

Crisis and Complex Care



NHG is integrating health and social care seamlessly through growing partnerships with the community as our ageing population's needs become more complex. Our Institutions are continuously seeking to provide safe, quality, and reliable care, and leveraging research and technological advancements to drive better outcomes for our residents in Central and North Singapore.







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TRANSFORMING CARE PROCESSES

Transformative Musculoskeletal Care Model

Musculoskeletal (MSK) cases, especially non-traumatic ones, are often seen in Tan Tock Seng Hospital (TTSH)'s Emergency Department (ED), contributing to increased patient load and long waiting times. In 2022, approximately 15 per cent of patients visiting the TTSH ED presented with MSK issues, and this figure is projected to grow with the ageing population. To address this demand, TTSH physiotherapists introduced a first-of-its-kind MSK care model in June 2022, which involves collaboration between the ED, Orthopaedic Surgery, Hand Surgery, Radiology, and Physiotherapy departments. Under this new care model, specially-trained Advanced Practice Physiotherapists (APPs) see patients directly after registration and triage. Working alongside ED doctors, APPs help manage acute musculoskeletal injuries and spinal pain, and prescribe medical imaging, as well as escalate potentially life-threatening conditions like heart attacks masquerading as MSK conditions. These result in better patient outcomes.

The MSK care model has resulted in increased patient satisfaction by reducing the wait time to see a doctor, more timely care interventions, and better cost savings for patients. The average length of stay in the ED for patients with MSK conditions has also decreased by 30 per cent. Efficiency in the ED has increased as doctors can focus on more life-threatening emergencies, such as stroke, major trauma, and cardiac arrest. This approach has also empowered physiotherapists

to take on an advanced scope of practice, thereby increasing job satisfaction.

Redesigning Care With Therapy-Assistant 1-on-1 Programme

The Therapy-Assistant (TA) 1-on-1 (TA101) programme in TTSH, introduced in 2018, features upskilled TAs reviewing select patient groups independently with oversight from physiotherapists.



The TA101 programme was piloted at the subacute recovery ward between 2018 and 2019, and demonstrated positive productivity outcomes. This freed up time for the physiotherapists to focus on complex cases and perform at their highest competencies. The programme also resulted in significant cost savings of 53.6 per cent for patients when they were reviewed by a TA as compared to a physiotherapist for the same care. In April 2022, the programme was expanded to all inpatient wards.

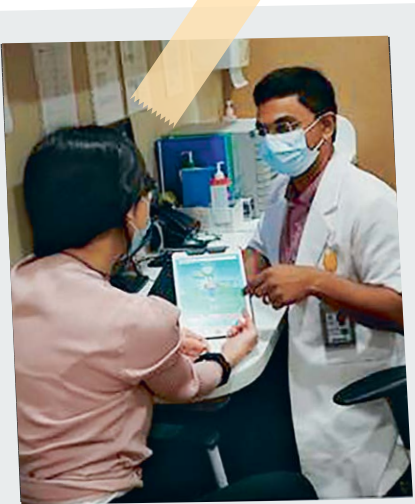


Revolutionising Cardiac Rehabilitation With *Heart-Track™*

Cardiac Rehabilitation (CR), which emphasises exercise training and heart health, plays an important role in patients' recovery after undergoing coronary bypass surgery. Launched in August 2019 by TTSH during the COVID-19 pandemic, *Heart-Track™* is the first digital prescription and monitoring system revolutionising CR delivery. Leveraging wearable technology, a mobile application, and gamification principles, it enables CR to be carried out safely and effectively in the comfort of a patient's home, while maintaining a high level of personalised care. Based on data collected between 2019 to 2022, *Heart-Track™* showed a significantly higher completion rate of CR sessions of 70.6 per cent as compared to the traditional method of 58.8 per cent. It also demonstrated improved patient effort tolerance, which is reflected in the six-minute walk test distance ($p=0.02$) as compared to the traditional group ($p=0.26$).

