of pre-exposure ASM
☐ I do not know

*If incorrect:*
Why?
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Is a repeat of exposure necessary?  ☐ Yes  ☐ No
Why?
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
27.

- Correct use of pre-exposure ASM
- Incorrect Use of pre-exposure ASM
- I do not know

*If incorrect:* Why?
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Is a repeat of exposure necessary?  ☐ Yes  ☐ No
Why?
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

102
28.

☐ Correct use of pre-exposure ASM
☐ Incorrect Use of pre-exposure ASM
☐ I do not know

If incorrect:
Why?
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Is a repeat of exposure necessary?  ☐ Yes  ☐ No
Why?
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
29.

☐ Correct use of pre-exposure ASM
☐ Incorrect Use of pre-exposure ASM
☐ I do not know

*If incorrect:*
Why?

__________________________
__________________________
__________________________
__________________________

Is a repeat of exposure necessary?  ☐ Yes  ☐ No
Why?

__________________________
__________________________
__________________________
__________________________

104
30.

☐ Correct use of pre-exposure ASM
☐ Incorrect Use of pre-exposure ASM
☐ I do not know

*If incorrect:*  
Why?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Is a repeat of exposure necessary?  ☐ Yes  ☐ No

Why?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Thank you for taking the time from your busy schedule to complete this survey.
APPENDIX C

PERMISSIONS
To: Mr J Castillo  
Manager Imaging Services  

23rd May, 2014  

Re: Seeking permission to carry out a research study at the Medical Imaging Department.  

I am a 3rd year student undertaking an undergraduate course leading towards a B.Sc. in Radiography with the University of Malta. This entails a research study which has to be submitted during the final year of the course. The proposed study title is ‘Use of Anatomical Side Markers (ASM) during planar X-ray imaging’, for which I have Dr. Francis Zarb, Lecturer, FHS as my supervisor.  

The aim of this study is to evaluate the use of anatomical side markers (ASM) by the radiographers working in a local Medical Imaging Department. My sample will consist of a number of qualified radiographers working within the Medical Imaging Department, who participate on a voluntary basis by filling in a questionnaire. Additional data required for the purpose of the research study will also be obtained by the evaluation of patient planar radiographic examinations performed over the last 5 years. Anticipated favourable outcomes of the study include a development of an information leaflet to promote awareness amongst radiographers on the importance of using ASM during planar X-ray imaging.  

Based on the above I would like to seek your permission to carry out the study.  

I appreciate the time taken to respond to this request. Should you have any queries regarding the nature of the study do not hesitate to contact me.  

Yours sincerely,  

Stephanie Attard  
Student Radiographer  

Dr. Francis Zarb  
Lecturer (FHS)
Comments:

---

I, the undersigned, grant permission for this study to be performed.

Signature: [Signature]

Mr. J Castillo
Manager Imaging Services

Date: 3rd June 2014
Data Protection at MDH
10 Aug 06

Dear Ms. Attard

With reference to your study, this is to confirm that, on the basis of the documentation you submitted, from the MDH data protection point of view you have been cleared to proceed with your study. Kindly contact Ms. Nadine Buagar on 2545 5334 to fill in the appropriate Data Protection Form.

Please remember that in no way should you retain any personal details you obtain from your research and this should be destroyed at the end of your study.

You are requested to submit a copy of your findings to this office at the end of your study.

Good luck with your study.

Kind regards,

Ms. Sharon Young
A/Data Protection Officer,
Mater Dei Hospital
DECLARATION BY VISITING STUDENTS

I hereby declare that I will respect the confidentiality and privacy of any personal data or information that I might come across during my attachment at Mater Dei Hospital and will in no circumstance disclose any such information. I also confirm that I am aware of the provisions of the Data Protection Act and that I will abide by all Government and hospital regulations related to data.

I am also aware that I will be assigned a mentor for the duration of my attachment and will abide by the directions given by the same mentor.

Details of student
Signature: ____________________________
Full name: ____________________________
ID number: ____________________________
Educational Institution: ____________________________
Date: ____________________________

Endorsement by Parent/Guardian (where applicable)
Signature: ____________________________
Full name: ____________________________
ID number: ____________________________
Date: ____________________________

Disclaimer: Mater Dei Hospital will not be, under any circumstance, liable for consequential or incidental damages that might arise out of or related to the behaviour of the said student vis-a-vis the above instructions.

