



PROCESS OF IMPLEMENTATION



1

Develop a suitable positioning device



2

Reengineer workflow following Model of Good Care (MOGC)



3

Provide training and coaching



4

A demonstration video on proper positioning to assist application of a new device & CME



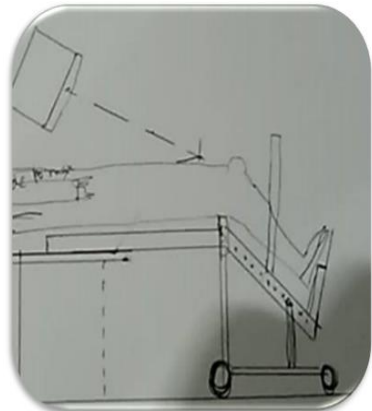


PROCESS OF IMPLEMENTATION: PROPOSED SOLUTION 1

SKYLINER

1

Apply a suitable positioning device for knee skyline X-Ray



The SKYLINER frame is equipped with one detector handle slot to provide comfort to the patient (patient not required to hold the heavy X-Ray detector)

**WORKFLOW OF
'SKYLINER' APPLICATION**

<p>1 Register the patient and choose a posteroanterior (PA) setting</p>	<p>2 Lie the patient in supine position on the table</p>	<p>3 Apply the gonad shield to the patient</p>
<p>4 Flex the patient's knee and raise the height of the table</p>	<p>5 Dock the SKYLINER below the table</p>	<p>6 Place the patient's leg to the SKYLINER</p>
<p>7 Place the sponge to support the patient's knee</p>	<p>8 The positioning should be similar to the above diagram</p>	<p>9 Position and adjust the detector holder</p>
<p>10 Insert the detector to the SKYLINER holder</p>	<p>11 Angle the x-ray tube ~60° caudally and collimate</p>	<p>12 Place the anatomical marker in the PA orientation and proceed with the exposure</p>

PROCESS OF IMPLEMENTATION: PROPOSED SOLUTION 2



Examination Performed using **MERCHANT VIEW**
(WITH SKYLINER device)

2

Reengineer workflow following Model of Good Care (MOGC)



PROCESS OF IMPLEMENTATION: PROPOSED SOLUTION 2



Patient arrives at registration counter



Staff verifies patient ID



Patient waits to be called

SKYLINER

**SKYLINE
IMMOBILISER DEVICE**



AFTER



BEFORE



BEFORE



Patient called and ID verified prior to the examination

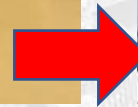
Examination Performed using **MERCHANT VIEW** (WITH **SKYLINER** device)



PROCESS OF IMPLEMENTATION: PROPOSED SOLUTION 3

3

Provide training and coaching



PROCESS OF IMPLEMENTATION: PROPOSED SOLUTION 4

Proper knee flexion



WITH SKYLINER



[Click the link or QR code to view the Skyliner application:](https://youtube.com/shorts/lqCGQh_T5Zs?feature=share)

https://youtube.com/shorts/lqCGQh_T5Zs?feature=share

4

Demonstration of video on proper positioning to assist application of a new device



LETTER FROM HOD FOR THE STANDARDISATION

Rujukan kami: PPUM/RAD/100/01/002 (106) Jld. 3

12 Jamadilawal 1444H
07 Disember 2022

IMPLEMENTATION APPROVAL

Semua Staf
Jabatan Pengimejan Bio-Perubatan
PPUM/FPUM

YBhg. Tan Sri/Datuk/Dato'/Datin/Prof./Dr./Tuan/Puan,

PEMAKLUMAN PENGGUNAAN PROJEKSI 'MERCHANT VIEW METHOD' UNTUK PEMERIKSAAN KNEE SKYLINE DENGAN MENGGUNAKAN ALAT INOVASI CEGAH GERAK SKYLINER DI JABATAN PENGIMEJAN BIO-PERUBATAN

Dengan segala hormatnya perkara di atas adalah dirujuk.

2. Dimaklumkan bahawa alat cegah gerak *Skyliner* telah direka oleh Kumpulan *Sunrise* untuk projek penambahbaikan kualiti sesi 2021/2022 di peringkat jabatan. Alat cegah gerak ini direka berkonsepkan teknik '*merchant view*', dimana:

- Teknik pemosisian ini tidak memerlukan pesakit memegang *detector*, sebaliknya *detector* ditempatkan di dalam slot pemegang khas yang telah disediakan bagi mengelakkan risiko *motion artifact*, terutamanya di kalangan pesakit tua dan tidak berupaya.
- Kebarangkalian *detector* untuk jatuh dapat dielakkan.
- Dos radiasi kepada organ sensitif seperti mata, tiroid dan payudara dapat dikurangkan lebih dari 91% berdasarkan *ujikaji* yang dijalankan menggunakan *phantom* X-Ray dengan bim X-Ray diposisikan ke arah *caudal*.
- lanya dapat mengekalkan keseragaman teknik pemosisian untuk pemeriksaan *Knee Skyline* bagi semua kategori pesakit.

3. Poster cara penggunaan dan teknik pemosisian menggunakan *Skyliner* seperti yang dikepikan (Lampiran A).

4. Sehubungan dengan, itu pihak kumpulan *Sunrise* ingin memohon jasa baik dan kerjasama dari semua Pengurus, Penyelia Digital Radiografi (DR) untuk mengalakkan semua staf menggunakan alat cegah gerak *Skyliner* demi menuju ke arah penambahbaikan teknik pemosisian projeksi *Knee Skyline* di kawasan DR, Tingkat 5, Menara Selatan. Pihak pasukan *Sunrise* juga mengalu-alukan sebarang komen atau maklum balas berkenaan pengalaman penggunaan alat inovasi cegah gerak ini.

