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Process Mapping and Optimization of Kidney Transplantation Workflows in a Tertiary Care Teaching Hospital: A Time-Motion Observational Study

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INTRODUCTION

Context & Burden: India faces a severe organ shortage amidst a rising burden of end-stage renal disease. The prevalence of chronic kidney disease (CKD) is estimated at 800 per million population. Despite an estimated requirement of 1.5 to 2 lakh kidney transplants annually, only about 18,000 are performed, the vast majority being living-donor transplants. India's deceased donation rate remains dismally low at 0.34 per million population (pmp), starkly contrasting with global leaders like Spain (>30 pmp).

Regulatory Framework (THOTA): Deceased organ donation is governed by the Transplantation of Human Organs and Tissues Act (THOTA) 1994 (amended 2011). THOTA stipulates rigorous protocols for brain-stem death (BSD) certification, requiring evaluations by a specially constituted medical board.

The Statutory Bottleneck: A critical mandate under THOTA is the mandatory 6-hour interval between the first and second brain-stem death certifications. While this ensures clinical certainty, it introduces a fixed, non-modifiable delay into the organ procurement pathway.

Time Constraints & Viability: Kidney transplantation is exquisitely time-sensitive. Prolonged cold ischemia time (CIT) significantly increases the risk of delayed graft function (DGF) and reduces long-term allograft survival.

Study Rationale: Given fixed statutory constraints, optimizing modifiable administrative aspects is critical. This study aimed to map existing pathways, quantify times, identify bottlenecks, and propose strategies to minimize CIT.

METHODS

Design: Prospective, observational time-motion study over an 18-month period.

Setting: A 1,100-bedded apex tertiary care teaching hospital in India, equipped with comprehensive and neurosurgical ICUs.

Sample Size: 36 consecutive kidney transplant cases were tracked (25 donor-side pathways, 11 recipient-side pathways).

Data Collection: Workflows mapped using standardized template. Researchers shadowed teams, recording precise timestamps.

Variables: Admission, GCS, BSD suspected time, Apnea tests, counseling, police NOC, lab TATs, cross-match.

Validation: Validated through stakeholder reviews; benchmarked against NOTTO/THOTA targets.

KEY METRICS

14.0 h Donor Workflow (Target 8-12h)	43% Statutory Wait Time
8h 10m Recipient Workflow (Target 6-12h)	2-3 h Potential Savings
180 min Police NOC Delay	

RESULTS & OBSERVATIONS

Donor-Side Workflow Duration: The mean total duration for the donor-side pathway (from suspected BSD to organ retrieval) was 14.0 hours. This significantly exceeded the national target benchmark of 8–12 hours.

Statutory vs. Modifiable Delays: The mandatory 6-hour interval between the two BSD certifications accounted for 43% of the donor-side time. Modifiable delays were significant in administrative domains.

Police Clearances: Procuring the mandatory NOC from local police in medico-legal cases caused a mean delay of 180 minutes (range: 60–360 minutes).

Family Counseling: The time required for grief counseling and obtaining consent was highly variable, ranging from 30 minutes to over 3 hours.

Recipient-Side Workflow Duration: The mean total duration for recipient preparation was 8 hours and 10 minutes. This fell well within the acceptable target range of 6–12 hours.

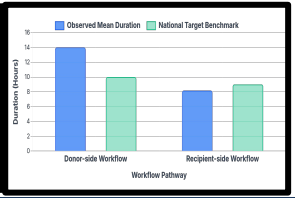
Recipient-Side Bottlenecks: Laboratory Turnaround: Tissue typing and virology took 120-240 minutes. Positive cross-match added 1-2 hours.

Section A: Hospital as Donor (n = 25)

Step	Timestamp	Details	Notes/Observation
Identification	T = 0	Potential brain-dead donor identified in ICU	
Stabilization	T + 30–60min	Hemodynamic stabilization initiated by ICU team	
Activation	T + 60–90min	Transplant Coordinator notified; team activated	
Counseling	T + 90–150min	Family counseling conducted by TC and MSW	Var (30min to 3h)
Consent	T + 150–180min	Next-of-kin provided consent (Form 8)	
First Cert.	T + 180–240min	BSD board; apnea test; Form 10 completed	
Wait Interval	T + 240 to 600min	Statutory 6-hour waiting period	Fixed Delay
Allocation	Concurrent	NOTTO notified; organ allocation list generated	
Police NOC	T + 300–480min	Police notification for NOC in MLC cases	Avg delay ~3h
Lab Work	Concurrent	Tissue typing, viral markers, cross-matching	
Second Cert.	T + 600min	Repeat apnea test; Form 10 completed	
Surgery Prep	T + 660–720min	OT prepared; anesthesia fitness confirmed	
Surgery	T + 720–840min	Organ retrieval and perfusion performed	
Handover	T + 840–870min	Organ preserved; handed to recipient team	
Body Handover	T + 870+min	Body handed to family; forensic formalities	

Section B: Hospital as Recipient (n = 11)

Step	Timestamp	Details	Notes/Observation
Alert	T = 0	Notification of organ offer received from NOTTO	
Recall	T + 30–120min	Recipient contacted and mobilized to hospital	
Workup	T + 150–270min	Clinical fitness, viral markers, fresh cross-match	
Decision	T + 270–300min	Cross-match results reviewed	Delay if +ve
Transport	Concurrent	Organ transported via "Green Corridor"	
Surgery	T + 390–480min	Transplant surgery performed	



MAPPED PROCESS FLOW (13 Activities)

1. PTD Assessment		2. PTD Referral
3. Duty Doc/ICU Coord		4. MSW Consult
5. Coordinator		7. Nursing/Coord.
6. BSD Committee 1		8. BSD Committee 2
9A. MSW Legal		9B. PRO/Police NOC
10. CMO Clearance		11A. Coord + PRO
11B. Anaes.	12. Tx Team	13. Nursing

Brain Death Certification Committee
Treating Doctor | Intensivist | Neurologist | Neurosurgeon | MS
*Must convene twice, separated by mandatory 6h interval (THOTA)

DISCUSSION

Inefficiency Locus: Workflow inefficiencies are predominantly concentrated in the pre-retrieval donor-side pathway. Recipient workflows are generally within benchmarks.

The Fixed vs. Modifiable Paradigm: The 6-hour interval is a fixed legal delay. Modifiable bottlenecks—primarily police clearances (NOC), communication gaps, and lab TATs—severely compound total duration.

Impact on Viability: Cumulative delays threaten organ viability. Surpassing the 12-hour CIT threshold increases delayed graft function risk.

Systems Engineering: Sequential workflows must convert to a parallel model. Redesigning the 6-hour wait could yield a 2-3 hour CIT reduction.

RECOMMENDATIONS

Implement Parallel Processing: Execute legal and consent tasks during 6-hour BSD wait.

Establish Police Liaison: Designate nodal officers to expedite NOCs.

Expand 24/7 Diagnostics: Round-the-clock immunology labs.

Deploy Digital Tracking: Real-time synchronization dashboards.

CONCLUSION

Standardizing parallel workflows is essential to reduce cold ischemia time and improve outcomes given fixed statutory timelines.

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