Ambulatory Care In Emergency Surgery (ACES) Programme

The Ambulatory Care in Emergency Surgery (ACES)



programme was implemented in June 2022 at Khoo Teck Puat Hospital (KTPH) to manage patients with uncomplicated general surgical conditions amenable to conservative treatment. These include conditions, such as uncomplicated diverticulitis, colitis, gastritis, suspected Mallory-Weiss tear, and biliary colic. ACES aims to reduce inpatient admission, implement early review and decision by senior clinicians, and early discharge within 24 hours. Under ACES, suitable patients are admitted to the Emergency Department Treatment Unit (EDTU) and upon discharge, they will be followed up within three days by

by the Telehealth & Integrated Network (THINK) Centre via a phone consultation, whereby any issues encountered will be reported to the General Surgery team. Outpatient investigations and procedures may also be arranged directly from EDTU without the need for a separate clinic visit, streamlining processes and improving patient and staff experience.

Comparing data between pre-ACES (June 2021 to May 2022) and post-ACES (June 2022 to June 2023), results showed that there was a significant reduction in the length of stay (LOS) from 35.3 hours (pre-ACES) to 19.9 hours (ACES), and 78 per cent of ACES patients were discharged within 24 hours compared to 31 per cent of patients pre-ACES. ACES patients also had decreased gross patient bills. There was no significant increase in both the seven-day ED revisit rate and 30-Day ED readmission. These results have shown that emergency surgical ambulatory care with a focus on early discharge and outpatient care is a safe and effective system that helps to reduce the length of stay, utilisation of hospital beds, and saves cost for suitable patients.



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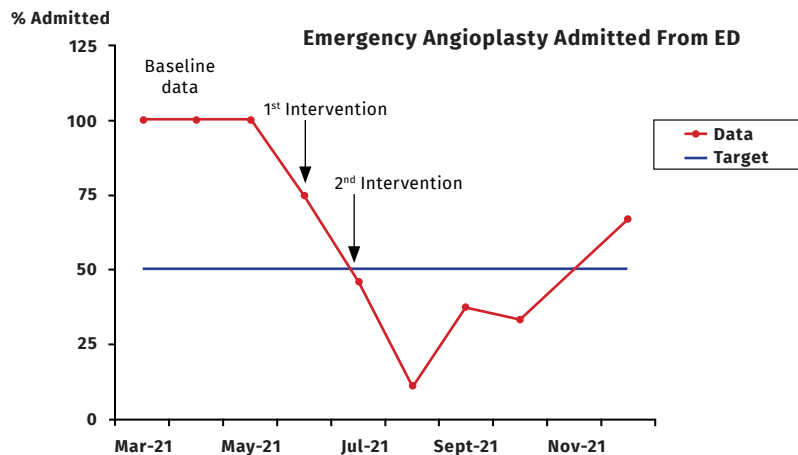
DAVINCI Project

KTPH sees an average of 10 to 15 admissions to the ED per month due to End Stage Renal Disease (ESRD) patients with haemodialysis access issues, leading to emergency procedures, inpatient dialysis slots, and inpatient stays. This results in increased costs to patients and the institution. In June 2021, KTPH introduced the Dialysis access Vascular Intervention Improving Outcome with Timely Evaluation And Management (DAVINCI) project to reduce ED admissions for ESRD patients with haemodialysis access dysfunction by 50 per cent over a one-year period. This initiative involved a dedicated KTPH team collaborating with National Kidney Foundation (NKF) centres in the Northern region of Singapore to establish a referral criteria and protocol within an elective outpatient setting for early detection, smooth communication with early intervention, and discharge back to the dialysis centre. Within nine months of implementation, the project achieved more than 50 per cent reduction in ED admissions, more than 170 hospital admission days saved, and cost savings of close to \$230,000. The project is currently being expanded to include private dialysis centres across the Northern region of Singapore.

