National Diabetes Collaborative

CHANGE PACKAGE

Optimising Blood flow, Locking solution, Anticoagulant & Standardising Technique (BLAST)

Catheter Flow Restoration with Lytic DwEll at Community DiAlysis CentRe (CLEAR)

JANUARY 2024

NiU National Improvement Unit Singapore

NKF

Singapore General Hospital SingHealth

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Message by NIU Director

National Improvement Unit Singapore (NIU) was set up by Ministry of Health Singapore (MOH) in 2021 to facilitate value creation for patients through enabling adoption of improvement science by providers who design and deliver health and social care. The goal is to reduce quality waste, inefficiency waste, and eliminate issues of overuse, underuse, and misuse in healthcare.

NIU achieves its aim by collaborating with healthcare clusters to drive sustainable improvements and one of this collaboration is to build a learning network around reducing diabetes hospitalisation (identified as one of the healthcare system priorities). NIU employed IHI's (Institute for Healthcare Improvement) Breakthrough Series Collaborative methodology and launched the 5-year National Diabetes Collaborative in 2021.

This change package summarises the learnings from the project led by SingHealth-Singapore General Hospital and the National Kidney Foundation as part of the National Diabetes Collaborative designed and facilitated by NIU.

This document outlines blueprint for change—an actionable framework for unblocking tunnelled hemodialysis catheters (THCs) in the community, achieving the aim of avoiding and reducing diabetes hospital admissions. It reflects our collaborative approach, detailing the iterative process of small-scale testing, refinement, and adaptation.

This change package underscores the power of collaboration and community integration. By engaging stakeholders at every level, we amplify our impact and foster a culture of shared responsibility for health outcomes. Through collaboration with healthcare clusters and community partners, we drive sustainable change and improve patient outcomes.

I would like to take this opportunity to thank MOH, senior leaders, sponsors, patients and teams for their contributions, dedication, and unwavering commitment. We will continue to work with you to support the implementation of these learnings and contribute to better health outcomes for our patients.

Dr Eunice Wong
Director

NiU
National Improvement Unit Singapore

INTRODUCTION

Diabetes is a growing health problem with a significant global health disease burden. The prevalence of diabetes in Singapore was 8.7% in 2021-2022.1 In the context of Singapore's rapidly aging population with steadily increasing life expectancy, morbidity from chronic and non-fatal health problems caused by diabetes, continues to present important challenges for the country's health system. In particular, diabetes is a major risk factor for chronic kidney disease (CKD) and is the leading cause of end-stage kidney failure (ESKF) in Singapore, accounting for 67% of new cases.2 The increasing incidence rate of the ESKF from 418.8 per million population (pmp) to 556.1 pmp in 2020 has important public health implications due to an increase in healthcare utilisation. 2 Specifically, the Organisation for Economic Co-operation and Development (OECD) Health at a Glance Report 2019 showed that Singapore's age-sex standardised diabetes admission rate was 2.1 times higher than the OECD average, after adjusting for prevalence.3 The top 2 reasons for diabetes admissions were nephropathy and peripheral vascular disease.3 Hence, there is a pressing need to create a new outpatient model of care to tackle the rising epidemic of ESKF secondary to diabetes.

BACKGROUND

The National Kidney Foundation (NKF) Singapore is a non-profit health organisation in Singapore.6 Being the biggest dialysis provider in the nation, NKF provides maintenance HD for 4529 patients in 40 dialysis centres (DC) in the community. Of these, 660 (15%) patients are using THCs as vascular access. In 2021, 168 cases were referred to acute hospitals for dysfunctional THC from these DCs over 6 months. Patients with THC dysfunction would receive treatment in the form of intraluminal lytic dwell in the hospital and undergo dialysis before being discharged back to the community. These admissions could potentially be averted by upskilling nurses in the community.

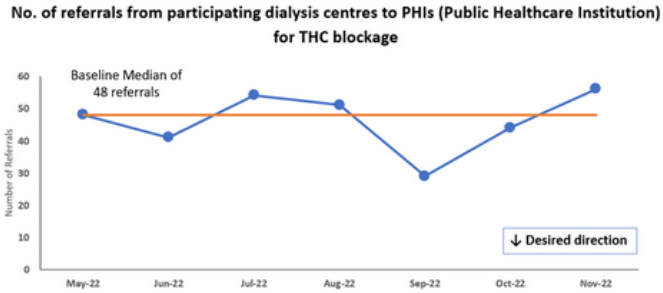
The majority of patients with ESKF chose haemodialysis (HD) as their long-term renal replacement therapy. 2 Vascular access for HD treatment is best achieved with an arteriovenous fistula (AVF) or arteriovenous graft (AVG). However, a significant number of patients require a tunnelled haemodialysis catheter (THC) to receive life-sustaining HD as bridging to AVF or AVG placement and maturation, or as permanent access after all opportunities for arteriovenous access have been exhausted. The use of THC for HD vascular access is associated with a relatively high incidence of complications, the most frequent of which is catheter dysfunction or low flow, that can lead to thrombotic complications.4 THC dysfunction is a major problem in ESKF patients, with 17 – 33% of THCs requiring removal due to blood flow that is inadequate, resulting in inadequate dialysis.5 Thrombosis is a common cause of THC dysfunction which can be treated with lytic dwell with high success rates.5 In Singapore, administration of lytic dwell to restore the flow of occluded THC is traditionally performed in acute hospitals as an inpatient procedure, resulting in delay in dialysis, inconvenience to patients, increased hospital bed occupancy rates and overall healthcare costs. Transition away from predominantly inpatient care is essential to improve patient outcomes and reduce the burden on our healthcare systems.

PROBLEM STATEMENT

The National Improvement Unit (NIU), as part of the National Diabetes Collaborative, partnered with the Department of Renal Medicine of Singapore General Hospital (SGH) and the National Kidney Foundation (NKF) to lead this quality improvement project (QIP) to avoid hospital admission and readmissions by reducing the referrals of THC dysfunction from community dialysis centres to public healthcare institutions (PHI).

AIM

This QIP seeks to reduce the number of referrals from community DCs to PHIs for THC dysfunction from a baseline median of 48 cases per month to 34 cases per month by December 2023 respectively.



To achieve this aim, the QIP engaged renal physicians from all PHIs in Singapore including Alexandra Hospital, Changi General Hospital, Khoo Teck Puat Hospital, National University Hospital, Ng Teng Fong General Hospital, Sengkang General Hospital and Tan Tock Seng Hospital. Forty community DCs under NKF were recruited to test the change ideas. The change ideas were implemented in stages and included:

1. Optimising **B**lood flow, **L**ocking solution, **A**nticoagulant and **S**tandardising **T**echnique (**BLAST**)
Instilling a solution with an anticoagulant effect such as heparin or sodium citrate in each THC lumen after each haemodialysis session creates a barrier against clot formation. Optimising anticoagulant dose according to patient's bleeding and clotting risk will prevent circuit clotting and intra-luminal thrombus formation in THC. Preventing blood influx by positive pressure technique during locking may also prevent intra-luminal thrombus formation. These practices can prolong THC patency and functionality, thereby reducing the need for thrombolytic agents or catheter replacement and improving the quality of life of patients with ESKF on haemodialysis.

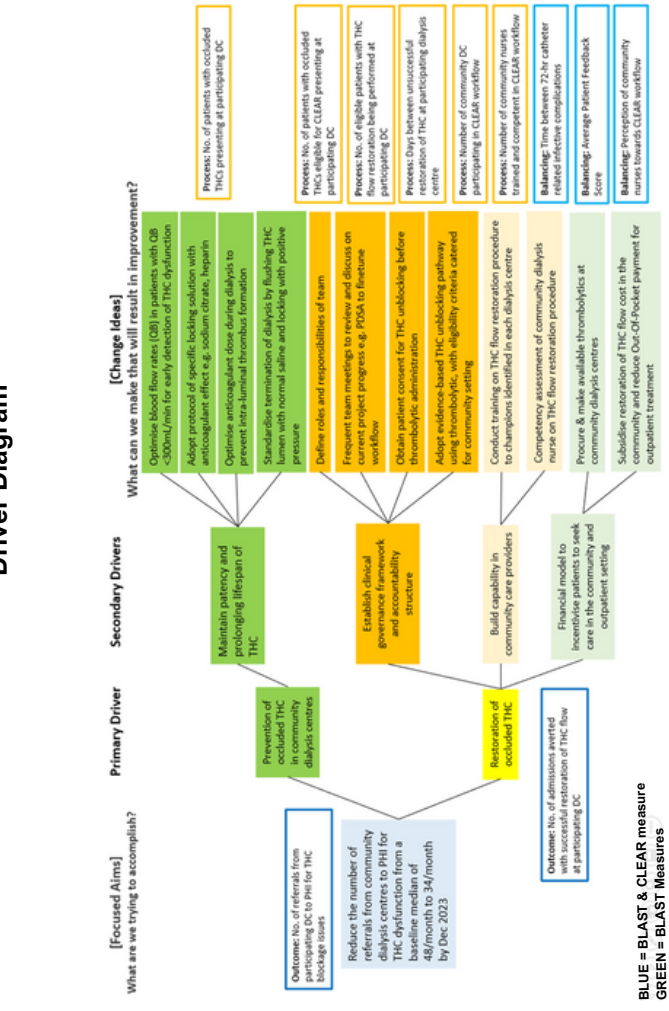
2. **C**atheter flow restoration with **L**ytic dw**E**ll at community di**A**lysis cent**R**e (**CLEAR**)
Intraluminal administration of a thrombolytic agent in each THC lumen is recommended to restore the function of dysfunctional THC due to thrombosis.7 The CLEAR initiative empowers community dialysis centres to treat THC dysfunction by upskilling the community dialysis nurses to administer thrombolytic agents.

