

INTRODUCTION

Diagnostic accuracy of CTPA/CECT Thorax examination in detection of thoracic great vessels, mediastinal and lung abnormalities is highly dependant on image quality.

High failure rate of CTPA/CECT Thorax examinations in children (50%) was identified in Radiology Department at Hospital Seberang Jaya in 2019.

Definition:
CTPA / CECT thorax: Computed Tomography Pulmonary Artery/ Contrast Enhanced Computed Tomography study to evaluate thoracic great vessels, mediastinal, lungs and airways structures.
Hounsfield unit (HU): a quantitative scale to measure the contrast density within the vessels of interest in CT examinations.
Region of interest (ROI): area where the cursor is targeted in order to start the CT scan

1. SELECTION OF OPPORTUNITY FOR IMPROVEMENTS

1.1 REASON OF CHOOSING

S • Delayed or inaccurate diagnosis leading to **delayed/inappropriate** management.
 • Repeat study causes **unnecessary radiation dose** to pediatric patients, increase workload and cost.

M • Percentage of failed CT examinations (collected using survey forms)

A • Accurate findings/diagnosis and management/intervention.
 • Reduce the need of repeat study.
 • Avoid unnecessary radiation dose.

R • Revision of SOP, providing training and CME, supervision of cardiac radiologist for reporting has managed to reduce the failure rate of CTPA/CECT Thorax in paediatric patients.

T • Adequate sample size within the time frame

1.2 LITERATURE REVIEW

Karen E Thomas et al. 2015 study has shown that **Dual bolus intravenous contrast injection (DBI) technique** resulted in concordant multi-compartmental (thoracic aorta, pulmonary arterial) **vascular enhancement**.

Abhishek Chaturvedi et al. 2016 study has stated that **inappropriate placement of ROI** for bolus tracking is a common cause of **non-diagnostic CT scan**.

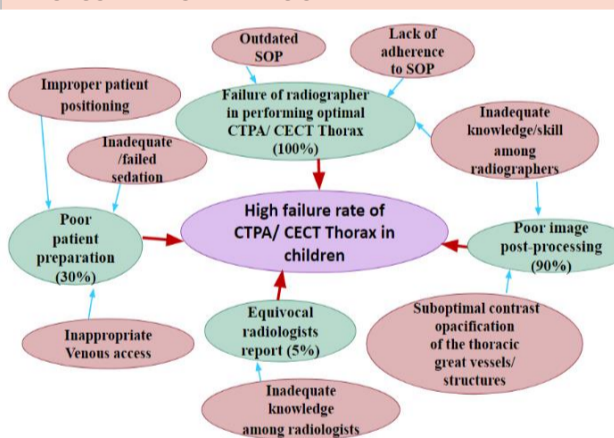
Cherry Kim et al. 2017 study had shown that a minimum of pulmonary arterial **enhancement of 180HU** is required for CTPA study to be judged as diagnostic.

1.3 PROBLEM STATEMENT

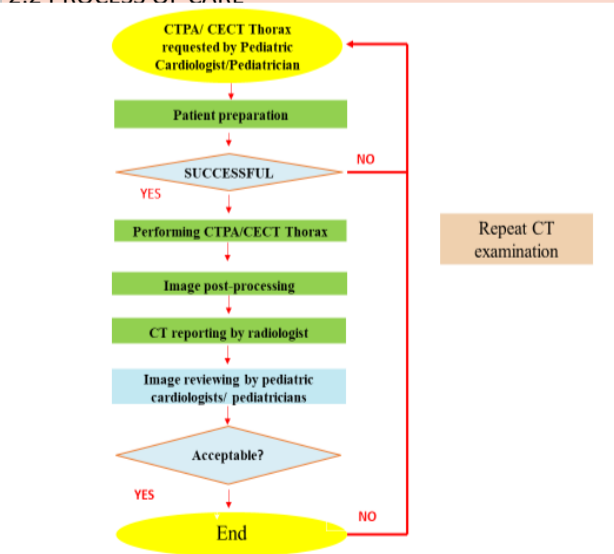
There is a high failure rate of CTPA/CECT Thorax examinations in children.
 This may lead to **delayed/inappropriate management, unnecessary radiation dose & increased workload**.
 The high failure rate of CTPA/CECT Thorax may be due to **outdated SOP, poor patient preparation and failure in performing CTPA/CECT Thorax** in children by radiographers.
 We hope to reduce the high failure rate of CTPA/CECT Thorax examinations in children.

2. KEY MEASURES FOR IMPROVEMENTS

2.1 CAUSE EFFECT ANALYSIS



2.2 PROCESS OF CARE



2.3 GENERAL AND SPECIFIC OBJECTIVE

GENERAL OBJECTIVE
 To reduce the high failure rate of CTPA/CECT Thorax examination in children from **50% in 2019 to < 10% by 2022**.

