INTRODUCTION OF SKYLINER TO REDUCE HIGH RETAKE RATE OF THE KNEE SKYLINE X-RAY: A PILOT STUDY

Yap Lilian Poh Poh[1], Eturajulu Ravi Chanthriga[1], *Puspanazan Sharalla[1], Jinder Gurdeep Singh[1], Segaran Balamurugan[1] and Abdul Rashid Mohd Azuan[1]

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GENERAL RADIOGRAPHY (X-RAY)

- General radiography or plain X-Ray is a **basic medical imaging** examination.

- It is an examination that produces images of the **internal structures** and **extremities** to assist in **diagnosis.**

- One of the common request for extremities in General Radiography is **knee X-Ray.**

- In the year 2021, knee X-Ray constitutes **13%** of the medical imaging requests for extremities.

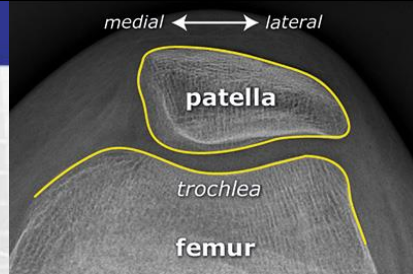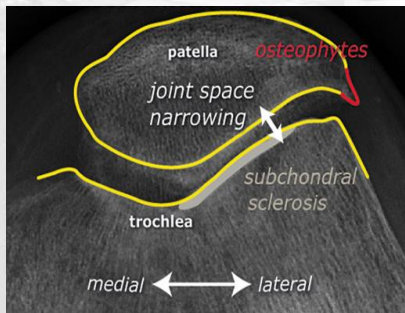- **Skyline view** is a common request of the knee X-Ray projection.
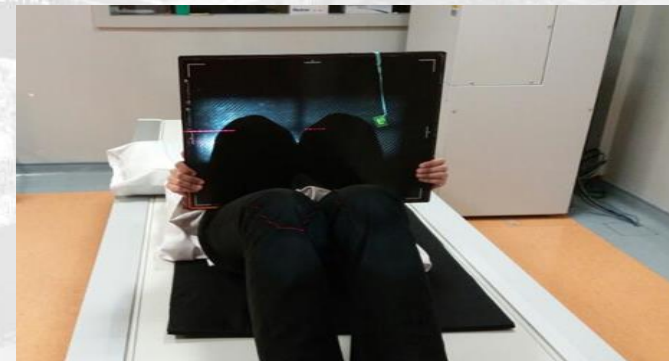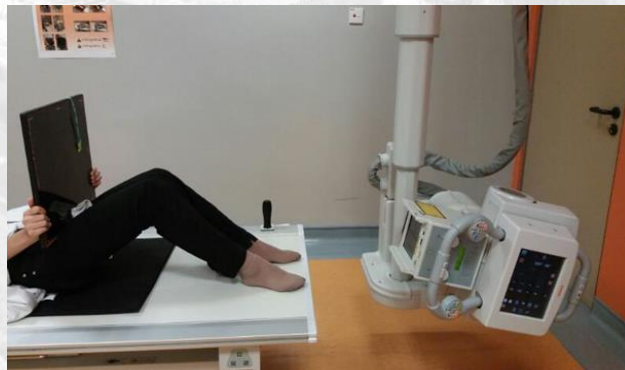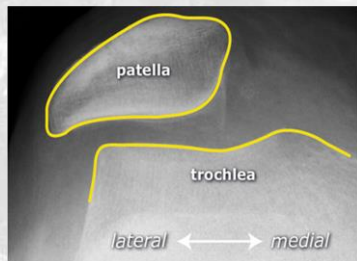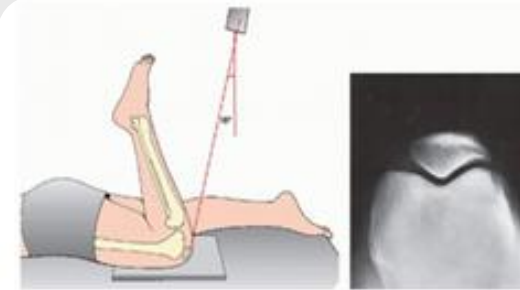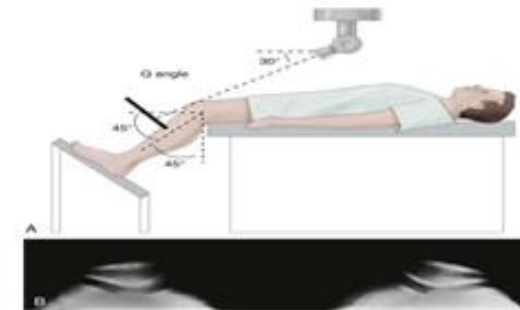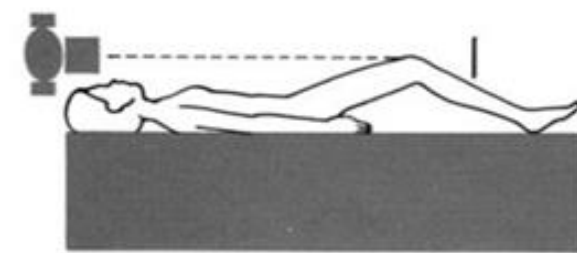
SKYLINE VIEW

1. Frequency of repetition of X-ray skyline (about >10%) due to blurred image caused by patient movement during exposure.
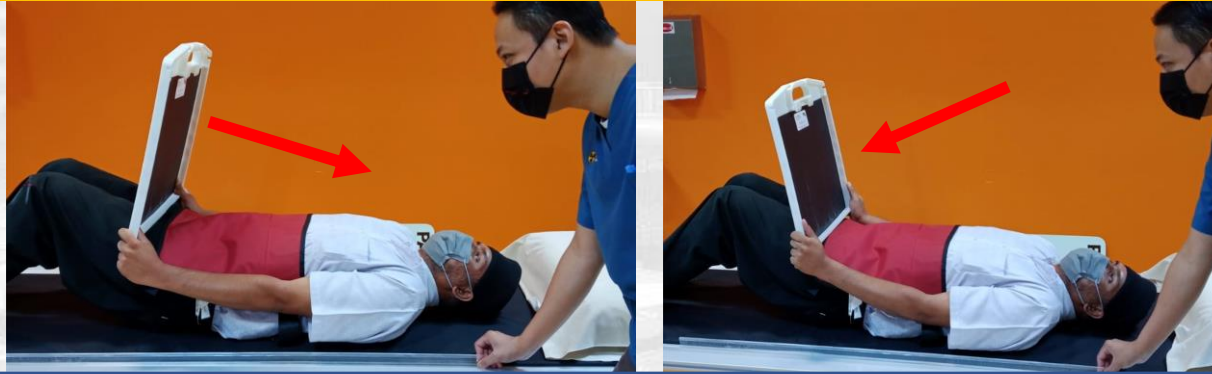
Detector was unstable and had high tendency of falling as patient had to hold it in position manually

2. Existing mobility devices are not compatible or ergonomic for some patients, especially patients who are old, weak or not strong

X-ray detector (weighs 4kg) have a **risk of falling** during skyline view positioning

Out of collimation

CURRENT WORKFLOW IN DEPARTMENT

Patient arrives at registration counter

Staff verifies patient ID

Patient wait to be called

Detector was unstable, risk of motion artifact and had high tendency of falling as patient had to hold it in position manually

Examination Performed LAURIN METHOD (without motion prevention device)

Patient called and ID verified prior to examination

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CURRENT PRACTICE – POSITIONING METHOD

X-ray detector (weighs 4kg) have a **risk of falling** during skyline view positioning

Cost of 1 X-Ray detector

~ RM200K

#2
KEROSAKAN HARTA/ASET PPUM YANG MEMERLUKAN PEMBAIKAN

DENDA: BERDASARKAN KOS PEMBAIKAN

LAURIN METHOD - CURRENT PRACTICE

Patient Is Semi-recumbent On The Table Holding A Detector Superior Of The Patella In The Landscape Orientation