Data Protection Statement: The personal data supplied on this form will be processed in accordance with the Data Protection Act, XXXVI of 2001.

HRA/1043/01.0
Ing. Joseph Caruana  
Chief Executive Officer  

23rd May, 2014

Dear Mr Caruana,

Re: Seeking permission to carry out a research study at the Medical Imaging Department.

I am a 3rd year student undertaking an undergraduate course leading towards a B.Sc. in Radiography with the University of Malta. This entails a research study which has to be submitted during the final year of the course. The proposed study title is ‘Use of Anatomical Side Markers (ASM) during planar X-ray imaging’, for which I have Dr. Francis Zarb, Lecturer, FHS as my supervisor.

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Based on the above I would like to seek permission to carry out the study.

I appreciate the time taken to respond to this request. Should you have any queries regarding the nature of the study do not hesitate to contact me.

Yours sincerely,

Stephanie Attard
Student Radiographer

Dr. Francis Zarb
Lecturer (FHS)
Comments:

I, the undersigned, grant permission for this study to be performed.

Ing. Joseph Cardana

Date: 5/6/14
**UNIVERSITY OF MALTA**

**UNIVERSITY RESEARCH ETHICS COMMITTEE**

*Check list to be included with UREC proposal form*

Please make sure to tick **ALL** the items. Incomplete forms will not be accepted.

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<td>Recruitment letter / Information sheet for subjects, in English</td>
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<td>1b.</td>
<td>Recruitment letter / Information sheet for subjects, in Maltese</td>
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</tr>
<tr>
<td>2a.</td>
<td>Consent form, in English, signed by supervisor, and including your contact details</td>
<td>✓</td>
</tr>
<tr>
<td>2b.</td>
<td>Consent form, in Maltese, signed by supervisor, and including your contact details</td>
<td>✓</td>
</tr>
<tr>
<td>3a.</td>
<td>In the case of children or other vulnerable groups, consent forms for parents/ guardians, in English</td>
<td>✓</td>
</tr>
<tr>
<td>3b.</td>
<td>In the case of children or other vulnerable groups, consent forms for parents/ guardians, in Maltese</td>
<td>✓</td>
</tr>
<tr>
<td>4a.</td>
<td>Tests, questionnaires, interview or focus group questions, etc, in English</td>
<td>✓</td>
</tr>
<tr>
<td>4b.</td>
<td>Tests, questionnaires, interview or focus group questions, etc, in Maltese</td>
<td>✓</td>
</tr>
<tr>
<td>5a.</td>
<td>Other institutional approval for access to subjects: Health Division, Directorate for Quality and Standards in Education, Department of Public Health, Curia...</td>
<td>✓</td>
</tr>
<tr>
<td>5b.</td>
<td>Other institutional approval for access to data: Registrar, Data Protection Officer Health Division/Hospital, Directorate for Quality and Standards in Education, Department of Public Health...</td>
<td>✓</td>
</tr>
<tr>
<td>5c.</td>
<td>Approval from person directly responsible for subjects: Medical Consultants, Nursing Officers, Head of School...</td>
<td>✓</td>
</tr>
</tbody>
</table>

| Received by Faculty office on | 01.07.14 |
| Discussed by Faculty Research Ethics Committee on | 24.07.14 |
| Discussed by university Research Ethics Committee on | 24.09.14 |
Appendix C - University Research Ethics Community Approval

TERMS AND CONDITIONS FOR APPROVAL IN TERMS OF THE DATA PROTECTION ACT

- Personal data shall only be collected and processed for the specific research purpose.
- The data shall be adequate, relevant and not excessive in relation to the processing purpose.
- All reasonable measures shall be taken to ensure the correctness of personal data.
- Personal data shall not be disclosed to third parties and may only be required by the University or the supervisor for verification purposes. All necessary measures shall be implemented to ensure confidentiality and where possible, data shall be anonymised.
- Unless otherwise authorised by the University Research Ethics Committee, the researcher shall obtain the consent from the data subject (respondent) and provide him with the following information: The researcher's identity and habitual residence, the purpose of processing and the recipients to whom personal data may be disclosed. The data subject shall also be informed about his rights to access, rectify, and where applicable erase the data concerning him.