MANAGING INFECTIOUS DISEASE OUTBREAKS

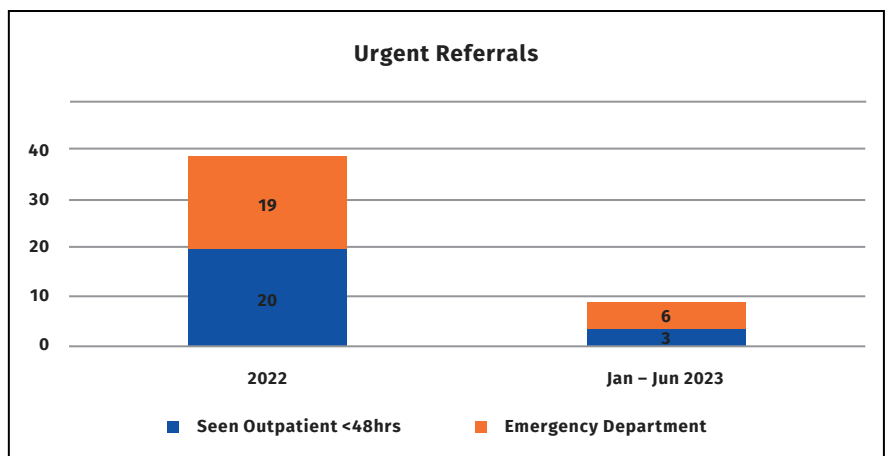
Ramping Up Of COVID-19 Isolation And General Ward Beds

There were three major COVID-19 waves in 2022 — the Omicron BA.2 subvariant in March, Omicron BA.4 and BA.5 subvariants in July, followed by the XBB variant in October and November. These waves —



	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21
ED	8	8	10	6	6	1	3	3	3	6
DaVinci	0	0	0	2	7	8	5	6	3	3
ED admission/Total Referral (%)	100	100	100	75	46	11	37.5	33	50	67

Emergency Admissions For Dysfunctional AV Access



Total Urgent Referrals Via DaVinci Pathway

coupled with patients who were not eligible for the Home Recovery Programme (HRP) due to complex comorbidities — created a high demand for isolation beds and facilities. In response to the surge in demand for bed capacity, the National Centre for Infectious Diseases (NCID) and TTSH ramped up available COVID-19 general ward and isolation beds. These beds were made available at NCID, TTSH, and TTSH Communicable Disease Centre (CDC) 2, as well as COVID-19 Treatment Facilities (CTF) sub-acute wards at Ren Ci Community Hospital. Multiple stakeholders across NCID and TTSH worked together to

operationalise the ramp-up plans, including ensuring infrastructure and IT readiness, smooth patient journey, and clinical service delivery from admission to discharge and/or decant, and efficient turnover of inpatient beds post-patient discharge.

Management Of Mpox Cases

Singapore reported a total of 19 confirmed mpox cases in 2022, of which 16 cases were treated in NCID's isolation ward and two cases were managed as outpatients in NCID's Clinic J under the swab-and-isolate or home recovery protocols. These protocols were jointly developed by





SURGICAL ENHANCED RECOVERY ASSISTANT (SERA) FEATURE IN THE NHG CARES APP

The user acceptance testing for the Surgical Enhanced Recovery Assistant (SERA) feature in the NHG Cares app was held in December 2022. The feature provides patients who are undergoing colorectal surgery with educational resources and personalised tasks for pre- and post-operation care to ensure they are well prepared for the procedure. The SERA feature was piloted in Q3 2023 for patients undergoing colorectal surgery, and would be customised for other surgery types in the future.

NCID and Ministry of Health (MOH), which are currently the default management pathway for mpox, along with national guidance on the assessment and management of patients for mpox.

In May 2022, NCID's Clinic J received the first suspected mpox case and subsequently reviewed more than 40 suspect cases by 31 December 2022. Suspected



mpox cases were admitted to NCID for isolation and screening for mpox. Following MOH's policy change in August 2022, suspected mpox cases seen in Clinic J Special Precaution Area were assessed for suitability to be discharged home or to Mpox Isolation Facilities while pending their PCR swab results.

NEW CARE MODELS FOR BETTER MENTAL HEALTH

IMH-SKH Collaboration To Improve Patient Care

In December 2022, the Institute of Mental Health (IMH) and Sengkang General Hospital (SKH) signed a Memorandum of Understanding (MOU) to enhance cross-institutional psychiatric and medical capabilities, provide efficient medical access for IMH inpatients, and collaborate on education, innovation, and research. The MOU aims to help optimise care for IMH's inpatients, as well as help both hospitals streamline care processes, optimise the use of healthcare resources, and elevate clinicians' skillsets. Under the MOU, Internal Medicine consultants from SKH run clinics twice a month at IMH, which cuts down the need for IMH inpatients to be sent to another hospital for specialist outpatient appointments, thus saving time and resources. A phone consultation service with SKH Internal Medicine consultants is also available for IMH's medical team for more urgent patient needs. Several programmes to improve access to specialist services for IMH inpatients have also been implemented, including fast-track orthopaedic consultation for minor trauma, direct-access



radiological services for ultrasounds and Computed Tomography (CT) scans of the brain, and email and phone consultation services for cardiology advice and doubtful electrocardiograms (ECGs) for patients with heart conditions.