Tube is angulated parallel to the patella depending on the degree of knee flexion

CEPHALAD ANGLE

Knee Is Bent Close To 30°
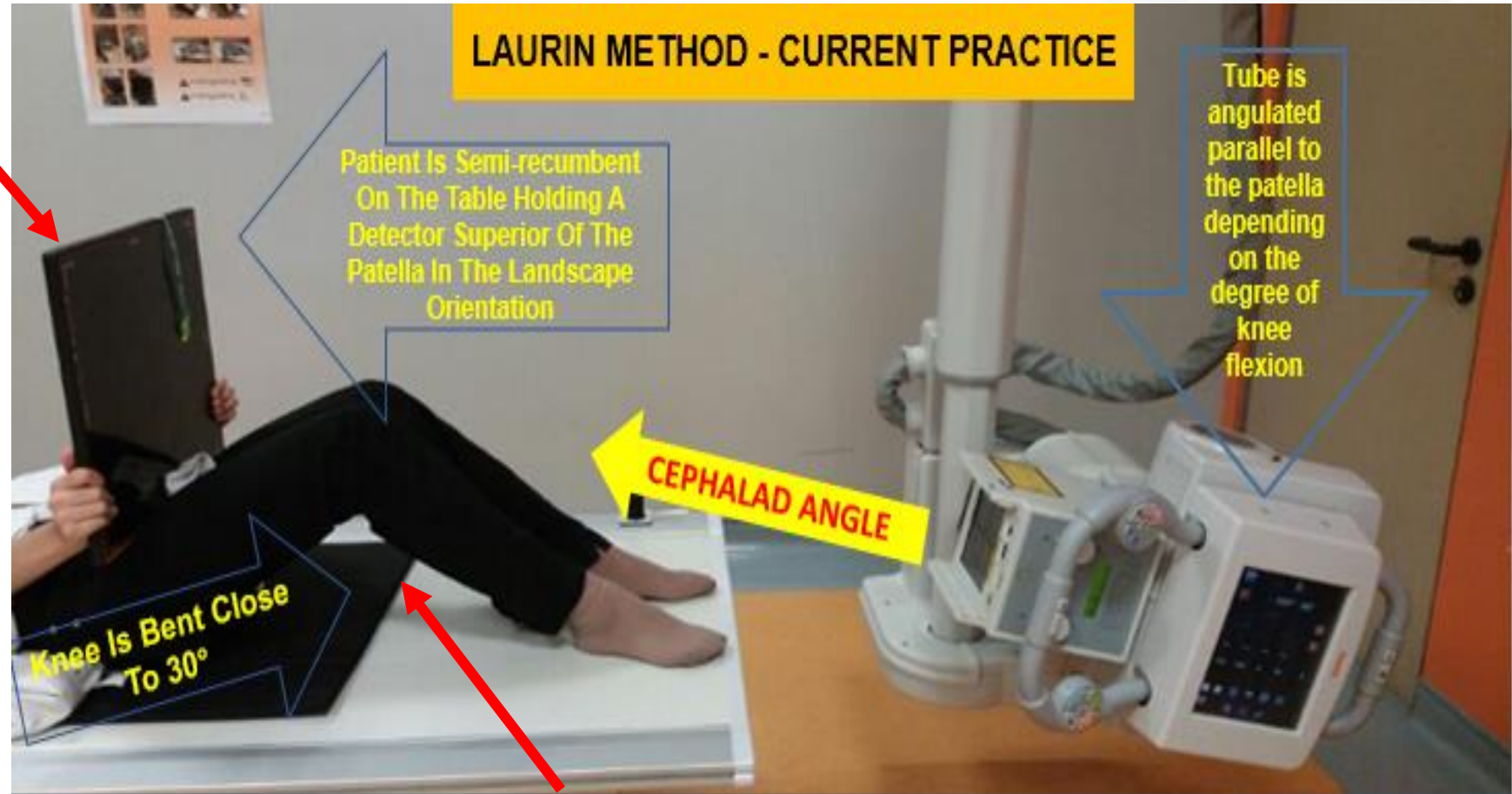
No **proper knee flexion** and X-Ray **beam angulation**

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CURRENT PRACTICE – POSITIONING METHOD

Click the link or QR code to view the current workflow:
https://youtube.com/shorts/4rcpR0dw1HM?feature=share

A demonstration video on current positioning for knee skyline X-Ray

BACKGROUND OF PROBLEM

Total detector FALL IMPACT in year 2021

No. of cases (y-axis: 0, 1, 2, 3)

Bar chart values by month:
- Jan-21: 0 0 0
- Feb-21: 0 0 0
- Mar-21: 0 0 0
- Apr-21: 1 (Low)
- May-21: 0 0 0
- Jun-21: 3 (Low), 1 (Medium), 0
- Jul-21: 1 (Low), 0 0
- Aug-21: 2 (Low), 0 0
- Sep-21: 1 (Low), 0 0
- Oct-21: 1 (Low), 0 0
- Nov-21: 2 (Medium), 0 0
- Dec-21: 2 (Low), 0 0

Month

FALL IMPACT
- ■ Low — 79%
- ■ Medium — 21%
- ■ High — 0%
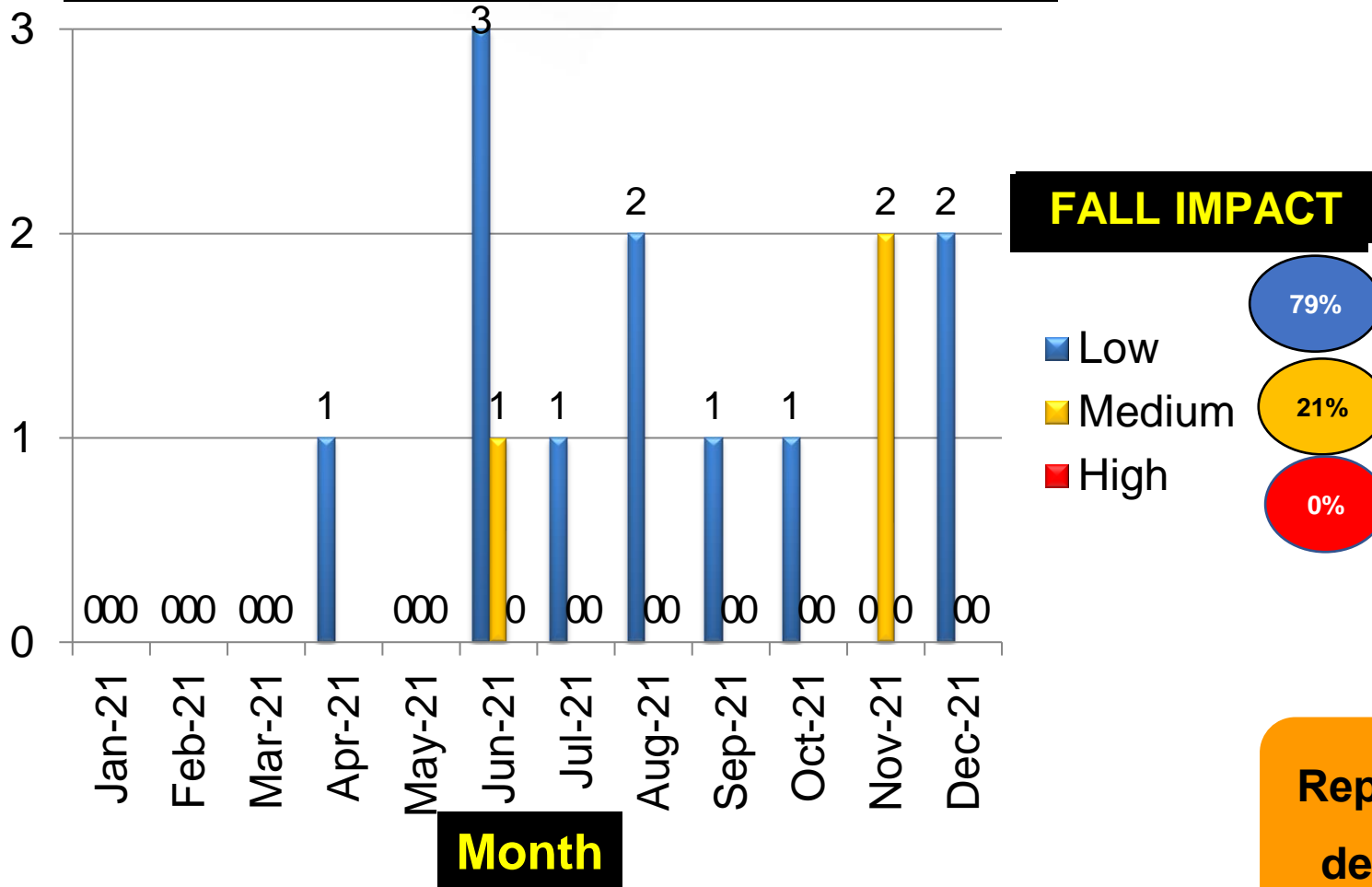
Six Digital Radiography (DR) room