Specific objectives

- To determine the high failure rate of CTPA/CECT Thorax examination in children.
- To identify the possible and contributory factors
- To formulate strategies and plan appropriate remedial measures.
- To carry out remedial measures efficiently.
- To evaluate the effectiveness of remedial measures implemented.

2.4 INDICATOR AND STANDARDS

Indicator:
 Percentage of failure rate of CTPA/CECT Thorax examinations in children:

$$\frac{\text{Total no of failed CTPA/CECT Thorax in children}}{\text{Total no of CTPA/CECT THORAX in children}} \times 100$$

Standard: <10%
 No KKM standard at present

2.5 MODEL OF GOOD CARE

Process	Criteria	Standard	Pre-remedial	Post 1	Post 2	Post 3	Post 4	Post 5
Patient preparation	1. Adequate sedation	100%	70%	80%	75%	78%	97%	97%
	2. Functioning venous access	100%	80%	100%	100%	100%	100%	100%
	3. Proper baby positioning	100%	100%	100%	100%	100%	100%	100%
Performing CTPA/CECT Thorax	1. Display new SOP in CT room.	100%	0%	100%	100%	100%	100%	100%
	2. Adherence to new SOP	100%	0%	100%	100%	100%	100%	100%
	3. Adequate knowledge skill among radiographer	100%	60%	90%	94%	97%	97%	100%
Image post-processing	1. Adequate knowledge/skill among radiographer	100%	40%	90%	94%	97%	97%	98%
	2. Adequate contrast opacification of the thoracic great vessels (HU>180)	100%	60%	93%	100%	100%	100%	100%
Image reporting by radiologist	Adequate knowledge among radiologists.	100%	95%	100%	100%	100%	100%	100%

3. PROCESS OF GATHERING INFORMATION

METHODOLOGY	
Design	Descriptive Cross Section
Duration Of Study & (Sample Size)	Verification Study- Jan - March 2019 Pre Remedial- May - July 2019 (30) Implementation Of Remedial- September - November 2019 Post Remedial Cycle 1 - December 2019 - February 2020 (30) Post Remedial Cycle 2 - May- July 2020 (31) Post Remedial Cycle 3 - November 2020 - January 2021 (30) Implementation Of Remedial 2- February - April 2021 Post Remedial Cycle 4 - May 2021 - July 2021 (31) Post Remedial Cycle 5- Nov 2021- Jan 2022 (35)
Sampling Tools	Observational Checklists Knowledge/Performance Checklists
Sampling Method	Universal Sampling
Inclusion Criteria	All CTPA/CECT Thorax Examination In Children 18 Years Old Or Below Done In Radiology Department, Hospital Seberang Jaya

4. ANALYSIS & INTERPRETATION

The Failure rate of CTPA/CECT Thorax in children: **40%**

ABNA: **30%**

SIQ	PRE	POST 1	POST 2	POST 3	POST 4	POST 5
1. Failure of radiographer in performing optimal CTPA/CECT THORAX	100%	10%	7%	5%	0%	0%
2. Poor image post processing technique	90%	10%	7%	5%	0%	0%
3. Poor patient preparation	30%	23%	28%	25%	3%	3%
4. Equivocal radiologists report	5%	0%	0%	0%	0%	0%

5. STRATEGIES FOR CHANGE

S1: Change from using single bolus to dual bolus

Dual bolus intravenous contrast injection (DBI) Protocol

BODY WEIGHT	CONTRAST VOLUME
< 30 KG	BODY WEIGHT x 1.5ml
30-50KG	BODY WEIGHT x 2ml
>50 KG	80 ml

BRANULA SIZE	MAXIMUM FLOW RATE (ml/s)
24G (YELLOW) - PAEDIATRIC	0.8-1.0
22G (BLUE)	1.5
20G (PINK)	4.0-5.0
18G (GREEN)	5.0-6.0

PHASE	TYPE	FLOW RATE	RATIO	PRESSURE
1	Contrast	Depending on the branula size	70	100
2	Saline	30	30	100
3	Contrast	50	50	100
4	Saline	50	50	100
5	Saline	-	-	100

Area Scan: Top to down (chest only)
 Contrast: Iopamiro 300
 Manual tracking: ROI at left ventricle

NEW

S3: CME/Training for radiographer and supervision by senior radiographer/radiologist



