Summer Training at
The Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow
(April 1–May 31, 2014)

A Study on the Prevalent Use of Mercury, Its Components or Amalgam in Medical Equipment, Appliances and Procedures in Patient Care Areas at a Tertiary Care Hospital

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MBA- Hospital & Health Management (MBA-HM)
2013-2015

The IIHMR University, Jaipur
2014

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CERTIFICATE

This is to certify that Dr. Raghavi Mittal has undergone her summer training in **THE SANJAY GANDHI POST GRADUATE INSTITUTE OF MEDICAL SCIENCES, LUCKNOW, UTTAR PRADESH** from 01th April to 31st May, 2014. The candidate herself carried out all the studies related to her summer training. Her approach to the study has been scientific and analytical. This summer training is in the partial fulfilment of the course requirement recommended for awarding the POST GRADUATE DIPLOMA IN HEATH AND HOSPITAL ADMINISTRATION.

I wish her success in all her future endeavours.

Col. (Dr.) Ashok Kaushik

Dean (Academics and Student Affairs)

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ACKNOWLEDGEMENT

It is my proud privilege to express my sincere gratitude and appreciation to my respected guide and mentor Dr. S.D. Gupta, Corporate Director, IHMR, Jaipur for his utmost guidance and help throughout the study. His untiring inspiration, keen interest, unfailing patience, valuable suggestions, painstaking supervision has inspired me to complete this summer training project. In this complete process I have imbibed values to carry on work with zeal and knowledge.

I take this opportunity to express my sincere thanks to Dr. Ashok Kaushik, Dean Academics and Student Affairs, IHMR, Jaipur, Dr. Hem Chandra, The Head of the Department, Hospital Administration and Mr. S.B. Singh, Assistant Engineer at the Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow for their constant help and encouragement to carry out the study.

I will be failing in my duty if I do not thank Mr. Manish and Sisters'-In-Charge at the Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow for providing me with valuable required information and help during the study period.

Finally I would like to thank my family and friends for providing me their untiring cooperation and prayers for my success. I would also like to thank all those who inspired and helped me in their own ways, whom I could not thank personally and whose names I am unable to mention herein.

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Hospital Administration

Institute of Health Management Research, Jaipur

Abbreviations

S.G.P.G.I.M.S - Sanjay Gandhi Post Graduate Institute of Medical Sciences

OPD - Outpatient Department

ERS - Emergency Services

IPD - In Patient Department

ICU - Intensive Care Unit

PGDHM - Post Graduate Diploma in Health and Hospital Administration

EMO - Emergency Medical Officer

PMSSY - Pradhan Mantri Swasthya Shuraksha Yojana

HRF - Hospital Revolving Fund

IRF - Investigations Revolving Fund

Hg - Mercury

BMW - Biomedical waste

MOPD - Main Out Patient Department

BMT - Bone Marrow Transplantation

CONTENTS

Chapter I

Introduction

1.1 Background of the Sanjay Gandhi Post Graduate Institute of Medical Sciences

The Sanjay Gandhi Post Graduate Institute of Medical Sciences was established in the year 1983 in the city of Lucknow, Uttar Pradesh. The institute was developed in an area of 550 acres of land on the Raebareli Road, Lucknow. It is autonomous medical institution as Deemed University by the Act of Uttar Pradesh assembly.

The hospital works as a referral hospital and endeavors to work on an appointment system. Most of the patients are required to bring referral slips. It is fortunate in receiving a grant aid from the Government of Japan with the help from the Central Government of India, for its equipment needs .A long term technical cooperation was forged between SGPGIMS and Nagoya University School of Medicine under the aegis of Japan International Cooperation Agency (JICA), to foster technology transfer and research collaboration.

Objectives of the Institute

- To create a centre of excellence for providing medical care, education and research facilities of high order in the field of medical sciences in the existing super specialties and such others, as may emerge in future, including continuing medical education.

- To develop patterns of teaching in post graduate medical education in super specialties, so as to set a high standard of medical education.

- To provide for training in paramedical and allied fields, particularly in relation to super specialties.

The Administrative Setup

The act has made specific provision in respect of the officers of the institute. However, for carrying out the business of the institute, the director is associated by the Additional director and the Joint Director (administrator) in respect of administrative matters, the dean for academic matter, the Finance Officer for the Finance matter, the Joint Director for material management, the Consultant (Technical engineering) and chief engineer for engineering matter (civil, electrical and biomedical) and the medical superintendent in respect of hospital matters. The institute comprises of different speciality department, the senior faculty member of the department being the head of the department. The Executive Registrar carried out examination and other related tasks.

Regular Staff

- Faculty > 180
- Senior Resident >250
- Nurses > 1000
- Technicians > 200
- Officers > 20
- Others > 800

Specialties

There are six super specialties which were started in phase 1 are:

- Neurological Sciences (Medical & Sciences)
- Cardiac Sciences (Medical & Sciences)
- Renal Sciences (Medical & Sciences)
- Gastroenterology (Medical & Sciences)
- Endocrinology (Medical & Sciences)
- Genetics and Immunology (Medical & Sciences)

Latest Inclusions

- Critical Care Medicine
- Hematology
- Hospital Administration
- Plastic Surgery
- Pulmonary Medicine
- Pediatric Surgery
- Maternal and Reproductive Medicine

Various Academic Programmes offered at the Institute

- D.M.
- M.Ch.
- M.D.
- PhD
- Post Doctoral Certificate Course
- BSc. Nursing
- Diploma in Hospital Administration
- Diploma in Nursing Informatics
- Diploma in Hospital Information System
- Diploma in Telemedicine
- Diploma in Public Health Information System
- Diploma in Library Information System

Hospital Organization

Patient care in a hospital is combined result of many services

- Clinical and Nursing services – Out Patient services, In Patient services, Emergency Receiving Station, Operation theatre.
- Supportive services- Laboratory, Blood Bank, Imaging, Drug Dispensary, Centre Sterile Supply Department, Medical Records Department, Medical social worker with Public Relation Office.

- Business services- Hospital Revolving Fund, Inventory Revolving Fund, Finance Management, and Material Management.
- Utility services- Communication, Transportation services, Fire Security, Dietary services, Laundry and Linen services, House-keeping services, Engineering services and Maintenance

Milestones of Development at S.G.P.G.I.M.S. Hospital, Lucknow, Uttar Pradesh

Years	Milestones
1980	Foundation stone laid by Dr. Neelam Sanjeeva Reddy, then president of India.
1982	Dr. B.C. Joshi appointed as Project Director.
1983	SGPGIMS established by an Act of Uttar Pradesh State Legislature.
1987	❖ The Government of Japan supported the institute with Grant –in aid of 3.32 billion yen. ❖ Outpatient and Inpatient Services started in the hospital. ❖ First surgery (post partum ligation) performed in the General hospital.
1988	First batch of DM, M.Ch and PhD students joined.
1989	First Renal Transplantation was performed.

1990	❖ DM (Clinical Immunology) course Started for the first time in India. ❖ Endoscopic Ultrasonography, Oesophageal Manometry and pH monitoring started for the first time in India. ❖ First Open Heart Surgery. ❖ DM (Medical Genetics) course started for the first time in India. ❖ MD (Transfusion Medicine) Course was started for the first time in India. ❖ Computerized radiography was started for the first time in India. ❖ Biostatistics Course started. ❖ Global Plenum on Organ Transplantation was organized. ❖ MRI machine was commissioned.
1991	❖ First batch of DM and MCh batch completed training. ❖ MCh(Surgical Gastroenterology) course, at a National level for the first time in India. ❖ Molecular Endocrinology laboratory started. ❖ Cerebrovascular studies with HEADTOME started for the first time in India. ❖ MRI was installed in radiology department.
1992	Plasma apheresis in transfusion medicine department was started.

1993	❖ New operation theatre complex started functioning. ❖ Surgical intensive unit was made operational. ❖ Automated rapid diagnosis system for bacterial infection started for the first time in India.
1994	❖ Intraoperative ultrasonography in endocrine surgery started for the first time in India. ❖ Scanning electron and transmission electron microscope become functional. ❖ Coil occlusion of patent ductus arteriosus performed for the first time in India. ❖ First convocation and first institute foundation day .
1995	Platelet apheresis in transfusion department was started.
1997	❖ Computerized Hospital Information Centre was developed. ❖ Spiral CT was installed. ❖ Hospital revolving fund was established.
1998	First bone marrow transplant was done.
2001	Shruti auditorium in the campus was commissioned.(750 seats)
2003	First liver transplant done in public sector in India.
	❖ The institute became the first centre in the world to apply innovation in ross

2004	procedure ❖ The tissue of the cow was used to correct a defective aortic valve. ❖ The institute took a lead in the country in adopting information technology in its routine activity. ❖ First in public sector to adopt H.I.S. and Telemedicine.
2004	A newly constructed 17 bedded block for the emergency services was commissioned. Earlier it was managed in one of the wards.
2005	❖ A new diagnostic block was various laboratory oriented departments was established. ❖ Voluntary counselling and diagnostic centre was established in the OPD by the National AIDS Control Organization.
2006	School of telemedicine and Biomedical informatics was established in the institute.
2007	❖ Was declared as a National Centre for resource development in Telemedicine by Ministry of Information and Communication. ❖ College of nursing was established.
2007	A separate gastroenterology ward was established.

2008	❖ Foundation stone and building construction of new 150 bedded hospital under the Prime Minister Swasthya Shuraksha Yojna was started. ❖ Academic department of Hospital Administration was established and the department was started. ❖ Diploma in Hospital Administration was started with 09 students enrolled.

Catchment Areas:-

- ❖ Uttar Pradesh-85%
- ❖ Madhya Pradesh- 04%
- ❖ Bihar-04%
- ❖ Uttaranchal-01%
- ❖ Nepal-01%
- ❖ Others-05%

Treatment Charges:-

❖ Registration Charges – Rs.250

❖ Renewal Fees (annual)- Rs. 100

❖ Bed Charges –

Private- Rs.1000/bed/day
(Costing approx –Rs2800/bed/day)
General-Rs.250/bed/day
(Costing approx-Rs. 2400/bed/day)

❖ Charges of surgery, consumable, surgical medicine extra.

Out sourcing of the facilities:-

(For the cost containment, cost effectiveness and cost efficiency)

Services:-

- ❖ Laundry
- ❖ Kitchen
- ❖ Security

- Sanitation
- Manpower – Patient helper
  -Nurses
- Medical gases
- Air conditioning
- M.R.I
- Ultrasound

- G.I. Endoscopy
- Lithotripter
- External Transportation

Public Facilities:-

- Patient Relation Accommodation and Rogi vishramalaya
- Canteen
- Meal for private room patient Attendant
- A.T.M. facility
- Bank facility
- Post office
- External and Internal transportation
- Educational Programme
- Railway reservation centre established
- 24 hrs coffee shop outside emergency ward

Peculiarities of the Institute:-

- The **first** public sector fully tertiary care (super speciality) Hospital in India.
- The **first** public sector fully computerized Hospital Information System (H.I.S.) run hospital in India.
- The **first** public sector hospital of Uttar Pradesh started outsourcing of services.
- The **first** hospital of Uttar Pradesh where kidney, liver, bone marrow transplantation was performed.
- The **first** medical institute of Uttar Pradesh who acquired qualified professional hospital administrator.