I, the undersigned hereby undertake to abide by the terms and conditions for approval as attached to this application.

I, the undersigned, also give my consent to the University of Malta’s Research Ethics Committee to process my personal data for the purpose of evaluating my request and other matters related to this application. I also understand that, I can request in writing a copy of my personal information. I shall also request rectification, blocking or erasure of such personal data that has not been processed in accordance with the Act.

Signature:

APPLICANT'S SIGNATURE

FACULTY SPONSOR'S SIGNATURE

I have reviewed this completed application and I am satisfied with the adequacy of the proposed research design and the measures proposed for the protection of human subjects.

DATE 23/6/2014

DATE 23/6/14

ATTACHMENTS:
* Recruitment letter, poster  * Other institutional approval  * Subject instructions
* Tests or questionnaires  * Information sheets or debriefing materials  * Other
* Written consent form (or script)

Return the completed application to your Faculty Research Ethics Committee
To be completed by Faculty Research Ethics Committee

We have examined the above proposal and advise

Acceptance       Refusal       Conditional acceptance

For the following reason/s:

Signature   Date 22/8/2014

To be completed by University Research Ethics Committee

We have examined the above proposal and grant

Acceptance       Refusal       Conditional acceptance

For the following reason/s:

Signature   Date 24/9/14
5. For limb projections that are done with two images on one image receptor, only one of the projections needs to be marked.

6. For limb projections where both the right and left sides are imaged side-by-side on one image receptor (e.g. AP both knees), both the ‘R’ and ‘L’ pre-exposure ASM must be used to clearly identify the two-sides.

7. For AP/PA or oblique chest projections, the pre-exposure ASM is placed on the upper-outer corner so that the thoracic anatomy is not obscured.

8. For decubitus positions of the chest and abdomen, the ‘R’ or ‘L’ pre-exposure ASM should always be placed on the side up (opposite the side laid on) and away from the anatomy of interest.

It is important to remember that no matter which projection is performed, and no matter what position the patient is in, if a ‘R’ pre-exposure ASM is used it must be placed on the “right” side of anatomy. If a ‘L’ pre-exposure ASM is used it must be placed on the “left” side of anatomy.
What are pre-exposure ASMs?

Pre-exposure ASMs are markers made of radio-opaque material such as metal which makes them visible on radiographs.

These are used in radiography containing the letters ‘R’ and ‘L’ to indicate the ‘right’ and ‘left’ side of the anatomy imaged.

Pre-exposure ASMs are fundamentally useful in radiography. Non-use or incorrect use of pre-exposure ASMs is classified as one of the most common sources of error in radiography.

Accepted ‘best practice’ standard regarding the use of pre-exposure ASMs requires that a correct pre-exposure ASM is placed within the primary collimation, to ensure its presence on the radiograph.

One must not compensate for the lack of pre-exposure ASM use by adding post-processed ASM, as this only provides a “safety net for poor practice” in radiography.

Results from the study...

...showed that ASMs were absent in 14% of radiographs taken during the last 5 years (2010-2014). When ASMs were included, the use of pre-exposure ASMs was only in 25.6% of radiographs, while post-processing ASMs were predominantly seen on 74.4% of radiographs.

Furthermore it was noted that the radiographers working in the medical imaging department have basic knowledge on the guidelines that should be followed when applying pre-exposure ASMs, but need further improvement in some areas regarding the use of pre-exposure ASMs on radiographs.

The study showed that most radiographers are interested in learning more about the use of pre-exposure ASMs in radiography, hence the reason why a leaflet is constructed.

Ballinger, Frank and Merrill (2003) provide specific pre-exposure ASM placement guidelines that radiographers should follow in radiography:

1. For AP and PA projections that include the right and left sides of the body (head, spine, chest, abdomen, and pelvis), a ‘R’ pre-exposure ASM is used.

2. For lateral projections of the head and trunk (head, spine, chest, abdomen, and pelvis), the side closest to the image receptor should always be marked. Pre-exposure ASM are placed anterior to the anatomy.

3. For oblique projections that include both the right and left sides of the body (spine, chest, and abdomen) the side nearest the image receptor is marked.

4. For limb projections, the appropriate ‘R’ or ‘L’ pre-exposure ASM should be used. The pre-exposure ASM must be placed within the edge of the collimated x-ray beam.