MEASUREMENT SYSTEM

Measure Name	Operational Definition	Data Collection Plan
OUTCOME		
No. of referrals from participating dialysis centres to PHI (Public Healthcare Institution) for THC blockage issues	Derived from the number of patients presenting with blocked THC minus the number of successful restorations	Who: Dialysis centre How: Manual collation/Excel data collection Sheet Frequency: Monthly
No. of admissions averted with the successful restoration of THC flow at participating dialysis centres	Successful restoration is defined as the ability to complete dialysis with prescribed blood flow or able to maintain blood flow of at least 200 mL/min with OCM ≥1 (including reversal of lumens) Admissions averted will be based on the date of successful restoration being achieved. E.g., patient sent home with Alteplase lock on 30 June and returns on 1 July for a successful THC restoration, will be considered as an averted admission on 1 July	Who: Dialysis centre How: Manual collation/Excel data collection Sheet Frequency: Monthly
PROCESS		
No. of patients with occluded THC presenting at all dialysis centres	Occluded THC is defined as the inability to complete dialysis at prescribed blood flow or maintain blood flow of at least 200mL/min with OCM ≥ 1 (including reversal of lumen)	Who: Dialysis centre How: Manual collation/Excel data collection sheet Frequency: Monthly
No. of patients with occluded THCs eligible for CLEAR presenting at participating dialysis centres	Eligibility is defined as the patient initially enrolled in CLEAR and fulfills clinical criteria on the day of THC blockage presentation	Who: Dialysis centre How: Manual collation/Excel data collection sheet Frequency: Monthly
No. of eligible patients with THC flow restoration being performed at participating dialysis centres	Patients will have THC flow restoration performed unless • Patient refuses treatment • Trained Nurse not available • Unavailability of thrombolytic drug	Who: Dialysis centre How: Manual collation/Excel data collection sheet Frequency: Monthly
Days between unsuccessful restoration of THC at participating dialysis centres	Unsuccessful restoration is defined as the inability to complete dialysis with a prescribed blood flow of at least 200mL/min	Who: Dialysis centre How: Manual collation/Excel data collection sheet Frequency: Weekly/Monthly
No. of community dialysis centres participating in CLEAR workflow	Number of community dialysis centres included in the project. A centre is included when nurses are trained and deemed competent in CLEAR workflow regardless if informed consent has been obtained for patient to be part of CLEAR	Who: Dialysis centre How: Manual collation/Excel data collection sheet Frequency: Monthly
No. of community nurses trained & competent in CLEAR workflow	Community nurses attending a structured training program and successfully completing the required competency assessment for the CLEAR procedure in participating dialysis centres	Who: Dialysis centre How: Manual collation / Excel data collection sheet Frequency: Monthly
BALANCING		
Time between 72-hr catheter related infective complications	THC-related infective complications are defined as exit site infection and / or catheter-related bloodstream infection	Who: Dialysis centre How: Manual collation / Excel data collection sheet Frequency: Monthly
Average patient feedback score CLEAR Patient Satisfaction Survey.s	Average score of patients for the following domains • Comfort Level with Procedure • Perception of Safety • Overall patient satisfaction • Preference for NKF to hospital Includes patients with unsuccessful flow restoration who get followed up in the next dialysis session at NKF	Who: Dialysis centre Source: Online/paper Frequency: Monthly
Perception of community nurses towards CLEAR workflow	Include all trained nurses with experience or no experience in unblocking THC from the participating dialysis centres Link to survey - FILL OUT FORM	Who: SGH/NKF Source: Online Frequency: One-time survey before spread

THEORY OF CHANGE

Driver Diagram



BLUE = BLAST & CLEAR measure
GREEN = BLAST Measures
WHITE = CLEAR measures

CHANGE PACKAGE (BLAST)
Prevention of occluded THC in the community dialysis centres

(A) Fundamental elements of the improvement initiative that should not be modified:

- Use of either heparin or sodium citrate as a locking solution for THCs after each dialysis session, as recommended by the clinical guidelines and best practices.7
- Monitoring and documentation of THC patency, blood flow, and complications such as infection, thrombosis, or bleeding.
- Education and training of staff and patients on the proper technique and procedure for THC care and maintenance.
- THC flushing with normal saline during termination of HD prior to locking of solution.
- Instilling locking solution with positive pressure.

(B) Adaptable principles of the improvement initiative that can be modified:

- Choice of heparin or sodium citrate as the locking solution, depending on the availability, cost, preference, and contraindications of each agent.
- Frequency and duration of THC flushing during haemodialysis, depending on the type of locking solution, the dialysis schedule, and the patient's condition.
- Involvement and engagement of multidisciplinary team members, such as nephrologists, nurses, pharmacists, vascular access specialists, and quality improvement facilitators.

(C) Resources and practical tools that exist to support implementation (including links if applicable):

- Literature review on the effectiveness and safety of heparin and citrate locking solutions for THCs: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9448397/
- Clinical practice guideline on vascular access for haemodialysis: https://www.ajkd.org/article/S0272-6386(19)31137-0/fulltext

(D) Infrastructure requirements:

- Reliable supply chain and inventory management system for heparin or sodium citrate locking solutions and other necessary equipment and supplies.
- Dedicated time for administering the locking solutions as part of THC care in the dialysis centre.
- Data collection and reporting system for tracking THC outcomes and process measures.
- Feedback and learning mechanisms for identifying gaps, barriers, and opportunities for improvement.

Maintain patency and prolonging lifespan of THC

((A) **Optimise blood flow rates (QB) in patients with QB <300mL/min for early detection of THC dysfunction**

Early detection of THC dysfunction before it becomes non-functional is essential. A dysfunctional catheter may be easily assessed in the community by increasing the blood flow rates (QB). Most THCs are capable of achieving QB exceeding 300 mL/min. Other clues to a malfunctioning catheter when QB is >300 mL/min, is arterial pressure more negative than -250mmHg, or venous pressure > 250mmHg at blood flow rates of 400 mL/min.8 Hence, QB is optimised to at least 300 mL/min for all patients on THC if there are no contraindications.

(B) **Adopt protocol of specific locking solution with anticoagulant effect**
Based on available evidence, a locking solution with an anticoagulant effect such as heparin 1000 units/mL, or sodium citrate 4% are suitable choices for lock solution to maintain patency of THCs.9
In NKF:

- ·All patients with newly inserted THCs, will receive sodium citrate 4% as a locking solution
- ·Heparin is used for patients with THC flow issues occurring in at least 2 HD sessions while on sodium citrate 4% lock or patients who have received a thrombolytic agent for THC malfunction (unless allergy to heparin or diagnosed with heparin-induced thrombocytopenia).
- ·Locking solution without anticoagulant effect such as normal saline, is only used for patients with contraindications (e.g., allergy to sodium citrate 4% and heparin).

(C) **Optimise anticoagulant dose during dialysis to prevent intra-luminal thrombus formation**
The use of anticoagulants for haemodialysis is common due to the propensity of clotting within the circuit, including THC. Hence, the dose should be individualised based on patient's bleeding risk and propensity for coagulation.

(D) **Standardise termination of dialysis by flushing THC lumen with normal saline and locking with positive pressure**
Once HD is completed, the THC is flushed with 5mL normal saline to clear any residual blood. After which, positive pressure locking (applying pressure on the syringe plunger while disconnecting it from the needleless cap or clamping the catheter during the last part of the flush) is used to prevent backflow of blood into the catheter.

CHANGE PACKAGE (CLEAR)
Restoration of occluded THC

(A) **Fundamental elements of the improvement initiative that should not be modified:**

- Administration of thrombolytic agents to restore the flow of malfunctioning THC should be done by trained and credentialed personnel.
- Use of a thrombolytic agent (registered drug) to restore flow of malfunctioning THC.
- Dose and dwell time of thrombolytic agent supported by literature i.e., Urokinase 30,000 units/lumen for 1 hr.
- Ensure patient safety when considering thrombolytic agent to restore the flow of dysfunctional THC by developing clear and specific inclusion and exclusion criteria (see Annex X below).
- Monitor appropriate outcome, process and balancing measures.
- Patient consent is to be obtained before thrombolytic agent administration.

(B) **Adaptable principles of the improvement initiative that can be modified:**

- Healthcare worker who administers the thrombolytic agent can be a doctor, nurse or dialysis technician.
- Informed consent should be obtained from the patient or legal representative prior to the administration of the thrombolytic agent, it can be verbal or written as deemed appropriate by dialysis centre management.