Total number of detector "FALL IMPACT": 14 in the year 2021

X-Ray detector (weighs 4kg) has a **risk of falling** during knee skyline view positioning

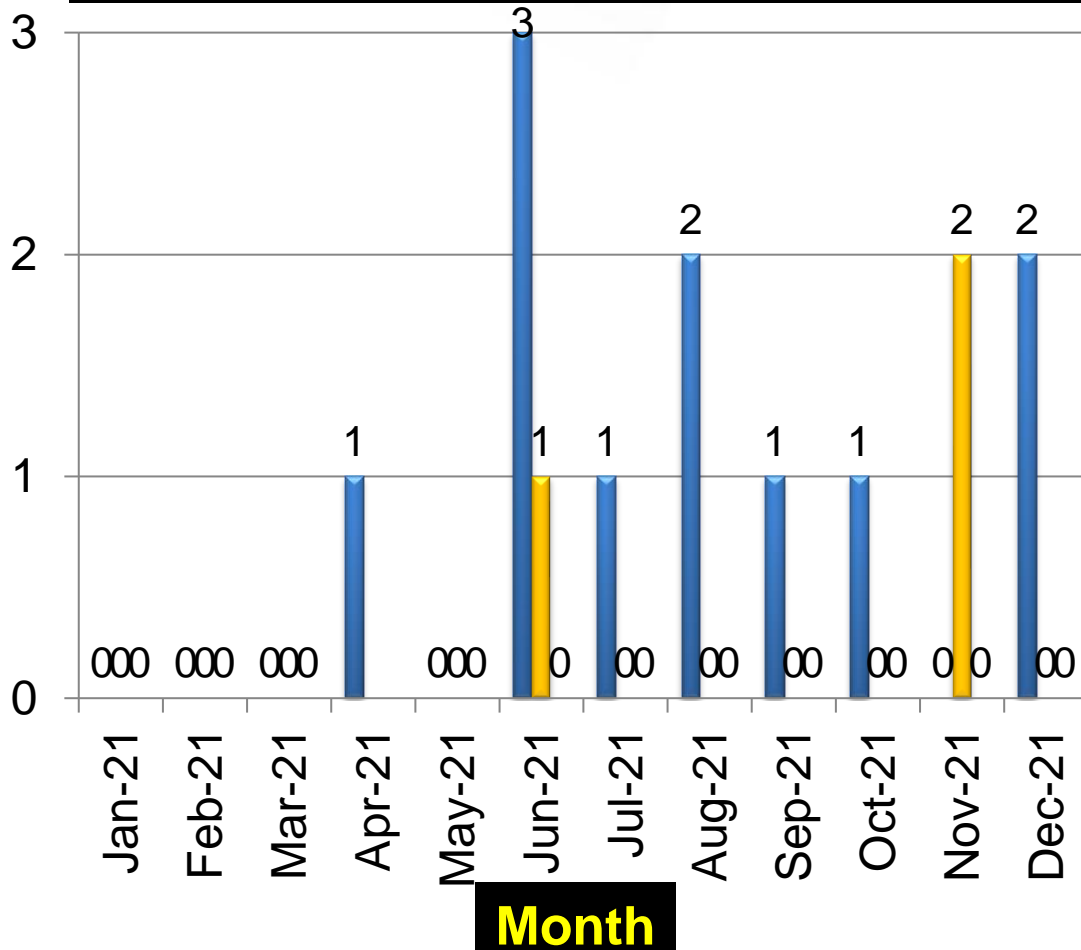**Reported incidents "FALL IMPACT" of the detectors (14 times in year 2021) >3%**

BACKGROUND OF PROBLEM

Total detector FALL IMPACT in year 2021

No. of cases vs Month

(Bar chart showing number of cases per month for Jan-21 through Dec-21)
- Jan-21: 0 0 0
- Feb-21: 0 0 0
- Mar-21: 0 0 0
- Apr-21: 1 (Low)
- May-21: 0 0 0
- Jun-21: 3 (Low), 1 (Medium)
- Jul-21: 1 (Low)
- Aug-21: 2 (Low)
- Sep-21: 1 (Low)
- Oct-21: 1 (Low)
- Nov-21: 2 (Medium)
- Dec-21: 2 (Low)

Month

FALL IMPACT
- ■ Low — 79%
- ■ Medium — 21%
- ■ High — 0%
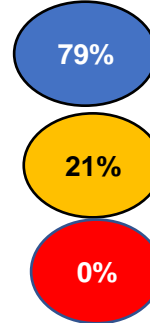
Cost of 1 X-ray detector

~ RM200K

Estimated cost of damage
~RM2.8 million!!!

Reported incidents "FALL IMPACT" of the detectors (14 times in year 2021) **>3%**

General objective:

- **to reduce the high retake rate of knee skyline X-Rays (>10%)**

Specific objectives

To reduce

1 radiation dose

2 time

3 cost

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	Deterministic effects	Stochastic effects
onset time	short	long
threshold	yes	no
probability	1 for all individuals above	increasing with dose
severity	increasing with dose	independant of dose
Consequences for nuclear installations	to prevent the occurrence of accidental situations and if any, to limit the consequences	to limit the exposure of workers, to reduce the exposure as low as possible

Risk of radiation induced cancer

Overall rate of repeat / retake analysis
should not exceed
10%

Recommended by Conference on Radiation Protection Quality Assurance Director in Diagnostic X-Ray. (http://www.crcpd.org/)

(these are still considered repeats).

After a period of time (recommend a minimal sample size of 250 patients or quarterly) analyze all of the films and record the reason that each film was placed in the collection box. The worksheet has several categories listed that are important in the management of an x-ray facility. For each film, place a mark in the box next to the appropriate cause. Record the total number of films that are checked for each category on the worksheet.

It is also important to record the total number of films used by the facility during the time period in order to determine total film usage.

Add up rows 1-10 on the worksheet to determine the total number of repeat or reject films and rows 11-14 to determine the total number of the other films. Also add these two numbers to

Conference of Radiation Control Program Directors, Inc. (CRCPD)
1030 Burlington Lane, Suite 4B
Frankfort, KY 40601
www.crcpd.org

First Published: July 1986
Revised/republished October 2009
QA Collectible: Repeat Analysis

Analysis of Results:

In order for this program to be of any value to the facility, the results must be reviewed PERIODICALLY! The overall rate should be less than 10%. The percentage of films in each category also needs to be reviewed to determine if a particular problem exists. If so, steps should be taken to correct that problem. As conditions improve, the overall percentages should decrease.