- The **first** public sector hospital developed equity in the treatment.
- No free treatment based on any Sex, age, creed, caste etc. Treatment is based on **advance deposit** from all patients to prevent bad debts.

Short comings of the Institute:-

- Far from the city and not well connected.
- Distance between highway and hospital is very large.
- Emergency services are having limited facilities.

- OPD is overcrowded.
- Corridors are real bottleneck.
- Non availability and Shortage of trained specialized nurses.
- Behavior of the available manpower.
- Professional liability.

1.2 An Overview of the various Departments and Services at the S.G.P.G.I.M.S., Lucknow, Uttar Pradesh

The Department of Hospital Administration

The role of administration is increasing day by day for effective and efficient delivery of health services. Patients satisfaction, cost containment, quality of medical care provided are few measurements of the output from hospital delivery system which can be achieved by using the management concept and techniques through the trained/qualified hospital administrators/managers.

In addition to active core administrative activities, the SGPGIMS has been imparting the teaching, training and research programmes in the field of hospital administration on regular basis for the last 15 years across the entire spectrum.

However the academic Department of Hospital Administration was established in the year 2008. The department has full time Diploma course in Hospital Administration (DHA). It intends to start MD in Hospital Administration soon.

The primary objectives of the department are to establish a centre for Teaching, Research & Training in the field of Hospital & Health Administration and to develop the manpower in same field. The operational objectives of the department are to facilitate the patient care services at all levels in order to achieve excellence through evidence based administration.

The Department of Hospital Administration is dedicated to teaching, training and research on all the issues that directly or, remotely relate to the hospital management/administration. It is also actively involved in organizing training program/seminars for the central and the state government, health services officers on various aspects of hospital & health administration and patient care management.

So far 30 students have been enrolled in DHA. The department has been involved as program study centre for P.G. Diploma in Hospital & Health Management run by IGNOU. Till date 350 students have been enrolled and educated by the department, it has a credit of bagging four gold medals out of 12 convocations held so far by IGNOU. There are more than 100 publications, 125 teaching/training programmes, 10 awards etc under the name of the department so far.

Faculties, Senior Resident of the department are also holding administrative duties of the Institute. The present strength of department is comprised of Dr. Hem Chandra as Professor & Head of the Department and of Dr. Rajesh Harshvardhan , Assistant Professor.

The department is located in the A- block of hospital building to begin with further an additional floor has been allotted in the newly constructed Technology Building ,located next to the College of Nursing in the Institute premises. The Departmental library have a collection of over 100 standard books in subject of Management Hospital Administration, Finance, Accountancy, Communication, Marketing, Public Health, 1Law, Nursing Research Methodology, Planning etc.

The Outpatient Services

Figure 1: OPD entry/exit at S.G.P.G.I.M.S., Lucknow, U.P

Location-

The Outpatient Services of the hospital is located on the ground floor of the S.P.G.I.M.S.

It witnesses an average patient turnout of 150 new and 200 old patients.

The following specialities providing patient care in the institute:-

Main Hospital

- Endomedicine / Endosurgery, Paediatrics
- Genetics/Immunology/Haematology
- Neuromedicine/Neurosurgery
- Gastromedicine/Gastromedicine
- C.V.T.S./ Cardiology
- Nephrology/Urology
- Radiotherapy and Nuclear Medicine

PMSSY Block

- Plastic Surgery and Burn
- Paediatrics
- Maternal and Reproductive health
- Pulmonary units

General Hospital

- Medicine
- Paediatrics
- Orthopaedics
- Gynaecology
- Skin
- Dentistry

For ambulatory care, the hospital has provision for day care ward with three endoscopy units and two operation rooms for minor surgical, investigate and interventional procedure.

The cardiac investigation facilities are Cath lab, 2D colour Doppler, ECHO and Tread mill and monitory equipment. Clinical pathology services are equipped with Technicians, auto analyser, blood cell auto analyser.

The Department of Radiology is equipped with MRI, whole body CT Scan, Computerized radiography automatic positioning GI table besides routine and mobile X-Ray Equipment and Ultrasound.

Modern mobile care is expensive and the state cannot afford to provide free medical care to all. The institute hence charges the patients for its services at rates which are subsidized and considerably reasonable, generating one-fourth of its total revenue through this manner.

Patient Movement in the Outpatient Services

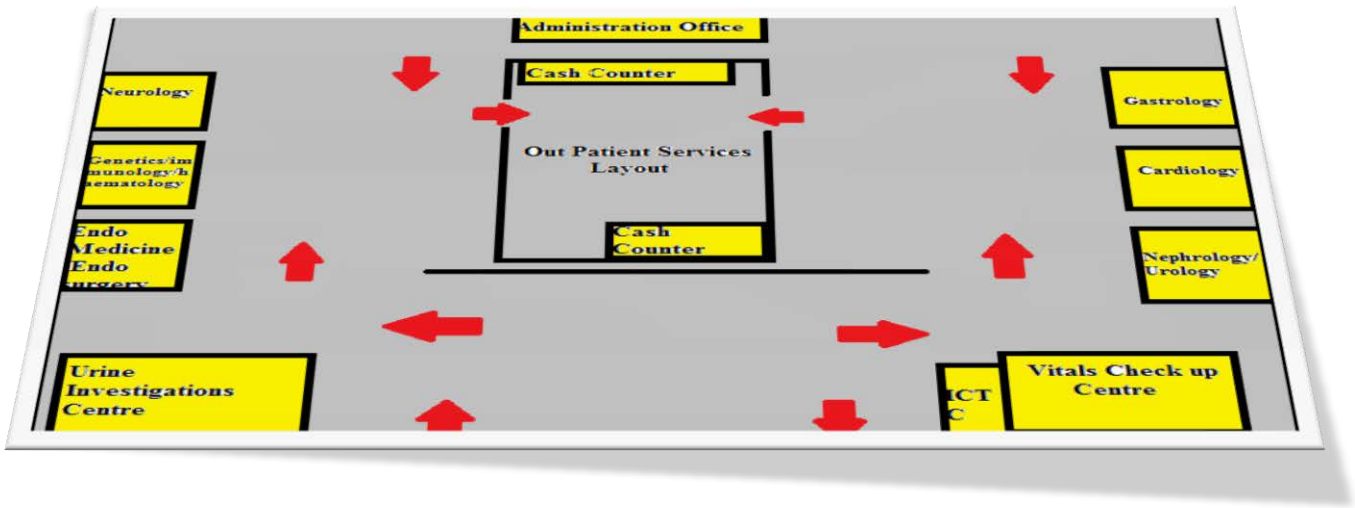


Figure 2:- Layout of the Outpatient Department in the Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow, Uttar Pradesh.

Patient Movement Flow Chart in the Out Patient Services of the S.G.P.G.I.M.S.

Patient enters the hospital → His/ Her referral card is checked at the registration counter and patient is registered on the HIS system.

↓

The patient is required to deposit money at the cash counter

A token number is provided to the patient.

↓

On the required token number the patient's vitals are recorded

He/ She is registered for the consultant on duty in the respective specialities halls.

↓

Based on the diagnosis by the consultant doctor of the patient, he/she is directed in following ways:-

- For investigations to the investigation cash counter.
- For admission in the IPD ward based on availability of the beds.
- For follow-up in future.

↓

Patient will exit the department and move as directed.

The Emergency Services

Location

The emergency services department is located on the ground floor of the S.G.P.G.I.M.S. hospital. It is a specialized block with a bed strength of 30 beds in ERS 1 and ERS 2 respectively.

The department serves as a separate entity with its own registration counter, cash counter, investigations centre and H.R.F. emergency.

Patient movement in the Emergency Services

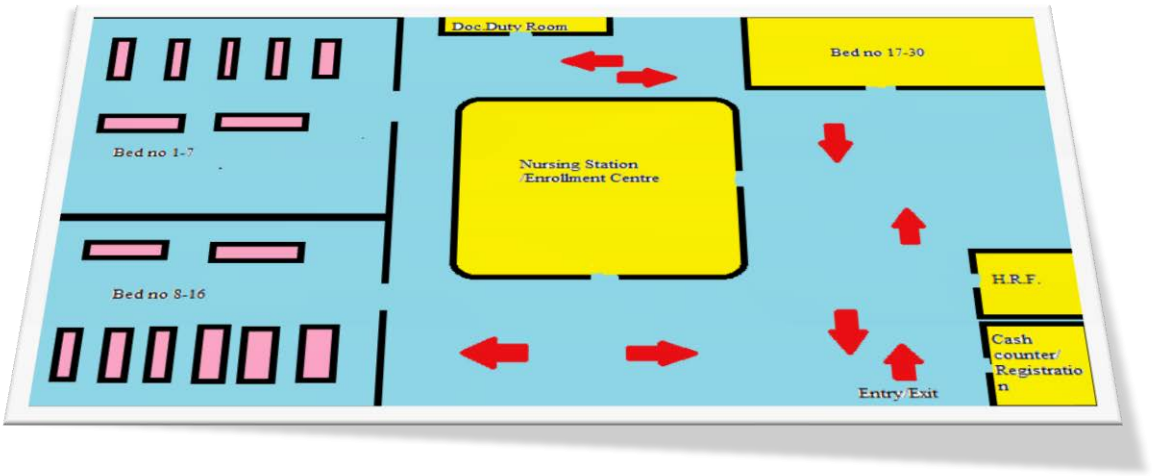


Figure 3: Basic layout of the emergency services department of the S.P.G.I.M.S, Lucknow, Uttar Pradesh.

Patient movement in Emergency Medical Services

Patient reports to emergency → The Emergency Medical Officer checks the records and referral of the patient.

↓

Treatment possible in the S.G.P.G.I.

↓

M.S / E.M.O. admits the patient, formalities Completed and the treatment is started.

↓

The consultant on call is informed.

Investigations are advised.

↓

The consultant examines the patient and decides on the future course of treatment.

↓

If the beds are available in the patient is treated.

in the emergency shifted

Treatment facility not available in Hospital

↓

The patient is referred out of the Hospital.

↓

If the bed is not available then the Department the patient is

And after stability he/she is asked to wait till beds are available.

The In Patient Department

जी-ब्लॉक (वार्ड ब्लॉक)			
क्रम सं०	तल संख्या	ए-ब्लॉक	बी-ब्लॉक
0	भू तल	इण्डो मेडिसिन	इण्डो सर्जरी
1	प्रथम तल	एम.आई.सी.यू.	कार्डियोलॉजी
2	द्वितीय तल	रेडियोथेरेपी, जेनेटिक्स	सी.वी.टी.एस.
3	तृतीय तल	नेफ्रोलॉजी	नेफ्रोलॉजी
4	चतुर्थ तल	यूरोलॉजी	यूरोलॉजी
5	पंचम तल	गैस्ट्रो मेडिसिन	गैस्ट्रो मेडिसिन
6	षष्टम तल	गैस्ट्रो सर्जरी	गैस्ट्रो सर्जरी
7	सप्तम तल	न्यूरो मेडिसिन	न्यूरो मेडिसिन
8	अष्टम तल	न्यूरो सर्जरी	न्यूरो सर्जरी
9	नवम तल	हेमेटोलॉजी, बी.एम.टी.	इम्युनोलॉजी

Figure 4: The figure depicts the signage for the IPD wards at S.G.P.G.I.M.S., Lucknow ,U.P.