(C) **Resources and practical tools that exist to support implementation (including links if applicable):**

- ·Unblocking Protocols
- ·Referral Forms
- ·Informed Consent Form
- ·Competency checklist
- ·Data collection sheet

(D) **Infrastructure requirements:**

- ·Adequate time for unblocking or available HD slot
- ·Availability of thrombolytic agent

Establish clinical governance framework and accountability structure

(A) Define the roles and responsibilities of team members

- Institutional leaders: identify risks and legal issues to be addressed, for example, consent for undertaking an unblocking procedure for malfunctioning THC was developed and endorsed by the NKF medical board. They also provide the necessary resources when needed.
- Team lead and co-lead: labour and workload distribution, define the time frame for expansion, measures and deliverables, decide on means and frequency of communication and resolve conflicts.
- Other team members: provide support that may include quality improvement methods, implementation, data collection and analysis.

(B) Frequent team meetings to review and discuss project progress

Teams met on a weekly basis to discuss cases on THC restorations performed to celebrate success, seek learnings and overcame challenges through collaborative problem solving. There was trust and openness in sharing perspectives with a focus on improvement and not judgement. Using the Plan-Do-Study-Act (PDSA) cycle approach, the team made quick adjustments to the workflow when testing the change ideas. (Annex – PDSA)

(C) Obtain patient consent for THC unblocking before thrombolytic administration

NKF senior management requested written informed consent for patients undergoing THC lytic dwell flow restoration. Informed consent was obtained for all patients.

(D) Adopt evidence-based THC unblocking pathway using thrombolytics, with eligibility criteria catered for community setting

A checklist with inclusion and exclusion criteria for patients to receive lytic dwell in community DCs was developed after gathering input from all stakeholders. The checklist was reviewed and revised periodically with inputs from all team members and following learnings from our PDSA cycles.

Build capability in community dialysis centres

(A) Conduct training on THC flow restoration procedure to nominated champions identified in each dialysis centre

Train the Trainer model was adopted. Hands-on simulation training sessions were initially conducted by renal physicians and subsequently taken over by NKF nursing champions, supported by the PHI renal physicians.

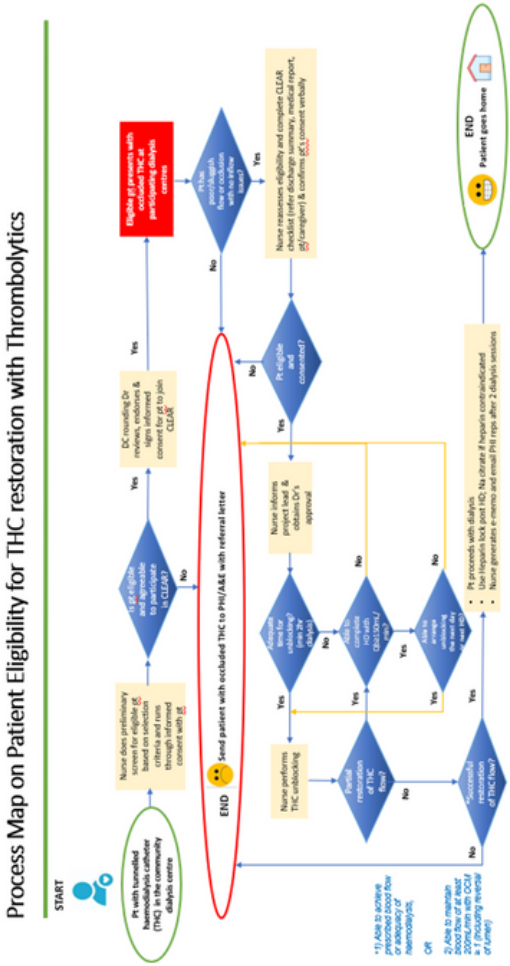
(B) Competency assessment of community dialysis nurses on THC flow restoration

Competency is assessed using a checklist after the simulation training in addition to supervised restorations by newly trained staff from senior clinical champions.

<u>Financial model to incentivise patients to seek care in the community and outpatient setting</u>

Discussion in progress between the National Improvement Unit and MOH.

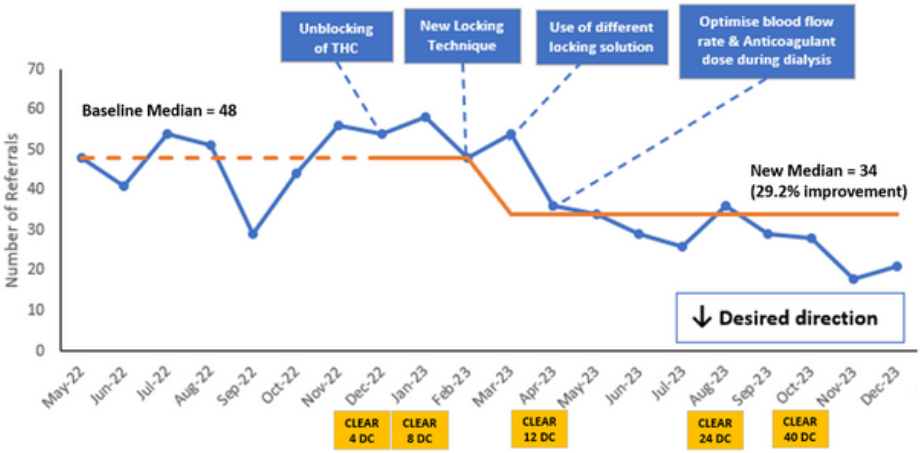
PROCESS MAP (CLEAR)



EVIDENCE FOR IDEAS

Outcome Measures

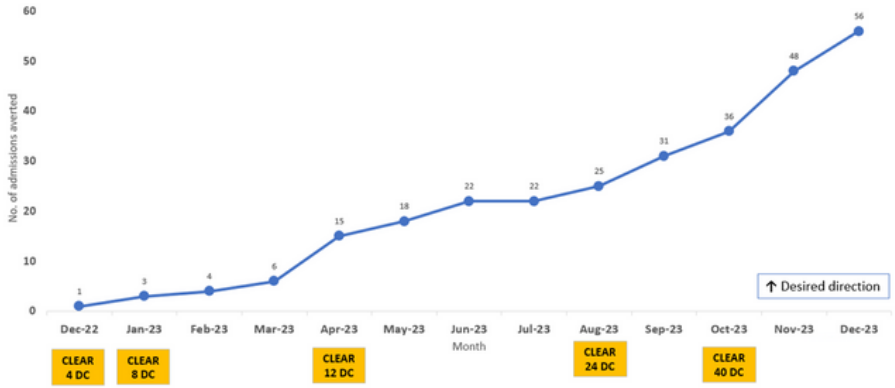
BLAST & CLEAR: No. of referrals from participating dialysis centres to PHIs (Public Healthcare Institutions) for THC blockage



*Yellow boxes reflecting the total number of dialysis centres participating in CLEAR workflow at different months on the graph

CLEAR: No. of admissions averted with the successful restoration of THC flow at participating dialysis centres

CLEAR: Cumulative no. of admissions averted with the successful restoration of THC flow at participating dialysis centres



By end Dec 2023, CLEAR has averted a total of 56 admissions with the successful restoration of THC.

Process Measures

BLAST: No. of patients with occluded THC presenting at all dialysis centres

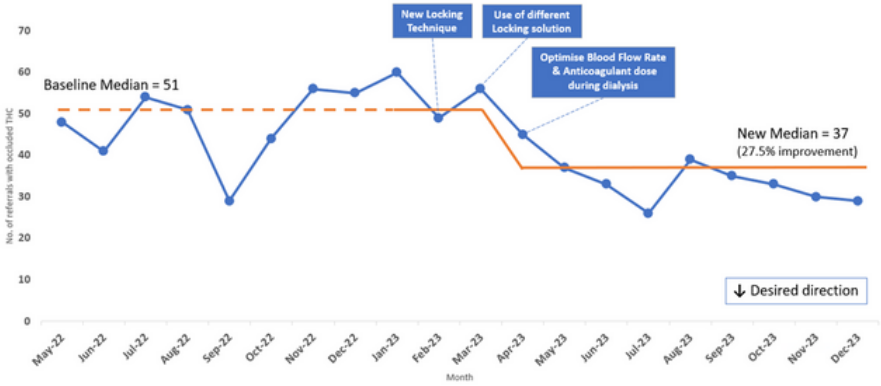
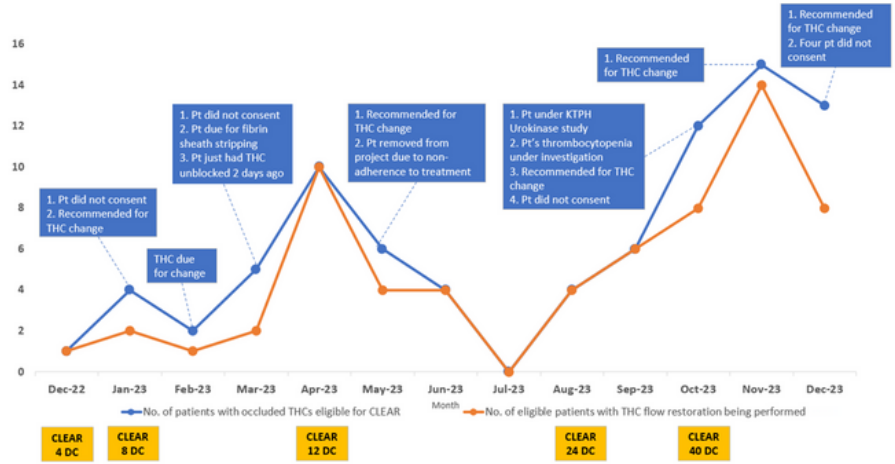