>10% correction action should be conducted

Educational Module Intervention for Radiographers to Reduce Repetition Rate of Routine Digital Chest Radiography in Makkah Region of Saudi Arabia Tertiary Hospitals: Protocol of a Quasi-Experimental Study

Introduction

Go to: ▸

Monitoring Editor: Gunther Eysenbach

Reviewed by Pooyan Khalighinejad and Elizabeth Krupinski

The repetition of radiographs **should not exceed 10%**

Good quality images in routine radiography should provide an adequate picture of the body's anatomy. Failure to obtain a good quality image requires the radiograph to be repeated. According to Foos et al [1], the term "repetition" refers to redoing a radiograph of a patient that was deemed clinically unacceptable. Repetition of an image is a critical event in radiology. It is recommended that the repetition rate should not exceed 5% [2-7]. The Diagnostic Imaging Quality Assurance Committee recommends that the repetition of radiographs should not exceed 5% to 7% [8]. The American Association of Physicists in Medicine recommends keeping the repetition rate below 6%, and when it increases to 10%, corrective action should be conducted [9]. The Australian College of Radiologists recommends an acceptable repetition rate of 2% and not more than 5% [10].
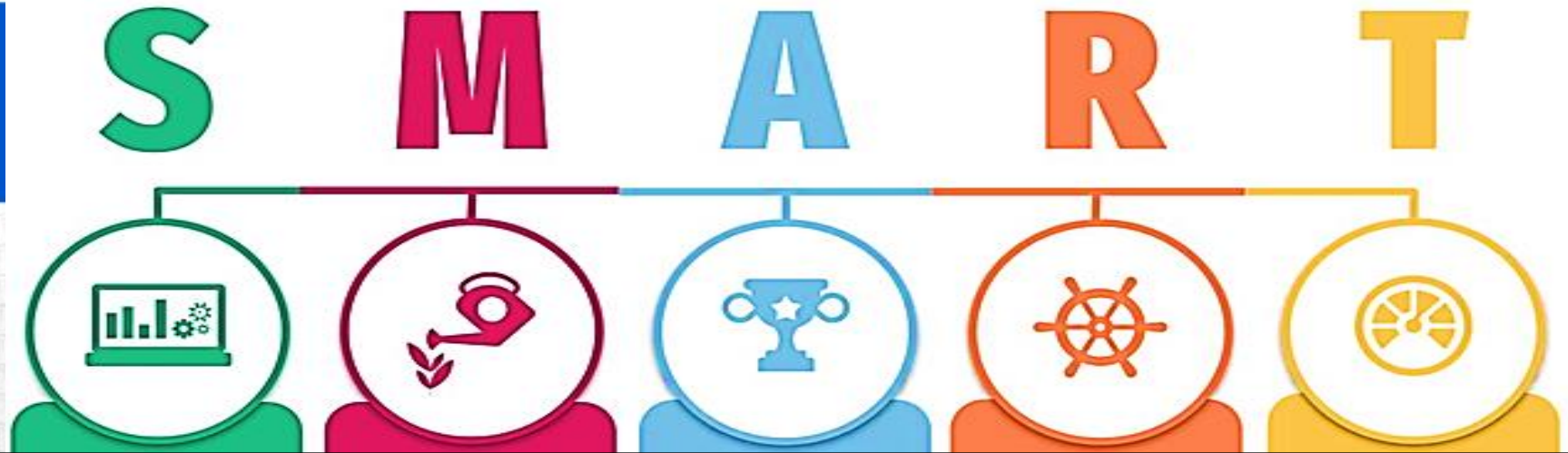
A study by Khafaji and Hagi [11] reported high repetition rates of radiography in Saudi hospitals, averaging 14.9%, which is higher than the international standard. Another study reported the repetition rate in 3 Ministry of Health hospitals ranged from 7.4% to 9.7%. The same study revealed that chest radiographs have higher repetition rates compared to other radiological procedures [12]. Related to that, it was revealed that radiographer error is one of the factors that strongly contribute to the issue of the repetition [13,14].

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BRAINSTORMING SESSION FOR TEAM MEMBERS

No	Problems identified
1	No standard method for knee skyline view
2	No suitable positioning device for knee skyline view
3	High risk of detector falling during the knee skyline view positioning
4	Repetition of examination due to motion artefacts
5	Poor image quality due to improper knee flexion

PROBLEM DEFINITION - SMART CRITERIA

SPECIFIC	• Technique protocol not reviewed (no standardisation) • Increased number of repeated patients • Increased risks of radiation dose to patients • Increased costs due to damaged detectors • Increased time spent positioning
MEASURABLE	Data can be easily obtained
APPROPRIATENESS	Producing optimised image quality is part of core business in the Department of Biomedical Imaging
RELIASTIC	The solution is possible with the guidance from previous studies done
TIMELINESS	The study can be completed within one year

EVALUATION BASED ON 5 PROBLEMS

No	Problems identified
1	No standard method for knee skyline view
2	No suitable positioning device for knee skyline view
3	High risk of detector falling during the knee skyline view positioning
4	Repetition of examination due to motion artefacts
5	Poor image quality due to improper knee flexion

Group Members	Specific					Measurability					Achievable					Remediable					Timeliness				
	PROBLEM																								
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
GURDEEP	2	3	3	2	3	2	3	3	2	3	2	3	3	2	3	2	3	3	2	2	2	3	3	2	3
AZUAN	3	3	2	2	3	3	3	2	2	3	3	3	2	2	2	3	3	2	2	3	3	3	2	2	3
SHARALLA	2	3	3	2	3	2	3	3	2	2	2	3	3	2	3	2	3	3	2	3	2	3	3	2	2
BALA	2	3	2	2	2	2	3	2	2	3	2	3	2	2	3	2	3	2	2	3	2	3	2	2	3
Total	9	12	10	8	11	9	12	10	8	11	9	12	10	8	11	9	12	10	8	11	9	12	10	8	11

4 GROUP MEMBERS - RATING SCALE: 1=Low, 2=Medium, 3= High (*Max score 4 x 3 =12)

SELECTED PROBLEM

NO	PROBLEM	Weightage According to "SMART" criteria					TOTAL
		Specific	Measurability	Appropriateness	Remediable	Timeliness	
1	No standard method for knee skyline view	9	9	9	9	9	45
2	No suitable positioning device for knee skyline view	**12**	**12**	**12**	**12**	**12**	⭐ **60**
3	High risk of detector fall	10	10	10	10	10	50
4	Repetition of examination due to motion artefact	8	8	8	8	8	40
5	Poor image quality due to improper knee flexion	11	11	11	11	11	55

SELECTED PROBLEM ⬅

4 GROUP MEMBERS - RATING SCALE: 1=Low, 2=Medium, 3= High   (*Max score 4 x 3 =12)

ANALYSIS OF PROBLEM (5W 1H)

ANALYSIS OF PROBLEM	DETAILS
What	High retake rate of the knee skyline X-Ray
Why	No suitable positioning device for knee skyline X-Ray
Where	Department of Biomedical Imaging, 5th floor South Tower, UMMC
When	During knee skyline view positioning
Who	i) Patients undergoing knee skyline examination ii) Radiographers involved in the examination process
How	Develop a suitable positioning device for knee skyline X-Ray

HIGH RETAKE RATE OF THE KNEE SKYLINE X-RAY (STANDARD <10%)

RETAKE RATE OF THE KNEE SKYLINE X-RAY SHOULD NOT EXCEED >10%

	Deterministic effects	Stochastic effects
onset time	short	long
threshold	yes	no
probability	1 for all individuals above	increasing with dose
severity	increasing with dose	independant of dose
Consequences for nuclear installations	to prevent the occurrence of accidental situations and if any, to limit the consequences	to limit the exposure of workers, to reduce the exposure as low as possible

Reduce risk of radiation induced cancer

R   L

Radiation Protection Principle: As Low As Reasonably Achievable (ALARA) - minimising the radiation doses and limiting the release of radiation dose by applying all "reasonable approaches or technique."

