CLINICAL WORKSTATION
An in-house Hospital Information System (HIS)

Christian Medical College, Vellore
Clinical WorkStation
5.5.98

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Product of the Department of Computerised Hospital Information Processing Services

Christian Medical College
Vellore
PART I

AWARD APPLIED BY:

PRIVATE SECTOR ORGANIZATION
PART II

INTRODUCTORY INFORMATION

PROJECT NAME: CLINICAL WORKSTATION: An in-house Hospital Information System (HIS)

INSTITUTE: Christian Medical College, Vellore

AWARD CATEGORY APPLIED FOR: SKOCH DIGITAL INCLUSION AWARD – Health

ADDRESS:
Christian Medical College,
Ida Scudder Road,
Vellore, Tamil Nadu – 632004
India

Telephone: 0416-2282010
Email: directorate@cmcvellore.ac.in

PROJECT COMMENCEMENT DATE: 2004

PROJECT COMPLETION DATE: December 2006

DETAILS OF RESPONDENT:
Dr. Sunil Chandy,
Director,
Christian Medical College,
Vellore, Tamil Nadu – 632004
India

Telephone: 0416-2282010
Email: directorate@cmcvellore.ac.in
CLINICAL WORKSTATION: AN IN-HOUSE HOSPITAL INFORMATION SYSTEM

Brief Overview of the project

Christian Medical College, Vellore (CMC) is an unaided, Christian minority health care institution which is committed to delivering world class health care to all sections of society, aided by the use of caring, cost effective technology. From its humble beginnings as a one-bedded clinic over a hundred years ago, CMC has blossomed into a large institution catering to over 6000 outpatients and 2600 inpatients daily, and home to 10,500 staff and students. An institution of this magnitude brings with it a raft of administrative and organizational complexities, which need to be continuously addressed in order to facilitate CMC’s goal of excellence in education, service and research.

In order to integrate the functions of various sections of the hospital – Laboratories, Medical Records Department (MRD), Pharmacy, Dietary, in-patient (IP) and out-patient (OP) areas, CMC required a fully integrated Hospital Information System (HIS) for the Main Hospital and peripheral centres. Since it would have been prohibitively expensive to outsource the development of a user friendly program that would be sophisticated enough to meet the needs of an ever expanding institution, CMC’s Department of Centralised Hospital Information Processing Systems (CHIPS) took up the challenge of developing, in-house, a program with the desired specifications. This HIS covers the patient registration and appointment system, admission-discharge-transfer (ADT) process, Outpatient and Inpatient billing, Company & Insurance billing and Reimbursement procedures, and is integrated with MRD, Laboratories, Pharmacy Department, Operation Theatre, Anaesthesia Department, Dietary and Laundry. It includes the Clinical Workstation that is an interface by which doctors can view and manipulate patient data.
The HIS has resulted in a tremendous increase in efficiency at all levels of the health care delivery process within CMC - allowing prompt service, reducing costs, minimizing the margin for human error and providing a tool for Continuous Quality Improvement (CQI) strategies by CMC.

**Challenges faced before deployment of the project**

CMC started with stand-alone microcomputers to perform Billing and Accounts procedures. However, as the services of the hospital expanded and the number of patients soared, so also did the need for storage and sharing of data. Results entered in the labs would previously take at least a day to reach the doctors desk based on which treatment would be modified. The lack of integration caused significant delays in patient billing, increased waiting time, and incurred additional costs in terms of finance and resources. Retrieving patient and financial information was difficult, thereby limiting decision-making processes. Manual processes were subject to entry errors. Information was available at limited areas and sometimes could not be provided in real-time. Gathering information for statistics and research was a complex operation. Generating financial statements was a phenomenal task.

**Objectives of the project**

1. To develop a fully integrated HIS for various areas of the hospital – Emergency Services, Pharmacy, Labs, MRD (Patient registrations, doctor schedules and OP/IP charts), IP areas (wards & intensive care units, billing, reimbursement and credit authorizations), OP areas (OPDs) and Dietary services.
2. To develop an integrated, user friendly Clinical workstation for doctors to view appointments, results, clinical images, theatre postings and inpatient lists; schedule doctor appointments & procedures; order investigations and prescriptions; and generate medical reports and discharge summaries – all at a single click.