Figure 5: Signage for for the specialized ICUs and Paediatric ICUs

Location:- The S.G.P.G.I.M.S. hospital, Lucknow, Uttar Pradesh has a separate nine floors block for the In Patient wards called the G Block. These wards have a decentralized system of a cash counter and HRF.

The Department comprises of

- The Head of the Department
- Senior Consultants
- Junior Consultants.

The Nursing Staff is comprised of

- Sister-in-Charge
- Head Nurses
- Junior Nurses.

Overall there are 5-6 nurses per shift.

The shift duties are as follows

- 8am-2pm
- 2pm-8pm
- 8pm-8am

The wards are Riggs type of design. Separate private rooms are provided to the patients as per their requirements and subject to availability.

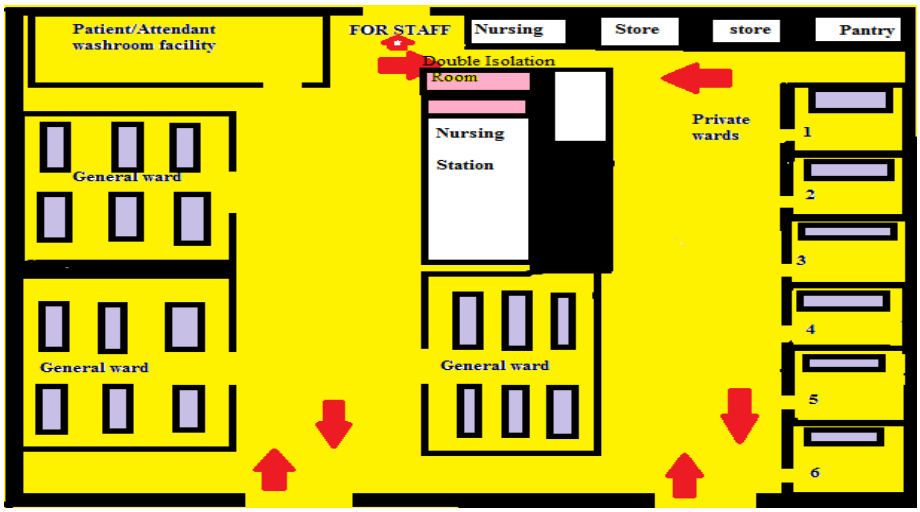


Figure 6: IPD ward design of S.G.P.G.I.M.S, Lucknow, Uttar Pradesh.

The patient is admitted from the OPD or after the Operation. He/ She is required to deposit money in the cash counter. The medicines are procured from the HRF centre which is decentralized in the hospital. One of the peculiar characteristics of this department is that it deducts money from the account card of the patient directly. In case money is remaining in the hospital account, at the end of treatment it is to be refunded back.

For the convenience of the patient' relatives they have been provided waiting halls.

Figure 7: The IPD ward design at the S.G.P.G.I.M.S. ,Lucknow, Uttar Pradesh.

Figure 8: Patient relatives waiting hall at S.G.P.G.I.M.S., Lucknow, Uttar Pradesh.

The discharge process

Patient is treated and he/she is ready for discharge.

↓

Doctor requests discharge process to be initiated.

Further follow-up treatment and medications are advised.

↓

The formalities are completed

Relatives are asked to clear the remaining dues (if any)

Avail a no-dues certificate from the cash counter and HRF.

Refund to be given if applicable.

↓

Patient relieved

She/he is asked to report to the OPD on desired date to the respective consultant.

Various services provided by the Institute for the benefit of the patient

The Transportation Services

The transport department is committed towards serving the patients with round the clock services. The department has been functioning at three levels –for the OPD patients, for the IPD patients and for the PMSSY patients. Overall there are approximately 100 wheelchairs, 30 stretchers available. Further the ambulatory service is regulated by the Public Relations Cell.

For providing personalized care to the patient and to reduce the inconvenience to the morbid there is a service attendant with each wheelchair and stretcher to carry the patient from the main entrance to the area of treatment intended. These attendants are working in three shifts.

The Laundry and Linen Services

The laundry and linen services are on contractual basis and outsourced in the S.G.P.G.I.M.S. The total manpower involved in maintaining the services are approximately 30. There are overall four machines for washing, four for hydro spin, three for drying and three for ironing the linen.

Process

Collection of dirty linen from the wards/ Utilities

↓

Washing with plain water + HCl (dil) 10%

↓

Washing with detergent and liquid soap

↓

Dipping in hypochlorite solution (dil) 8%

↓

Stains removed

↓

Washing in plain water

↓

The linen is dried and then ironed and supplied back to their respective wards/Utilities.

They maintain the following records

-Cloth incoming register

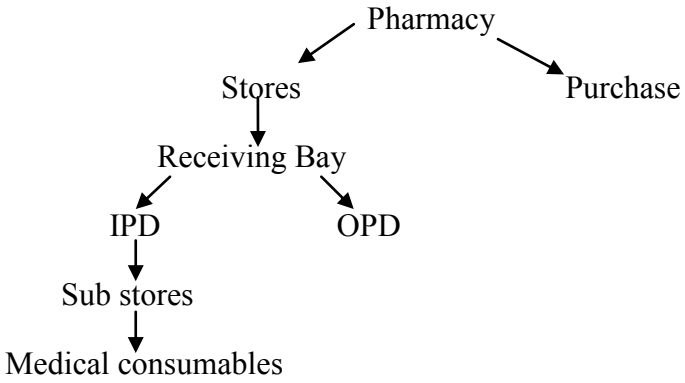
-Cloth outgoing register

-New linen stitch register

-Alteration register

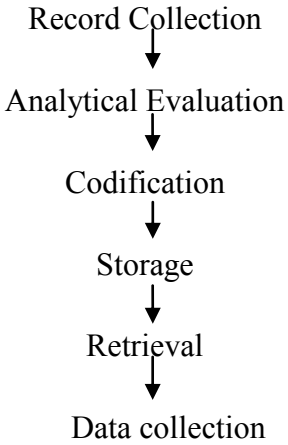
Pharmacy

Process



The Medical Records Department

Process



Various records maintained are:-

-IPD files received register

-IPD files dispatch register

-OPD files received register

-OPD files dispatch register

-Birth records

-Death records

This department ensures maintenance of all the health records of the hospital in an organized manner. The staff ensures the preservation, storage, confidentiality and retrieval of documents of the patients.

The Hospital Revolving Fund (HRF) and the Investigation Revolving Fund (IRF)

There are very few institutes which have Hospital Supply Chain Management of drugs and medicines, surgical goods, vendor managed inventory and outsourcing of patient care and services.

The HRF and IRF are based on the model of "Business Process Re-engineering." This concept ensured hassle free procurement and distribution of drugs and medicines and surgical consumables. It works on the principles of "self-sustainability."

The medicines and investigations are available round the clock in the institute.

This system has allowed decreased movement of files and records, reduced mistrust, increased transparency, fairness, accountability and promptness**.**

Department of Telemedicine

The department of telemedicine was started in the year 1999. It is involved in following activities:-

-Tele health care

-Distant Medical Education

-Research and Development

-Developing Core Competence

-Participants in National Policy Initiatives

-Telemedicine consultancy and solution providers

-Organizational activities in Telemedicine

1. 3 Mercury

Background of Mercury

Hg is the modern chemical symbol for mercury. It comes from *hydrargyrum*, a Latinized form of the Greek word Ύδραργυρος (*hydrargyros*), which is a compound word meaning "water-silver" (hydr- = water, argyros = silver) — since it is liquid like water and shiny like silver.

The element was named after the Roman god Mercury, known for speed and mobility. It is associated with the planet Mercury; the astrological symbol for the planet is also one of the alchemical symbols for the metal; the Sanskrit word for alchemy is Rasavatam which means "the way of mercury". Mercury is the only metal for which the alchemical planetary name became the common name.

Mercury was found in Egyptian tombs that date from 1500 BC. In China and Tibet, mercury use was thought to prolong life, heal fractures, and maintain generally good health, although it is now known that exposure to mercury vapour leads to serious adverse health effects.

The ancient Greeks used mercury in ointments; the ancient Egyptians and the Romans used it in cosmetics which sometimes deformed the face and by 500 BC mercury was used to make amalgams (alloy of mercury) with other metals.

Mercury continues to be a substance of great significance in Hindu religious practices. The Vishnudharmottara Purana, a Hindu text dedicated to the arts, contains a section dated from around the 7th century AD that mentions “red lead” (in Latin mercury ore, cinnabar, is minium or “red lead”) as a source of red pigment and the Jaina text,
the *Citra Kalpadruma*, details the preparation of this pigment.

Mercury was widely employed as an agent to treat syphilis and, in addition to its use as an antibiotic, has been the active ingredient in many other medicinal, including diuretics, antiseptics, antipruritics, analgesics, and laxatives.(1)

Mercury and its compounds have been used in medicine, although they are much less common today than they once were, now that the toxic effects of mercury and its compounds are more widely understood.

- The element mercury is an ingredient in dental amalgams.
  Thimersal (called *Thimerosal* in the United States) is an organic compound used as a preservative in vaccines, though this use is in decline.
- Another mercury compound merbromin (Mercurochrome) is a topical antiseptic used for minor cuts and scrapes is still in use in some countries.
- Mercury in the form of one of its common ores, cinnabar, is used in various traditional medicines, especially in traditional Chinese medicine.
- Today, the use of mercury in medicine has greatly declined in all respects, especially in developed countries. Thermometers and Sphygmomanometers containing mercury were invented in the early 18th and late 19th centuries, respectively. In the early 21st century, their use is declining and has been banned in some countries, states and
  - medical institutions. In 2002, the U.S. Senate passed legislation to phase out the sale of non-prescription mercury thermometers.

Characteristic Features

Mercury is a heavy silver-white metal which is found in liquid state at room temperature. It is also known as Quick Silver. It has a melting point of -38.83 degree Centigrade and boiling point of 356.73 degree Centigrade(2).