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APPLICATION OF APPROVAL

APPROVAL GRANTED

UNIVERSITY OF MALAYA MEDICAL CENTRE

Fwd: MEMOHON KEBENARAN BAGI MENJALANKAN PROJEK PENAMBAHBAIKAN KUALITI (QUALITY IMPROVEMENT PROJECT) DI JABATAN PENGIMEJAN BIO PERUBATAN

Ruzimah Johari <ruzimah@ummc.edu.my>   Thu, Dec 8, 2022 at 10:35 AM
To: Lilian Yap <lilian@ummc.edu.my>

-------- Forwarded message ---------
From: Ruzimah Johari <ruzimah@ummc.edu.my>
Date: Tue, 22 Nov 2022 at 09:57
Subject: MEMOHON KEBENARAN BAGI MENJALANKAN PROJEK PENAMBAHBAIKAN KUALITI (QUALITY IMPROVEMENT PROJECT) DI JABATAN PENGIMEJAN BIO PERUBATAN
To: Ketua Jabatan Pengimejan Bioperubatan <kj_rad@ummc.edu.my>
Cc: Mohamad Zamri Mohamad Zin <mzamri@ummc.edu.my>, Hanizan Ahmad <Hanizan@ummc.edu.my>, Ravi Chanthriga Eturajulu <ravi@ummc.edu.my>

MEMOHON KEBENARAN BAGI MENJALANKAN PROJEK PENAMBAHBAIKAN KUALITI (*QUALITY IMPROVEMENT PROJECT*) DI JABATAN PENGIMEJAN BIO PERUBATAN

Merujuk perkara di atas, pasukan penambahbaikan kualiti Jabatan Pengimejan Bio-Perubatan bagi ingin memohon kebenaran bagi menjalankan projek inovasi penggunaan alat cegah gerak yang dinamakan sebagai *Skyliner* di bahagian Radiografi Am, di Tingkat 5, Menara Selatan, Jabatan Pengimejan Bio Perubatan.

2. Untuk makluman, projek ini akan dipertandingkan pada **Konvensyen Kumpulan Inovatif Dan Kreatif (KIK) Universiti Malaya** pada Disember 2022 dan juga mana-mana pertandingan di luar PPUM sekiranya ditawarkan melalui Jabatan Perkembangan & Amalan Perubatan (JPAP), PPUM. Projek yang telah berjaya akan digunakan sebagai aliran kerja semasa bagi meningkatkan lagi kualiti perkhidmatan di jabatan dari segi klinikal dan pengurusan. Bersama ini, dilampirkan pamplet projek berkaitan untuk rujukan.

3. Pihak kami berharap dengan penambahan aktiviti penambahbaikan kualiti seumpama ini dapat menggalakkan lebih ramai lagi penglibatan staf dengan perkongsian idea-idea menarik yang dapat digunakan dan dikembangkan di dalam jabatan.

Sekian, Terima Kasih.

--

'Saya yang menjalankan amanah'

Ruzimah Johari
Pegawai Juru X-Ray,
Jabatan Pengimejan Bio-Perubatan,
Pusat Perubatan Universiti Malaya.

UNIVERSITY OF MALAYA MEDICAL CENTRE

Lilian Yap <lilian@ummc.edu.my>

Fwd: MEMOHON KEBENARAN BAGI MENJALANKAN PROJEK PENAMBAHBAIKAN KUALITI (QUALITY IMPROVEMENT PROJECT) DI JABATAN PENGIMEJAN BIO PERUBATAN
1 message

From: Khairul Azmi Abd Kadir <khairulazmi@ummc.edu.my>
Date: Wed, 4 Jan 2023 at 16:38
Subject: Re: MEMOHON KEBENARAN BAGI MENJALANKAN PROJEK PENAMBAHBAIKAN KUALITI (QUALITY IMPROVEMENT PROJECT) DI JABATAN PENGIMEJAN BIO PERUBATAN
To: Ruzimah Johari <ruzimah@ummc.edu.my>
Cc: Ravi Chanthriga Eturajulu <ravi@ummc.edu.my>, Ketua Jabatan Pengimejan Bioperubatan <kj_rad@ummc.edu.my>, Siti Nur Aishah Zolkaple <sitinuraishah@ummc.edu.my>

KEBENARAN MENJALANKAN PROJEK PENAMBAHBAIKAN KUALITI JABATAN

Dengan hormatnya saya merujuk kepada perkara di atas.

2. Sukacita dimaklumkan bahawa pihak Pengurusan Jabatan Pengimejan Bio-Perubatan bersetuju Projek Penambahbaikan Kualiti (QI) bagi kumpulan **Kumpulan *Sunrise*** dilaksanakan selaras dengan hala tuju jabatan dan PPUM.

3. Dengan kebenaran menjalankan projek ini, diharapkan tuan/puan dapat melaksanakan tugas yang diamanahkan dengan penuh komitmen dan dedikasi demi memantapkan lagi aktiviti penyelidikan dan penambahbaikan di dalam Jabatan.

4. Sehubungan dengan itu, pihak Pengurusan Jabatan ingin mengucapkan tahniah & syabas kepada tuan/puan yang melibatkan diri dalam projek QI ini. Semoga ia dapat memberi manfaat kepada jabatan khususnya dan organisasi amnya, selain menjadi nilai tambah kepada prestasi peningkatan kendiri staf yang terlibat. Tahniah juga diucapkan kepada ahli-ahli Portfolio Penyelidikan dan Penambahbaikan Kualiti Jabatan yang diketuai oleh Puan Ravi Chanthriga a/p Eturajulu, Pegawai Juru X-Ray di atas program yang dilaksanakan. Diharapkan lebih ramai staf yang akan terlibat pada masa hadapan.

Sekian, terima kasih.

Sekian, terima kasih.

"PENERAJU PENGAJARAN PERUBATAN"
"WAWASAN KEMAKMURAN BERSAMA 2030"
"BERKHIDMAT UNTUK NEGARA"

Saya yang menjalankan amanah,

Prof Madya Dr Khairul Azmi Abd Kadir
Ketua
Jabatan Pengimejan Bio-Perubatan

IMPACT OF PROBLEM TO STAKEHOLDERS

Stakeholders	Description	Positive impact with project completion	Negative impact without project completion	Degree of impact
Employees (Radiologists & Radiographers)	• Enhanced image quality • **Reduced repetition** • **Help with the diagnosis**	• Gain job satisfaction & sense of fulfilment • Enhanced knowledge, skill & capacity • Enhanced patient safety (e.g., **reduce radiation dose**)	• Increased risks of safety to patients (e.g., **side effects of radiation**) • Lack of ownership	**High**
Patients & caregivers	• Individuals who are sick and caregivers provide assistance to them • Received diagnostic imaging services **to improve treatment**	• Increased patients & caregiver satisfaction • Reduced risks from imaging examinations • **Enhanced treatment**	• Increases patients & caregivers' **burden** • Increased **side effects** from imaging examinations • Limited options to clinician in requesting diagnostic imaging to improve treatment	**High**
Management	• Planning, organising, and coordinating **to provide quality service**	• Cost **savings** • Increased **safety**	• Customer **complaints** • Bad **reputation** and **image**	**High**
Legislative Dept	• Important instruments in organising society and **protecting citizens**	• **Reduced risks** of litigation	• Increased risks in **litigation** • Customer **complaints**	**High**

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ACTION PLAN: 5W 1H

WHAT — Reduce retake rate of the knee skyline X-Ray

WHERE — General X-Ray room

WHO — Patients indicated for knee skyline X-Ray

WHY
- To reduce radiation dose/ cost/ time/ complaints/ litigation issues
- To improve diagnostic value

WHEN — While performing knee skyline X-Ray

HOW — To develop a suitable positioning device

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PEOPLE

Patient related

Lack of competency

Lack of experience

Level of skills Differ

Age, Anatomy & pathology of patients

Patient condition

Patient Size

METHOD

Improper Positioning Technique

No proper positioning device

Poor Image Quality

No proper positioning device

Insufficient knee flexion

Positioning technique varies

No standardised method

Images are not optimal

High retake rate of the knee skyline X-Ray

Lack of fund to purchase suitable device

Budget

Costly positioning accessories

MONEY

DEVICE

Unsuitable Positioning Tool

No proper positioning device

Fishbone / Ishikawa diagram for possible causes of a problem

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VERIFICATION OF POSSIBLE CAUSE

