

Assessment of CT Coronary Angiogram utilization at the National Hospital of Sri Lanka (NHSL)

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ABSTRACT

Background: The escalating burden of cardiovascular diseases in Sri Lanka has intensified the demand for Computed Tomography Coronary Angiogram (CTCA) at the National Hospital of Sri Lanka (NHSL). However, operational constraints and disproportionate capacity have generated significant service backlogs for timely cardiac care.

Objectives: This study aimed to assess the utilization and operational efficiency of CTCA services at NHSL, analyse underlying systemic bottlenecks, and propose targeted quality improvement strategies to optimize patient throughput and reduce waiting lists.

Methods: A mixed-methods problem-oriented case study was conducted. Qualitative data were gathered via key informant interviews with cardiologists, radiologists, radiographers and biomedical engineers, alongside focus group discussions and field observations. Quantitative data were obtained by reviewing departmental administrative records, process mapping, waiting lists, and cadre statistics. Issues were structured using SWOT analysis, the Pareto principle, an Eisenhower matrix and root cause analysis.

Results: Annual demand increased sharply from 1,406 patients in 2022 to over 3,000 in 2025. The primary systemic bottleneck was prolonged waiting times of 2–3 months for non-emergency patients, coupled with a 48-hour reporting delay. Root causes included restricted operational hours (8:30 AM–4:00 PM), severe staffing shortages (68 radiographers in position against an approved cadre of 104), absence of comprehensive maintenance agreements leading to equipment downtime, and sole reliance on a single 640-slice scanner.

Conclusion: Service congestion in tertiary cardiac imaging can be addressed by transitioning to extended operating hours (8:00 AM–8:00 PM), implementing integrated teleradiology solutions to cut turnaround times to within 24 hours and securing robust equipment maintenance contracts to ensure continuous high-quality diagnostic delivery.

Keywords: CT coronary angiogram, Teleradiology, Operational hours expansion, Healthcare quality improvement, Turnaround time, Waiting lists, NHSL, Resource allocation.

INTRODUCTION

Background

Computed Tomography Coronary Angiogram (CTCA)

Computed Tomography Coronary Angiography (CTCA) is a non-invasive imaging modality that plays a crucial role in the early detection and evaluation of coronary artery disease. It enables visualization of coronary arteries and identification of atherosclerotic plaque, including calcifications, at an early stage (National Institute for Health and Care Excellence, 2016). As a highly sensitive diagnostic tool, CTCA reduces the need



for invasive procedures such as conventional coronary angiography in selected patients. It is considered a first-line investigation for individuals with low to intermediate risk of coronary artery disease. Additionally, CTCA contributes to cost-effectiveness in healthcare by facilitating timely diagnosis, reducing unnecessary hospital admissions, shortening hospital stays, and improving overall resource utilization (Kapoor & Thompson, 2009).

Objectives

General Objective

To assess the utilization of CT Angiogram services at the National Hospital of Sri Lanka (NHSL)

Specific Objectives

- I. What is the current functionality of the CT angiogram services at NHSL.
- II. To identify the challenges and gaps affecting the utilization of CTCA services at NHSL.
- III. To propose recommendations and implementation strategies to optimize the CTCA services at NHSL.

Justification

The assessment of CT Angiogram utilization at the National Hospital of Sri Lanka (NHSL) is essential due to the increasing burden of non-communicable diseases (NCDs), particularly cardiovascular diseases, which are the leading cause of mortality in Sri Lanka (Chronic Non-Communicable diseases, 2009). Assessment of CT Angiogram utilization will improve diagnostic accuracy, reduce unnecessary invasive procedures, enhance patient outcomes, and contribute to more efficient resource allocation within NHSL. This aligns with national health priorities to combat cardiovascular disease through better prevention, early diagnosis, and management, supporting the objectives of the National Task Force on Non-Communicable Diseases.

PROBLEM ANALYSIS

Methodology

Study Design and Study setting

A mixed-methods, problem-oriented case study was conducted at the Radiology Department, National Hospital of Sri Lanka (NHSL), Colombo.

Study period

The secondary data collected from January 1, 2022 to December 31, 2025.

Sampling Technique

A purposive sampling was employed for qualitative inquiry to ensure maximum variation in professional roles.

Key Informant Interviews

Interviews with key informants, including Consultant Cardiologists, Consultant Radiologists, Radiographers and biomedical engineers have identified several systemic constraints impacting the utilization of CT coronary angiography (CTCA). Informants also noted the growing demand for CTCA services without a corresponding increase in service capacity, resulting in congestion and delays in patient management.

Focus Group Discussions

Focus group discussions conducted with Consultant Radiologists, Radiographers and relevant operational staffs with Deputy Director Ambulatory care and OPD section of NHSL.