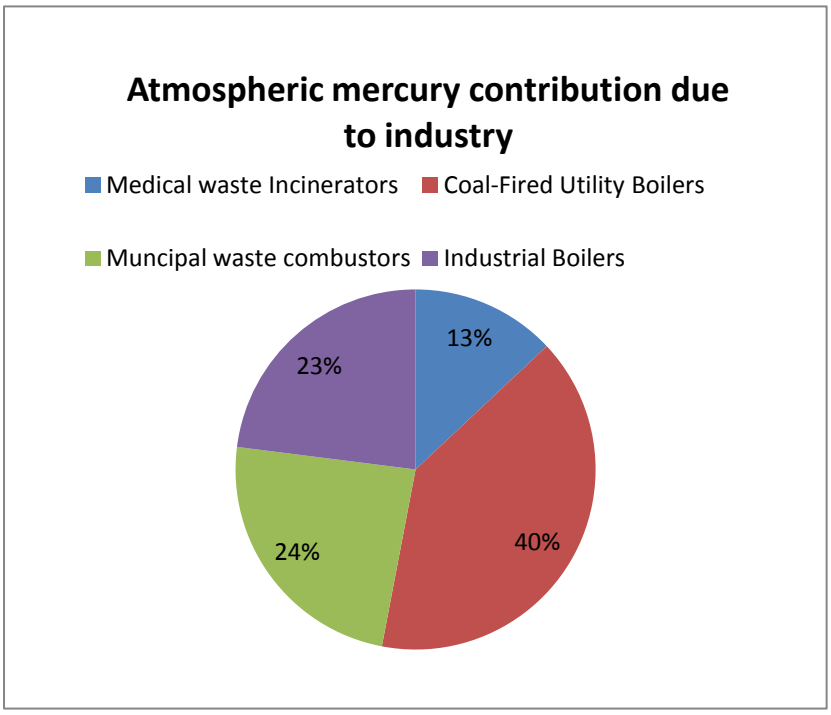
In comparison to other metals it is a poor conductor of heat but a fair conductor of electricity. Mercury readily vaporizes and may stay in the atmosphere for up to a year (3).

When released into the air, it is transported and deposited globally. Mercury is seen to ultimately accumulate at the bottom of water bodies, where it is transformed into its more toxic organic form, methyl mercury, which accumulates in fish tissue(4).

Sources of Mercury

Although mercury is naturally occurring in volcanoes, natural deposits, and oceanic

Volatilization, human activities have substantially increased the amount of mercury cycling through the ecosystem



Source: 1997, EPA study (5)

Presence of Mercury in the environment (Flora and Fauna)

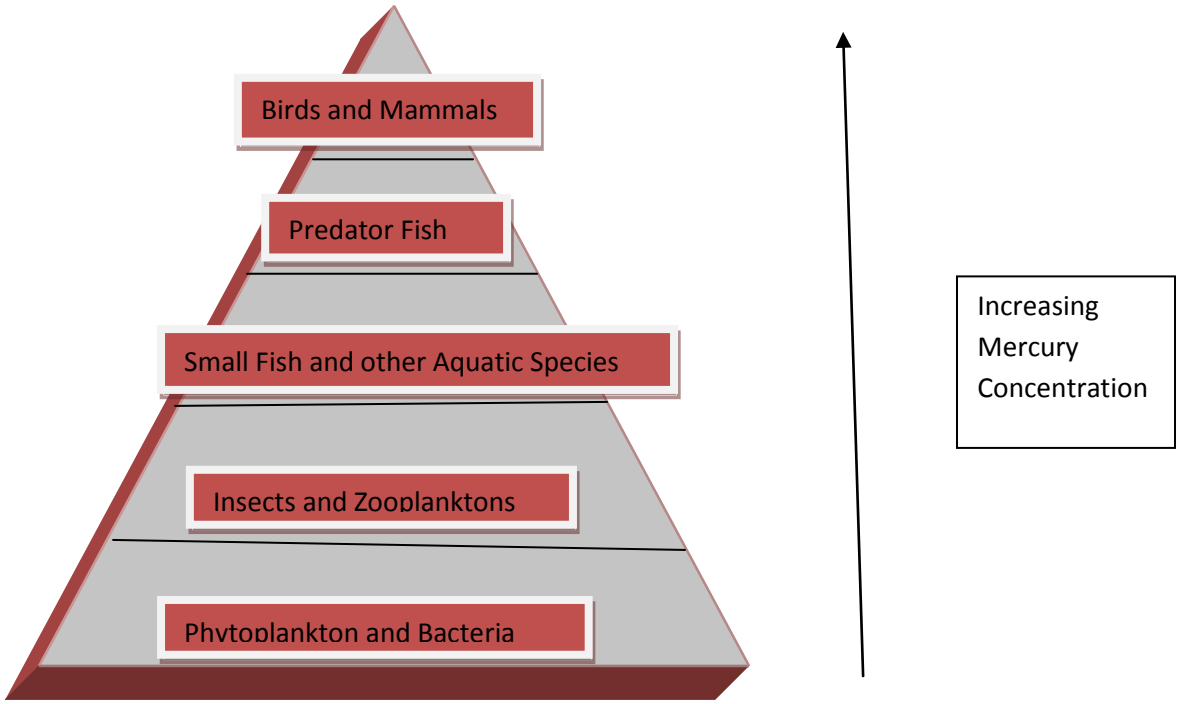


Figure 8: Accumulation of mercury in the food chain.

Uses of Mercury

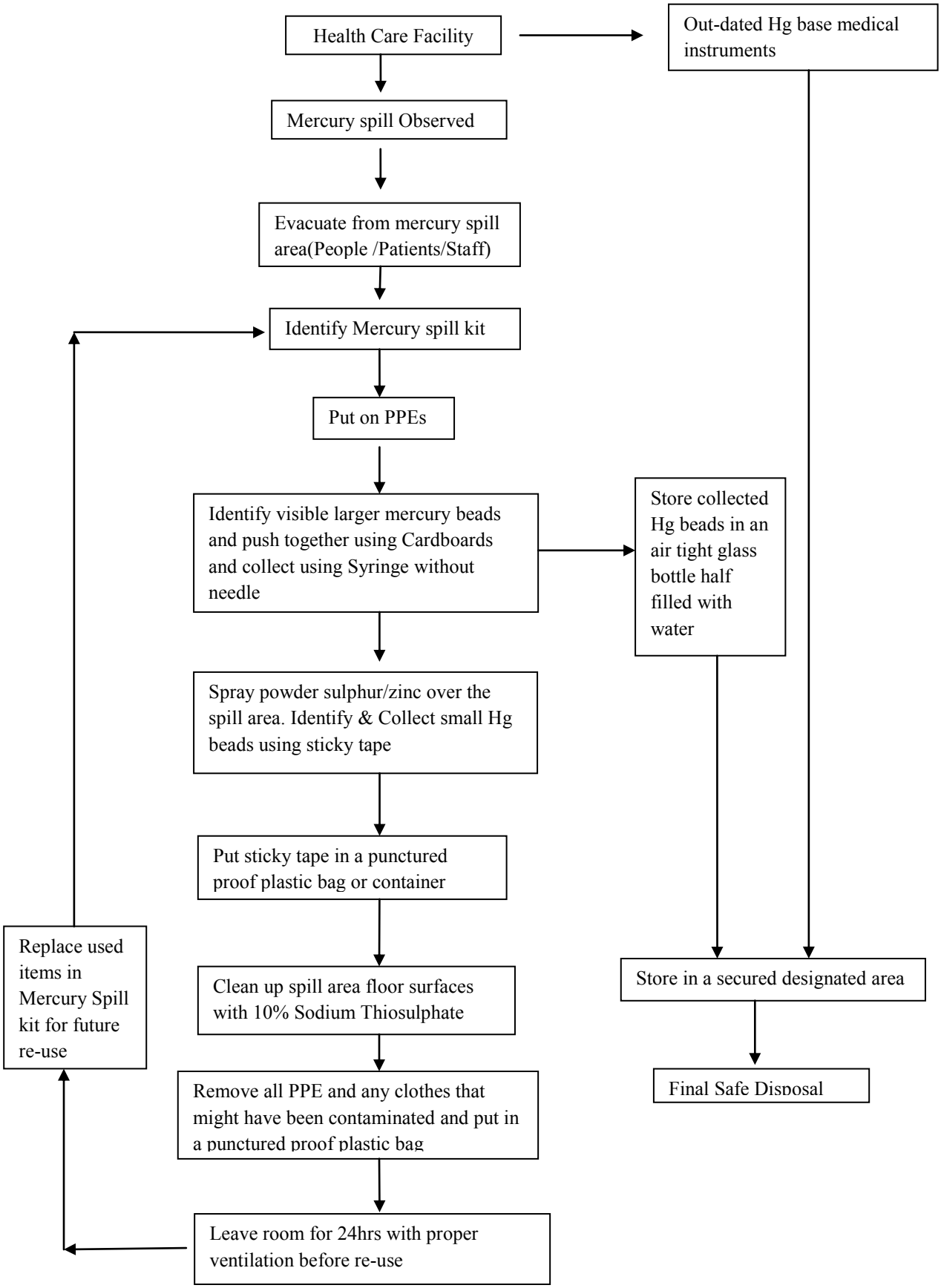
Mercury is a rare element which occurs in the form of Mercuric Sulphide. It is used for the extraction of gold and silver

- as a catalyst for chlor-alkali production
- in manometers for measuring and controlling pressure
  in thermometers
- in electrical and electronic switches, in fluorescent lamps
- in amalgam fillings (6)
  Chemical compounds of mercury are used in batteries
- in biocides
- in paper industry
- in paints
- as antiseptics in pharmaceuticals
- as reagents in laboratories
- and as catalysts

Mercury toxicity

Over the past half century it has become increasingly apparent that exposure to mercury can have adverse health consequences. This began with the recognition that "pink disease," or acrodynia, was related to the use of mercury-containing medications, which eventually resulted in the exclusion of calomel (Hg_2Cl_2) from most teething powders in 1954(7).Adverse health consequences due to environmental contamination by mercury were exemplified by the Minamata Bay disaster in 1956 in Japan (8). A syndrome of progressive muscular dystrophy, blindness, neurological dysfunction, paralysis, coma, and death was shown to be related to industrial contamination by methyl-mercury of aquatic life in the Minamata Bay area, resulting in the eventual demise of over 2,265 individuals. Also related to this disaster, it was demonstrated that local pregnant women who consumed mercury contaminated fish gave birth to infants with severe developmental disabilities (9). Chronic exposure to mercury from environmental sources such as fossil fuel emissions from power plants (10) or from other sources such as fish consumption, amalgam fillings, fluorescent light bulbs, and vaccines,(11) has been postulated to be a possible causative factor in the aetiology of symptoms of central nervous system dysfunction and renal toxicity.(12) Mercury exposure is also believed my many to play a role in the Apparently increasing incidence of developmental disorders, such as autism (13) and in the aetiology of learning disabilities,(14) such as attention deficient disorder (ADD) and attention-deficit hyperactivity disorder (ADHD). Mercury now is clearly recognized as a hazardous chemical that can cause serious health problems,(15) especially in children and during foetal development.(16) It is known to react with sulfhydryl, phosphoryl, carboxyl, and amide groups, and is a neurodevelopment toxicant that can adversely affect enzymes, cellular membrane function, and neurotransmitter levels;(16,17) can increase oxidative stress, lipid per- oxidation, and mitochondrial dysfunction; and can disrupt synaptic transmission, microtubule formation, amino acid transport, and cellular migration in the developing brain.(18)