PEOPLE

ROOT CAUSE	VERIFICATION	PIC	IMPACT
Lack of competency	Repeat reject rate was high (>10%)	SHARALLA	✅
Patient related	Some patients are unable to cooperate	GURDEEP	❌

Detector was unstable and had high tendency of falling as patient had to hold it in position manually

Total no. of cases for Knee X-Ray (patella)

Total number of 59/467 images of the knee skyline view was rejected from May to Dec 2021

Repetition of skyline view - 13% (standard <10%)

- NO OF CASES
- NO OF REPEAT CASES

Lack of competency

Total detector shock impact in year 2021

Shock impact
- Low 79%
- Medium 21%
- High 0%

Six Digital Radiography (DR) room

Total number of detector shock impact: 14 in the year 2021

X-Ray detector (weight between 3-5 kg) have a **risk of falling** during knee skyline view positioning

Reported incidents "shock impact" of the detectors by 3% in year 2021
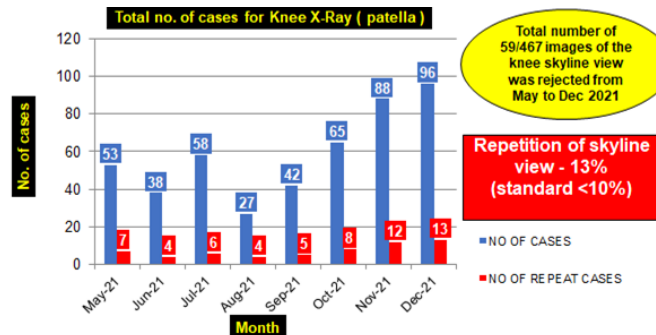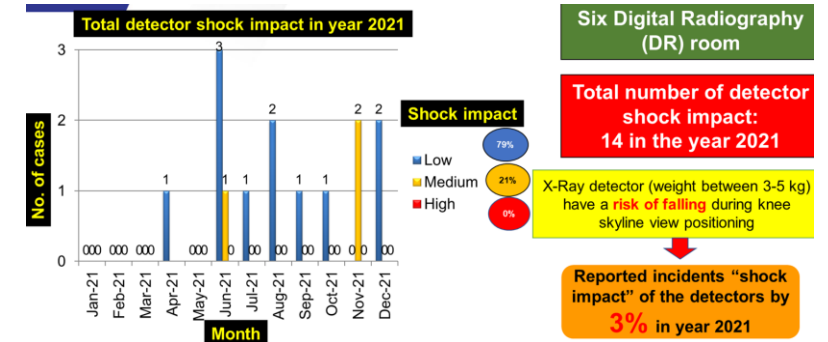
Patient related

METHOD

ROOT CAUSE	VERIFICATION	PIC	IMPACT
Poor image quality	No proper positioning device	BALA	✅

Detector was unstable and had high tendency of falling as patient had to hold it in position manually

SKYLINE

R   L

Suboptimal image quality

METHOD

ROOT CAUSE	VERIFICATION	PIC	IMPACT
Positioning technique varies	No standardised method	BALA	✅

VERIFICATION OF POSSIBLE CAUSE DEVICE

ROOT CAUSE	VERIFICATION	PIC	IMPACT
Unsuitable positioning tool **NO PROPER DEVICE**	1. No proper positioning device 2. Possible to fall during positioning – non optimised image quality	SHARALLA	✔
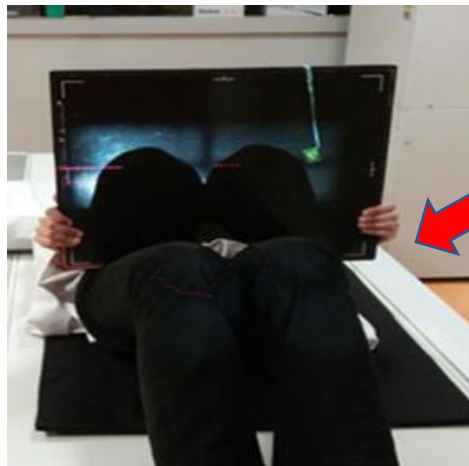
Patient is required to hold the X-ray detector

NO PROPER DEVICE

VERIFICATION OF POSSIBLE CAUSE

MONEY

ROOT CAUSE	VERIFICATION	PIC		IMPACT
Lack of fund to purchase suitable positioning device	Budget constraint		AZUAN	❌
Costly positioning accessories in the market	Lack of fund		GURDEEP	❌

Stock #	Description	Your Price
1104-C3a	Box style merchant board with arms to accommodate DR Panels up to 1-1/4 thick. SPECIFY your panel dimensions at time of order.	$2,146.85
1104-C3	Box style merchant board with no arms.	$1,388.88

~RM 5.5k-8.5K

DEVICE

ROOT CAUSE	VERIFICATION	PIC	IMPACT
Unsuitable positioning tool **DEVICE-1**	• High retake causes high radiation exposure to patient • Time consuming to adjust • Not ergonomic	SHARALLA	✅

Patella out of collimation

EXISTING IMMOBILISER AVAILABLE AT THE DEPARTMENT

DEVICE-1

REJECTED

Mobile ✅

Higher radiation to the patient – unable to shield gonad region fully and knee region tend to be out of collimation ❌

Not ergonomic – not all patient able to lie on top of the sponge especially weak and old patient ❌

Time consuming – not user friendly due to multiple adjustments required ❌
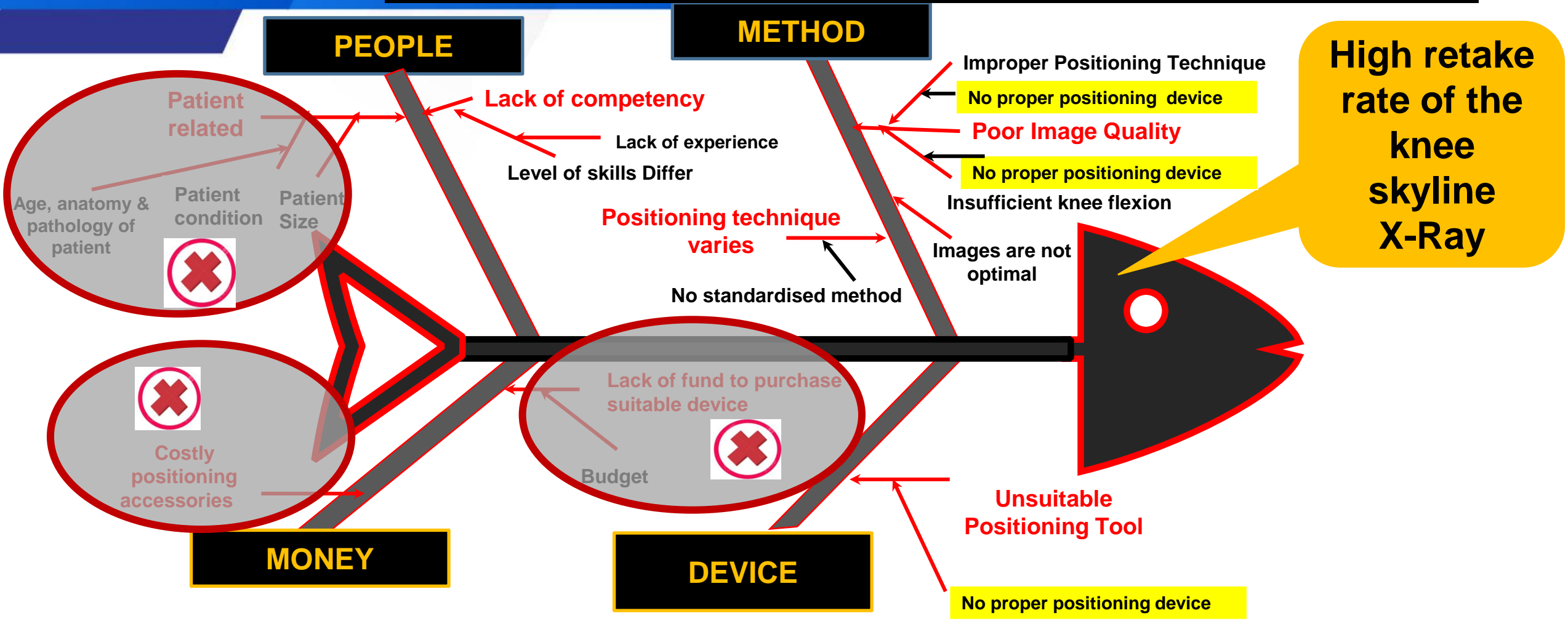
Fishbone / Ishikawa diagram for possible causes of a problem