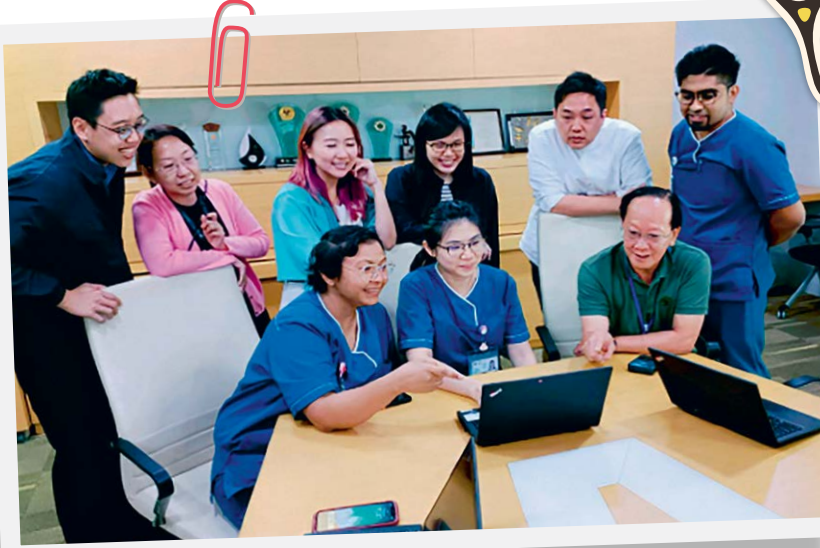
IMH and SKH will also work on cross-institutional training to build up manpower capabilities on both sides to provide holistic care for patients with medical and psychiatric needs. One example is the Care & Response training conducted by IMH for SKH staff on the management of patients with disturbed behaviour, to enable better management of IMH patients upon admission to SKH.

Coordinated Care With Adult Disability Homes

Adult Disability Homes (ADHs) often have difficulty managing and caring for residents who have developmental disabilities and severe behavioural issues, and typically send such residents to IMH's emergency services. In March 2022, IMH's Medical Social Work department collaborated with Thye Hwa Kwan Sembawang



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A total of 225 patients took part in the programme, with results showing improved treatment engagement, better medication adherence and clinical outcomes, and significantly reduced readmission rates, as well as outpatient default rates. Feedback from the recovering individuals, their caregivers, and community partners also showed that they felt well-supported during the post-discharge period. IMH is currently running TCP in four wards, with plans for expansion across the hospital in the future.

RESEARCH FOR BETTER POPULATION HEALTH

Transforming Vascular Health Programme

To build research intensity and capability in metabolic health, NHG Group Research supported the establishment of the Transforming Vascular Health programme led by TTSH in collaboration with Lee Kong Chian School of Medicine (LKCMedicine) in January 2023. The programme aims to stratify individuals at risk of vascular complications to identify suitable interventions and prevent or delay the onset of disease progression. It involves two complementary arms:

- The discovery arm will study biomarker-based risk stratification, vascular inflammation, and vascular phenotyping.
- The translation arm will focus on the implementation of risk scores, methods for risk stratification, and personalised interventions.

To-date, patient recruitment has commenced, and the first research visit was successfully held in August 2023.

AI Tool To Identify High-Risk Frequent Admitters And A&E Users

Current methods for identifying frequent admitters (FAs) or accident and emergency (A&E) users are typically developed using patient data, and often over-estimate

(THK-S) Home to introduce the Care Coordination Project, which involves tight case coordination via a new care coordination framework and regular case discussions for such residents to improve their care outcomes, reduce their hospital admissions, and increase referral acceptance. Based on a study between March 2022 and March 2023 and a review conducted in December 2022, the Care Coordination Project showed significant improvements to these patients' care outcomes, with a reduction in IMH emergency attendance of 42 per cent and admission rates of 39 per cent for patients residing in THK-S. When admitted to IMH, the length of stay for these patients was also shortened by 39 per cent, and the readmission rate within 30 days decreased from 6 per cent to 0 per cent. The results indicate more effective management of these patients' treatment and better reintegration into the community.