5. Oleh yang demikian, jika terdapat sebarang masalah, komen atau cadangan penambahbaikan menggunakan alat inovasi cegah gerak ini, mohon pihak Pengurus, Penyelia dan Juru X-ray DR untuk berhubung dengan En. Mohd Azuan di bilik 7 (PACS) di samb. 4178 atau no. HP: 017-2756257, En. Gurdeep Singh (010-2795525), En. Balamurugan (016-2050363) atau Pn. Sharalia (016-6184261).

6. Di atas segala kerjasama dan tindakan dari semua staf untuk memajukan maklumat ini kepada staf di bawah seliaan masing-masing amatlah dihargai dan didahului dengan ucapan ribuan terima kasih.

Sekian.

"PENERAJU PENGAJARAN PERUBATAN"
"BERKHIDMAT UNTUK NEGARA"

Saya yang menjalankan amanah,

PROFESOR MADYA DR. MOHAMMAD NAZRI BIN MD SHAH
Pemangku Ketua

Jabatan Pengimejan Bio-Perubatan

ACCEPTED



WORKFLOW OF 'SKYLINER' APPLICATION



Register the patient and choose a posteroanterior (PA) setting



Lie the patient in supine position on the table



Apply the gonad shield to the patient



Flex the patient's knee and raise the height of the table



Dock the SKYLINER below the table



Place the patient's leg to the SKYLINER



Place the sponge to support the patient's knee



The positioning should be similar to the above diagram



Position and adjust the detector holder



Insert the detector to the SKYLINER holder



Angle the x-ray tube ~60° caudally and collimate



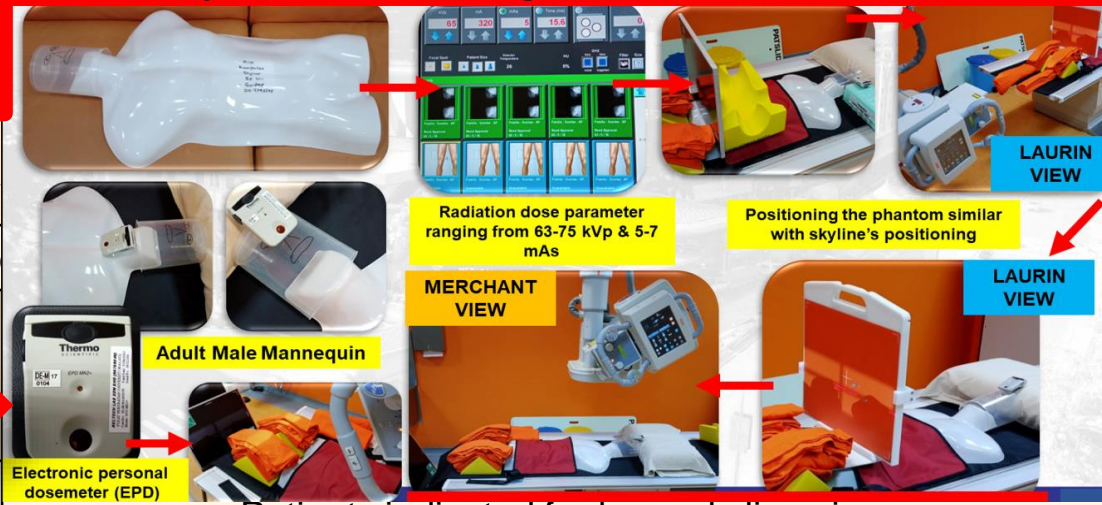
Place the anatomical marker in the PA orientation and proceed with the exposure



PROCESS OF GATHERING INFORMATION

	Retrospective Data	Prospective Data		
	Previous	Phantom Study	Merchant View (Pilot Study)	Laurin View
Study Design	Quantitative Study			
Study Setting	Department of Biomedical Imaging, *UMMC			
Sample Size	467 Patients	(6 **ROIs x 5 shoot = 30 set) 30 Set (Laurin View) + 30 Set (Merchant View) = 60 set of data	30 Patients	
Data Collection	May – December 2021.	January - March 2022.		October 2021 - March 2022.
Study Tools	X-ray Console, MS Excel			
Data Analysis	1. Image quality - Reject analysis	1. Radiation dose	1. Image quality - Reject analysis 2. Cost 3. Time	
Inclusion criteria	Patients indicated for knee skyline view	-	Patients indicated for knee skyline view	
Exclusion criteria	Patients with chronic osteoarthritis	-	Patients with chronic osteoarthritis	

PROCESS OF GATHERING INFORMATION

	Retrospective Data	Prospective Data		
	Previous	Phantom Study	Merchant View (Pilot Study)	Laurin View
Study Design		Quantitative Study		
Study Setting		Department of Biomedical Imaging, *UMMC		
Sample Size	467 Patients	<div style="border: 2px solid red; padding: 5px;"> (6 **ROIs x 5 shoot = 30 set) 30 Set (Laurin View) + 30 Set (Merchant View) = 60 set of data </div>		
Data Collection	May – December 2021.	<div style="border: 1px solid black; padding: 5px;"> Sensitive Organs Eyes Thyroid Breast Pelvis Symphysis pubic Pelvis – Non-shielded </div>		
Study Tools		 <p>Phantom Study: Dose To Sensitive Organs Between Laurin And Merchant Method.</p> <p>Radiation dose parameter ranging from 63-75 kVp & 5-7 mAs</p> <p>Positioning the phantom similar with skyline's positioning</p> <p>Adult Male Mannequin</p> <p>Electronic personal dosimeter (EPD)</p> <p>Patients indicated for knee skyline view</p>		
Data Analysis	1. Image quality - Reject analysis			
Inclusion criteria	Patients indicated for knee skyline view			
Exclusion criteria	Patients with chronic osteoarthritis	-	Patients with chronic osteoarthritis	



PROCESS OF GATHERING INFORMATION (ASSESSMENT)

What data	How (instrument)	Where	Who	When
Questionnaire	Feedback form	General X-Ray rooms	Patient	Post examination knee skyline X-ray
Questionnaire	Google Form	General X-Ray rooms	Radiographer	Post examination knee skyline X-ray
Questionnaire	Google Form	X-Ray reporting room	Radiology Medical Officer (MO)	During reporting