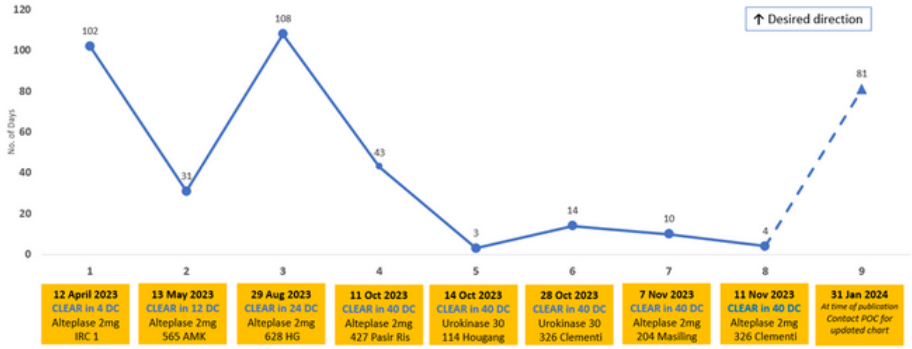
**Chart reflects an interrupted time series with different change ideas tested over time and therefore does not reflect causality of a single intervention.*

CLEAR: Number of patients with occluded THCs eligible for CLEAR presenting at participating dialysis centres VS number of eligible patients with THC flow restoration being performed at participating dialysis centres



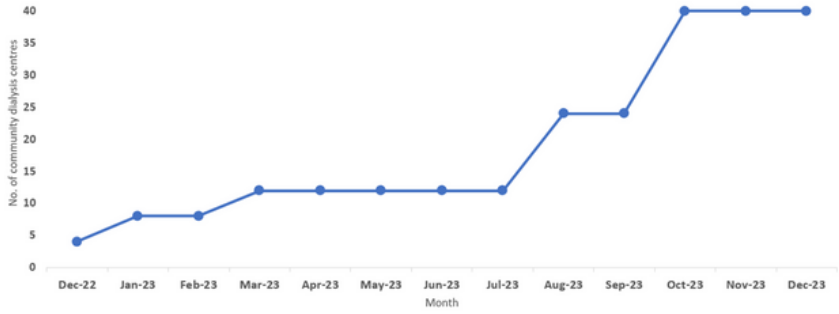
**The intent of the above chart was to track the process reliability of our THC restoration and that we were not missing eligible patients who presented with occluded THC. The discrepancy between the two line charts helped refine our eligibility criteria.*

CLEAR: T chart on Days between unsuccessful restoration of THC at participating dialysis centres

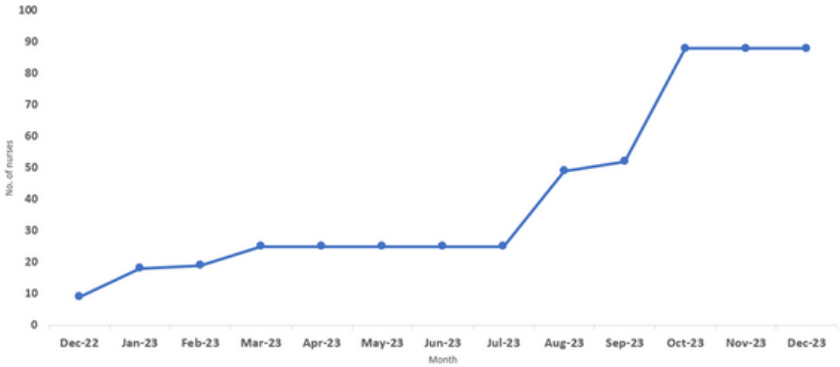


**Yellow boxes reflecting date of unsuccessful restoration, total number of DC included in CLEAR, drug used and the name of DC where unsuccessful restoration took place.*

CLEAR: No. of community dialysis centres participating in CLEAR workflow



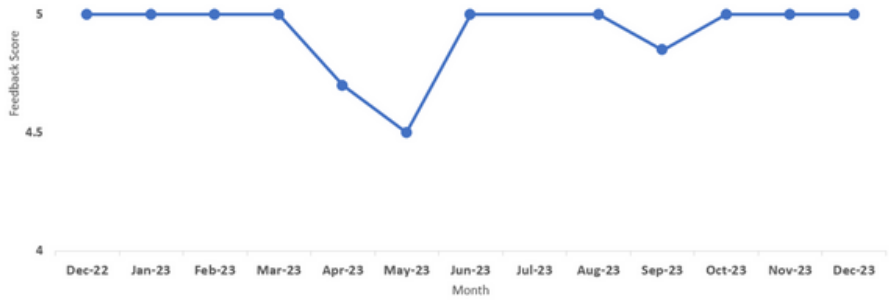
CLEAR: No. of community nurses trained & competent in CLEAR workflow



**A total of 100 community dialysis nurses have been trained to date, of which 88 are from participating dialysis centres.*

Balancing Measures

CLEAR: Average patient feedback score

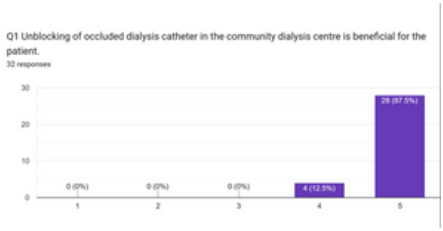


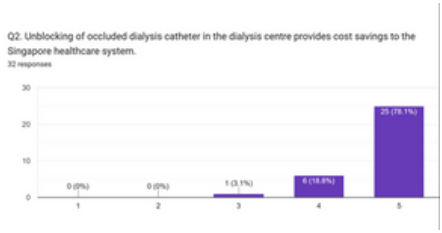
**No feedback score for July 2023 as no THC restoration was performed*
 # Feedback score not done for 2 restorations as the same patient had multiple restorations (pt 207, pt 211)

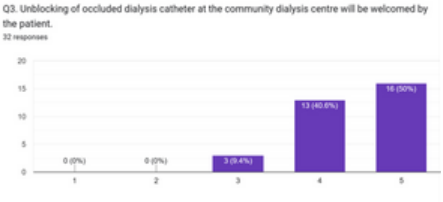
CLEAR: Time between 72-hr catheter related infective complications

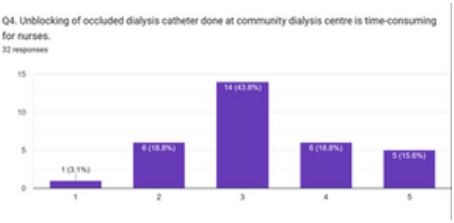
There was no 72-hr catheter-related infective complications reported during the project duration from 31 Dec 2021 to 31 Jan 2024 (date of publication)

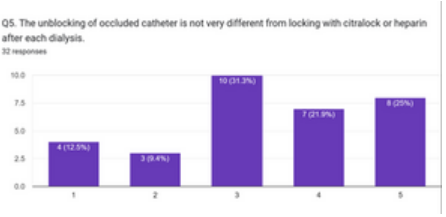
CLEAR: Perception of community nurses towards CLEAR workflow*

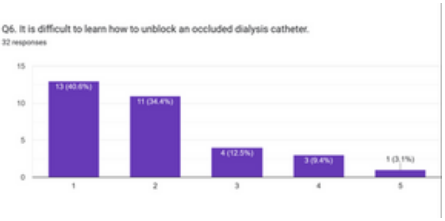


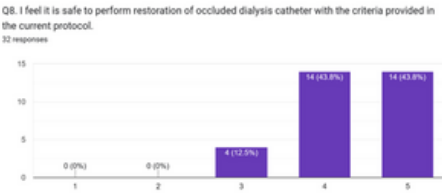


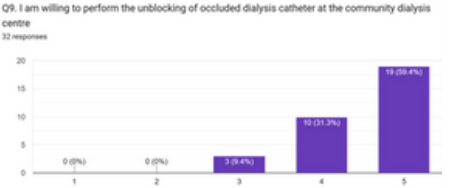


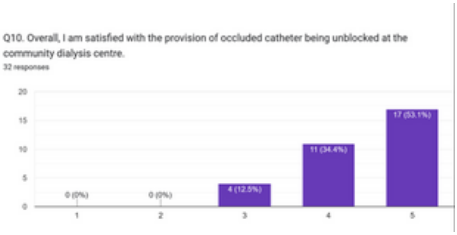












1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree

*A one-time survey collected in August 2023 from 32 NKF nurses (12 DC) before spreading to 24 DC

PATIENT AND STAFF STORIES

First Occluded Tunnelled Haemodialysis Catheter (THC) Successfully Restored in the Community in Singapore

Sister Lucy & Sister Siva came back to work on New Year's Eve 31 Dec 2022 upon hearing an occluded THC

"It was a family day with my daughter that day and she understood the nature of my job.

