Incredible Care QIX Award (Process Excellence)

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Project Title: Increasing Clinically Appropriate Contrast-enhanced MRIs (CE MRI) in CKD 4 Patients		
Department: Department of Diagnostic Imaging	Period: July 2025 – Dec 2025	Facilitators/Author: Dr Eric Fang
Sponsors (HODs): Prof Khong Pek Lan	Team Leader/s: Dr Samuel Lau	
Team Members: Dr Tan Wei Chuan, Dr Chia Ming Li, Dr Yip Jia Yun, Muhammad Fauzi, Dr Sandra Tan, Dr Jon Tan, Dr Sean Lee, Dr Lim Mei Chin		

A. Define the Problem (PLAN)

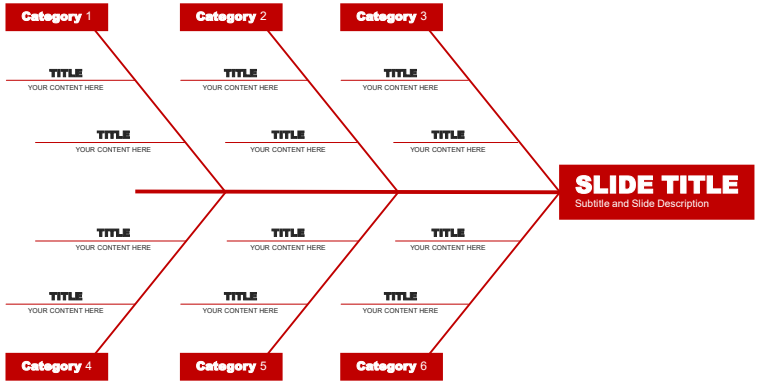
- What is this project about?
- Why is it important to work on this problem?
- What is the baseline data?

B. Goal (PLAN) Set SMART goals | Specific, Measurable, Achievable, Relevant, Time-based |

Example: To reduce re-attendance due to fever and preventable conditions in children's emergency from 50% to 20% within 6 months

C. Problem Analysis (PLAN) Gap Analysis

You may use more than 1 problem solving tools (Gap Analysis, VSM, Paradigm, Pareto Chart)

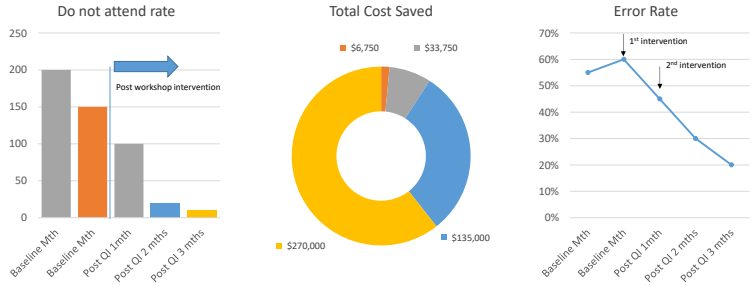


D. Interventions & Action Plan (DO)

SN	Description	People responsible	Date of implementation

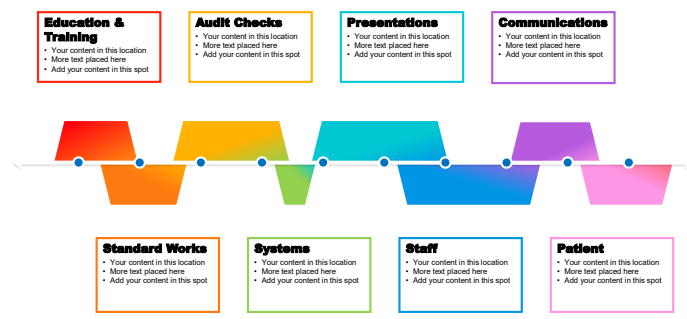
E. Benefits / Results (CHECK)

Align your measurements to your goals. Include charts to show improvements and whether results are sustained over time (for at least in the recent 3 months). Show annotated run chart to indicate start of implementation



F. Strategy for Spreading/ Sustaining (ACT)

What actions are required for continuous improvement? How will the results be sustained for the long run? Will the project be spread to other areas?