3. To allow acquisition and availability of relevant real-time information and allow billing to be automated with data entry.

4. To ensure transaction security and minimize human errors.

5. To incorporate a Self-Service Module allowing ease of access to an individual’s information.

Description of the implemented project

The Department of CHIPS in CMC set about the arduous task of developing an integrated HIS in-house in 2003.

The following modules were developed and incorporated into the HIS:

1. Patient registration and appointment system using multiple portals (Manual, Call centres, Web, Smart Card)

2. Paperless Lab orders and authenticated online investigation results

3. Paperless Blood collection area: this has been linked with a pneumatic chute system to transfer samples from the collection point to lab areas, thus minimizing delay and human error

4. A system of optional alerts for lab results which are grossly abnormal or presumed to have a high clinical impact

5. A Clinical Work station that:
Allows doctors to view appointments, results, clinical images and summaries for admissions & prescriptions; schedule doctor appointments & procedures; order online IP/OP investigations and prescriptions; facilitate online billing for services and operative charges; finalize theatre postings; and generate medical reports and discharge summaries.

- Alerts physicians regarding potential drug interactions with each prescription
- Provides online patient and doctor alerts via software/SMS

6. Customized SMS Gateway for alerts to employees and patients

7. Web paging, multi-line telephonic paging and CART (Cardiac Arrest Resuscitation Team) paging for priority paging

8. Surgery and Anaesthesia Management with scheduling, automated billing and logbooks for doctors

9. Pharmacy management – Quotations and Purchase Order Management integrated with Finance module, Stores,Dispensing and Returns

10. Admission-Discharge-Transfer management with automated billing

11. Credit authorization for cashless transactions and reimbursement for patients

12. Online Dietary orders

13. Antenatal records linked with birth registers

14. Doctors schedule management integrated with Patient appointments

15. Procedure appointment module

16. MRD module: IP and OP chart tracking and International Classification of Diseases (ICD) coding
17. Electronic Medical Records (EMR): Using a unit based proforma with options for entry of patient’s history, vital signs, diagnosis, prescription and imaging; OP Follow-up, PDF creation, and patient correspondence

18. Online patient calling system in OPD

19. Automated Casualty Module: incorporating Doctor’s alerts and Patient tracking based on priority

20. HR Module: Integrated with Finance, and including leave management, auditing of concessional benefits, and a Biometric attendance management system

21. Inventory programs

22. Built in Security with authentication for all levels of information

23. Payment
   - All HIS modules are integrated with the Billing module, Company and Insurance billing, and reimbursements
   - Payment is also possible via CHRIS card (CMC debit card) and credit card

24. Finance and Accounting: All HIS modules are integrated with the Finance Module

25. Purchase of all equipment has also been computerized along with stores management process
# The Development of CMC’s Hospital Information System

| Before 2003 | • Pharmacy Stores, Office and direct orders  
|            | • Drug dispensing module |
| 2003       | • Study of the various modules for HIS  
|            | • Planning  
|            | • Started development of various modules  
|            | • Discharge summary and medical reports |
| Jan 2004   | • Implementation of the ADT module  
|            | • Subsequent integration with the Clinical workstation  
|            | • Planning for subsequent modules  
|            | • Staff and dependent Module |
| Jun 2004   | • Implementation of the Appointments scheduling, Investigation payments  
|            | • Integration with the Clinical workstation  
|            | • Online Lab Modules  
|            | • Result view for the doctors at a click |
| Jul-Aug 2004 | • Medical records and chart tracking  
|            | • OR posting, Theatre billing  
|            | • Anaesthesia |
| Oct 2004   | • Inpatient billing, Integration with the Clinical workstation and other lab modules  
|            | • ICD coding  
|            | • Drug history and Medication |
| 2005       | • Online Lab ordering  
|            | • Online E prescriptions  
|            | • Credit authorization for cashless transactions and reimbursement for patients  
|            | • Automation of online Ward and ICU charging |
| 2006       | • Extension to the Peripherals  
|            | • Implementation of the CHRIS card  
|            | • Centralized machine scheduling  
|            | • Payment through various portals like (web, Kosk) |
| 2007 onwards | • Integration with finance  
|            | • Paperless blood collection area  
|            | • Emergency Module  
|            | • EVR with unit based performa  
|            | • SMS alerts |
DRUG ALLERGY ALERTS