ISHIKAWA 2
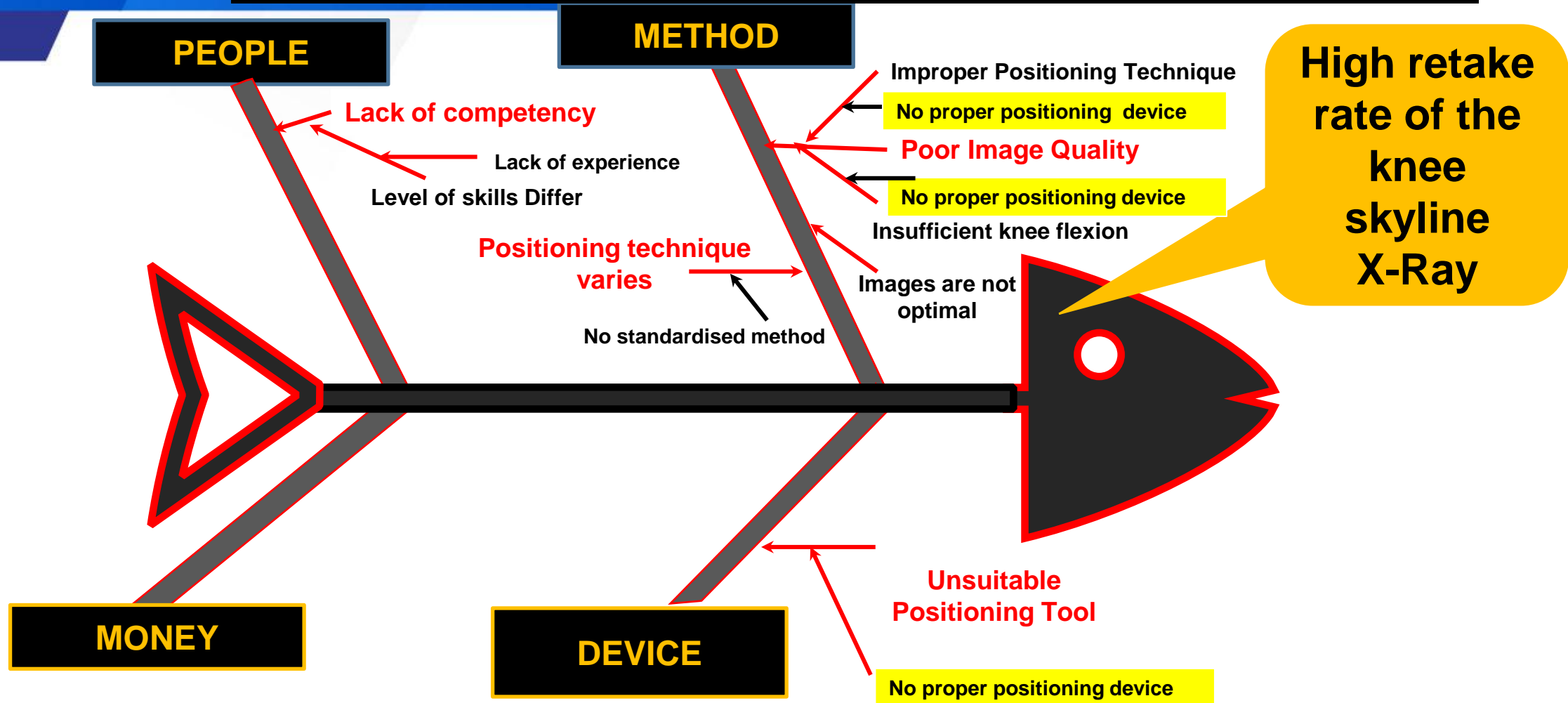
Fishbone / Ishikawa diagram for possible causes of a problem

HOW FINAL SOLUTIONS WAS DETERMINED?

Root Cause (s)

Solution (s)

	Root Cause (s)	Solution (s)
People	**Poor image quality**	• **Develop a suitable positioning device to reduce motion artefact**
Method	**Lack of competency**	• **Provide training** • **Hands on demonstration on skyline view positioning**
Device	**Unsuitable positioning device**	• **Develop a suitable positioning device to assist in optimisation of image quality** • **To reduce the possibility of detector falling during positioning**
Method	**Positioning technique varies**	• **Standardised method of positioning** • **Provide training and coaching**

Device

SKYLINE IMMOBILISER DEVICE

Root Cause	Solution	Evaluation	Outcome	Verified	Decision
Unsuitable positioning device	Developed a positioning device called as **SKYLINE IMMOBILISER DEVICE** to reduce the retake of knee skyline X-Ray	To apply the new positioning device (e.g., tested on 10 patients)	-Positioning device **more fragile** **Holder broken** -**Not ergonomic** for some patients, especially patients who are old, weak or not strong	SHARALLA	✖

Lack of durability (broken after using on 10 patients)

Bulky and heavy

Not well accepted due to its non-stability

Not ergonomic and required patient to hold

REJECTED
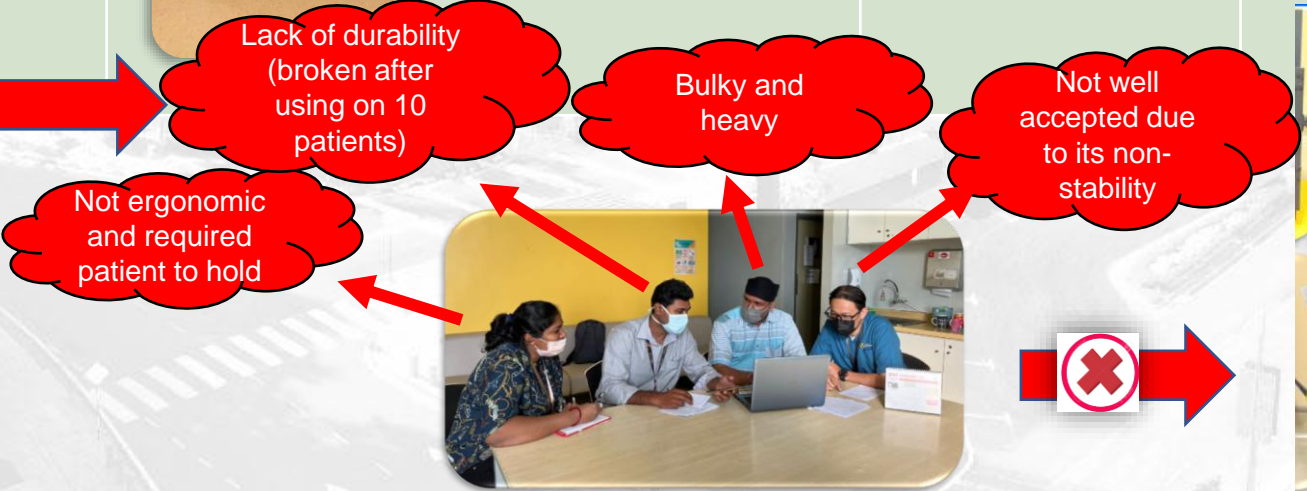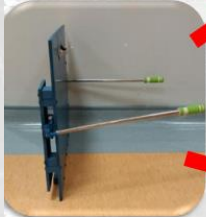
DISADVANTAGES:
1) Made of wood which is bulky and heavy
2) Require patient to hold - not suitable for older aged patient
3) Fragile – easily broken and not long lasting
4) Not highly favor due to its non-stability
5) Produce similar high radiation dose