PROCESS OF GATHERING INFORMATION (ASSESSMENT)

1

PATIENTS

- Pain assessment

2

RADIO-
GRAPHERS

- Feedback survey

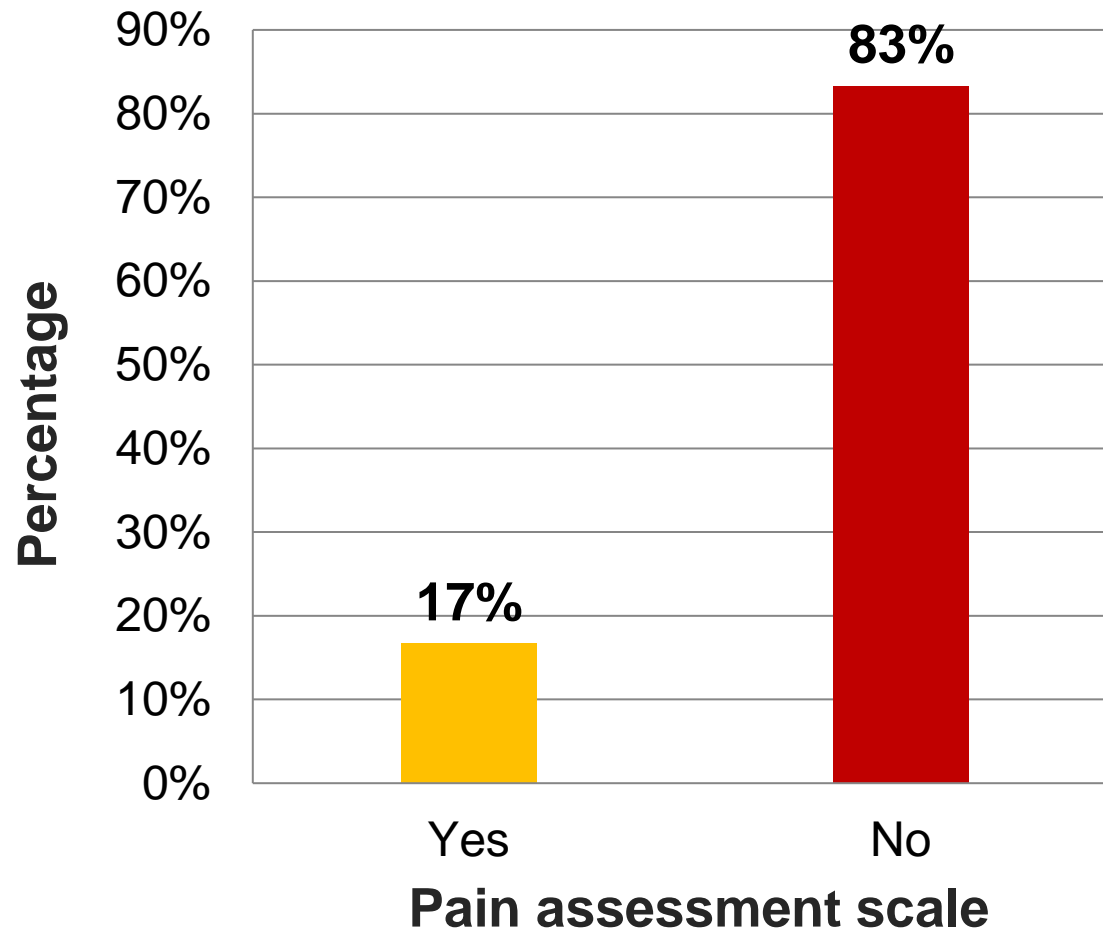
3

MOs

- Image quality assessment



1 RESULT: PAIN ASSESSMENT



> 80 %
No pain during
positioning

Knee skyline view
n=30



Pain assessment post application of SKYLINER



PROCESS OF GATHERING INFORMATION (ASSESSMENT)