*This unblocking procedure was something we have **wished to be able to do for our patients** at the centre for a long time as previously patient had to be directed to ED*

*I feel good about the procedure and it is **something worthwhile and significant I can do to avert an admission**."*

Sister Sivamani Anandam
Nurse manager with 25 years of working experience who cleared the first occluded THC in NKF

Mr Abdul Salam Abdul Razak, 74 yo Indian

Patient admitted a few times in the past months

*"Going to the hospital is difficult. It is **inconvenient and not very comfortable as I need to ask people for help.** I will also need to seek MSW for help if bill is high.*

*When I was told that the unblocking procedure can be done at the dialysis centre, **I was happy**."*

Mr Abdul Salam, first patient to receive successful restoration of his THC in the community on 31 Dec 2022

*"I am **very happy** that my uncle did not go to the hospital. Otherwise, I would need to bring my uncle and aunt to the ED and it can be **stressful as a designated caregiver** each time the hospital calls to give an update."* **Zarina Kamal,** niece of Mr Abdul Salam & has her own family to care for

Mr Ng Hock Chye, 66 yo Chinese

Joined NKF in March 2023; Multiple co-morbidities with frequent admission & had successful restoration of his THC on 14 Oct 2023

*"I really appreciate that **NKF nurses can perform THC unblocking procedure for me** when I have a blocked catheter. It **saves me time** having to go to Emergency Department and this is a big help for me in reducing my financial burden. The nurses are **my life savers**."*

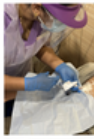
Mr Michael Chan, 72 yo Chinese

Patient admitted a few times in the past 1 year

*"I was worried when my dialysis catheter did not work and I **fear going to the hospital** as it is not comfortable for me and I am not used to the food.*

*I prefer to have this done in NKF and I **feel safe as I know the nurses and they will take care of me**."*

Mr Michael Chan
Second patient to receive successful restoration of his THC in the community on 6 Jan 2023



*"Having this additional knowledge and receiving compliment from patient **inspire me** in rendering a safe and quality nursing care"*

Mary Joy, SSN with 15 years working experiences in NKF. Successfully restored 2 cases of THC

*" I see my patient with the **smiling face** after successfully restoration of THC, I felt this new workflow is **worth it**"*

Bee Lei, Deputy Nurse Manager with 11 years working experiences in NKF. Successfully restored 4 cases of THC

Mr Ernest Phua, 54 yo, Chinese

Joined NKF in July 2023. Multiple catheter flow issues required 2 times THC unblocking in NKF (31 Oct 2023 & 21 Nov 2023) & THC exchange in hospital

*"I'm currently working full time. I **worry a lot** that if I **need to go to the hospital frequently** for appointment or procedure, this will **affect my job performance** due to taking extra medical leave."*

*" I'm **grateful** that NKF offered me to **participate in this unblocking project** and is a big help for me, it **save me time** in travelling and waiting in the queue at the hospital. It also helps me a lot to reduce the medical expenses."*

*"The patient **thanked me multiple times** and I felt deep in my heart that **I had helped him**. The new workflow serves its purpose well.*

Putting myself in his shoes, he would have to go to the hospital, wait at ED for several hours and missed out on his Chinese New Year celebrations."

Regie Canson, Senior Staff nurse with 15 years of working experience
2nd nurse in NKF to successfully restore occluded THC

MEET OUR TEAM

Core Team

Dr Tan Ru Yu
Team Lead,
Sr Consultant SGH

Dr Jason Choo
Medical Director, NKF
(from 1 Apr 2023)

Ms Pauline Tan
Deputy Director
Nursing, NKF

Ms Lucy Lu
Sr Nurse Manager,
NKF

Ms Yasmin Ng
Sr Improvement
Specialist, NIU
(till 31 Jan 2024)

Mr Shady Botros
Project Director, IHI

Dr Behram Ali Khan
Medical Director
(till 31 Mar 2023)

Dr Pang Suh Chien
Team co-Lead,
Sr Consultant SGH

Ms Ng Li Choo
Sr Nurse Clinician,
SGH

Ms Serene Xin
QI facilitator, SGH

Ms Shiva Shangari
Improvement
Specialist,
NIU (from 1 Feb 2024)

Support Team

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Patient advocate

Mr Neo He Xiang
QI Facilitator, SGH

Seow Yee Ting
Cluster Coordinator,
SHS IPSQ

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Head & Sr Consultant,
TTSH

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Sr Consultant, TTSH

Dr Allen Liu
Sr Consultant,
KTPH

Dr Chua Horng Ruey
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Nephrology

Dr Umer Farooq Khan
Assoc Consultant, NUH

Dr Charmaine Sia
Consultant, NUH

Dr Priyanka Khatri
Consultant, AH

Dr Shilpa Rastogi
Head & Sr Consultant,
NTFGH

MEET OUR TEAM

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Consultant, SGH

Dr Alvin Tng
Consultant, SGH

Dr Koduri Sreenkanth
Head & Sr Consultant, CGH

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Senior Consultant, Endocrinology, SGH

Point of Contact

BLAST (Optimising **B**lood flow, **L**ocking solution, **A**nticoagulant & **S**tandardising **T**echnique)

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- Ms Lucy Tan, Senior Nurse Manager, NKF
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CLEAR (**C**atheter Flow Restoration with **L**ytic Dw**E**ll at Community Di**A**lysis Cent**R**e)

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BLAST: Percentage of THC patients using respective locking solution

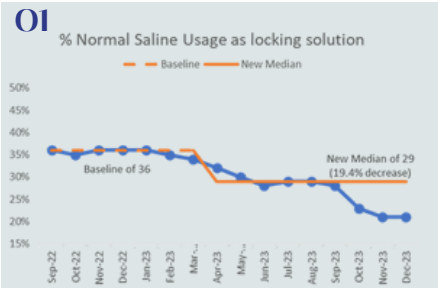

Fig.1 % Normal Saline Usage as locking solution

Fig.1 depicts a notable 19.4% decline in the utilisation of normal saline as a locking solution, indicating a sustained reduction in its usage over time. Fig. 2 and 3 illustrate a consistent upward trend in the adoption of sodium citrate and heparin, indicating a concurrent increase in their usage. These findings highlight an ongoing transition within clinical practices towards the increased adoption of sodium citrate and heparin as preferred locking solutions for THCs. It can also be seen from these figures that the usage of saline is continuing to decrease over time while the usage of sodium citrate and heparin is continuing to increase respectively.

- **Adopt protocol of specific locking solution with anticoagulant effect**

Data was collected retrospectively. A crude measure on the consumption of normal saline, heparin and sodium citrate could be used alternatively

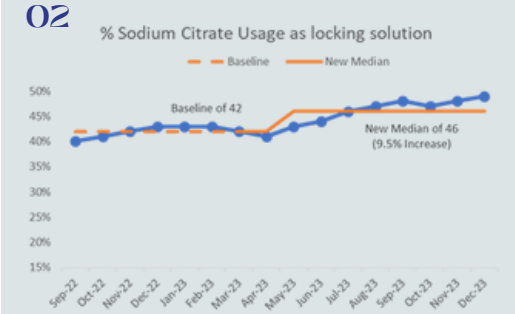

Fig.2 % Sodium Citrate Usage as locking solution

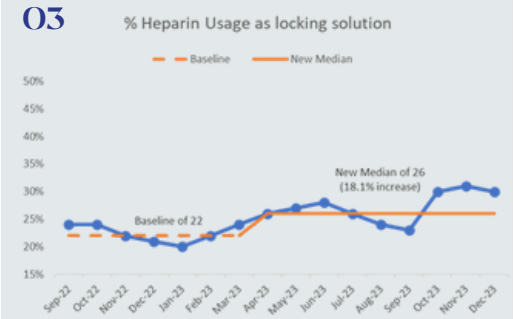

Fig.3 % Heparin Usage as locking solution

- Optimise blood flow rates (QB) in patients with QB <300mL/min for early detection of THC dysfunction
- Optimise anticoagulant dose during dialysis to prevent intra-luminal thrombus formation
- Standardise termination of dialysis by flushing THC lumen with normal saline and locking with positive pressure

Improvement for the above change ideas could be tracked by auditing a sample of 10-15 patients per month for compliance.

A common vision & progressive learning:

• Bringing together individuals who share a common vision, facilitated by the National DM collaborative acting as a catalyst, ensured the availability of essential resources at the opportune moment.

• Collaborative efforts across disciplines proved indispensable in enhancing patient care and outcomes, enabling prompt initiation of treatment, reducing healthcare expenses, and enhancing staff job satisfaction.

• Initially focusing on four dialysis centres, we progressively incorporated additional PHIs to expand the patient pool, accelerating our learning curve. This expansion eventually encompassed all 36 dialysis centres.

• Through iterative rapid-scale testing, we swiftly refined our THC restoration process, as demonstrated by our PDSA cycles

Adaptability, Flexibility & Learning from Others

- Alteplase 2mg was initially selected due to its ease of dilution, user preference and familiarity. However due to a global drug shortage, its unregistered drug status in Singapore and escalating drug price of Alteplase 2mg vial, we later pivoted to the use of Urokinase 60,000 units vial.