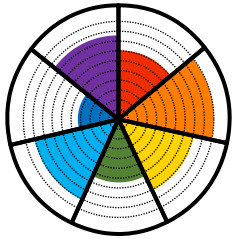


The 6 box QIX template is brought to you by Quality Improvement Department wef 1 April 2023

A. Define the Problem (PLAN)

- There are currently limited contrast-enhanced imaging options deemed safe for CKD 4 patients in NUH. Contrast-enhanced ultrasound is a viable option for evaluation of select hepatic and renal lesions, but has limited use for other body parts. Contrast-enhanced CT is also not advised in such patients due to the risk of contrast-induced acute kidney injury.
- CE MRI may hence be the safest option available as gadolinium-based contrast agents (GBCAs) used in CE MRI are not nephrotoxic. However, GBCAs have historically been avoided in this group of patients due to the risk of nephrogenic systemic fibrosis (NSF) with older-generation GBCAs (reported up to 2-5% risk).
- Updated guidelines from the American College of Radiology (ACR) from 2020 have stated that GBCAs can be used in CKD 4 patients if clinically indicated, due to the minimal risk of NSF associated with current-generation GBCAs. A revised version of the guidelines in 2024 deemed ALL MR contrast agents used in NUH to be of minimal risk of NSF.

B. Goal (PLAN) Set **SMART** goals | **S**pecific, **M**easurable, **A**chievable, **R**elevant, **T**ime-based |



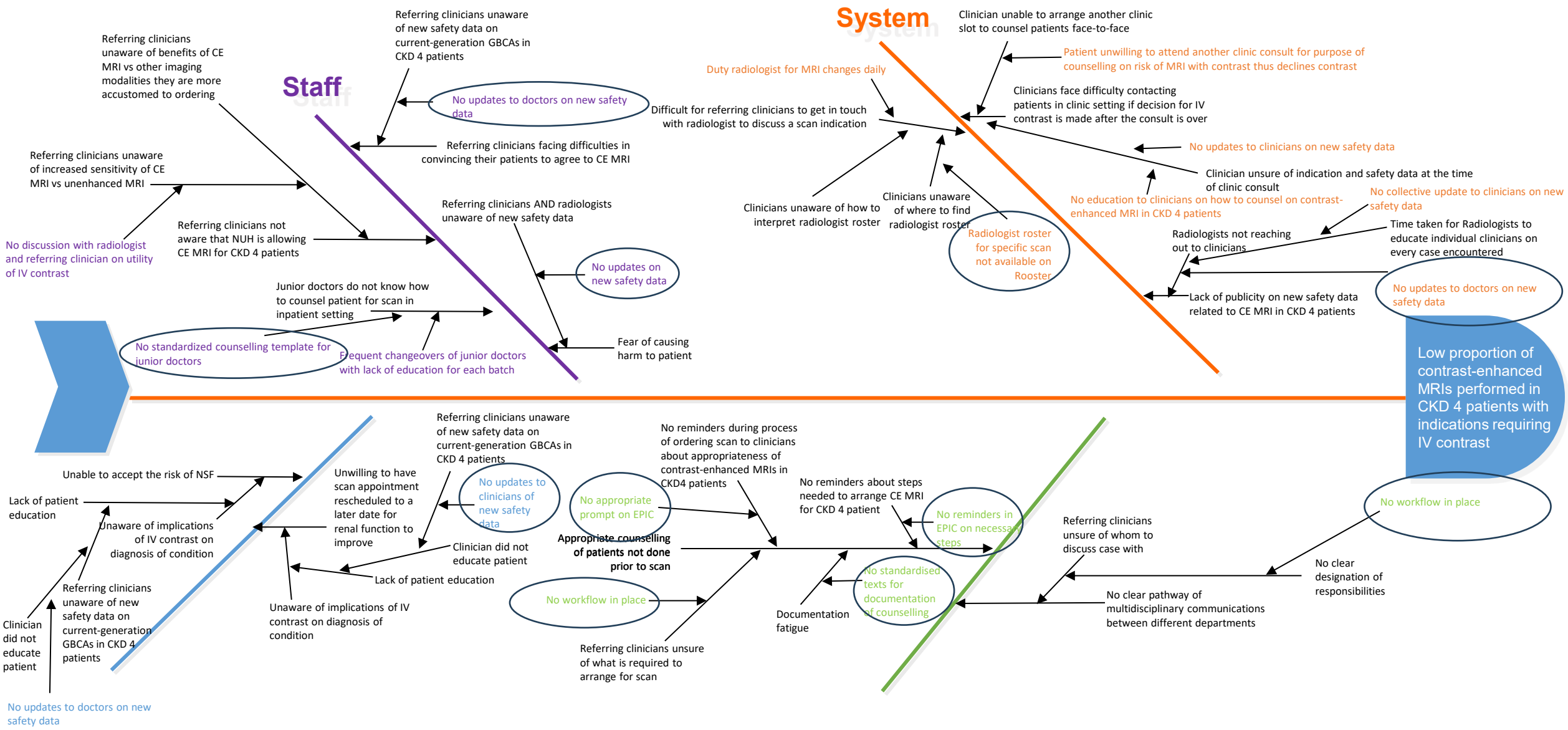
From the period of Jan to May 2025, 56 studies were performed for CKD 4 patients with indications that would have benefitted from administration of IV contrast. Only three were ultimately performed with IV contrast (pre-intervention median of 6.7%).