Review of Institutional Records

A comprehensive review of administrative and service records pertaining to CT Coronary Angiogram (CTCA) services was undertaken in collaboration with the staff of the radiology department. These records were scrutinized for completeness, accuracy, and consistency, as well as for the capture of key data elements, including patient numbers, waiting lists, procedure volumes and reporting times. Additionally, the frequency of data recording and reporting was assessed.

Field Observations

Observations were carried out on a limited scale within CT imaging units to evaluate the real-time workflow involved in delivering CT Coronary Angiogram (CTCA) services.

SWOT Analysis

Table 1: SWOT Analysis



Problem List

The following key problems were identified, based on the information gathered.



a. **Limited CTCA Service Hours**

Although CTCA services are available around the clock, they are primarily offered during standard business hours, resulting in underused resources and limited patient capacity.

b. **Human Resource Constraints**

There is a significant shortage of radiographers.

Table 2: Radiographers Cadre details, NHSL

Category	Approved Cadre	In Position
Radiographers	104	68
Special Grade Radiographers	4	1

c. **Prolonged Waiting Time**

Non-emergency patients experience waiting periods of approximately 2–3 months, delaying diagnosis and clinical decision-making.

d. **Increasing Demand without Capacity Expansion**

There is a steady rise in demand for CTCA services without a corresponding increase in infrastructure, workforce, or service sessions, resulting in service congestion.

e. **Dependence on a Single CT Scanner**

CTCA procedures are predominantly performed using a single high-capacity CT machine, while other available machines are underutilized due to technical and operational limitations.

f. **Delayed Reporting of Results**

Reporting delays of approximately 48 hours affect timely clinical decisions and patient management.

g. **Inadequate Performance Monitoring**

Lack of structured monitoring systems and key performance indicators (KPIs) limits the ability to track efficiency, identify bottlenecks, and implement improvements.

h. **Equipment Maintenance Issues**

Absence of comprehensive maintenance agreements increases the risk of machine downtime and service interruptions.

i. **Referral Pattern Imbalances**

A high proportion of referrals originate from a single specialty (cardiology), potentially leading to inappropriate prioritization and inefficient utilization of the service.

Problem Prioritization

Upon identifying several challenges impacting, the utilization of CT Coronary Angiogram (CTCA), a structured prioritization process was implemented, employing the Pareto principle (80:20 rule) and the Eisenhower matrix, with active stakeholder participation of Consultant Radiologists, Radiographers and relevant operational staffs with Deputy Director Ambulatory care and OPD section of NHSL. The issues were ranked according to their magnitude, impact on patient care, urgency, and the feasibility of intervention.

Among the issues identified, the prolong waiting period for CTCA was highlighted as the primary concern, as it reflects the combined impact of rising demand, restricted service capacity, and limitations in human resources, which directly influence clinical decision-making and patient outcomes.

Table 3: Eisenhower Matrix

	URGENT	NOT URGENT
IMPORTANT	- Increased demand without capacity expansion. - Prolong waiting time.	- Inadequate performance monitoring. - Limited operational hours.
NOT IMPORTANT	- Delayed reporting by CR. - Incentives limitations to radiographers.	- HR Constraints. - Referral pattern imbalances.