DISCHARGE SUMMARY MODULE
E-PHARMACY TO ORDER MEDICATIONS AND CHECK DRUG INTERACTIONS
ONLINE LAB MASTER TO ORDER INVESTIGATIONS

VIEWING PATIENT RESULTS
IMAGING

OPERATION NOTES
DOCTOR’S APPOINTMENT MANAGEMENT

BED MANAGEMENT SYSTEM
IP DISCHARGE BILL PROCESSING

LABORATORY MODULE
ELECTRONIC MEDICAL RECORDS

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<td>Duration</td>
<td>No of years on treatment</td>
<td>Duration</td>
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<tr>
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<td>Ex-Smoker</td>
<td>Riympedonia</td>
</tr>
<tr>
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<td>No</td>
<td>Time Mentioned</td>
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<tr>
<td>Duration</td>
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<tr>
<td>Tobacco</td>
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Details

Presenting Complaints

Chest Pain

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Dyspnea on Exertion

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Description of the hardware and software products, technologies and solutions deployed in the project

**Software:** Oracle and VB, VB.net, ASP, ASP.net.

**Hardware:** RAC (Real Application Cluster) 3 Node environment with a two node RAC for business continuity (Disaster Recovery) and a separate datamining server. The benefit of this is that RAC will be able to handle load balancing and failover, deliver high performance, increased throughput, and high availability of the database for 365x24x7 environments. We have achieved 99.999% availability and eliminated system downtime during scheduled maintenance. Real Application Clusters also support all Oracle backup procedures. Currently CMC is able to store data from the year 2000 onwards.


**Other technologies/solutions employed:**

- CMC debit card (CHRIS card), which can be used for payments at cash counters and kiosks within hospital, for online payment and payment through the CMC Call Centre
- Machine interfaces in labs
- Security implemented via passwords and/or contactless security card
- Customized SMS Gateway for alerts to employees and patients
- Web paging, multi-line telephonic paging and CART (Cardiac Arrest Resuscitation Team) paging for priority paging
- Complete CISCO switched network with Virtual Private Networks and security walls was put in place, which extended Clinical services to the entire CMC residential campus through broadband or LREs
- Audit vault
Details of coverage of the targeted population

Christian Medical College, Vellore serves 16.72 lakh outpatients per year in the main hospital and about 4.7 lakh outpatients in the peripheral centres. We have 3049 beds including those at peripheral centres, which cater to 1.30 lakh inpatients and 17,883 new births per year.

Comparison of the pre-deployment scenario and post deployment benefits

Prior to development of the HIS, the system was plagued by delays in reporting of investigations, admission-discharge-transfer management, billing and procurement. Retrieving patient information for clinical care and research, and generating financial statements to aid in decision making was difficult. The dependence on manual entry led to document storage issues and increased the risk of human error.

The development of the HIS brought about a sea change in the organizational capabilities of the institution, besides boosting efficiency at every level.

- Secure, real-time, relevant information is now available anywhere on the institutional campuses
- MIS for Administration and Auditors
- Online investigation results available as soon as they are ready, thus aiding clinical decision making. Trend of lab investigations over a time period can be studied using graphical displays.
- Information regarding drug interactions is available in real-time, as a prescription is being written
- Every patient’s Drug and Investigative history is available online for auditing
- Speed of service has increased significantly
- Patient billing delays have decreased dramatically
Patient reports are generated quickly without needing re-entry of data.

Research information is easily retrievable; alerts can be generated for study participants and patients enrolled in clinical trials.

Change in workflow can be easily managed since an in-house team has developed the solution.