Goal: To increase the proportion of clinically appropriate CE MRIs in CKD 4 patients from 7% to 30% in the next 6 months.

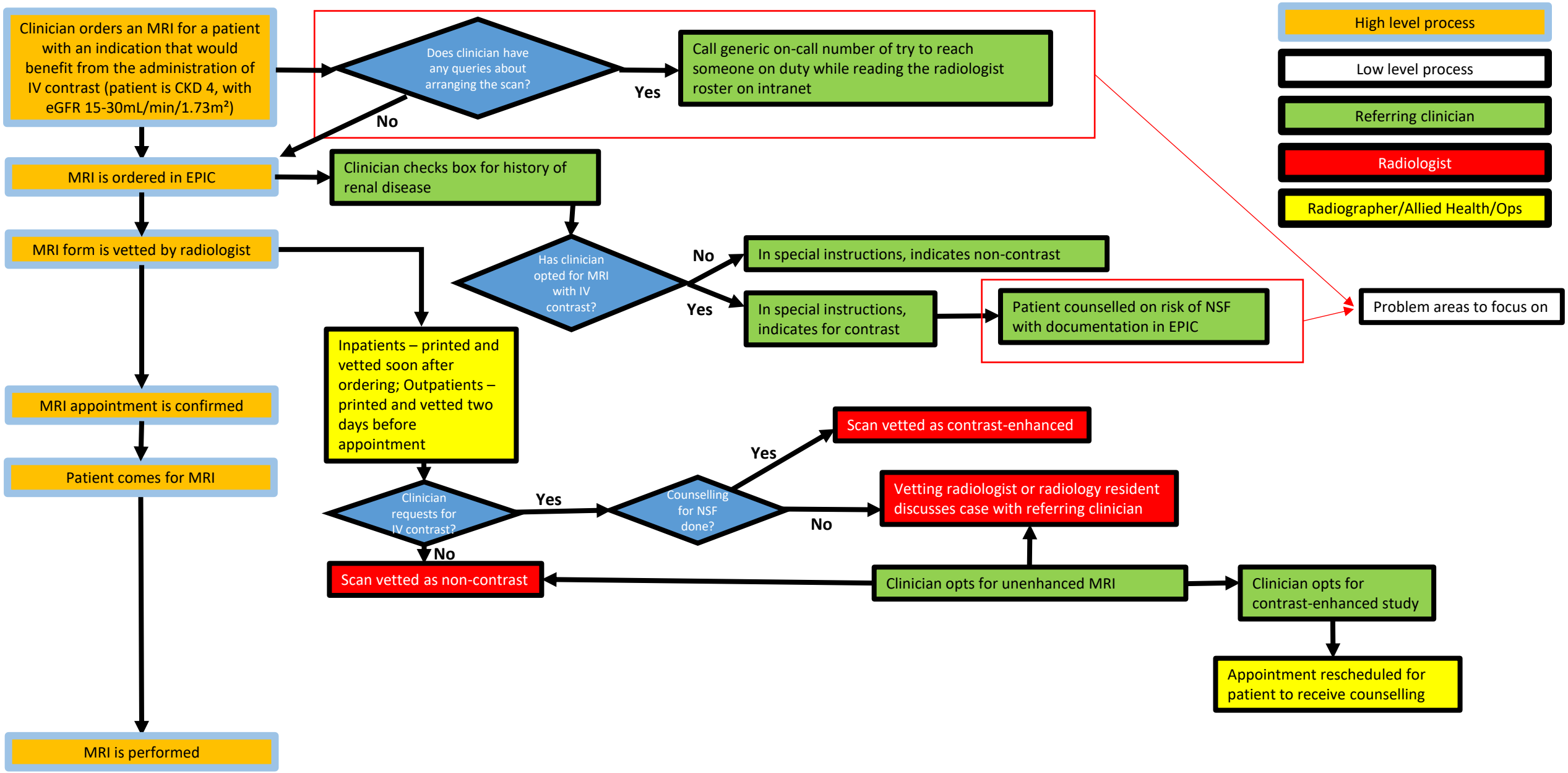
Clinically appropriate CE MRIs are defined as MRIs with indications that would have resulted in the administration of IV contrast if the patient's eGFR were >30mL/min/1.73m^2 in the absence of other unrelated contraindications.