1

PATIENTS

- Pain assessment

2

RADIO-
GRAPHERS

- Feedback survey

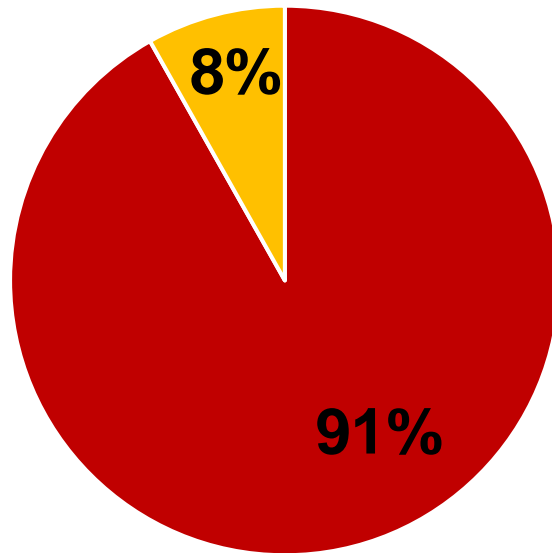
3

MOs

- Image quality assessment



SKYLINER is ergonomic

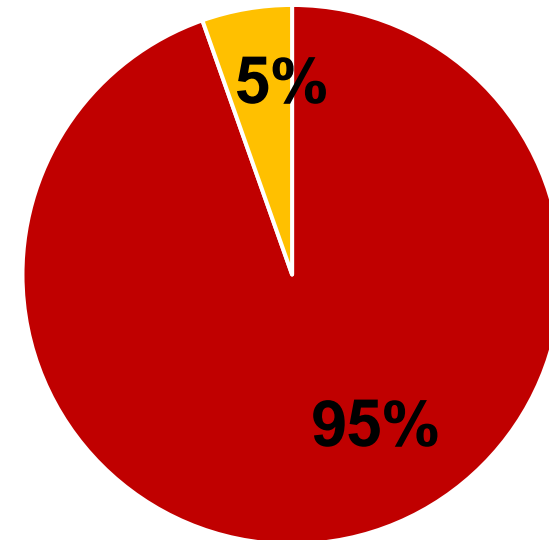


■ Yes ■ No

> 90%



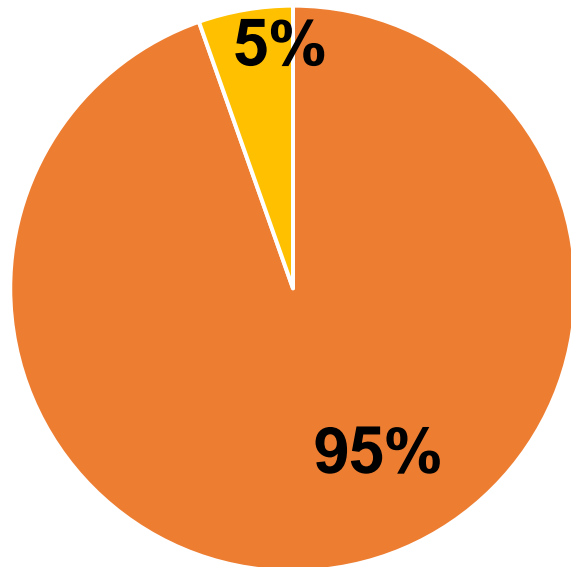
SKYLINER eases workflow



■ Yes ■ No



SKYLINER ease workflow

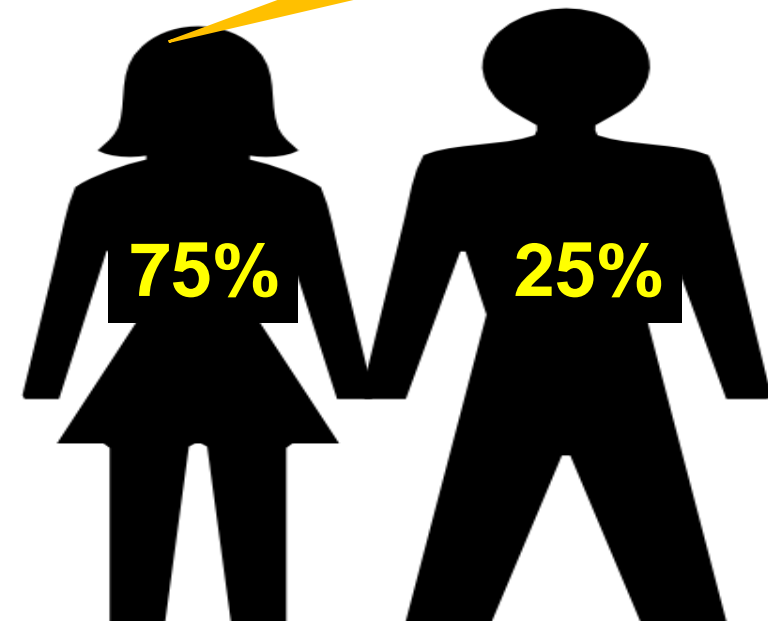


■ Yes ■ No

Data of 37
Radiographers
using SKYLINER

> 90% agree
to suggest
to use
SKYLINER

>50 % had more
than 10 years
working
experience



Radiographer's demographics



PROCESS OF GATHERING INFORMATION (ASSESSMENT)