Note on the cost effectiveness of the project

1. In terms of Cost savings

The cost of Oracle licences is 4.5 lakhs and the expenditure on Salary for all staff employed in CHIPS is approximately 12.5 Lakhs per year.

This is a cost effective solution for CMC, since in addition to the cost saved on purchase of software, maintenance and alteration costs are also reduced as all solutions are developed in-house.

2. In terms of improving customer service

- A customized, cost-effective, smart card solution with full security features (CHRIS card) was introduced. E-account holders of banks like Punjab National Bank and IOB can now make web payments and appointments online through a module provided by CHIPS. Credit card holders of any bank can make payments and book appointments through the payment gateway of ICICI Bank.

- Information is available at kiosks with the use of the CHRIS card.

- Patients have benefited from a dramatic reduction in billing and appointment delays and significant increase in speed of service.
Drug and Investigative history being available to doctors at the time of treatment means that drug interactions, duplicate orders and payments can be avoided.

**Details on the extent of integration with other e-Governance projects**

- A CMC debit card (CHRIS card), was developed, which can be used for payments at cash counters and kiosks within hospital, for online payment and payment through the CMC Call Centre
- Patients can book repeat appointments for doctors online, through ICICI payment gateway.
- A Customized SMS Gateway was constructed for alerts to employees and patients
- The system incorporates Web paging, multi-line telephonic paging and CART (Cardiac Arrest Resuscitation Team) paging for priority paging

**Details of the Cyber Security measures in the project**

We have enabled Audit trails (Oracle Audit Vault) for sensitive data and role based authentication for information to ensure that data is not exposed to all.

**Future Road map on coverage, up gradation/integration**

The main aim for the future is moving towards a paperless hospital with Electronic Medical records (EMR) and a good decision support system. It is also planned to create a patient tracking system using RFID tags for the monitoring of drugs, equipment and other valuable items.
The HIS development team

Mr. Ebenezer Sundararaj, Sr. Systems Manager introduced RDBMS in CMC. Storage of the patient’s life-time clinical record was planned and the migration of existing data from Fox to Oracle spearheaded. The Clinical Workstation was his brainchild and has seen steady growth since its inception. The list of other personnel involved are as follows:

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Qualification</th>
</tr>
</thead>
<tbody>
<tr>
<td>EBINEZER SUNDARRAJ</td>
<td>Sr. Systems Manager</td>
<td>B.Sc., M.C.A., M.Phil</td>
</tr>
<tr>
<td>ANISHA R MACADEN</td>
<td>Systems Manager II</td>
<td>B.Sc, M.C.A</td>
</tr>
<tr>
<td>SURESH S</td>
<td>Sr. Programmer I</td>
<td>B.Sc, M.C.A</td>
</tr>
<tr>
<td>ANITHA SHEBA RACHEL A</td>
<td>Systems Manager II</td>
<td>B.TECH, M.S.</td>
</tr>
<tr>
<td>MARGOSCHIS MARY SONY</td>
<td>Sr. Programmer I</td>
<td>B.Sc, M.C.A</td>
</tr>
<tr>
<td>LAKSHMIKANTHAN S</td>
<td>Sr. Programmer III</td>
<td>B.Sc, M.C.A</td>
</tr>
<tr>
<td>VASANTHI S</td>
<td>Sr. Programmer III</td>
<td>B.Sc, M.C.A</td>
</tr>
<tr>
<td>MARSHAL DAVID E.</td>
<td>Sr. Programmer III</td>
<td>B.Sc, M.C.A</td>
</tr>
<tr>
<td>PRAKASH M</td>
<td>Sr. Programmer III</td>
<td>B.Sc, M.C.A</td>
</tr>
<tr>
<td>SHARFUNNISA K A</td>
<td>Sr. Programmer IV</td>
<td>B.Sc, M.C.A</td>
</tr>
<tr>
<td>SAM THEOPHILUS A</td>
<td>Sr. Programmer IV</td>
<td>B.Sc, M.C.A</td>
</tr>
<tr>
<td>VASUMATHI J</td>
<td>Sr. Programmer IV</td>
<td>B.E.,</td>
</tr>
<tr>
<td>RADHIKA M</td>
<td>Sr. Programmer IV</td>
<td>B.E., (Comp. Science &amp; Eng.)</td>
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<tr>
<td>SILPA KUMARI M</td>
<td>Sr. Programmer IV</td>
<td>B.Sc, M.C.A</td>
</tr>
<tr>
<td>ARTHI T.</td>
<td>Sr. Programmer V</td>
<td>B.Tech.,</td>
</tr>
<tr>
<td>BHARATH B.</td>
<td>Sr. Programmer V</td>
<td>B.Tech.,</td>
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<tr>
<td>K. HEMALATHA</td>
<td>Sr. Programmer V</td>
<td>B.Sc, M.C.A</td>
</tr>
<tr>
<td>S. DEEPA DORATHY</td>
<td>Sr. Programmer V</td>
<td>B.Sc, M.C.A</td>
</tr>
<tr>
<td>GODWIN JEBAKUMAR C.V.</td>
<td>Sr. Programmer V</td>
<td>M.Sc (Software Engineering)</td>
</tr>
<tr>
<td>DEEPAK PRAVEEN RAJ A</td>
<td>Sr. Programmer V</td>
<td>B.E (Computer Science)</td>
</tr>
<tr>
<td>NAVIN R</td>
<td>Sr. Programmer V</td>
<td>B.Sc, M.C.A</td>
</tr>
<tr>
<td>MARY NANCY C.</td>
<td>Sr. Programmer V</td>
<td>B.E (Computer Science)</td>
</tr>
</tbody>
</table>
CURRICULUM VITAE