Flow chart depicting how to clean a mercury spill



Chapter II

Review of Literature

- **Clarkson TW et al(2003)** gave a review of The Toxicology of Mercury, Current Exposures and Clinical Manifestations and had concluded that All forms of mercury have adverse effects on health at high doses. However, the evidence that exposure to very low doses of mercury from fish consumption, the receipt of dental amalgams, or thimerosal in vaccines has adverse effects is open to wide interpretation. Moreover, attempts to reduce such exposure may pose greater health risks than those hypothesized to occur from mercury.
- **Masur LC(2011)** gave a review of the Use of Mercury in Historic and Current Ritualistic and Spiritual Practices and concluded that In spite of the major efforts being undertaken to reduce or eliminate the use of, and opportunities for exposure to, mercury, its utilization in ethno- medical and magico-religious rituals and spiritual practices continues. Extensive educational and socio-cultural interventions aimed at curtailing these practices appear to lack significant effect. The adverse health effects of, and the environmental contamination by, these uses of mercury likely will continue to present major personal, public, and environmental health challenges.
- **Palmer RF et al(2009)** conducted a study determine if proximity to sources of mercury pollution in 1998 were related to autism prevalence in 2002 and had reached a conclusion that for every 1000 pounds of industrial release, there was a corresponding 2.6% increase in autism rates and a 3.7% increase associated with power plant emissions. Distances to these sources were independent predictors after adjustment for relevant covariates. For every 10 miles from industrial or power plant sources, there was an associated decreased autism Incident Risk of 2.0% and 1.4%, respectively
- **Guzzi G et al(2012)** conducted a study to determine the effect of thimerosal, a topical antiseptic and preservative in vaccines routinely given to children, methyl mercury, and mercuric chloride on cellular viability in Jurkat T cells, a human T leukemia cell line and had concluded that contrary to thimerosal and methyl mercury, mercuric chloride did not modify Jurkat T cell viability.
- **Kingman A et al(1998)** had conducted a study to evaluate the mercury concentrations in urine and whole blood associated with amalgam exposure in a US Military

population and concluded that The amalgam exposure was quite variable in the small groups of subjects who had higher levels of Hg in urine or blood. Thus, these elevated levels could not be totally explained by amalgam exposure.

- **Barregard L et al(1995)** conducted a study to describe people with high mercury (Hg) uptake from their amalgam fillings, and to estimate the possible fraction of the occupationally unexposed Swedish population with high excretion of urinary Hg and had concluded that although the average daily Hg uptake from dental amalgam fillings is low, there is a considerable variation between people; certain people have a high mercury uptake from their amalgam fillings.

- **Olstad ML et al(1992**) had evaluated the risks associated with Mercury vapour from Dental Amalgam and had concluded that mercury is a toxic substance. For high exposures, observed mostly in occupational settings, the severity of response correlates with the duration and intensity of the exposure. The relationship between the severity of response and the duration of exposure has, however, not been quantified at levels of exposure associated with dental amalgam restorations.

  In addition, subtle signs and symptoms of chronic mercury intoxication may not be found through routine physical examinations. At the mercury doses produced by amalgam fillings, the evidence is not persuasive that the wide variety of non-specific symptoms attributed to fillings and "improvement" after their removal are attributable to mercury derived from the fillings.

- **Englund GS et al(1998)** conducted a study to evaluate the mercury in biological fluids after Amalgam Removal and had concluded that the removal of amalgam fillings results in a minor increase of Hg in plasma, followed by a considerable decline in all media. The Hg levels in plasma and urine slowly approached the levels found in subjects without any history of amalgam fillings.
- **Ahlquist M et al(1993)** had conducted a study to enumerate the number of amalgam fillings in relation to cardiovascular disease, diabetes, cancer and early death in Swedish women and had concluded that the significant inverse correlations between number of amalgam tooth fillings and the endpoints studied disappeared when number of teeth and socioeconomic group were included in a multivariate analysis. The study thus did not provide any evidence for a correlation between amalgam fillings and cardiovascular disease, diabetes, cancer or early death.

Chapter III

Rationale

3.1 Difficulties managing mercury in hospitals

A survey in the Czech Republic showed that mercury waste from hospitals (estimated to 1000 kg/year) was generally not recycled but incinerated or land filled as hazardous waste, thus contributing to potential contamination of the environment.(19)

3.2 Higher costs of mercury devices

Mercury devices represent a significant financial burden for hospitals. Mercury devices must be collected separately and treated as hazardous waste. It can also be quite costly to clean a contaminated healthcare facility if a sphygmomanometer breaks.

While non-mercury devices are sometimes more expensive to purchase than mercury devices, total life-cycle costs of mercury devices are often higher than the mercury-free alternatives.

Reasons for the higher cost of mercury devices include: compliance with regulations around mercury handling; cleaning up after spills; need to train staff how to safely dispose of broken equipment; and hazardous waste management.

Market expansion is also increasing the number of competitively-priced options for healthcare facilities (20). Thus substituting mercury devices with safer mercury-free alternatives can be considered cost efficient.

3.3 Availability of Alternatives

Many mercury free alternatives are now available at competitive pricing in the market. Thereby, providing an opportunity for the hospitals to contribute towards environmental protection.

Chapter IV

Aim and Objectives

4.1 Aim : To quantitatively study the availability of mercury, its components, or amalgam in various medical equipment, appliances and procedures involved in patient care activities and its potential harm towards hospital environment in a tertiary care hospital.

4.2 Objectives

- To identify various patient care areas where mercury, its components or amalgam are used in Equipment, Appliances and Procedures at the Sanjay Gandhi Post Graduate Institute of Medical Sciences.
- To quantitatively calculate the availability of the mercurial Equipment, Appliances and Procedures.
- To estimate the potential harm towards the environment in case of mismanagement of mercury, its components or amalgam.
- To recommend a phase-out strategy towards the use of mercurial Equipments, Appliances and their replacement based on the standard guidelines available for hospitals.

Chapter V

Methodology

- **Study Design**

  This study is a Descriptive type of study design.

- **Study Area**

  The study was conducted in the In-patient Services, the Out –Patient Services, the Dialysis unit and the Emergency Medical Services of the S.G.P.G.I.M.S., Lucknow.

- **Study population**

  The study population included all the doctors, nurses, patients, staff and attendants at risk due to potential mercury spillage in the hospital environment in an event of breakage of sphygmomanometers.

- **Sample**

  The study was conducted in the following manner

Primary Data

In-depth Survey with Observational study- For identifying the equipments, appliances and procedures where mercury, its components or amalgam is being used in the S.G.P.G.I.M.S., Lucknow.

In-Depth Survey - For quantitative estimation of the potential harm caused due to mercury spillage towards the hospital environment.

Secondary Data

Review of literature from appliance application guide books and standard user guidebooks available for the study topic from various sources.

Chapter VI

Observations

The Biomedical Waste Services of the Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow is responsible for keeping the complaint logbook as well as maintenance and disposal of the biomedical waste materials used in the institute**.**

Thermometers, Sphygmomanometers, Oesophageal dilators are some of the common instruments used in the hospital (Refer table below : -).

It was observed during the study period that the traditional mercury thermometers have been replaced with the modern digital thermometers in S.G.P.G.I.M.S.

Objective 1

Various areas where mercury is used in the institute are:-

Area where mercury is used in Equipment	Type of Equipment identified
In-patient services	Sphygmomanometer, Thermometers(only old patients)
Out-patient services	Sphygmomanometer, Thermometers(old patients)
Emergency Medical Services 1	Sphygmomanometer
Emergency Medical Services 2	Sphygmomanometer
Dialysis unit	Sphygmomanometer

It was observed that the most commonly the mercury containing instrument used in the patient care area was the sphygmomanometer

Objective 2

Based on the study conducted the following data was collected from the study area. Based on the observations of the objective one the focus of the study kept on sphygmomanometer primarily.

		Sphygmomanometers		
Patient care area	**No. of beds**	**In Inventory**	**Defective**	**Working**	**Replaced**
Endomedicine	30	11	5	6	0
Endosurgery	28	4	0	4	0
MICU	22	2	0	2	14(digital)
Cardiology	30	4	0	4	0
CVTS	30	8	0	8	0
Nephrology A	32	21	11	6	4
Nephrology B	30	7	4	2	1(digital)
Gastromedicine A	30	10	6	4	0
Gastromedicine B	30	9	3	4	2
Neuromedicine A	30	6	1	4	1(digital)
Neuromedicine B	32	4	1	3	0
Neurosurgery A	32	9	4	5	0
Neurosurgery B	33	4	0	4	0
Radio/Genetics/BMT	17	4	0	4	0
Urology A	30	10	4	3	3
	30	9	2	7	0

Urology B					
Immunology	30	7	2	5	0
Haematology/BMT	28	3	2	1	0
Gastrosurgery A	30	9	2	4	3
Gastrourgery B	32	8	4	4	
MOPD	0	42	0	42	0
ERS 1	13	14	7	7	0
ERS2	14	3	0	3	0
Dialysis	35	20	7	13	12(digital)
		228	65	149	

Overall it is observed that there are approximately 230 sphygmomanometers in the stock in the institute at present.

Objective 3

The following observations are based on the data collected for the patient care areas under the scope of study from the BMW services for the year **2011, 2012 and 2013** respectively.

The total number of the complaints recorded due to replacement of mercury in the sphygmomanometers as depicted by the column diagram:-