- In addition to Urokinase 60,000 units being a registered drug, no additional infrastructure, and cold chain during transport were required, allaying the concerns of drug integrity due to temperature excursion. Taking a leaf from KTPH Urokinase protocol which had been tested in local population, we then adopted Urokinase 30,000 units/lumen which simplified the drug preparation process with no wastage and allowed a higher Urokinase dose to be used.

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ANNEX

1a	**Perform pilot testing of unblocking of THC using Alteplase 2mg at participating NKF centres** Start and End Date: 31 December 2022
Plan State the objective of the test and make predictions about what will happen and why.	**OBJECTIVE** Test the feasibility of using the newly developed Alteplase protocol to treat the 1st patient who presents to any of the 4 participating NKF centres with a blocked THC and assess its success in preventing an ED admission **QUESTIONS TO BE ANSWERED FROM THIS TEST** 1. Will the adopted approaches increase the patient pool & improve the chances of capturing an eligible patient? 2. Can the procedure be done successfully by an NKF nurse? 3. Will this new process help prevent an ED admission? 4. Is our protocol clear and easy to follow? 5. What does the patient think about the procedure? 6. What does the nurse think about the procedure? **PREDICTION (WHAT)** 1. One eligible patient would present to one of the 4 participating NKF centres 2. The procedure will be done successfully with no complications. 3. The new process will help prevent an ED admission 4. There may be a need to refine the protocol 5. Patient may feel uncertain about how the procedure will go as this is the first case done in the community 6. Nurse may be anxious and hesitant to take up this new role **PLAN (HOW)** WHO: Senior Nurses who have been trained and completed the competency assessment WHAT: Perform the unblocking of THC using Alteplase WHEN: Eligible patient presents with occluded THC to any of the 4 participating NKF centers WHERE: All 4 Participating NKF centers PLAN (DATA COLLECTION) Quantitative data - gather by NKF staff using data collection form ; Qualitative data - gather by NIU staff from both patients and staff
Do Carry out test of change, document results.	**METHOD (HOW)** • One patient presented with blocked THC at NKF@KLA on 31/12 when he was 25 min into the dialysis. • Nurse tried to maneuver the THC to improve blood flow for 30 min before the decision was made for flow restoration using Alteplase. There was a subsequent delay of Alteplase instillation as the nurse trained in this new procedure was not on duty and had to travel back to the dialysis centre. • The eligibility checklist was run through before diluting the drug. Nurse also checked if there was any THC clearance done in the last 30 days. At 2.40pm, Alteplase was instilled into the lumen and aspirated after an hour at 3.40pm as per protocol. • There were only about 1.5 hours left for the patient's dialysis slot after successful restoration of flow. As there was a dialysis slot available that evening, the nurse extended the patient's dialysis. • Patient missed his arranged transport due to a delay in the dialysis session. Nurse contacted the patient's niece to pick up the patient instead. • Patient's THC was successfully unblocked in the community. He had no sign of infection at the next dialysis session • Quantitative and Qualitative data gathered as planned
Study Compare results to your predictions. What have you learned? What is your conclusion?	**RESULTS** • One eligible patient presented at one of the NKF centres during the study period • Restoration of THC flow was successful with no complications, protocol was clear and easy to follow • An ED admission was averted • Patient was happy that he could have the clearance of his THC done at the dialysis centre. Average patient feedback score was 5/5 using the feedback questionnaire • Nurse was very satisfied with the results and felt she had done something significant to avert patient's admission despite having to return to work **LESSONS LEARNT** • 30 min were initially spent maneuvering the THC access, reducing the remaining available time for dialysis. Decision to start Alteplase can be made earlier with clear guidance e.g. reverse flow technique when encountering compromised flow. • There was no need to check if the patient had any THC clearance done in the past 30 days based on current protocol. • There may be a need for some patients to come back the next day due to trained staff being unavailable or no dialysis slot being available that day. • NKF@KLA has the largest number of patients on THCs among the participating NKF centres and is likely to have another episode soon. The 2 standby stocks have been utilised and will need to be replenished as soon as possible. **CONCLUSION** • Need a clearer definition of occluded THC i.e. No or poor flow on the aspiration of both lumens or unable to achieve prescribed blood flow during dialysis and what maneuver to perform to proceed with Alteplase unblocking • Need to update nurses that protocol does not require checking that THC clearance was performed in the past 30 days • Transport may need to be rearranged for some patients e.g. with the patient's caregiver. • Alteplase would need to be transferred from other centres with a smaller number of patients with THCs to NKF@KLA
Act Modify, abandon or adopt change based on what you have learned. Plan the next cycle.	**Modify the change** NKF to update protocol and disseminate information on the following • what constitutes an occluded catheter • the reverse flow technique to perform when encountering a blocked THC • no need to check if any THC clearance in the past 30 days NKF to transfer Alteplase from centers with a smaller number of patients with THCs to NKF@KLA so that there is standby stock Nurses would need to make transport rearrangements (including caregivers' transport) for some patients with delayed dialysis sessions post-THC clearance Include another 4 NKF dialysis centres. NKF champions will train new nursing staff

1b	Perform pilot testing of unblocking of THC using Alteplase 2mg at participating NKF centres **Start and End Date: 5 January 2023 to 6 January 2023**
Plan State the objective of the test and make predictions about what will happen and why.	**OBJECTIVE** Test the feasibility of using the newly developed Alteplase protocol to treat the 2nd patient who presents to any of the 8 participating NKF centres with a blocked THC and assess its success in preventing an ED admission **QUESTIONS TO BE ANSWERED FROM THIS TEST** 1. Will the adopted approaches to increase the patient pool improve the chances of capturing an eligible patient? 2. Can the procedure be done timely and successfully by an NKF nurse following an update of protocol? 3. Will this new process help prevent an ED admission? 4. What does the patient think about the procedure? 5. What does the nurse think about the procedure? **PREDICTION (WHAT)** 1. One eligible patient would present to one of the 8 participating NKF centres 2. The procedure will be done timely and successfully according to protocol 3. The new process will help prevent an ED admission 4. Patient may feel uncertain about how the procedure will go as the procedure has always been done in the community 5. Nurse may be anxious and hesitant to take up this new role **PLAN (HOW)** WHO: Senior Nurses who have been trained and completed the competency assessment WHAT: Perform the unblocking of THC using Alteplase WHEN: Eligible patient presents with occluded THC to any of the 8 participating NKF centers WHERE: All 8 Participating NKF centres **PLAN (DATA COLLECTION)** Quantitative data - gather by NKF staff using data collection form Qualitative data - gather by NIU staff from both patients and staff (survey)
Do Carry out test of change, document results.	**METHOD (HOW)** • The 2nd patient presented with blocked THC at NKF@KLA on 5/1/23 evening and he was eligible for THC clearance using Alteplase. • The replacement Alteplase vials had not been replenished in time at NKF@KLA • Patient was medically stable and willing to come back the next day, however he had no caregiver to bring him to the dialysis centre. The nurse made special arrangements for his transport. • Patient arrived the next day on 6/1 morning. The same nurse who performed THC clearance on 31/12 was on duty. • Drug preparation was observed by nurse colleagues who noticed the use of 2 different needles to dilute the 2 Alteplase vials. • Alteplase was then instilled at 7.20am and aspirated at 8.20am. Restoration of the occluded catheter proceeded smoothly and the patient continued with his dialysis in his allocated time slot. • Patient's THC was successfully unblocked in the community and avoided an ED admission. He had no sign of infection at the next dialysis session • Quantitative and Qualitative data gathered as planned
Study Compare results to your predictions. What have you learned? What is your conclusion?	**RESULTS** • One eligible patient presented at one of the NKF centres during the study period • The decision to unblock was made earlier. There was however no alteplase and transport had to be arranged for the patient to return the next day. • An ED admission was averted • Patient was relieved that he did not have to go to the hospital and felt safe with the NKF nurse unblocking his occluded THC. Average patient feedback score was 5/5. • Nurse gained more confidence as it was her second time performing the same procedure. **LESSONS LEARNT** • The same needle could be used when diluting the 2 vials of Alteplase with normal saline. Protocol updated accordingly • **Despite the unavailability of the drug, the patient was medically stable and willing to come back the next day. However, transport proved difficult to rearrange for this patient.** • NKF@KLA remains to have a higher probability of patients with occluded THC compared to other participating NKF centres. • Patient felt safer and trusted the NKF nurses to perform the procedure despite the procedure normally being done in the hospital **CONCLUSION** • IV drug preparation can be improved with feedback from peers during observation • **Admission can still be averted and need not be limited by drug/ nurse availability if the patient is medically stable, willing to come back and transport arrangements could be made for the patient to return the next day.** • Standby stocks at NKF@KLA would need to be replenished as soon as possible so that there is no out-of-stock situation and patient would not have to return the next day • The **long-term relationship patient has with NKF nurses helps foster his trust** in NKF performing this new procedure
Act Modify, abandon or adopt change based on what you have learned. Plan the next cycle.	**Modify the change** • Small fine tune in the drug administration process to feedback to nurse involved • NKF to timely transfer Alteplase from centers with smaller number of patients with THCs to NKF@KLA while awaiting further stock replenishment. • Admission can still be averted and need not be limited by drug/ nurse availability if the patient is medically stable, willing to come back and transport arrangements could be made for the patient to return the next day.