1

PATIENTS

- Pain assessment

2

RADIO-
GRAPHERS

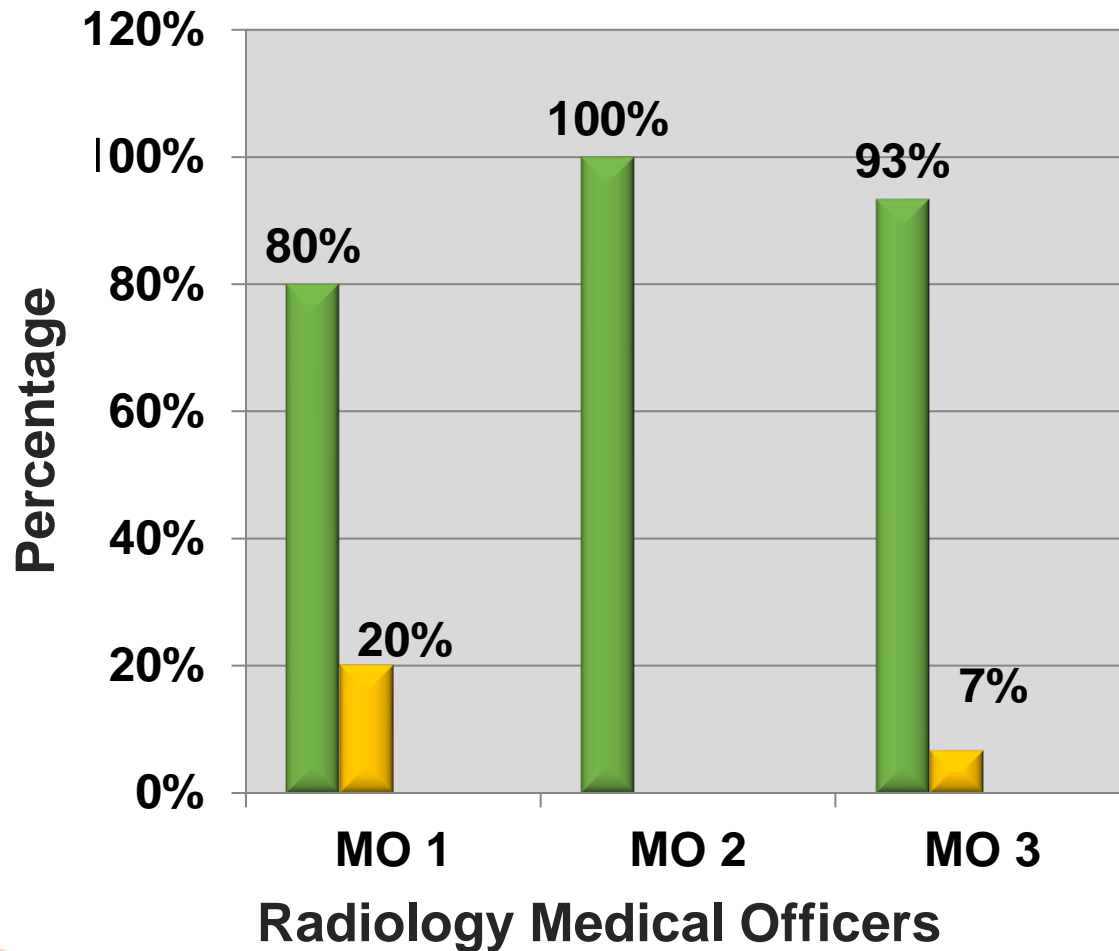
- Feedback survey

3

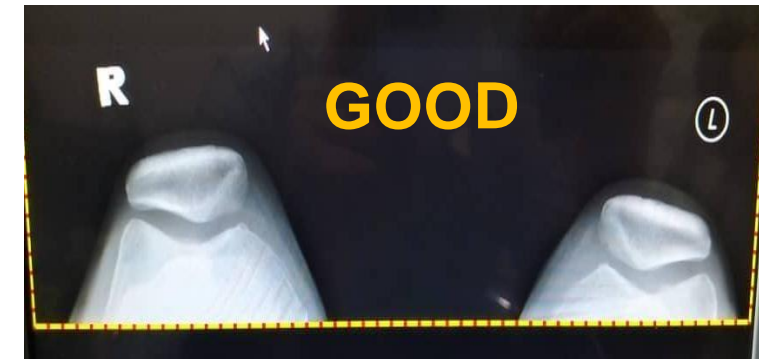
MOs

- Image quality assessment

RESULTS: RADIOLOGY MEDICAL OFFICERS FEEDBACK SURVEY



> 80%
rated as
Perfect Images



RESULTS

1 $\mu\text{Sv} = 0.001\text{mSv}$

= Comparable to natural background radiation for of 3 hours

Accumulated scattered radiation

= 0.2 mSv

$p=0.005$

Accumulated scattered radiation

= 0.001 mSv

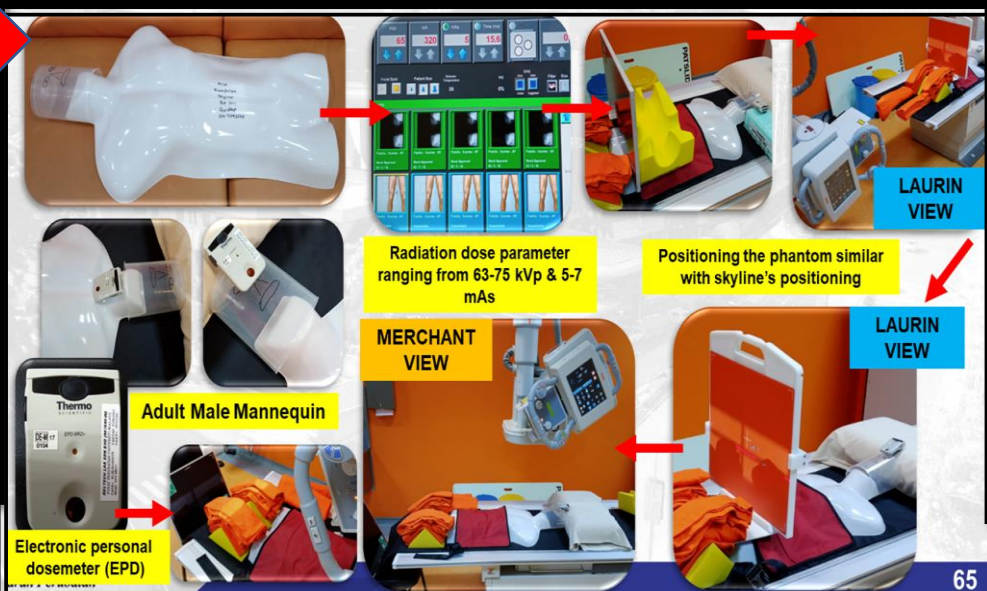
> 90%
Reduced radiation dose to the sensitive organs

(equivalent 21 days background radiation)

(equivalent 3 hours background radiation)

PHANTOM STUDY

Sensitive Organs	LAURIN METHOD (X-ray tube cephalad direction)		
	Skin dose (μSv)	Approximate effective radiation dose (mSv)	Background radiation (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



Sensitive Organs	MERCHANT METHOD (X-ray tube caudad direction)			Dose saving (%)
	Skin dose (μSv)	Approximate effective radiation dose (mSv)	Background radiation (hours)	
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

> 90% dose reduction

RESULTS

BEFORE

AFTER

**WITHOUT
POSITIONING
DEVICE**

LAURIN METHOD

**WITH
POSITIONING
DEVICE –
SKYLINER**

MERCHANT METHOD



p=0.009



**42%
TIME
REDUCED**



**TOTAL POSITIONING TIME
OF KNEE SKYLINE X-RAY
~ 6 MINUTES**

**TOTAL POSITIONING TIME OF
KNEE SKYLINE X-RAY
~ 3.5 MINUTES**



RESULTS

Variable	Standard protocol (Laurin View)	Customised protocol (Merchant view)	P-value
Patient (n)	30	30	1.000
Repeat Skyline View (n)	4	0	*0.046
Image quality			
Perfect	21	25	0.560
Good	9	5	
Moderate	0	0	
Poor	0	0	
**Positioning time-1 (min.)	5.95	3.54	*0.009
**Positioning time-2 (min.)	6.76	3.54	*0.001
**Phantom Study (mSv)	0.2	0.001	*0.005
n, Number of patients; **mean value; min., minutes; mSv, millisievert; *The significant difference was declared at $p < 0.05$.			