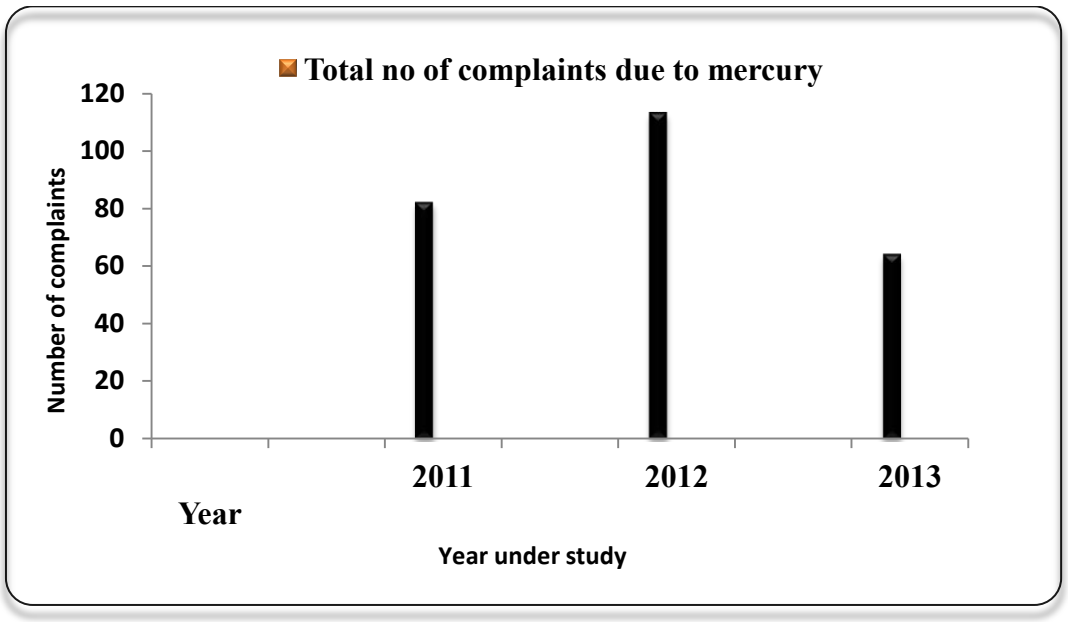


Figure no:-10

Source: BMW engineering register of S.G.P.G.I.M.S., Lucknow

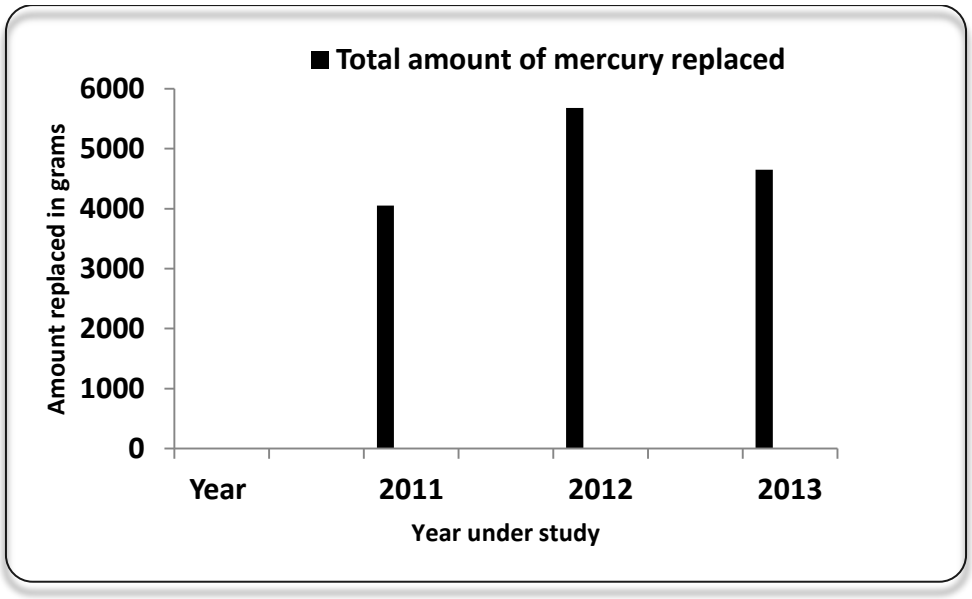
Year	Total number of complaints recorded for mercury replaced
2011	82
2012	113
2013	64

It was observed that the total number of the complaints recorded for mercury replaced was highest for the year 2012 which was numerically equal to approximately 113. For the years 2011 and 2013 they were 82 and 64 respectively. It is observed that there is overall 19% reduction in the number of complaints due to mercury spillage.

The figure eleven represents the total amount of mercury replaced by the Biomedical Services of the S.G.P.G.I.M.S., Lucknow. As we observe the total amount of replacement in the Sphygmomanometers was minimum in 2011(4050g), at its peak in 2012(5680g).

In the year 2013 it decreased to 4650g approximately. Thus, the average discharge of mercury as a biomedical waste from the institute is about 4793g

Year	Total amount of mercury replaced(in grams)
2011	4050
2012	5680
2013	4650
Average	4793.33

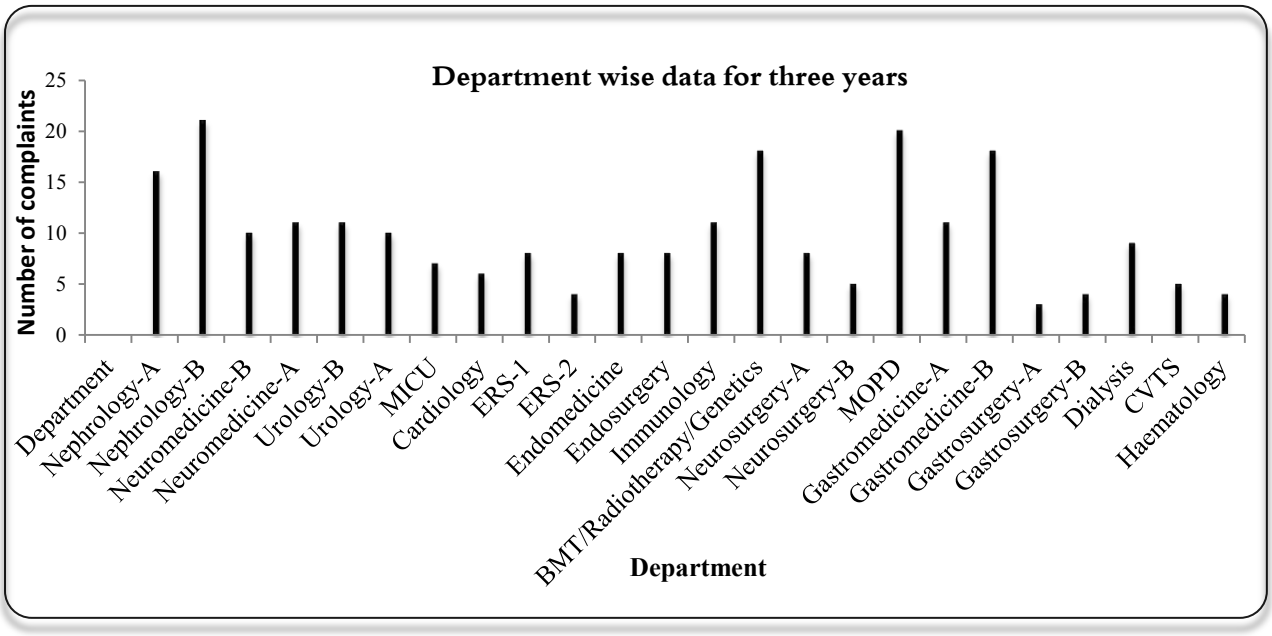


Source: BMW engineering register of S.G.P.G.I.M.S., Lucknow

It must be noted here that the institute has now stopped the procurement of the mercury due to its toxic properties, decreased economic feasibility of operations.

The following table depicts the data collected from the Biomedical Services of S.G.P.G.I.M.S., Lucknow providing information on the total as well as department-wise number of complaints received due to mercury related issues in the sphygmomanometers.

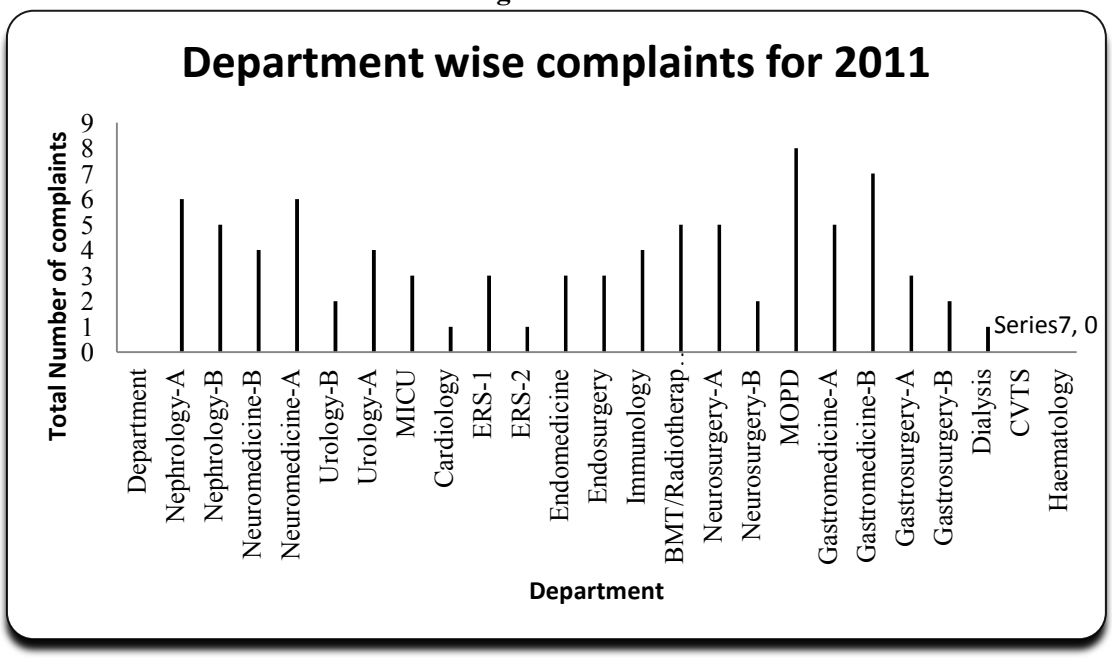
Department	Complaints received for 2011	Complaints received for 2012	Complaints received for 2013	Total number of complaints recorded
Endosurgery	3	2	3	8
Endomedicine	3	3	2	8
MICU	3	4	0	7
Cardiology	1	4	1	6
NephrologyA	6	4	6	16
Nephrology B	5	12	4	21
Urology A	4	2	4	10
Urology B	2	6	3	11
Gastromedicine A	6	5	0	11
Gastromedicine B	7	4	7	18
Gastrosurgery A	3	0	0	3
Gastrosurgery B	2	1	1	4
Immunology	4	6	1	11
Radiotherapy/BMT	5	9	4	18
Neuromedicine A	6	5	0	11
Neuromedicine B	4	5	1	10
Neurosurgery A	5	3	0	8
Neurosurgery B	2	3	0	5
ERS 1	3	2	3	8
ERS 2	1	1	2	4
Dialysis Unit	1	4	4	9
MOPD	8	5	7	20



Source: BMW engineering register of S.G.P.G.I.M.S., Lucknow

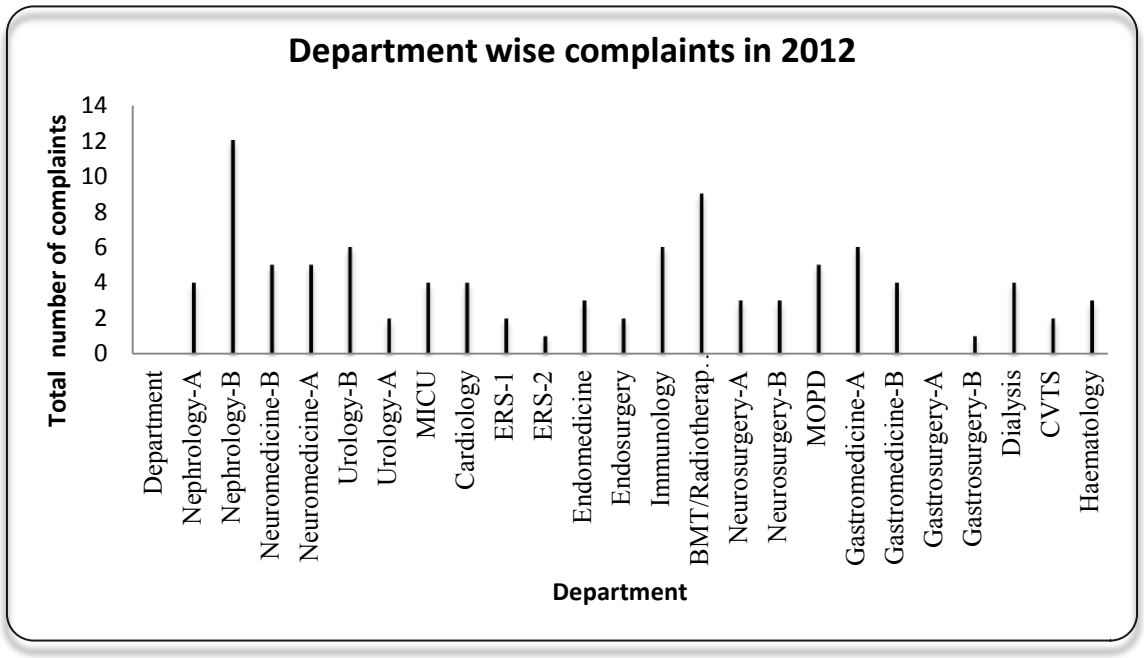
In-depth analysis of number of complaints reported by various departments in relation to total mercury spillage