1c	**Perform pilot testing of unblocking of THC using Alteplase 2mg at participating NKF centres** **Start and End Date: 23 January 2023**
Plan State the objective of the test and make predictions about what will happen and why.	**OBJECTIVE** Test the feasibility of using the newly developed Alteplase protocol to treat the 3rd patient who presents at any of the 8 participating NKF centres with a blocked THC and assess its success in preventing an ED admission **QUESTIONS TO BE ANSWERED FROM THIS TEST** 1. Will the adopted approaches to increase the patient pool improve the chances of capturing an eligible patient? 2. Can the procedure be done timely and successfully by an NKF nurse following an update of protocol? 3. Will this new process help prevent an ED admission? 4. What does the patient think about the procedure? 5. What does the nurse think about the procedure? **PREDICTION (WHAT)** 1. One eligible patient would present to one of the 8 participating NKF centres 2. The procedure will be done timely and successfully by an NKF nurse following an update of the protocol 3. The new process will help prevent an ED admission. 4. Patient may feel uncertain about how the procedure will go as the procedure has always been done in the community 5. Nurse may be anxious and hesitant to take up this new role **PLAN (HOW)** WHO: Senior Nurses who have been trained and completed the competence assessment WHAT: Perform the unblocking of THC using Alteplase WHEN: Eligible patient presents with occluded THC to any of the 8 participating NKF centers WHERE: All 8 Participating NKF centres **PLAN (DATA COLLECTION)** Quantitative data - gather by NKF staff using data collection form Qualitative data - gather by NIU staff from both patients & staff
Do Carry out test of change, document results.	**METHOD (HOW)** The 3rd patient presented with a blocked THC at NKF@KLA on 23 Jan (2nd day of CNY) and he was eligible for THC clearance using Alteplase. There was no delay in starting Alteplase unblocking. Procedure was approved by the medical director while he was overseas Alteplase was instilled according to protocol at 1:45pm and aspirated at 2.45pm. Restoration of the occluded catheter proceeded smoothly, and the patient continued his 4-hour dialysis which extended later in the evening. The patient went home by taxi which was his usual mode of transport. Patient's THC was successfully unblocked in the community and avoided an ED Admission. He had no sign of infection at the next dialysis session Quantitative and Qualitative data gathered as planned
Study Compare results to your predictions. What have you learned? What is your conclusion?	**RESULTS** One eligible patient presented to one of the NKF centres during the study period and restoration of THC flow was successful with no complications Protocol was clear and easy to follow An ED admission was averted Patient was very happy to have the clearance of his THC done at NKF and as he would have otherwise missed the CNY celebration. Average patient feedback score was 5/5 using the feedback questionnaire Nurse felt confident about the THC restoration process and was satisfied with the results that he had helped pt avert admission to celebrate CNY **LESSONS LEARNT** Restoration of THC flow continues to be well received by patients and staff Most patients would need a **minimum of 2 hours of dialysis** post-successful THC unblocking. Some of these dialysis sessions extend beyond the patient's allocated slot and the patient might require additional transport rearrangement. This will prove **challenging for patients presenting with blocked THC on a Saturday evening.** This is because there may not be adequate time for dialysis after the instillation of Alteplase due to closing time on Saturday followed by a 3-day gap before the patient's next scheduled dialysis on Tuesday. **Importance of timely medical clearance to avoid unnecessary delay that may lead to an avoidable admission** **CONCLUSION** Patients who are ambulance-dependent for transport and unwilling to arrange for alternative transport once extended dialysis is completed post-THC unblocking could be excluded from the pilot Patients who present with occluded THC occurring on a Saturday evening would need to be thoroughly assessed by a physician before proceeding with the restoration of THC flow Eligibility criteria to be updated to exclude patients presenting on a Saturday evening AND not deemed medically fit based on physician assessment to wait till Tuesday to continue his dialysis and those on ambulance transport
Act Modify, abandon or adopt change based on what you have learned. Plan the next cycle.	**Modify the change** Eligibility criteria to be updated to exclude patients who rely on ambulance* for transport and those who are unwilling to arrange for their own transport following an extended dialysis session post THC clearance Patients who present with occluded THC on a Saturday evening and deemed medically fit based on physician assessment to have only 2-hour dialysis may wait till Tuesday for restoration. Otherwise, the patient will be referred to ED. **There were only 2 patients with THC requiring ambulance transport and unblocking was done the next HD session without the need for special transport arrangement. Hence, we did not exclude these patients subsequently.*

2	**Perform pilot testing of unblocking of THC using Alteplase 1mg at participating NKF centres** **Start and End Date: August – September 2023**
Plan State the objective of the test and make predictions about what will happen and why.	**OBJECTIVE** Test the feasibility of using the newly developed Alteplase 1mg protocol to treat eligible patient who presents at any of the participating NKF centres with a blocked THC and assess its success in preventing an ED admission **QUESTIONS TO BE ANSWERED FROM THIS TEST** 1. Did the process go as predicted with the new centre? Are there any other new things we can learn from this PDSA? 2. What does the patient think about the procedure? **PREDICTION (WHAT)** 1. Alteplase 1mg/lumen will work as literature has shown that it is as efficacious as 2mg 2. Patient may feel appreciative that an admission has been averted **PLAN (HOW)** WHO: Senior Nurses who have been trained and completed the competence assessment WHAT: Perform the unblocking of THC using Alteplase 2mg WHEN: Eligible patient presents with occluded THC to any of the 12 participating NKF centres WHERE: 12 Participating NKF centres (MSD, WD1, TM1, JW1, BM2, SRG, TM2, WCR, PR2 (ALJ), PNG, ADT & TPH) **PLAN (DATA COLLECTION)** Quantitative & Qualitative data - gathered by NKF staff
Do Carry out test of change, document results.	**Case 1** On 8 August, patient at 825 Woodlands presented with sluggish flow, and managed to complete HD with Qb 190-200. Unblocking was arranged the following HD. On 10 Aug, Alteplase 1mg was instilled and aspirated an hour later. Patient managed to attain Qb 250 during dialysis (on Reverse flow), OCM 1.36. It was a successful restoration. On 12 Aug, sluggish flow and negative A pressure during HD, able to keep Qb 200-210, OCM 1.28. On 15 Aug, sluggish outflow in both lumens, able to keep Qb 180-200 only. **Case 2 (same case as above)** On 17 Aug, unblocking was repeated with Alteplase 1mg/ lumen. Still mild sluggish flow noted, able to keep Qb 200-220 with intermittent alarms, completed HD with OCM 1.69. Considered successful unblocking. Had HD on 19 & 21 Aug with Qb 200ml only. Elective admission in TTSH for AVF creation, THC exchange on 22 Aug. On 24 Aug, unable to maintain Qb, HD stopped after 1 hour and pt was referred back to TTSH. Underwent Perm Cath exchange on 26/8/2023. **Case 3 and 4 (unblocking done on 5 & 15 Sep 2023)** On 4 Sep, patient at 204 Marsiling presented with sluggish flow, able to complete HD with Qb 180-220, with a low OCM of 0.99. Unblocking was arranged the following day. On 5 Sep, Alteplase 1mg was instilled and aspirated after one hour. Good inflow and outflow post-procedure, able to commence HD with QB 300ml/min with normal flow. After 5 mins, switched to reverse flow and noted A pressure was cutting back. QB reduced to 250-280ml/min. Completed 4hrs HD mins achieved OCM 0.99 (Prescribed HD time 255mins). 08/09/2023 - Able to dialyse with QB 220-260ml/min and dialysis time of 255mins. OCM 1.20 11/09/2023 - Able to dialyse with QB 250-280ml/min and dialysis time of 255mins. OCM 1.12 13/09/2023 - Able to dialyse with QB 250-280ml/min and dialysis time of 255mins. OCM 1.06 (Machine intermittently alarming as AP was cutting back intermittently to -224 to -226mmHg) 15/09/2023: Unblocking was re-attempted. Alteplase 1mg instilled and aspirated after one hour, good inflow & outflow initially, able to achieve QB 260ml/min, completed 3 hours of HD. 18/09/2023 - Able to dialyse with QB 220mlmin only (reverse flow as machine intermittently alarming as AP was cutting back) & dialysis time of 255mins, OCM 0.97 19/09/2023 - Able to dialyse with QB 250mlmin (reverse flow) & dialysis time of 255mins. Unable to increase QB further as machine intermittently alarming as AP was cutting back. OCM 1.01 For Elective admission on 2 Oct for PC exchange arranged by Dr Allen (KTPH) **Case 5** On 09/09/2023, patient from 427 Pasir Ris DC presented with sluggish flow, QB only 160-180, completed 3 hours and 45 mins HD with OCM 0.86, unblocking was arranged on the next HD 12/09/2023 - Alteplase 1mg was instilled and aspirated after one hour. Good inflow and outflow post-procedure, able to commence HD with QB 280ml/min, OCM 1.39. 14/09/2023 – able to maintain QB 250-230, OCM 1.24 16/09/2023 – sluggish flow, able to maintain Qb 220+, completed 3.5 hours of HD with OCM 0.68 18/09/2023 - able to maintain QB 230+, OCM 1.27 **Case 6** 11/09/2023, patient from 204 Marsiling DC presented with sluggish flow, able to complete HD with QB 160-180 only, OCM 1.09, Unblocking was arranged on the following HD. 13/09/2023- Alteplase 1mg was instilled and aspirated after one hour. Good inflow and outflow post-procedure, able to achieve QB 250ml/min with normal flow, AP -126 to -250mmHg and VP 92 – 112 mmHg. Completed 3hrs 45mins achieved OCM 1.20. Subsequent 2 HD session (15/09/2023 & 18/09/2023) - Able to dialyse with prescribed QB of 280ml/min and dialysis time of 240mins. OCM 1.36 & 1.33 respectively.
Study Compare results to your predictions. What have you learned? What is your conclusion?	* Alteplase 1mg/lumen was effective and not inferior to 2mg/lumen based on our experience * Patients were pleased with the restoration being done at NKF centres. The average patient feedback score was 5/5 using feedback questionnaire In total, Alteplase 1mg/lumen dosage had been used for 6 cases and restoration was deemed successful in all cases. There were 3 cases (TTSH, KTPH, SGH) of re-occlusion within 2 weeks of restoration with Alteplase 1mg. To confirm that the re-occlusion was not due to drug dosage failure, CLEAR team requested the following PHIs to confirm if there was fibrin sheath during line exchange. Currently, they have reviewed 2/3 cases confirmed to be due to fibrin sheath and not due to the difference in dosage (comparing to 2mg/lumen).
Act Modify, abandon or adopt change based on what you have learned. Plan the next cycle.	**Modify the change** Given the outstanding 31 Alteplase vials that will expire in May 2024, the team agreed to convert DC on Alteplase 1mg to 2mg protocol, starting in Nov and Dec 2023. NKF would need time to re-train the nurses. The team aims to convert all DC to Urokinase usage by January 2023