Doing so would presumably lead to earlier diagnosis and initiation of treatment. This would translate to cost savings in the form of reduced length of stay for inpatients, fewer repeat visits for outpatients, as well as reducing or eliminating the need for repeat imaging or more complex procedures/tests.

C. Problem Analysis (PLAN) Gap Analysis



C. Problem Analysis (PLAN) Value Stream Map

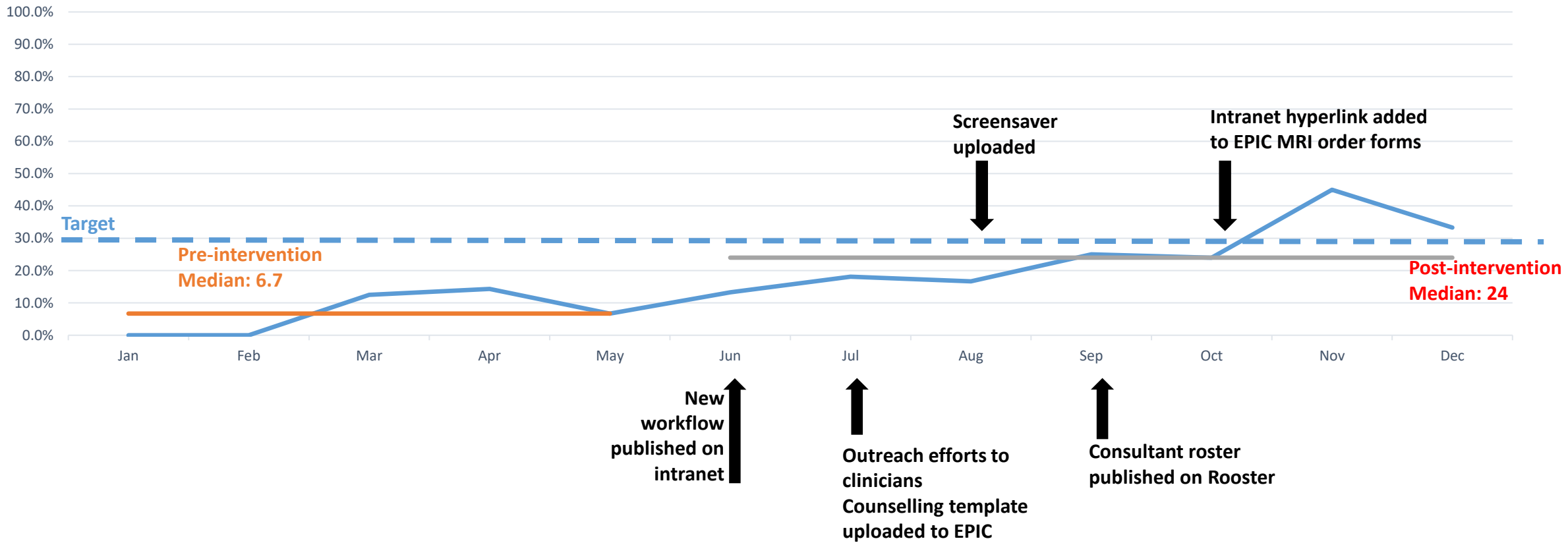


D. Interventions & Action Plan (DO)

ROOT CAUSE	INTERVENTION	DATE OF IMPLEMENTATION
No clear workflow in place	Intervention 1: Create a workflow for the hospital departments detailing steps required to perform CE-MRI n CKD4 patients	June 2025
No updates to doctors on new safety data	Intervention 2: Take a 3 prong-approach to educating doctors, ensuring all levels of seniority and required departments are reached: Department Briefings to radiologists, Roadshows for senior doctors, HO orientation for junior doctors, Desktop screensaver	July – Aug 2025
No standardised counselling template for junior doctors	Intervention 3: Creation of EPIC Smartphrase for counselling patient for purpose of taking informed consent to perform contrast-enhanced MRI in CKD 4 patient	July 2025
Radiologist roster for specific scan not available on Rooster	Intervention 4: Duty Radiologist with whom clinicians may discuss appropriateness of MRI to be made available on Rooster, akin to other subspecialities' consult rosters	Aug 2025
No reminders in EPIC on necessary steps	Intervention 5: Amendment to radiology MRI order forms on EPIC, to include a reminder to doctors on possibility to perform CE-MRI in CKD4 patients, and steps needed to do so	Oct 2025