Root cause analysis of prioritised problems

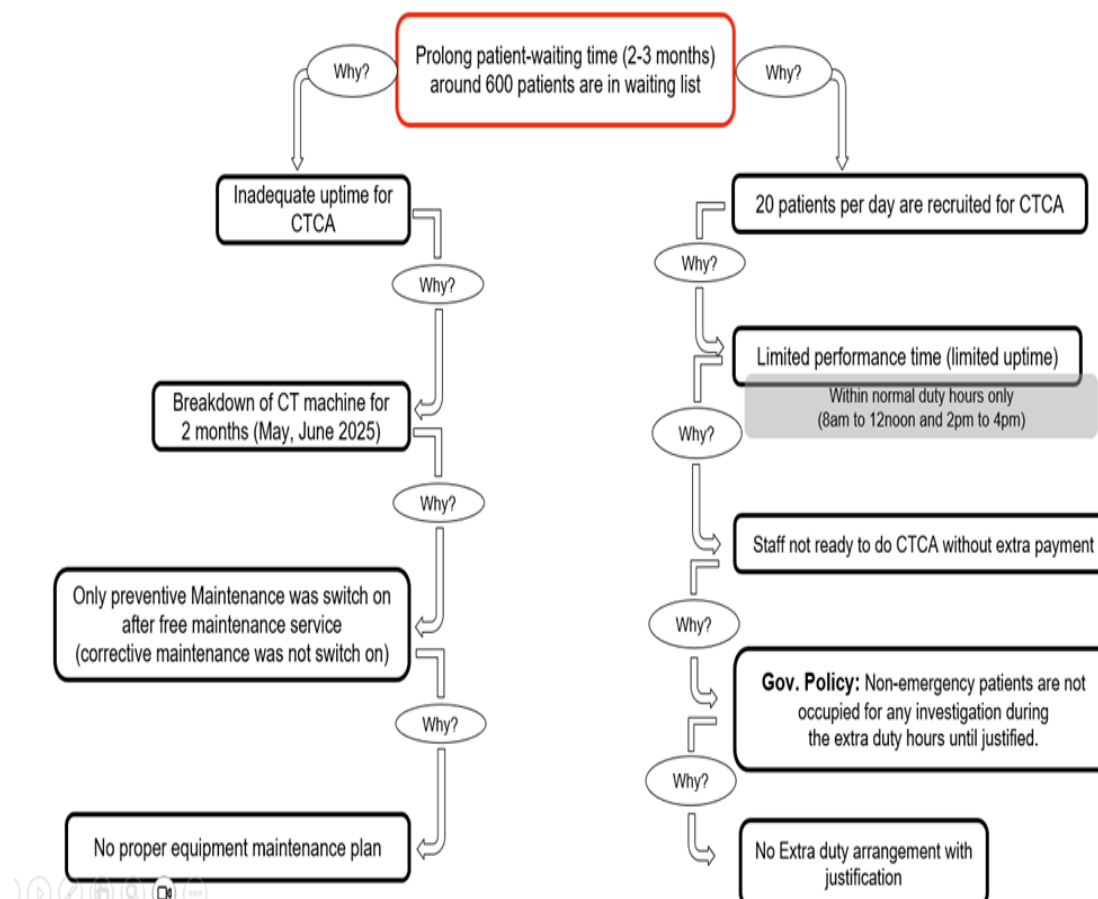


Figure 1: Root Cause Analysis of Prolonged CTCA Waiting Time



The findings of this study highlight important operational challenges affecting CTCA service delivery in a large tertiary hospital. Prolonged waiting time for CT coronary angiography reflects a mismatch between increasing diagnostic demand and available service capacity. Dependence on a single CT scanner for CTCA procedures significantly increases vulnerability to service disruptions. Equipment maintenance planning plays a critical role in ensuring continuity of diagnostic imaging services. Limited CTCA service hours also represent a major operational constraint. Expanding diagnostic imaging services beyond routine duty hours has been shown to improve patient throughput and reduce waiting lists in several healthcare systems

Proposals

No	Proposal	Advantages	Disadvantages	Feasibility
1	Extended CTCA working hours after routine time.	Better utilization of the existing 640-slice CT scanner. Helps reduce the existing 2–3 month waiting period.	May require payment of incentives/overtime. Requires careful coordination of radiology unit and cardiology unit.	High feasibility as it requires administration approval, service scheduling and staff roster arrangements.
2	Strengthen CTCA Radiographers capacity	Supports continuity of service and reduces dependence on the limited number of trained staff.	Training requires staff time and resources. Redistribution of staff may affect other radiology services if not carefully planned.	Moderate to high feasibility. Immediate measures such as duty redistribution and targeted training can be implemented within the existing structure.
3	Establish standardized CTCA referral criteria.	Enables transparent prioritization of patients according to urgency. Supports more equitable use of limited CTCA capacity.	Requires agreement among referring physicians, radiology and cardiology teams.	Moderate to high feasibility because it can be developed using existing international guidelines with professional colleges.
4	Establish an integrated CTCA teleradiology facilities.	Reduces reporting turnaround time and supports timely clinical decisions.	Maintenance contracts and teleradiology may require additional expenditure.	Moderate feasibility. As initial cost is high.

RECOMMENDATIONS

Among the stated proposals the Proposal 1 and 4 is recommended,

Proposal	Focus Area & Objective	Implementation Strategy
Proposal 1: Extended CTCA service hours.	Extend CTCA services beyond routine hours (8:30 AM–4:00 PM) to evening and weekend slots.	Establish revised duty rosters for radiographers. Maximize utilization of the existing high-capacity 640-slice CT scanner.
Proposal 4: Integrated CTCA Teleradiology facilities.	Establish integrated CTCA teleradiology facilities for off-site reporting support.	Enable remote image interpretation and digital transmission. It reduces the current reporting delays from ~48 hours to preliminary reports within 24 hours.