S5: Revision of pediatric department written sedation protocol

REVISED SEDATION ALGORITHM

First dose syrup chloral hydrate 50mg/kg dose 30 minutes before procedure

After 20-30 minutes, if not sedated

2nd dose syrup chloral hydrate 50mg/kg

After 20-30 minutes, if not sedated

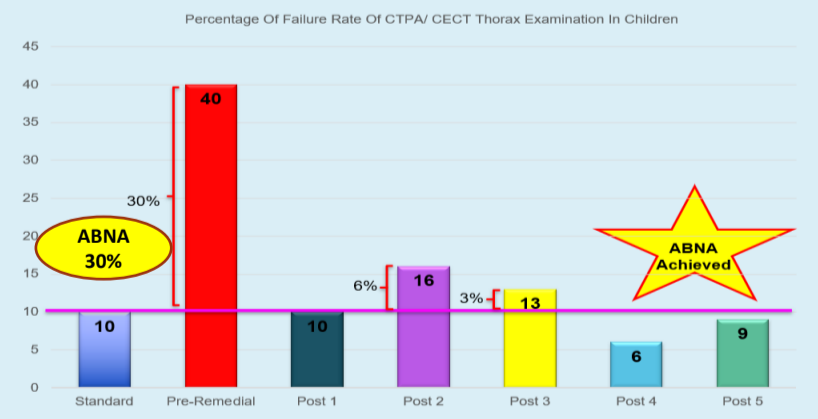
IV Midazolam 0.2mg/kg/dose

After 5 minutes, if not sedated

NEW

IV midazolam 0.2mg/kg
 If not sedated to discuss with specialist, KIV IV ketamine 1mg/kg/dose (if required to give IV atropine 0.01mg/kg/dose prior to IV ketamine)

6. EFFECTS OF CHANGE

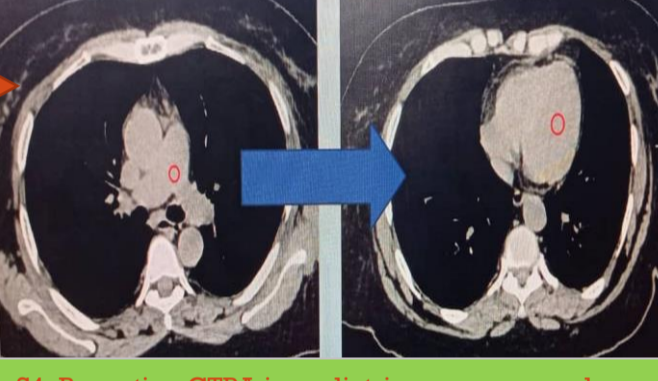


7. IMPACT

- Reduced radiation (patient & staffs): **1 CTPA ~12 mSv = 600 Chest xray**
- Cost saving: **RM 885 per procedure**
- Save up to **RM8850 per month**
- Avoid **delayed/inaccurate diagnostic findings** and **delayed/inaccurate treatment**, which may affect patient's prognosis and clinical outcome.
- Reducing patients' **anxiety** and patients' parents **absenteeism in workplace**.
- Save **Manpower (5 staffs/procedure)** & **Man-hours (90 minutes/ procedure from performing CTPA to reporting)**
- DBI Technique has been **replicated in Radiology Department, Hospital Pulau Pinang**.

	Pre remedial (2-3/2019)	Post 1 (7-8/2021)	Post 2 (1-2/2022)
Sample size	50	51	51
Successful	24%	82.4%	92.2%

S2: Shift the ROI at bifurcation to ROI at left ventricle



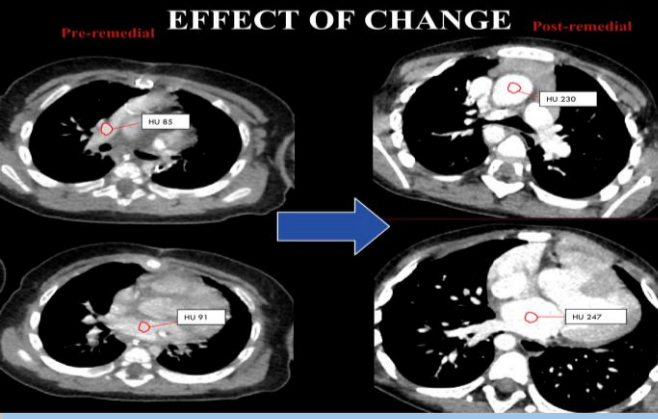
S4: Reporting CTPA in pediatric age group under supervision of visiting cardiac radiologist.



S6: CME/Training of the new medical officers joining pediatric department



Better contrast enhancement in CTPA/CECT Thorax



8. CONCLUSION

- Percentage of failed CTPA/CECT Thorax examinations in paediatric patient of **50% has been reduced to <10%**.
- Outdated SOP and lack of knowledge among radiographers** in image acquisition and image post-processing techniques are the main contributing factors.
- The implementation of remedial measures such as revision of SOP, providing training and CME, supervision of cardiac radiologist for reporting has managed to reduce the failure rate of CTPA/CECT Thorax in paediatric patients.
- We managed to **achieve our standard of <10%**.

9. THE NEXT STEP

- We wish to maintain our current result by ensuring continuous implementation of the remedial actions.
- We are considering **trial of dual bolus intravenous contrast injection** in other CT examinations such as CT Abdomen/ Pelvis.
- We wish to **introduce the new SOPs to radiology departments in other hospital**

10. ACKNOWLEDGEMENT

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