E. Benefits / Results (CHECK)

Proportion of Clinically Appropriate Contrast-enhanced MR Studies in Patients with eGFR 15-30mL/min/1.73m²



E. Benefits / Results (CHECK)

Benefits to Patients

1. Increased patient satisfaction
2. Reduced number of re-visits to the hospital

Benefits to Clinicians

1. Increased diagnostic confidence and clinical decision making

Benefits to Organization

1. Reduced Resource Utilization (hospital beds, scan slots, outpatient clinic slots)
2. Cost savings
   - A. Scan reaches diagnosis, reduced frequency of follow-up or no follow-up required: $70.8 saved per patient per month
   - B. Further investigation with alternative modality avoided: $100-$133.3 saved per patient per month
   - *All costs as subsidized patient*
     - *Outpatient MRI: $800*
     - *Percutaneous biopsy under IR: $400; average cost of B2/C patient per bed-day = $800*
     - *PET-CT: $1600*
     - *Repeat clinic visit : $50*

F. Strategy for Spreading/ Sustaining (ACT)

- Eventual inclusion of both CKD 4 and CKD 5 patients
  - Goal to reconvene with Nephrology department in 1H 2026 with data

- Workflow can be introduced to AH and NTFGH diagnostic imaging departments in the future

Appendix

Intervention 1: Creation of hospital workflow

- Workflow was created with input from Departments of Diagnostic Imaging Nephrology
- Uploaded and made available on hospital intranet

Screenshot from intranet page ^

Selected screenshot from the hospital workflow >

GUIDELINES
(summarised in Flowchart 1)

1. **Patient selection** – the use of Group II GBCAs in patients with eGFR <30 mL/min/1.73m^2 will be rolled out **in a stepwise fashion**. This will first be permitted for patients with **eGFR 15-30 mL/min/1.73m^2**.

   For patients with eGFR <15 mL/min/1.73m^2 or eGFR 15-30 mL/min/1.73m^2 with concomitant acute kidney injury (AKI), referring physicians should discuss these requests with a nephrologist.

2. **Patient Screening** – screening of kidney function will follow NUH Dept of Diagnostic Imaging guidelines, in which patients with risk factors for chronic kidney disease will undergo creatinine point-of-care testing if no valid eGFR result is available within the last three months.

3. **GBCA Selection** – Group II GBCAs will be administered at the lowest dose necessary to achieve diagnostic results, not exceeding standard dosages

4. **Risk-Benefit Assessment** – the decision to perform CE MRI in patients with eGFR 15-30 mL/min/1.73m^2 should be made collaboratively by a radiologist and the referring physician, weighing the diagnostic benefits of CE MRI against the minimal NSF risk. Alternative imaging modalities (primarily non-contrast imaging) should be preferred if CE MRI is not essential (for instance, if the risk of NSF outweighs the benefit of prompt diagnoses with CE MRI).

5. **Informed Consent** – following decision to proceed with CE MRI in a patient with eGFR 15-30mL/min/1.73m^2, the referring physician is to document the following:
   a. The name of the radiologist the case was discussed with
      i. **Associate Consultant and above during office hours, senior resident on-call during on-call hours**
   b. Discussion with the patient including
      i. Indication for CE MRI
      ii. Potential risk of NSF with Group II GBCA administration (<0.07%)
      iii. Alternative diagnostic strategies, if any

   Use EPIC SmartPhrase **DDINUHMRICKD** for documentation.

6. **Ordering of MRI** – under Special Instructions, please indicate "CKD 4 with contrast. Counselled for NSF." This is to ensure the study is vetted appropriately by radiologists.

7. **Dialysis considerations** – dialysis does not need to be initiated solely to prevent NSF in patients with eGFR 15-30mL/min/1.73m^2.

8. **Monitoring and Follow-Up** – monitor patients for signs of NSF (e.g. skin thickening, joint stiffness, or red/dark patches) for at least three months post-GBCA administration. Patients should be educated to report symptoms promptly.