EVALUATION ON SOLUTION: TRIAL

Device

Root Cause	Solution	Evaluation	Outcome	Verified	Decision
Unsuitable positioning device	Developed a **more** suitable positioning device **SKYLINER-PROTOTYPE** to reduce the retake of knee skyline X-Ray	To apply the new positioning device (e.g., tested on 10 patients)	• The images were optimised • The positioning device **more solid**	GURDEEP	✅

SKYLINER

DESIGN AND CREATION

Method

Root Cause	Solution	Evaluation	Outcome	Verified	Decision
Poor image quality	Developed a **more** proper positioning device to reduce motion artefact	Analysed retake rate	Retake rate reduced by **7%**	AZUAN	✔

Reject repeat rate reduced by 7%
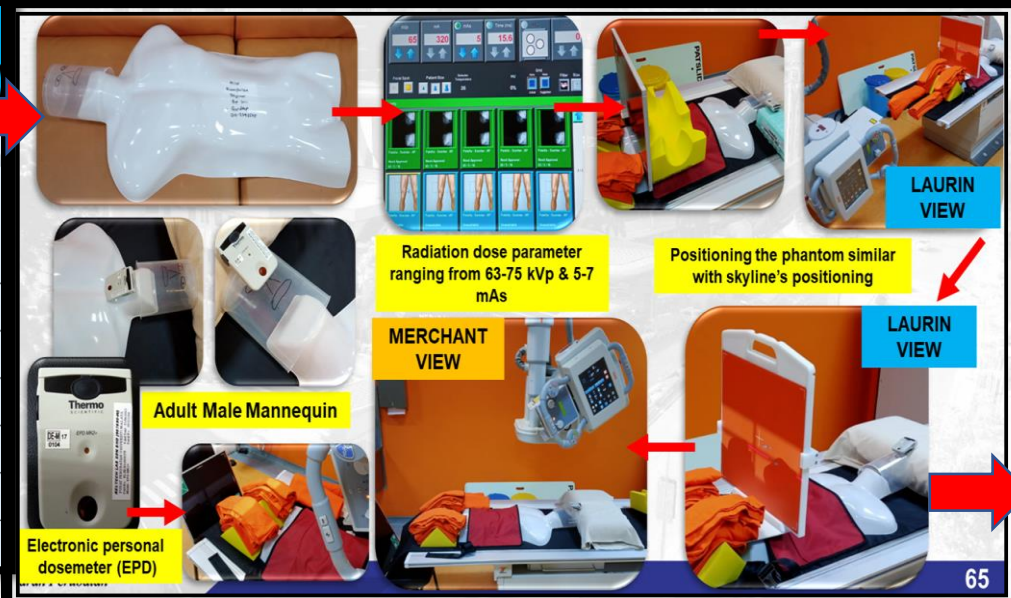
Patient don't require to hold the detector

Total no. of cases for Knee X-Ray (patella)

	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22
NO OF CASES	102	79	117	103	87	97	89	145	134	141	120
NO OF REPEAT CASES	6	5	8	7	6	4	5	8	6	7	5

No. of cases

Month

Total number of 74/1214 images of the knee skyline view was rejected from Jan to Nov 2022

Repetition of skyline view – from 13% reduced to 6%

(standard <10%)

Method

Root Cause	Solution	Evaluation	Outcome	Verified	Decision
No proper positioning technique	Developed a more proper positioning to reduce retake and radiation dose	• Electronic personal dosimeter (EPD) measurement on the patient • Phantom study to analyse radiation dose	To standardise positioning method - able to reduce radiation dose	**GURDEEP**	✓

LAURIN METHOD
(X-ray tube cephalad direction)

Sensitive Organs	Skin dose (μSv)	Approximate effective radiation dose (mSv)	Background radiaton (hours)
Eyes	2.2	0.002	6.6
Thyroid	7.4	0.007	22.2
Breast	4.1	0.004	12.3
Pelvis	32.1	0.032	96.3
Symphysis pubic	128.0	0.128	384.0
Pelvis – Non-shielded	254.0	0.254	762.0

Radiation dose parameter ranging from 63-75 kVp & 5-7 mAs

Positioning the phantom similar with skyline's positioning

MERCHANT VIEW

LAURIN VIEW

Adult Male Mannequin

Electronic personal dosemeter (EPD)

MERCHANT METHOD
(X-ray tube caudad direction)

> 90% dose reduction

Sensitive Organs	Skin dose (μSv)	Approximate effective radiation dose (mSv)	Background radiaton (hours)	Dose saving (%)
Eyes	0.20	0.0002	0.6	**91**
Thyroid	0.50	0.0005	1.5	**93**
Breast	0.30	0.0003	0.9	**93**
Pelvis	0.00	0.0000	0.0	**100**
Symphysis pubic	0.00	0.0000	0.0	**100**
Pelvis – Non-shielded	0.00	0.0000	0.0	**100**

65

PUSAT PERUBATAN UNIVERSITI MALAYA

Root Cause	Solution	Evaluation	Outcome	Verified	Decision
Method No proper positioning technique	Developed a more proper positioning to reduce retake and radiation dose	• Electronic personal dosimeter (EPD) measurement on the patient • Phantom study to analyse radiation dose	To standardise positioning method - able to reduce radiation dose	**GURDEEP**	✔

LAURIN METHOD
(X-ray tube cephalad direction)

Sensitive Organs	Skin dose (μSv)	Approximate effective radiation dose (mSv)	Background radiaton (hours)
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LAURIN VIEW

MERCHANT VIEW

LAURIN VIEW

Adult Male Mannequin

Electronic personal dosemeter (EPD)

65

MERCHANT METHOD
(X-ray tube caudad direction)   > 90% dose reduction

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Pelvis – Non-shielded	0.00	0.0000	0.0	**100**

	Root Cause	Solution	Evaluation	Outcome	Verified	Decision
People	Lack of competency	• Provided training • Hands on demonstration on skyline view positioning	• Competency skill assessment • Outcome of image quality	Competency level improved **> 7%**	SHARALLA	✓

People

	Root Cause	Solution	Evaluation	Outcome	Verified	Decision
	Positioning technique varies	• Standardised method of positioning – **MERCHANT METHOD** • Provided training and coaching	• Image quality assessment • Competency skill assessment	Improved technique	 BALA	✅

POSITIONING TECHNIQUE VARIES

Provide training & coaching for STANDARDISATION
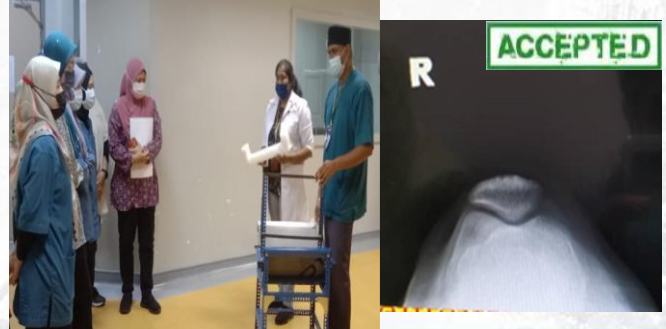
HOW WERE SOLUTIONS DETERMINED?

Root Cause (s)

Solution (s)

People — **Poor image quality**
- Develop a suitable positioning device to reduce motion artefact ✅

Method — **Lack of competency**
- Provide training
- Hands on demonstration on skyline view positioning ✅

Device — **Unsuitable positioning device**
- Develop a suitable positioning device to assist in optimisation of image quality ✅
  - SKYLINE IMMOBILISER DEVICE (Positioning device more fragile) ❌
  - SKYLINER (Positioning device more durable) ✅

Method — **Positioning technique varies**
- Standardised method of positioning
- Provide training and coaching ✅