MONITORING AND STANDARDISATION

APPLICATION OF SKYLINER

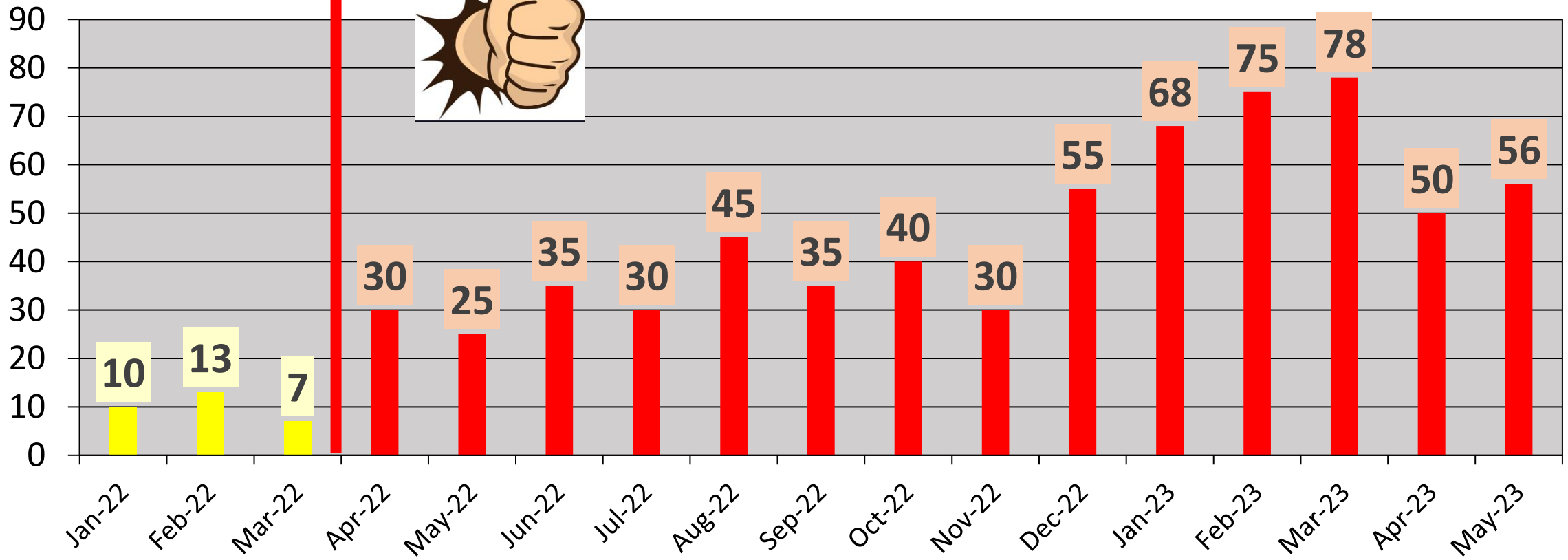
**ZERO
RETAKE**

PILOT

STANDARDISATION



No. of patients



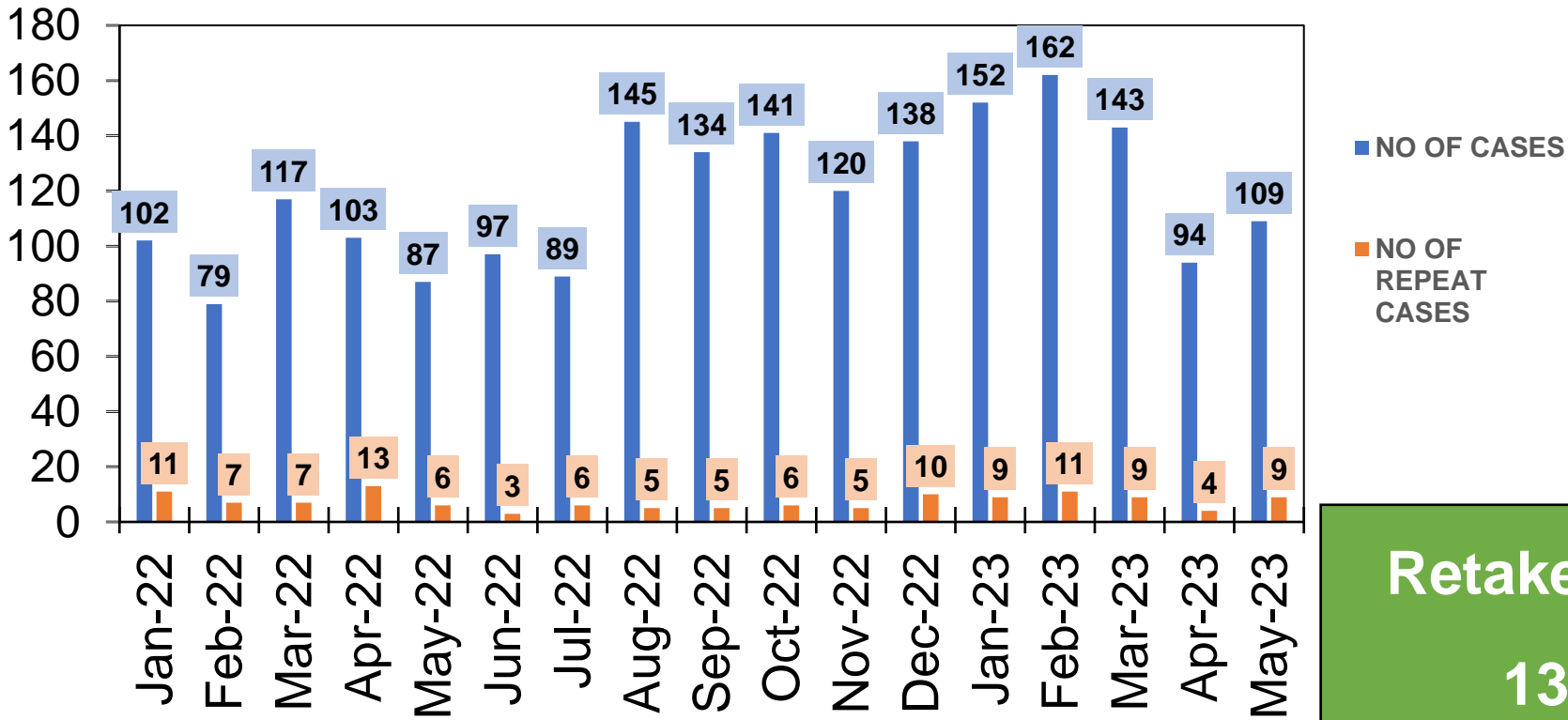
Month



ACHIEVEMENT AND VALUE CREATION

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

No. of cases



Total number of 2012 images of the knee skyline view was performed from Jan 2022 to May 2023

Retake of skyline view – from 13% reduced to **6%** (standard <10%)

Month

TARGET SETTING – ACHIEVED!

RETAKE RATE OF THE KNEE SKYLINE X-RAY LESS THAN 10%

BEFORE

13%

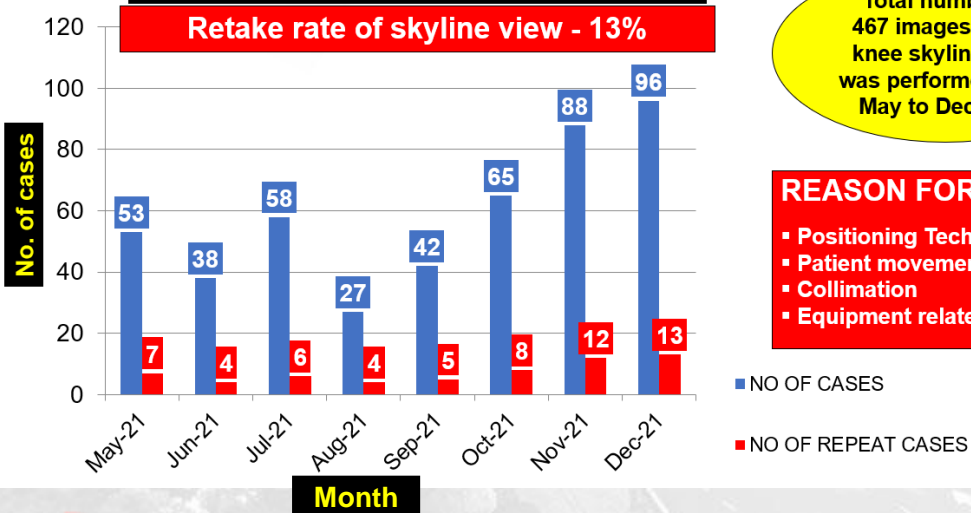


AFTER

6%

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