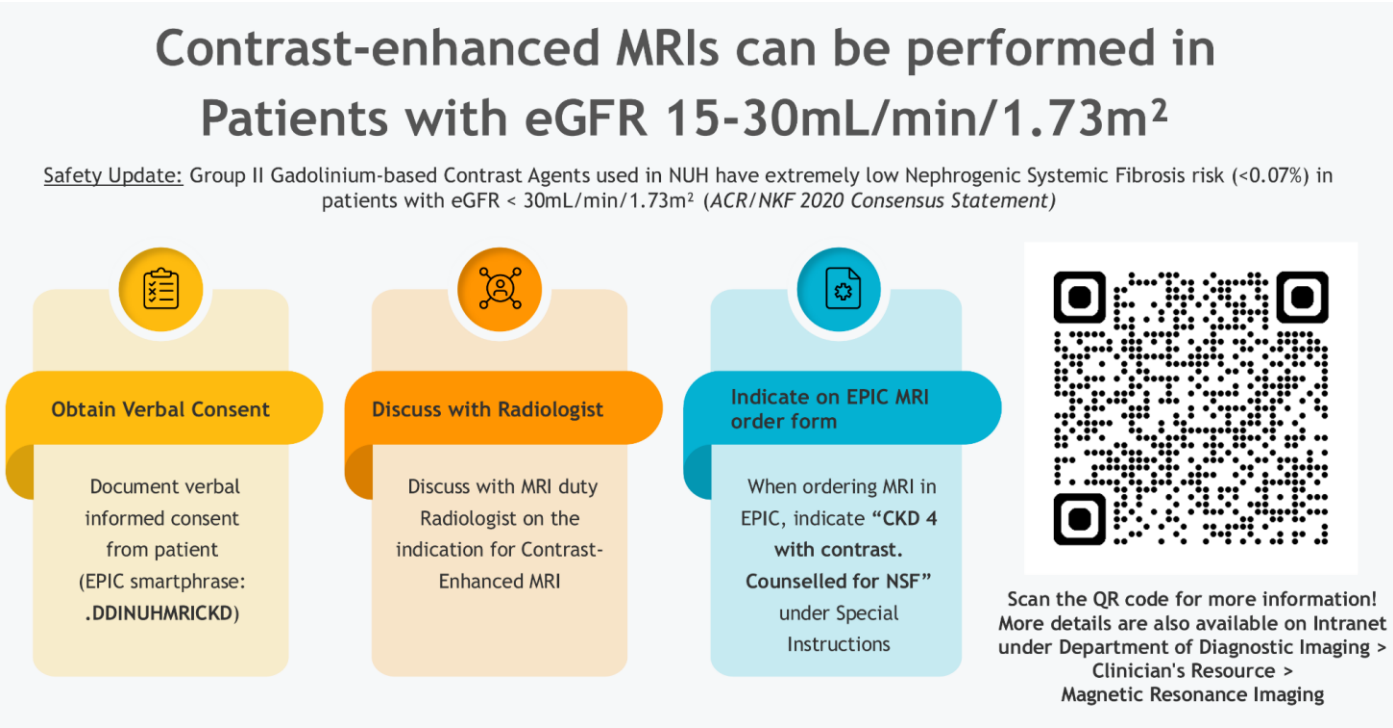
Adapted from: Consensus Statements from the American College of Radiology (ACR) and National Kidney Foundation (NKF), 2020

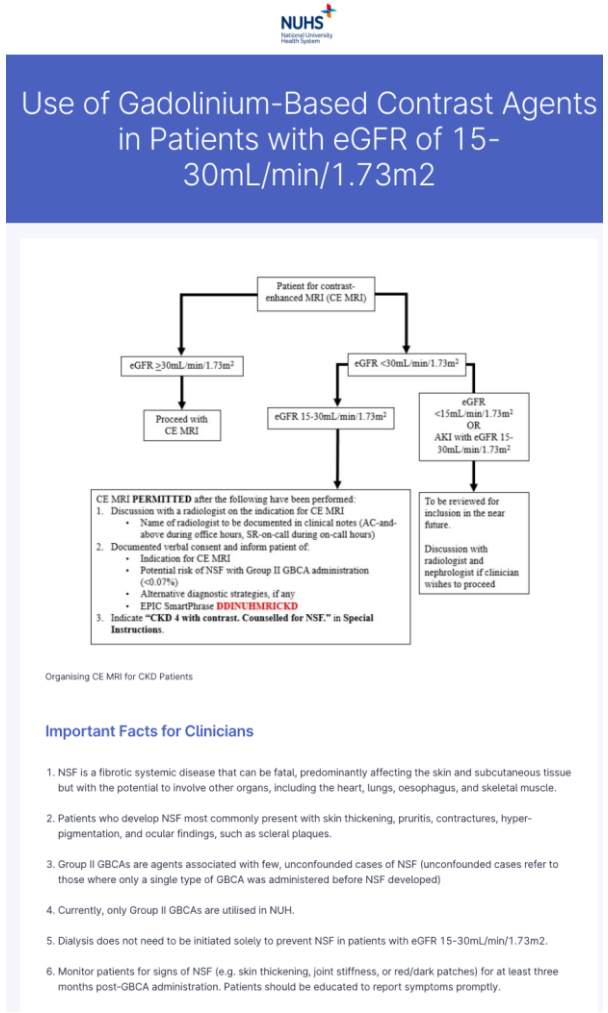
Version 3 (last reviewed July 2025)