Ebinezar Sundarraj
Department of Computerized Hospital Information Processing Service (CHIPS)
Medical Informatics
Christian Medical College Hospital
Vellore - 632 004 (Tamil Nadu), India.

email:  
ebby@cmcvellore.ac.in  
esundararaj@gmail.com

Date Of Birth: 14th April 1968

Gender: Male

Educational Qualifications:

<table>
<thead>
<tr>
<th>Year</th>
<th>Qualification</th>
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<tbody>
<tr>
<td>2003</td>
<td>M.Phil. Manonmaniam Sundaranar University</td>
</tr>
<tr>
<td>1998</td>
<td>MCA Madurai Kamaraj University</td>
</tr>
<tr>
<td>1989</td>
<td>Post Graduate Diploma in Computer Applications (Rank Institute Madras)</td>
</tr>
<tr>
<td>1989</td>
<td>B.Sc.(Maths), Voorhees College, Madras University</td>
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</table>

Joined Christian Medical College, Hospital in the year 1990 and in 1991 started the first Clinical Network in the Department of Neurological Sciences., extending the IT services to Operation theatre, ICU’s, Wards, Consultants room and Neuro Labs. In the year 2001 was promoted as EDP Manager of the Christian Medical College, started the New Hospital Information System (HIS), Today CMC is an institution with more than 3000 beds and 6000 outpatients on a given day with 8400 employees. The IT needs of this 112 Years institution is fully taken care by the In-House team. All the five campuses are connected through Optical Fibre and through Wireless connections.

Nature of Job: Project Architect and Database Administrator (Oracle)

WORK EXPERIENCE

<table>
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<tr>
<th>Year</th>
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<tbody>
<tr>
<td>2014-</td>
<td>General superintendent for CMC hospital</td>
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<tr>
<td>2013-</td>
<td>Head of department- (CHIPS)</td>
</tr>
<tr>
<td>2012-</td>
<td>Sr.Systems Manager</td>
</tr>
<tr>
<td>2010-2012</td>
<td>Systems Manager</td>
</tr>
<tr>
<td>2001-2010</td>
<td>EDP Manager</td>
</tr>
<tr>
<td>1995-2001</td>
<td>Programmer-Sr.Programmer</td>
</tr>
</tbody>
</table>

Worked as Senior Developer & Site Manager at NORMAH, Kuching Malaysia Eutech Cybernetics Ltd, Malaysia (Health Care Division) for 3 months March – May 2000
Worked as HIS Consultant, for Bosco Institute of Information Technology (BIIT), Yelagiri November 2010 – February 2011