3	**Perform pilot testing of unblocking of THC using Urokinase 30,000IU at participating NKF centres** **Start and End Date: October 2023 – December 2023**
Plan State the objective of the test and make predictions about what will happen and why.	**OBJECTIVE** Test the feasibility of using the newly developed Urokinase protocol to treat eligible patient who presents at any of the participating NKF centres with a blocked THC and assess its success in preventing an ED admission **QUESTIONS TO BE ANSWERED FROM THIS TEST** 1. Did the process go as predicted with the new drug? Are there any other new things we can learn from this PDSA? 2. What does the patient think about the procedure? **PREDICTION (WHAT)** Urokinase 30,000IU per catheter lumen will work to unblock THC Patient may feel appreciative that an admission has been averted **PLAN (HOW)** WHO: Senior Nurses who have been trained and completed the competence assessment WHAT: Perform the unblocking of THC using Urokinase 30,000IU WHEN: Eligible patient presents with occluded THC to 28 participating NKF centers in October 2023 onwards WHERE: 28 Participating NKF centres (YS2, SMI, WD2, HG1, BP2, PSR, JW2, BPJ, YS4, TWY, TP2, CP2, URD,YS1, YS3, BBK, HG2, BED, KLA, QT1, BD2, CLE, AM3, KKT, UBK, AM2, CP1 & JE1) **PLAN (DATA COLLECTION)** Quantitative & Qualitative data - gathered by NKF staff
Do Carry out test of change, document results.	**Case 1** • On 14/10/23 - PC both limbs outflow sluggish, good inflow. HD commenced but after 40 mins, AP was high and not able to maintain Qb. Plan for PC unblocking, clear data done, patient consent taken and Dr approved. Proceed for PC unblocking, instilled 30,000iu to each PC lumen. Both PC limbs inflow and outflow patent. Re-commenced HD with Qb 250 and gradually to 280ml/min. AP 160-180, VP 95- 112mmHg. Concluded HD 45mins earlier due to VP high, noted clots at V chamber. • On 17/10/23, patient came for usual HD, both A and V limbs patent. AP 134-156, VP 100-120, OCM 1.51. Memo given to PHI successful unblocking. **Case 2** • On 14/10/23 - PC A limb no outflow, V limb outflow sluggish, both limbs inflow patent. Commenced HD but unable to maintain Qb 150. Proceed for PC unblocking, instilled 30,000iu to each PC lumen. • After aspiration of urokinase, HD was recommenced however AP is still high and unable to maintain 150ml/min. HD was concluded after 40mins and referred to ED • Refer to ED on 14/10/23 for unsuccessful unblocking. Memo given to PHI unsuccessful unblocking. **Case 3** • On 17/10/23 - Femoral cath both A and V limbs inflow and outflow patent. Commenced HD on reverse flow, noted AP -200 to -170, VP 69- 33 with Qb 150-200. OCM 1.07. Unable to maintain prescribed Qb. Plan for unblocking next HD. • On 19/10/23, Urokinase 30,000 units each lumen done and aspirated after 1hour. Post aspiration, both limbs flow good inflow and outflow. Able to keep QB 250ml/min, OCM improved 1.35. Memo given to PHI successful unblocking. **Case 4** • Patient discharged on 23/10/23 due to blocked F/C, successful urokinase done in hospital on 22/10/23. On 24/10/23, Pre HD commencement, A and V limbs inflow and outflow fair. AP 180-100, VP 180-120 with Qb 200 and towards last hour. Qb only can maintained 180. Plan for unblocking next HD. • On 26/10/23 - Prior instillation of urokinase, A and V limbs inflow and outflow fair. Urokinase 30,000units each lumen done and aspirated after 1 hour. Post aspiration, both limbs flow good inflow and outflow post unblocking. Able to keep QB 250-280ml/min. AP 140, VP 90-70. OCM 1.49. Memo given to PHI successful unblocking.
Study Compare results to your predictions. What have you learned? What is your conclusion?	1. Urokinase 30,000iu to each PC lumen was effective 2. Patients were pleased with the restoration being done at NKF centre. The average patient feedback score was 5/5 using feedback questionnaire In total, Urokinase 30,000iu/lumen dosage had been used for 4 cases. Case by case review was done by the CLEAR team which concluded that the change of drug from Alteplase to Urokinase for restoration was just as effective and successful.
Act Modify, abandon or adopt change based on what you have learned. Plan the next cycle.	Adopt. Urokinase 30,000 IU per lumen will be adopted in most of the NKF centres and eventually after Jan 2024, all NKF DC will be using this drug. Being a registered drug, it will be used to spread to other community DCs in Singapore.

4	**Perform pilot testing of revised eligibility checklist at participating NKF centres** **Start and End Date: December to January 2024**
Plan State the objective of the test and make predictions about what will happen and why.	**OBJECTIVE** Test the feasibility of using the revised patient eligibility checklist to treat more eligible patients who present at any of the participating NKF centres with a blocked THC and assess its success in preventing an ED admission. (Patients on warfarin will still be excluded as per current criteria as community dialysis centres may not have patients' latest INR results) **QUESTIONS TO BE ANSWERED FROM THIS TEST** 1. Did the process go as predicted with no untoward events as we expand our patient pool to include patients with no outflow (as long as inflow is present in both lumens), those on direct oral anticoagulants (DOACs) and low molecular weight heparin (LMWH)? 2. Do the nurses have any difficulty in following the latest checklist? **PREDICTION (WHAT)** 1. There were no untoward events e.g. inability to aspirate thrombolytic agent, no bleeding complication as we expand our patient pool by revising the eligibility criteria. 2. Nurses had no issues following the latest checklist **PLAN (HOW)** WHO: Senior Nurses who have been updated on the revised CLEAR checklist WHAT: Perform the unblocking of THC on this new pool of patients WHEN: Eligible patient presents with occluded THC to any of the 40 participating NKF centres WHERE: All 40 participating NKF centres **PLAN (DATA COLLECTION)** Qualitative data - gathered by NKF staff
Do Carry out test of change, document results.	From December 2023 to January 2024, we did not encounter any case with aspiration issues for those with no outflow. In January, two patients on LMWH e.g. subcut Clexane had undergone the unblocking procedure. The restoration for both LMWH cases were successful. There was no untoward event or complication observed after. We did not encounter patients on DOACs
Study Compare results to your predictions. What have you learned? What is your conclusion?	We did not encounter complication arising as we expand our patient pool. Nurses felt comfortable with the revised eligibility criteria and did not raise any concerns. During our PDSA discussion, it was surfaced that the exclusion criteria could be adjusted to allow 3rd restoration in case PHI needed more time to arrange for elective change of THC with a footnote.
Act Modify, abandon or adopt change based on what you have learned. Plan the next cycle.	Adopt/Modify as above The checklist will • continue with the expanded eligibility criteria • new comment to allow for 3rd restoration where applicable.

Our Commitment & Journey Together

10 February 2023 - Senior Leadership with CLEAR team at Dr Ross Wilson's Project Consultation

18 Apr 2023 - National DM Collaborative Cluster Leadership Engagement - CLEAR team with Dr Don Berwick & Dr Ross Wilson

14 Oct 2023 - CLEAR team at SGH Department of Renal Medicine 50th Anniversary Gala Dinner

7 Nov 2023 - Core team having project consultation with Brandon Bennett, IHI improvement advisor