Appendix

Intervention 2: Doctor engagement

- Senior clinicians were addressed through subspecialty tumour board meetings to allow for opportunity to ask questions and make clarifications
- In-person sessions were arranged for medical and surgical HOs and MOs to inform them of the new workflow
- Desktop wallpaper was created and uploaded





Desktop wallpaper ^

One-page summary of workflow from the QR code >

Appendix

Intervention 3: Standardized counselling template

- Counselling template was uploaded to EPIC with smartphrase shortcut

Consent for contrast-enhanced MRI (CE MRI) of _____ with a Group II Gadolinium-Based Contrast Agent (GBCA) in a patient with eGFR <30mL/min/1.73m^2

Indication: _____

Alternatives:

1. Non-contrast imaging. These may have poorer diagnostic accuracy, which increases the risk of delayed diagnosis, potentially resulting in morbidity and mortality.
2. Contrast-enhanced computed tomography, in which the use of iodinated contrast agents poses a risk of contrast-induced acute kidney injury that may necessitate dialysis initiation. Group II GBCAs are not nephrotoxic.
3. Contrast-enhanced ultrasound, primarily used for evaluation of the liver and kidneys, which is operator-dependent and may not be appropriate.

Risk of Nephrogenic Systemic Fibrosis (NSF):

- NSF is a debilitating, sometimes fatal, disease that predominantly affects the skin and subcutaneous tissue but can also involve other organs, including the heart, lungs, oesophagus, and skeletal muscle. Patients who develop NSF most commonly present with skin thickening, pruritis, contractures, and hyper-pigmentation.
- Majority of NSF cases have occurred in patients with eGFR <30 exposed to multiple doses of Group I GBCAs.
- Group II GBCAs are associated with few, if any, unconfounded cases of NSF. The risk of NSF from Group II GBCA administration in patients with eGFR <30 is likely less than 0.07% based on a 2019 meta-analysis.

Safety Measures:

- Only Group II GBCAs are used in NUH.
- The indication for CE MRI has been discussed with a radiologist **(name: _____).** Considering the alternative diagnostic modalities available, the benefit of timely diagnosis outweighs the limited risk of NSF with Group II GBCA use.
- Group II GBCA will be administered at the lowest dose necessary to achieve diagnostic results, not exceeding standard dosages.