Transitional Care Programme To Bridge Inpatient And Community Care

IMH piloted the Transitional Care Programme (TCP) from May 2022 to March 2023 to bridge the gap

between inpatient and community care for patients with mental health conditions requiring more intensive and home-based support immediately after discharge. The TCP leverages on the formulated care plan and therapeutic relationship with the inpatient team to engage and support the recovering patients upon discharge. Under the programme, patients assessed to have moderate to high post-discharge transitional needs will receive interventions over six months in three phases:

- Pre-discharge phase: Engagement emphasises rapport-building and needs assessment in the ward.
- Post-discharge phase: Interventions, including symptom and medication management, psychosocial rehabilitation, and caregiver support, are carried out via regular home visits by IMH and a community partner, telephonic support, and clinic visits.
- Disengagement phase: The patient and caregiver are prepared for the transfer of care from TCP to community psychiatric services.

Table 1. Top Predictors Used In AI Models

Frequent hospital admissions		Frequent A&E visits	
Predictor	Relative importance	Predictor	Relative importance
Electronic frailty index — No. of deficits	1.000	No. of A&E visits with no admissions in previous one year	1.000
No. of unplanned acute hospital admissions in the previous one year	0.645	No. of P3 A&E visits in previous one year	0.952
No. of ICD10AM disease subcategory (primary diagnosis) in the previous one year	0.364	No. of doctors seen in previous one year	0.278
Elixhauser readmission score	0.306	No. of AHRQ multiCCS level 1 (primary diagnosis) in previous one year	0.231
Hospital frailty risk score — High risk	0.238	Male, age 6 to 40	0.212
No. of A&E visits in the previous one year	0.162	Frequent user of A&E in previous one year	0.144
Total length of stay for all acute hospital admissions in the previous one year	0.148	No. of AHRQ multiCCS level 2 (primary diagnosis) in previous one year	0.137

A&E: Accident and Emergency; ICD: International Classification of Diseases; AHRQ: Agency for Healthcare Research and Quality; multiCCS: multi-level Clinical Classification Software; P3: Priority 3; P4: Priority 4.

risk among general residents. To address this, NHG's Health Services and Outcomes Research (HSOR) Department used artificial intelligence (AI) to identify NHG residents at high risk of frequent hospital admissions and A&E visits in the following year to implement targeted interventions to reduce their likelihood of such admissions and visits.

The training dataset comprised NHG residents alive at the end of 2019, while the testing and validation dataset comprised residents alive at the end of 2020 and 2021, respectively. FAs were

identified based on three or more admissions, and frequent A&E users were identified based on three or more A&E visits within a year to TTSH or KTPH. Demographics, comorbidities, economic status, risk factors, care predictors, disease severity, and historical healthcare use were used to construct an AI model each for FAs and frequent A&E users, through data training, optimisation, and validation.

Among approximately 1.4 million NHG residents, 4,062 (0.27 per cent) were FAs and 2,221 (0.15 per cent) were frequent A&E

users. With HSOR's AI models, selecting the top 10,000 residents with the highest risks would identify 1,697 FAs and 799 frequent A&E users using included predictors (Table 1). Without the AI models, only 27 FAs and 15 frequent A&E users would be identified in a random selection of 10,000 residents. These AI models can therefore help healthcare providers to reduce the likelihood of frequent hospital admissions or A&E visits through targeted interventions, thus lowering healthcare costs and improving health outcomes.

EQUIPPING STAFF WITH CRISIS PREPAREDNESS

In May 2022, NHG Group Quality published the *Crisis Management of Serious Incidents* book to better equip staff with the knowledge and skills to handle crises. It captures valuable learnings and illustrates the collaboration between NHG and Institutions in the management of two serious incidents. Perspectives and contributions of the crisis team leads and Quality leaders are also featured, highlighting areas where NHG can further enhance patient safety.