Figure no:-13

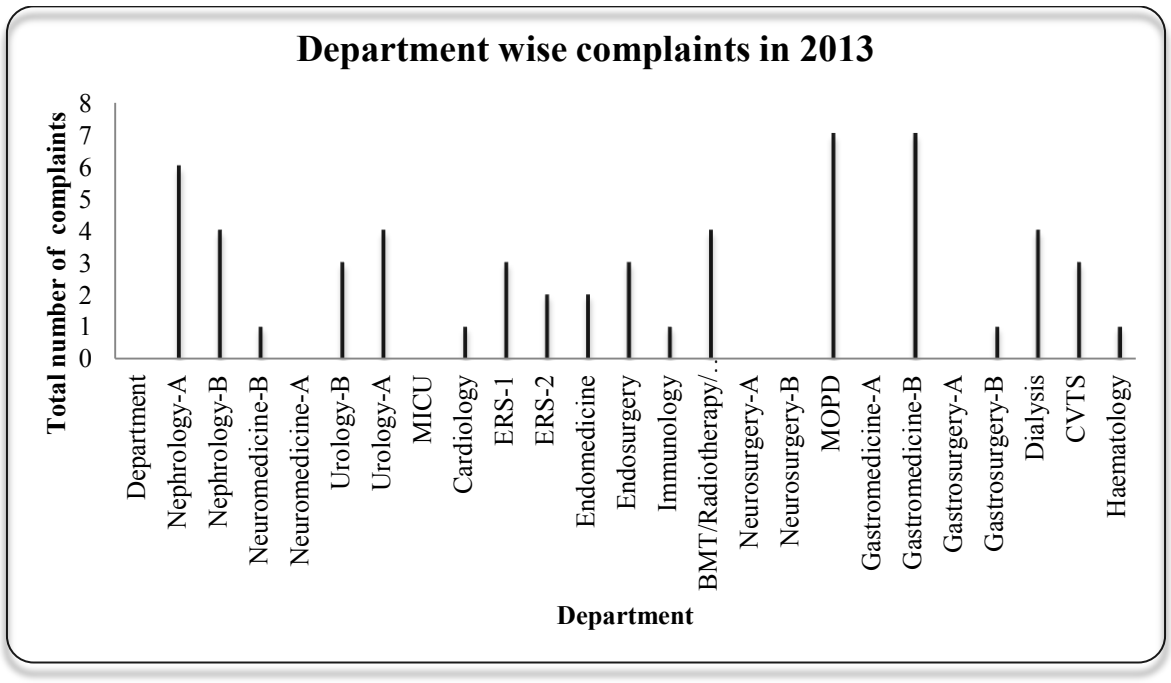


Source: BMW engineering register of S.G.P.G.I.M.S., Lucknow

Figure no:-14



Source: BMW engineering register of S.G.P.G.I.M.S., Lucknow



Source: BMW engineering register of S.G.P.G.I.M.S., Lucknow

Thus we observe that

Year	Departments showing peaks in column diagram
2011	**Gastromedicine(A)**, Gastrosurgery(A),Neuromedicine(A),**Nephrology(B)**
2012	**Nephrology(B)**, Immunology, BMT/Radiotherapy, Urology(B),**Gastromedicine(A)**
2013	Nephrolgy(A),MOPD, Gastromedicine(B)

Thus we observe that some of the departments have recorded more number of complaints than others in the institute. It must be noted that these areas have patients with comparatively high morbidity which may be one of the contributing factor .

Total Mercury Hazard to the environment

Average permissible mercury disposal by one hospital -3000g/year

Average mercury waste at S.G.P.G.I.M.S.- approximately 4800g/year

One gram of mercury released into the environment can contaminate 20 acres of lake

Therefore, this excess of 1800g of mercury per year released into the environment at S.G.P.G.I.M.S. is equivalent to contamination of 36000 acres of lake per year!!!!!!

Chapter VII

Discussion

A retrospective study was conducted in the Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow. The data was collected from the biomedical engineering services for year 2011 till 2013. Further data was recorded from the patient care areas for the purpose of recording the approximate inventory of the sphygmomanometers.

A survey was conducted in the patient care areas to assess the inventory records as well as to gather information about the level of awareness regarding the harmful effects of mercury.

It was observed that during an unstructured interview conducted for the study population; particularly amongst the nursing personals the level of awareness regarding mercury toxicity was very low. Further there was unawareness regarding the proper mercury spill management and disposal. This creates a substantial threat towards the environment in terms of mercury exposure.

It was observed that the average rate of discharge of mercury in the environment is about 4800g every year. Based on the review of articles available on online sources it was found that for a hospital the average permissible amount of release of mercury and its components should be around 3000g.

Hence if we compare these values there is a definite indication that the hospital environment is exposed towards the potential chronic effects of mercury toxicity.It must be noted that the study has a notable limitation in its inability to calculate the exact amount of exposure in the humans.

The following aspects are some of the reasons for the above limitation.

- Limited time period of study.
- Lack of resources to conduct blood analysis of the staff members.
- Moving beyond the departmental scope of work.
- The calculations can be done on long term periodic basis because the health effects are seen on chronic exposure. This estimation becomes difficult as in every spill same personnel may not be affected.
- To calculate the exact amount of mercury in the air at present the required resources and expertise are limited.

Further it was observed that the numbers of complaints recorded due to mercury spillage are reportedly on a higher side in departments with comparatively high patient morbidity.

The following reasons can be associated with this

- High amount of patient unrest.
- Patient and attendant curiosity.
- Improper positioning of the Sphygmomanometer by the staff while taking BP measurements.
- Mishandling of the Sphygmomanometer by the staff personnel.
- Lack of space.

Chapter VIII

Conclusion

The leading reason for a healthcare facility to become mercury-free is an ethical motivation to protect people and the environment. As significant users of products containing mercury, hospitals have an opportunity to play a key role in protecting public health and the environment by minimizing their use of these products thereby positively influencing community health by eliminating a known health hazard. They also set a higher standard for other businesses in the community.

Another benefit to becoming mercury-free is that it allows healthcare facilities to avoid the costs of storing and disposing of hazardous wastes and the costs of meeting mercury emission regulation standards.

Under the stringent rules to be implemented by the government putting a limit towards the permissible emission of mercury as a biomedical waste from the hospital there will be a need for more monitoring and pollution control equipment.
Instituting stringent policies to eliminate mercury in the hospital waste stream will help hospitals comply with these standards and will eliminate added costs.

In addition, mercury elimination or reduction can eliminate the costs incurred by expensive spill cleanups and the costs associated with personnel training on the proper identification and use of this widely distributed hazardous substance.

The Sanjay Gandhi Post Graduate Institute of Medical Sciences , Lucknow , Uttar Pradesh is constantly striving towards achieving at par excellence at all the levels of patient care management and welfare activities.

In view of the potential harm and threat caused by the use of mercury or its components particularly in the patient care areas the institute has completely phased out the use of traditional laboratory thermometers and have replaced them with the electronic thermometers.
Now the institute wishes to phase out the use of traditional sphygmomanometers with suitable alternatives which are patient friendly as well as economically feasible also.

Chapter IX

Recommendations

As observed in the study there has been invariably high exposure of mercury in the hospital environment both internally and externally.

Various steps that can be taken to prevent the potential harm caused by an accidental exposure in future are:-

9.1 Make a commitment

To fulfil the task of becoming a mercury free organization first a commitment has to be made at all the level.

A mercury-elimination task force should be created which will be headed by the project manager, representatives from various units of hospital inclusive of nurses, administration, purchasing, waste, hygiene and safety, maintenance, medical and dental areas. These team members should be given authority to seek help from all the levels of the hospital as and when required.

Training and Education

Plan training programmes for the health care personnel and awareness-raising and information for the community. Surveys on the perceived mercury-risk can be carried out with all hospital personnel to identify training needs and define the content of the training sessions.

Emphasis can be given to broadening knowledge about the toxicity of mercury, its impact on health and the environment, the correct way to handle small spills, segregation and transitional storage of mercury waste.

In these programmes the team members should also participate and facilitate a two way motivational dialogues .Thus, providing a holistic approach to the initiative.

9.2 The hospital management should sign a Pledge or Letter of Commitment to Phase-Out Mercury.

This pledge should guarantee the means for implementing the replacement of mercury-containing supplies and devices

9.3 Conduct a mercury inventory

A baseline situational assessment and inventory of equipment, instruments and waste products that contain mercury can be created in the institute which will help in monitoring the smooth phasing out procedure**.**

It will further help in evaluating the mercury situation in the hospital at the time of project implementation. The details about finding where and how much amount of mercury is, how spills are handled, and where mercury waste is disposed of are entailed through this process.

Thus, more precise is the information available at this phase, more accurate training and implementation actions will be in future.

As part of the inventory, a data base should be established quantifying the amount of mercury identified, the instruments that contain it and the areas where it is found; all the devices in the institution that contain this toxic metal should be labeled.

A detailed account of the quantities of mercury-containing supplies or instruments in use, in stock, in repair, in storage as obsolete equipment should be complied and segmented by area or sector of the hospital. Any waste products containing mercury that are stored inside the hospital should also be accounted for.

All areas of the hospital should be surveyed, including those where the instruments are used directly, as well as those for repairs or storage of obsolete equipment.

Also existing inventory programs, standards for procedure and practices currently in place for handling supplies that contain mercury(clean-up of small spills, segregation and storage within the hospital, purchasing policy, training personnel etc.)

In case of assessment of how waste is handled a survey or interviews can be done.

9.4 Evaluate Alternatives

Various alternatives are now available for the hospitals. Thus, some of the parameters on which the evaluation can be done are as follows:-

- Pricing

- Effectiveness

- Efficiency

- Market reviews of the product

- Long term handling and maintenance of the product.

- Disposal and Liability costs.

- Benefits Vs other products available in the market etc.

9.5 Develop a Mercury-Substitution Program

A multi-pronged program for eliminating mercury in the hospital should be established.

-Replace the Sphygmomanometers with safe, accurate, affordable alternatives.

-Adopt a mercury-free purchasing policy.

Technical considerations

Technical Specifications- HCWH specifications for sphygmomanometers should be subscribed to when procuring the devices.

Battery Supply

Battery should be mercury free and adequate supply should be available.