Table 4: CTCA Capacity improvement chart

No	Operational Aspect	Current Status	Target Status	Strategy for Improvement
1	Operating Hours	8:30 AM – 4:00 PM (7.5 hrs / 450 mins/day)	8:00 AM – 8:00 PM (12 hrs / 720 mins/day)	Implement extended evening and weekend shifts (Proposal 1).
2	Procedure Duration	30 to 40 minutes per procedure	30 minutes per procedure	Streamline pre-scan prep (IV line, beta-blockers, consent) outside the scanner room.
3	Daily Patient Output	~15 patients per day	25+ patients per day	Extended operating hours with parallel patient pre-preparation.
4	Scanner Downtime	High risk due to lack of comprehensive agreements	Minimal downtime with scheduled maintenance	Establish comprehensive maintenance contracts to ensure 640-slice machine uptime.
5	Staffing & Cadre	Shortage (68 radiographers in position vs. 104 approved)	Expanded, trained radiographer shifts	Duty redistribution, targeted CTCA training for other radiographers.
6	Reporting Turnaround	48-hour reporting time.	Preliminary report within 24 hrs.	Integrate teleradiology facilities (Proposal 4).

IMPLEMENTATION

Table 5: Implementation Timeline.

No	Implementation Activity	Responsible Person	Time Frame
1	Decision making to extend CTCA service hours (evening/weekend sessions)	DDG / Deputy Director NHSL, Consultant Radiologist, Special Grade Radiographer	4 weeks
2	Preparation of revised duty roster for radiographers and staff	Special Grade Radiographer	2 – 4 weeks
3	Develop incentive scheme for extended working hours	DDG / Deputy Director NHSL, Chief Accountant	2 – 4 weeks
4	Develop and implement standardized referral guidelines	Consultant Cardiologist, Consultant Radiologist, Consultant Physician	2 – 4 weeks
5	Establish centralized appointment and triage system	Consultant Cardiologist, Consultant Radiologist, Consultant Physician	1 – 2 months
6	Introducing preliminary reporting within 24 hours / teleradiology support	Consultant Radiologist, Consultant Health Informatician	2 months
7	Conduct regular audit and review meetings	DDG / Deputy Director NHSL, Quality Management Unit	Quarterly
8	Establish comprehensive maintenance contracts for CT machines	Biomedical Engineer, Procurement Division	2 – 3 months
9	Conduct training programmes for radiographers and staff	Head of Radiology, MO Planning	1 – 2 weeks



ETHICAL CONSIDERATIONS

Administrative clearance was granted by National Hospital of Sri Lanka. Informed consent was obtained from all interview and focus group participants prior to session initiation, with guaranteed confidentiality and anonymization.

CONCLUSION

Optimizing the utilization of CT Coronary Angiography (CTCA) services at the National Hospital of Sri Lanka represents a critical opportunity to enhance overall health system responsiveness, particularly in the context of the rising burden of cardiovascular diseases.

The restructured CTCA service, with extended service hours, improved workflow processes, strengthened human resources and timely reporting mechanisms, will facilitate prompt attention and ensure equitable access to essential diagnostic services. The introduction of structured referral pathways and performance monitoring systems further supports appropriate utilization, transparency and accountability within the service.

This approach not only improves clinical outcomes through early and accurate diagnosis but also ensures that patients receive timely, respectful, and efficient care. Ultimately, optimizing CTCA utilization at NHSL will strengthen the health system's capacity to respond to patient needs and serve as a model for improving advanced diagnostic services within the country.

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APPENDICES

Table 6: Statistics of CTCA, NHSL 2025

Month	CTCA	CTPA	Renal	Neck	Mesen	Lower limb	Upper limb	Aortic	Cerebral	Carotid	Total
January	212	12	18	1	1	18	4	21	19	3	293
February	190	9	6	1	2	8	3	18	15	1	232
March	288	12	16	2	3	12	2	18	16	-	339
April	163	13	12	-	3	2	3	16	12	1	209
May	87	34	13	1	4	4	4	16	8	2	112
June	2	17	8	-	-	-	-	3	8	1	5
July	298	29	26	8	7	14	7	32	16	5	333
August	267	23	31	6	8	17	8	41	18	4	329
September	316	32	28	7	6	21	6	40	16	6	350
October	200	44	22	4	3	8	3	18	12	1	219
November	276	31	18	5	7	18	7	38	21	2	311
December	249	28	19	5	6	20	6	41	26	3	286



Total	2548	284	217	40	50	142	53	302	187	30	3018
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Table 7: CT Scanner capacity at NHSL.

CT Machine	Location	Slice Capacity	Utilization for CTCA	Reason for Non-utilization / Selection
CT-01	Main X-ray Building	16 slices	No	Insufficient slice capacity for high-quality CT coronary angiography
CT-02	Main X-ray Building	640 slices	Yes	High-resolution scanner suitable for cardiac imaging; currently used for CTCA
CT-03	Accident Service Building – Neurotrauma Unit	64 slices	No	Lower image quality compared with CT-02; primarily reserved for emergency trauma imaging
CT-04	OPD New Building	160 slices	No	Lack of trained nursing staff for CTCA procedures; no allocated cardiology slots; PACS system not connected with cardiology unit