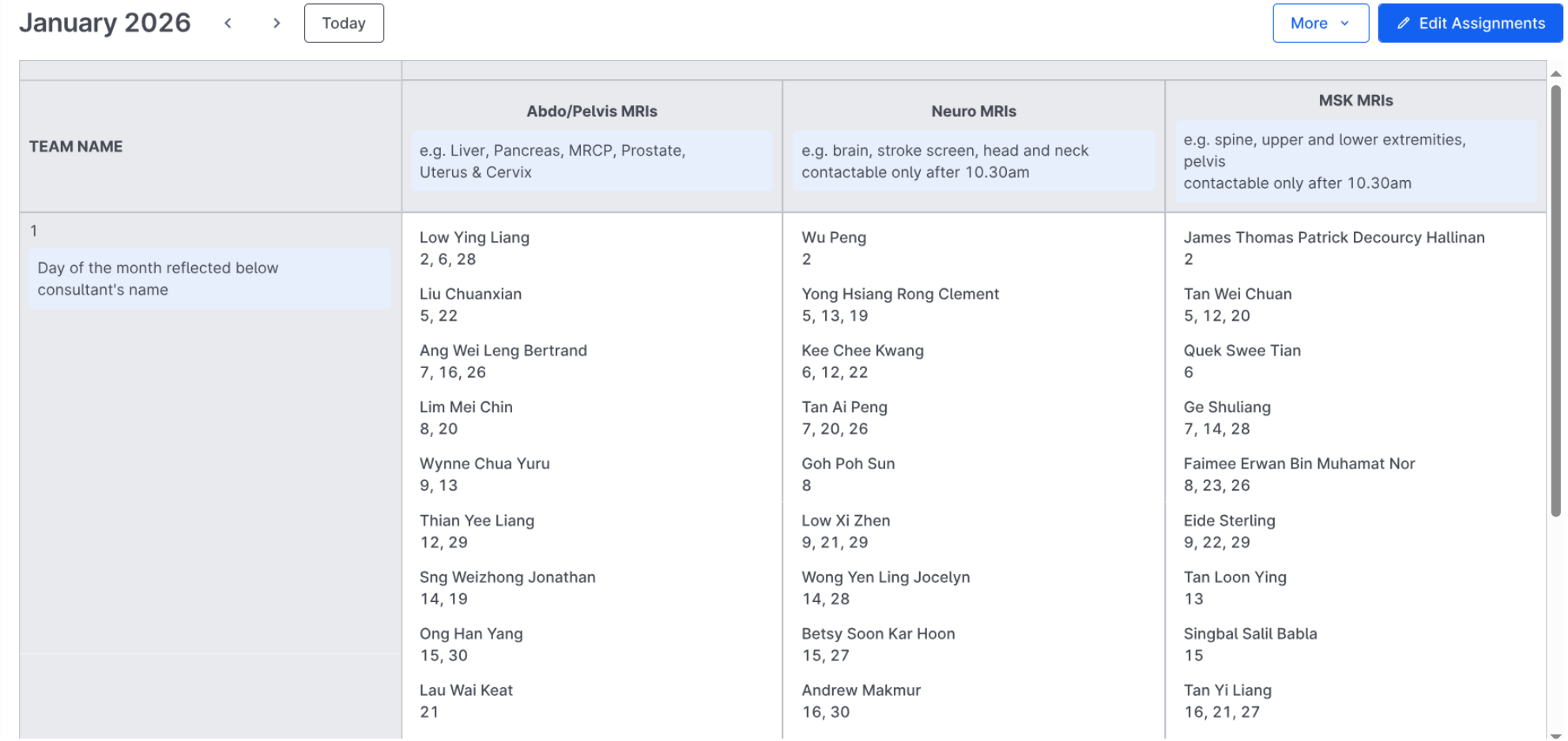
The patient was advised to monitor for symptoms of NSF (e.g. skin thickening, joint stiffness, or red/dark patches) for at least three months post-GBCA administration and report symptoms promptly.

Patient understands the above and is agreeable to proceed.

Appendix

Intervention 4: Consultant outpatient MR roster

- Created an easy-to-understand consultant outpatient MR roster for clinicians, if they were to require advice on a particular patient's scan of choice



January 2026 ‹ › Today

More | Edit Assignments

TEAM NAME	Abdo/Pelvis MRIs e.g. Liver, Pancreas, MRCP, Prostate, Uterus & Cervix	Neuro MRIs e.g. brain, stroke screen, head and neck contactable only after 10.30am	MSK MRIs e.g. spine, upper and lower extremities, pelvis contactable only after 10.30am
1 Day of the month reflected below consultant's name	Low Ying Liang 2, 6, 28 Liu Chuanxian 5, 22 Ang Wei Leng Bertrand 7, 16, 26 Lim Mei Chin 8, 20 Wynne Chua Yuru 9, 13 Thian Yee Liang 12, 29 Sng Weizhong Jonathan 14, 19 Ong Han Yang 15, 30 Lau Wai Keat 21	Wu Peng 2 Yong Hsiang Rong Clement 5, 13, 19 Kee Chee Kwang 6, 12, 22 Tan Ai Peng 7, 20, 26 Goh Poh Sun 8 Low Xi Zhen 9, 21, 29 Wong Yen Ling Jocelyn 14, 28 Betsy Soon Kar Hoon 15, 27 Andrew Makmur 16, 30	James Thomas Patrick Decourcy Hallinan 2 Tan Wei Chuan 5, 12, 20 Quek Swee Tian 6 Ge Shuliang 7, 14, 28 Faimee Erwan Bin Muhamat Nor 8, 23, 26 Eide Sterling 9, 22, 29 Tan Loon Ying 13 Singbal Salil Babla 15 Tan Yi Liang 16, 21, 27