Economic Considerations

Conduct a cost comparison between the mercury –containing devices and the alternatives. Here it should be kept in mind the initial cost of mercury free sphygmomanometers vs the ongoing cost of replacing mercury containing sphygmomanometers, which break regularly. The cost of calibration of different types of blood pressure devices and mercury spill clean-up should also be taken into account.

Other factors to be considered are the final, safe disposal of mercury as a hazardous waste, the environmental consequences from metal emissions and health impacts.

Create a Purchasing Policy

A policy should be created to stipulate that only mercury-free devices should be purchased. The providers should be informed of the new purchasing policy. A market analysis and assessment should be done, identifying local suppliers and importers of the mercury-free alternatives.

Establish Mercury Waste Management and Storage Program

A policy and program to manage segregate and store mercury waste should be developed and implemented as mercury-based medical devices are being substituted in a hospital.

The features of this plan should include:

Storage

-the hospital should provide an adequate physical space for transitional storage of mercury waste produced by the establishment.

-the hospital should create and make known the standard procedure to follow for appropriate storage.

-Adequate final disposal or treatment of the waste should be promoted, avoiding incineration of waste.

-a selective battery collection program should be put into practice so that batteries are treated and disposed of properly.

-HCWH strongly recommend against the recycling, importing and/or exporting of mercury, as well as the manufacture of instruments that contain it.

Spills

Each area facility should develop its own procedures to clean up spills according to what is practical and available while maximising protection for patients and health workers.

9.6 Post Implementation Evaluation

Re-evaluate hospital plans and document progress towards eliminating mercury, identify obstacles, share experiences with other health care establishments.

Chapter X

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10.2

ANNEXURES

Hospital Statistics at a Glance

S. No	Details	2007	2008	2009	2010	2011	2012
1.	Registration	52521	58894	65547	71335	76620	80442
2.	Follow up patients	168831	183687	204095	243027	284062	311905
3.	Discharges	26518	27611	29259	33705	34762	34809
4.	Bed Occupancy Rate	74.4%	76.1%	78.6%	74.4%	76.6%	76%
5.	Surgery	7331	7680	7353	7724	8202	8137
6.	Investigations	1587304	1658143	2051488	2282945	2385210	2484384
7.	Ultrasound	21049	21358	16810	20315	20694	20216
8.	Blood donation	18995	21404	21541	22025	22486	22465
9.	ERS patients	12476	12985	13417	12114	11505	10785
10.	Hospt. Revenue collection(April-March Financial year)	Rs. 262842359.00	Rs. 278251815.00	Rs. 315291091.00	Rs. 397711615.00	Rs. 458548002 8.00	Rs. 465860018.00

Approximate content of mercury in some of the medical instruments used in health care facilities and their applications.

S. No.	Product	Mercury Content	Applications
1	Fever and other thermometers	0.5g-3g	Fever (Temperature) measurement
2	Manometers	300g-600g	Blood Pressure measurement
3	Sphygmomanometers	20g-60g	Blood Pressure Measurement

4	Mercury batteries (Mercuric oxide, silver oxide, mercury zinc, mercuric oxide, zinc air, contaminant in other types of batteries	5mg-25mg	Blood analysers, defibrillators, fetal monitors, hearing aids, holter monitors, pacemakers, pagers, picker calibres, spirometer alarms, telemetry transmitters, temperature alarms.
5	Chemical Reagents (Mercury (2) oxide, mercury chloride, mercury (2) sulphate, mercury nitrate, mercury iodide, sulphuric acid (commercial grade; mercury as impurity), Zenker's solution		Laboratory
6	Pharmaceuticals	Around .01%	Vaccines eye drops, herbal medicines, (thimerosal, phenylmercuric nitrate),Mercurochrome; Veterinary Chemicals (mercuric chloride, phenyl mercuric nitrate and sodium ethylmercurithiosalicylate.

Source: Patterns of mercury-containing products (Huber 1997; Environment Canada 2002; Mercury Policy Project 2005; UNEP 2005)

Uses and modes of release of mercury in the environment from HCFs

Table no 13

Uses of mercury in health care	**Modes of release of mercury in the environment**
Thermometers(measurement of body temperature)	Slipping and breaking during use hence Hg spillage
Thermometers for laboratory (water baths, diagnostic tests , coolers, incubators)	Slipping and breakage
Barometers(in respiratory therapy to calibrate blood gas analysers)	Slipping and breakage
Sphygmomanometers (measurement of blood pressure)	Slipping and breakage during use
Esophagealdilators/ bougie tubes (dilate oesophagus)	Leak or breakage

Feeding tube (provide nutrition to patients)	Leak or breakage
Gastrointestinal tubes(Cantor tubes and Miller Abbott tubes, clear intestinal obstructions)	Spillage and rupture of tube
Strain gauge(measure arterial blood flow)	Breakage
Urinometer (measure specific gravity of urine)	Breakage
Laboratory chemicals (Fixatives, stains, reagents, preservatives)	B-5 fixative is discharged into the sewer system during rinsing of tissues.
Medical batteries(blood analysers ,monitors, hearing aid, halter monitor, pacemaker, spirometer, temperature alarm etc)	Breakage
Thimerosal(A Hg containing preservative to prevent bacterial contamination in vaccines)	---
Cleaning products	Through wastewater

Source: Environmentally sound Management of Mercury waste in health care facilities (draft report), Central Pollution Control Board (Ministry of Environment & Forest) Delhi, Sept 2010

Annexure 1

Steps for replacement of mercury based patient thermometers and specifications of mercury free devices

(Source: Draft document of WHO/GEF UNDP health care waste management project on mercury phase out from health care facilities)

Steps for replacement of mercury containing thermometers

Step 1- Determine which thermometer is right for your application. Many aspects have to be considered when selecting the types of non- mercury thermometers. Many scientific papers compare the accuracy and suitability of different types of thermometers and conclusions and sometimes contradictory consultations with the health care providers as to select different types of non-mercury devices to accommodate the age of the patients ,their medical conditions, institutional setting, portability ,sterilization process ,costs ,ease of use ,safety, patient comfort, time spent for temperature measurement ,storage requirements, and

uniformity. Two common alternatives to mercury thermometers are digital thermometers and phase change (dot matrix) thermometers.

Step 2- Identify vendors that will provide the chosen thermometer type and compare the vendor validation package for compliance with the appropriate standard.

Step 3- Review the vendor(s) requirements for calibration of the thermometer. Determine who in the facility will complete the required calibrations and the time needed to complete this task or an Annual maintenance contract with the vendor to provide these services.

Step 4- If desired, ask the vendor(s) for several trial units and evaluate them in the areas where they will be used. After receiving feedback from the users of the unit identify the desired type and model of the unit.

Step 5- Develop a bid specification for the purchase of the requirement units to include the number of units that will be required and develop a budget for the replacement project including the purchase of the units ,installation requirements,caliberation schedules and removal and disposal of the mercury containing units and he purchase of any supplies needed on an ongoing basis. Submit the bid specification to potential vendors and review vendor bids .Select the vendor for the project.

Step 6- Determine the phase-in schedule for the new units. Consider the ability of the chosen vendor to provide the number of units purchased in a timely fashion. Consideration should also be given to the time needed to install or replace the units and calibration of the units (if needed).

Step 7- Identify the waste vendor that will be responsible for disposal of the mercury containing units and develop procedures that will be followed once the mercury containing units have been removed.

Step 8- Purchase the units according to the phase-in schedule.

Step 9- Calibrate and install the units.

Step 10- Remove the mercury containing units to a designate storage area or waste disposal site. Careful packing to minimize breakage and secure sealed containers to prevent spills The mercury containing units should be packed in puncture resistant leak proof container to avoid any leakage of mercury.

Step 11- Dispose the mercury containing units according to local hazardous waste regulations.

Annexure 2

Steps for replacement of sphygmomanometers and specifications of mercury free devices.

(Source: Draft document of WHO/GEF UNDP health care waste management project on mercury phase out from health care facilities)

Steps for replacement of mercury containing sphygmomanometers

Step 1-Deterimine which type of sphygmomanometer will meet the needs of your facilities.

Step 2-Identify the vendor(s) that are able to provide the sphygmomanometer of choice. Request copies of the unit validation packages and evaluate the packages against the applicable standards.

Step 3-As part of unit selection process it may be desirable to run a trial in the facility where the units will be used to determine the ease of use, requirements for calibration and maintenance of the unit and the time estimates to install,calibrate and maintain the units.

Step 4- After receiving feedback from the users of the unit identify the desired type and model of the unit.

Step 5- Develop a bid specification and submit to the potential vendors (as needed). Include in the bid specification the number of units that will be required and develop a budget for the replacement project that includes the purchase of the units ,installation requirements ,calibration schedules, removal and disposal of the mercury containing units and the purchase of any supplies needed for maintenance of the units on an ongoing basis.

Step 6- Determine the phase-in schedule for the new units. Consider the ability of the chosen vendor to provide the number of units purchased in a timely fashion. Consideration should also be given to the time needed to install or replace the units and calibration of the units.

Step 7- Identify the waste vendor that will be responsible for disposal of the mercury containing units and develop procedures that will be followed once the mercury containing units have been removed.

Step 8- Purchase the units according to the phase-in schedule.

Step 9- Calibrate and install the units.

Step 10 –Remove the mercury containing units to a designated storage area or waste disposal.

Annexure 3

Mercury from "Mercury reduction in the health care section, of www.sustainablehospitals.org

Table no 14

Product	**Location/Use**	**Available Alternatives**
Batteries(Mercury oxide)	Oxygen monitors, ECG monitors, Personnel pagers, Defibrillators, hearing aids, pacemakers, fetal monitors etc	Lithium, Zinc air, Alkaline batteries.
Cantor tube	Gastrointestinal device	Anderson tube
Colormetric chloride analysis	Chemistry	Ion-Selective electrode method
Weighed esophageal dilator (Maloney or Hurst bougie)	Operating Room	Mercury-Free versions are now available with Tungsten or stainless steel as a weight.
Weighted feeding tubes(old)	Patient care	Virtually all new nursing incubator thermostats now contain alcohol ,rather than mercury.
Lamps: Fluorescent Germicidal metal halide High-Pressure Sodium Ultraviolet Mercury Vapor High Intensity Dicharge	Variety of Areas	Use the most long-lasting, Energy- efficient lights available for your intended use
Microwave oven (old)	Various areas	Use new models
Miller-Abbott tube	Gastrointestinal device	Tungsten tubing as a weight

Sequential Multiple Analyser(SMAC)	Chemistry	Ion selective electrode
Sphygmomanometer	Patient care, measure blood pressure	Aneroid, Electronic
Mercury switches	Various areas	Bi-metallic strips or electronic strips
Thermometer	Patient care, Emergency room	Electronic(Thermistor) • Oval • Rectal • Ancillary Electronic(IR) • Tympanic Glass Tube(non mercury)
Thermometer	Laboratories (water baths, lab ovens, refrigerators, incubators)	Alcohol Electronic
Vacuum systems(may use mercury-containing manometers)	Maintenance	Eliminate where possible, protect from breakage and spills