**Project Details in Brief:**

**HIS (Hospital Information System):**
Introduced RDBMS (Oracle) in CMC. Storage of the patient’s life-time clinical record was planned and the migration of existing data from Fox to Oracle spearheaded. CHIPS now provides 24/7 services with no downtime for backups and 99.2% service uptime. Planned and implemented the integration of various function in different sections of the hospital – Laboratories, Medical Records Department (MRD), Pharmacy, Dietary, in-patient (IP) and out-patient (OP) areas, New practices for the Admission-Discharge-Transfer process were introduced and Online Bed Availability Status viewing was enabled. The Human Resource Management module was started and categories (staff, dependants, students, etc) commanding medical benefits were streamlined. The Theater billing processes, tariffs, and clinical data entry were streamlined. This not only resulted in financial profit, but also provided ready clinical data for surgeons. IP & OP billing processes were redefined and all existing computer modules were integrated with the billing module so that all billing information was available online.

**Finance:**
Planned and implemented all the finance software like Payment cashbook, Ledger, Receipt Cash books, Trail balance and salary and salary related modules that is currently running CMC. Planned and Migrated the old finance data from the Fox to the new System. Contactless security cards for authentication was introduced for all rule based financial transactions.

**Networks:**
A new networking infrastructure was introduced - a CISCO network with Virtual Private Networks and security walls was put in place which enabled CHIPS to extend Clinical services to the entire CMC residential campus through broadband. Currently the number of active nodes at a any given point of time is around 3000. Planned the implementation of MAN (metro area network) covering 5 campuses on fiber with RF as redundancy. Planned the implementation of WAN to get connected to internet and Telemedicine. Planned the implementation of LAN on traditional Ethernet to interconnect 3000 and odd computers to access HIS, intranet and internet. Optical fiber LAN has been implemented on residential quarters to access Intranet, PACS and HIS at residence to attend on emergencies.

**Extension to Peripherals:**
All peripheral hospitals were connected to the main hospital network through optic fibre. All existing software modules were extended to Schell Hospital, LCECU, Rehabilitation Institute and MHC, CHAD and RUHSA

**CHRIS Card and Net Banking:**
A customized cost-effective smart card solution with full security features was introduced. E-account holders of banks like Punjab National Bank and IOB can now make web payments and appointments online through a module provided by CHIPS. Credit card holders of any bank can make payments through the payment gateway of ICICI Bank.
**SMS and Paging:**

Introduced, planned and implemented the Customized SMS Gateway, web paging, multi-line telephonic paging and CART (Cardiac Arrest Resuscitation Team) paging for priority paging.

**Purchase and Material Management Module:**

Planned and set the work flow for the Purchase and Material management module for the process of procurement, receiving and distribution of all the items in CMC which is linked to the finance module.

**Implementation of RAC & Oracle Database administrator:**

Deployed Oracle RDBMS and been the Database administrator for oracle databases since it was started in 2000. Migrated to the current setup consisting of RAC (Real Application Cluster) 3 Node environment with a two node RAC for business continuity (Disaster Recovery) and a separate data mining server. Planned the migration from Oracle Database 11g, Enterprise Edition with Real Application Clusters and implement Oracle Enterprise Manager to achieve 99.999% availability and eliminate system downtime during scheduled maintenance. The upgrade also improved system performance by approximately 50%.

**Senior Training Fellowship Award**

Visited various Health Care Centers in USA between September 2000 – December 2000 for studying Clinical Information Systems

EDGE Award – 2011 for the Hospital Information Systems

**Other Administrative work**

Member, IT Policy Committee
Member, Salary Revision(2008) Committee
Member, Salary Anomaly Consideration Committee
Member, Information Technology Advisory Committee
Member, Computer Sub committee
Member, Employees Grievances Redressal Committee (Class 1 Employees)
Member, Hospital Billing & Tariff Committee
Christian Medical College
Ida Scudder Road,
Vellore, Tamil Nadu - 632004
India
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