Retake rate of skyline view - 13%

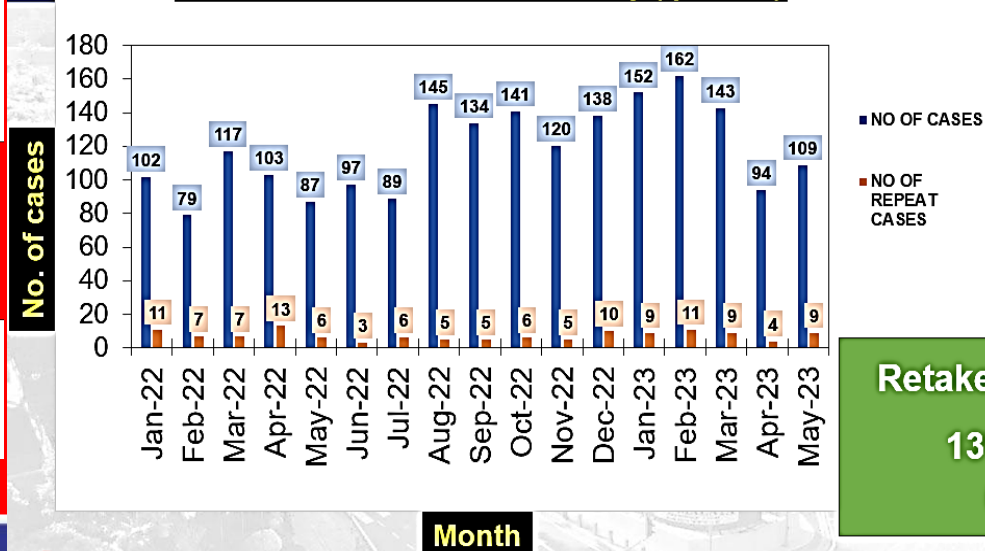


Total number of 467 images of the knee skyline view was performed from May to Dec 2021

REASON FOR RETAKE:

- Positioning Technique
- Patient movement
- Collimation
- Equipment related artefacts

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



Total number of 2012 images of the knee skyline view was performed from Jan 2022 to May 2023

Retake of skyline view – from 13% reduced to 6% (standard <10%)



PROJECT COST INCURRED

SKYLINER

GROUP NAME	DETAILS	COST (RM)
SUNRISE	Prototype (Steel Material)	350
	DIY Material (Do It Yourself)	50
	Others	50
	Redesigned SKYLINER	350
TOTAL		800

SKYLINER-PROTOTYPE



RM450



RM800

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



PROJECT OUTCOME



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



**Danger
Radiation
risk**



**Reduced
radiation dose to
sensitive organ**



**Reduced retake
rate & risk of
retake**



**Reduced risk
of detector
falling, time
and cost)**

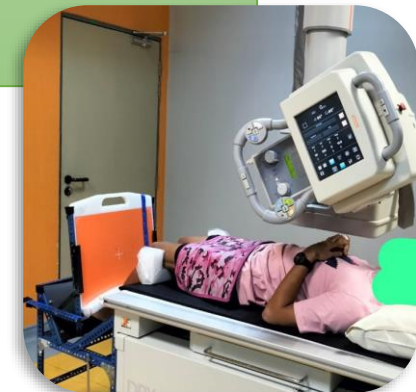
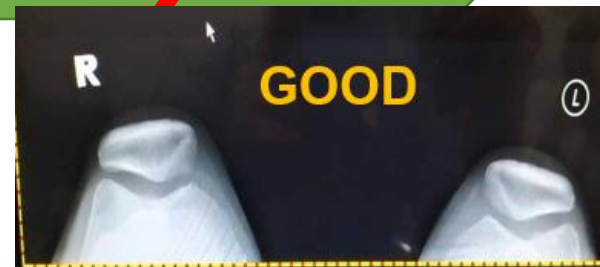
**Maintaining the
image quality**

**Patient's
comfort level
improved**

Sensitive Organs	LAURIN METHOD (X-ray tube cephalad direction)		
	Skin dose (µSv)	Approximate effective radiation dose (mSv)	Background radiation (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

Sensitive Organs	MERCHANT METHOD (X-ray tube caudad direction)			
	Skin dose (µSv)	Approximate effective radiation dose (mSv)	Background radiation (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

> 90% dose reduction





PUSAT PERUBATAN
**UNIVERSITI
MALAYA**



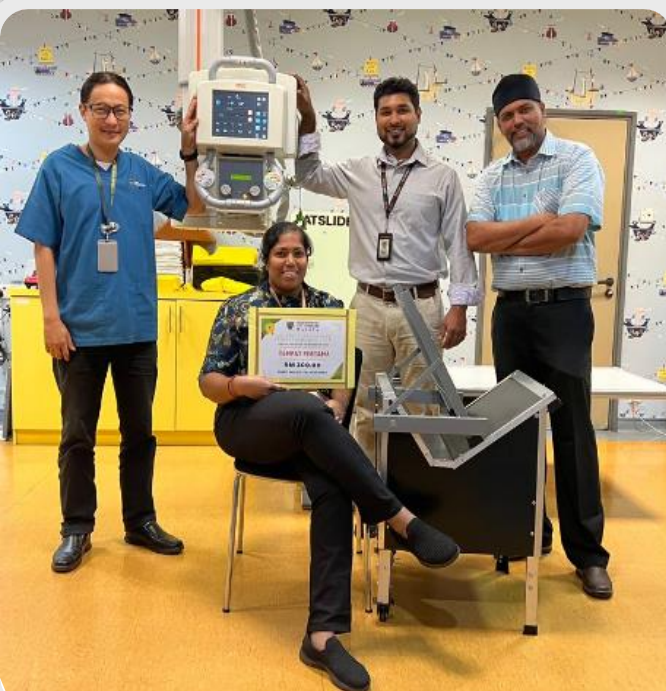
QUALITY IMPROVEMENT (QI)
PROJECT:
INNOVATION IN
IMMOBILIZATION

DEPARTMENT OF BIOMEDICAL
IMAGING

15 OCTOBER 2022
SEKAPUR SIREH HALL
TRAUMA & EMERGENCY
BUILDING
-17



From ZERO to HERO!!!



FIRST PRIZE (CHAMPION)

Department Level
Quality Improvement (QI) Project:
Innovation In Immobilisation & Radiographers'
Annual Meeting 2022
University of Malaya Medical Centre



HOPE INNOVATION AWARD

Convention of the Innovative and Creative Group (KIK)
of the University of Malaysia
18 and 19 January 2023



NEXT STEP



To reproduce **SKYLINER** for each X-Ray room



To promote **SKYLINER** to other institutions – ‘spin-off projects’



To patent **SKYLINER** with structured teaching module



REFERENCES

- Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation, Board on Radiation Effects Research, Division on Earth and Life Studies, National Research Council of the National Academies. Health risks from exposure to low levels of ionizing radiation: BEIR VII Phase 2. Washington, DC: The National Academies Press; 2006. [27 October 2010]. URL: www.nap.edu/catalog.php?record_id=11340.
- Azmy C, Guerard S, Bonnet X, Gabrielli F, Skalli W. EOS(R) orthopaedic imaging system to study patellofemoral kinematics: assessment of uncertainty. Orthop Traumatol Surg Res. 2010;96:28–36. [[PubMed](#)]
- RadiologyInfos.org For patients. Radiation Dose in X-Ray and CT Exams: Radiological Society of North America; 2022. Available from: <https://www.radiologyinfo.org/en/info/safety-xray>.



Click the link or QR code to view the current workflow:

<https://youtube.com/shorts/4rcpR0dw1HM?feature=share>



[Click the link or QR code](#) to view the Skyliner application:

https://youtube.com/shorts/lqCGQh_T5Zs?feature=share



ACKNOWLEDGEMENTS



AP. Dr. Khairul



Mr. Zamri



Ms. Hanizan



Mdm. Chanthriga



Mdm. Lilian



Mdm. Ruzimah



Ms. Hasanah



Ms. Aisyah

**HEAD
DEPARTMENT OF BIOMEDICAL IMAGING**

Assoc. Prof. Dr Khairul Azmi Abd Kadir

**STAFF
DEPARTMENT OF BIOMEDICAL IMAGING**

**Mr. Mohd Zamri Mohd Zin; Ms. Hanizan Ahamad; Mdm Ravi Chanthriga Eturajulu;
Mdm. Lilian Yap Poh Poh; Mdm. Ruzimah Johari; Ms. Norhasanah Mohd Amir;
Ms. Siti Nur Aisyah Zolkaplie**

**& ALL THOSE WHO CONTRIBUTED DIRECTLY AND INDIRECTLY TOWARDS THE
SUCCESS OF THIS PROJECT**



Mdm. Azian



Mdm. Dina

Medical Physics Department



Mdm. Azleen



Mr. Wan Mohd Haizily



Thank
You!

