Along with the tremendous advances in clinical care witnessed during the last part of 20th century, there was a shift in image of hospitals also. Traditional role of hospitals has been depicted in figure 5.1, which focuses on mainly curative role of hospital regarding treatment of in patients and out patients. 

Figure 5.1

Hospitals in India - Traditional Model

Buildings / space

STAFF
Medical / Paramedical

Facilities

OPD
Mainly curative services

Patients + Escorts
Indoor

(Source: Developed by Dr. A.J. Singh and Er. Parampreet Kaur)

The image of the hospitals gradually changed for the better when the hygiene management improved. Today, hospitals are being reoriented from just being the centres for medical care and treatment to hospitals, now they are also supposed to provide comprehensive system of promotive, preventive, curative and rehabilitation services. It has been stated in a WHO document that “the hospital is an integral part of a social and medical organization, the function of which is to provide for the population, complete health care, both curative and preventive, and whose out-patient services reach out to the family in its home environment; the hospital is also a centre for the training of health workers and for bio-social research.”

The changed image of modern hospital in contemporary twenty first century society is depicted in figure 5.2. As per this image, hospitals are now expected to provide multitude of services besides curative services. Community participation
and involvement of various other groups besides medical and paramedical staff in running the hospital services is the backbone of this model.\textsuperscript{116-118}

**Figure 5.2**

**Health Promoting – Hospital Model**

(Source: Developed by Dr. A.J. Singh and Er. Parampreet Kaur)

This model is based on the concept of health promoting hospitals, which emerged in 1980’s. To be health promoting in any meaningful sense, a hospital has to be committed to instituting a process of organization development and change. It
must extend its activities in the health care system beyond merely providing clinical and curative services.\textsuperscript{24,116} Health must appear on the agenda of policy makers in all sectors and at all levels of the hospital and work carried out in a hospital must be organized so as to create a healthy hospital environment.

As per HPH concept, hospitals impact on health not only through the provision of prevention, treatment and rehabilitation services of high quality, but also through their impact on the local environment.\textsuperscript{24} These impacts can be both positive as well as negative. These impacts have made a hospital a complex organization. Administration of such a complex organization requires blending of technical and administrative competence in the right quantity, at the right time, at the right place, by the right man and in the right way or process. Each hospital is a distinct entity and as such each has to be tailored to the specific aims to be accomplished, the specific tasks to be performed, the volume of services to be rendered and the type of the community to be served. In view of this, there has also been development of ancillary services viz. hospital administration, hospital engineering, hospital architecture etc.

In the dynamic society of today, the hospital occupies a unique place to accommodate explosion of science into medicine and the whole galaxy of new treatment techniques, new equipment and proliferation of services which have made a profound impact on the provision of care facilities and services. Besides this, the development of socio-politico, cultural and educational systems have made the people conscious of their rights and they demand that modern and best means of medical and health care be made available to them; not only within the four walls of the hospital but at their door step or in the vicinity of living places. Each hospital is distinct in its characteristics as it differ in structure, functions, performance and the community it serves. So, besides providing the curative services, research and training facilities of high quality, hospitals also have to ensure that they practice ‘NO HARM’ policy i.e. human health should not be adversely affected due to impact of hospitals on local environment.
Today's patients are better informed about healthcare and its ramifications. At no time in history have people known so much about healthcare as they do today. For this reason, they shop for the best hospital regardless of cost. When it comes to their health, people want the best whatever it takes. That is why the traditional hospitals of yesteryears have now become distinctly passe while the advanced high-tech hospitals that are mushrooming across the country are becoming the preferred destinations - the mecca for healthcare. Modern hospitals focus on the needs of the patient. They create a cohesive course of events, where treatment is taken to the patient rather than the other way around. Today's hospital is educator and employer, consumer and caretaker, activist and advocate, missionary and merchant...a leader in assuring the health and well-being of the community." Such is the mission of Bay Area Hospital in Coos Bay, Oregon, which greets every visitor to its website with the message “Your Health is Our Care” and it would be the mission of all hospitals soon.

The unprecedented changes that are taking place in the healthcare field pose a great challenge to those who plan and design hospitals in the first place and those who manage and operate them thereafter. Medico-technological developments can also present challenges because both the examination and treatment equipment can become outdated before the building is even completed. Electronic records may place greater demands on technical installations, but they also offer an excellent opportunity to improve existing working routines. Accreditation (a form of quality control that follows certain standards) will also present a challenge for hospitals in the future, putting both patient safety and patient procedures under the microscope. All of these things make demands on hospital administrators' ability to adhere to a very tight budget. Where costs are concerned, this development means that hospital owners will begin to focus more on operations than on construction and they will be open to alternative types of partnerships and financing. By the beginning of the twenty-first century, the work of a major hospital in an industrialized country has been transformed from that of a century earlier. The image beamed into homes throughout the world, in television programmes such as the North American series “ER”, is that a ‘hospital’ means a modern complex in which seriously ill patients are treated at high speed with highly technical equipment and by skilled specialist
A patient with a head injury is given an immediate magnetic resonance imaging scan and is seen by a neurosurgeon who has sub specialized in intracerebral trauma.

HPH concept recognizes that hospitals are also part of the environment. Structure and function of hospitals are affected by the overall environment and hospitals themselves affect the environment. In order to minimize these environmental problems, action should be taken to deal with pollution at source, i.e. waste should be segregated and concentrated within health care institutions, and whenever possible it should be disposed off safely. Also due consideration must be given to the impact on environment, especially to risk of pollution of water, air and soil, besides aesthetics. After all, hospitals and other health-care establishments have a “duty of care” for the environment and for public health, and have particular responsibilities in relation to the waste they produce. The onus is on such establishments to ensure that there are no adverse health and environmental consequences of their waste handling, treatment, and disposal activities.

In a society well protected against epidemics, each individual seeks medical advice 3 to 4 times a year either for protection of his or her health or because of illness or injury. The priority of a health institution is the care of the patient. Accordingly, its policy has been oriented traditionally to the health and well-being of the patient, which has less relevance to environmental problems. However, it is essential that health centers be concerned with environmental protection, otherwise, a vicious circle of diseases derived from inadequate waste management could be created with deleterious effects on the workers in charge of this task, the hospital community, and the population in general. Although hospitals face many unique challenges in grappling with environmental hygiene compliance issues, the challenges tend to be similar for all hospitals. This is the case not only with respect to shared institutional characteristics, but also even with respect to particular medical processes and materials in use in hospitals today.

Hospitals are in strong position within the health care system to be the advocates for health promotion. They represent the main concentration of health
service resources, professional skills and medical technology. The fact that hospitals command extensive resources means that even a small shift of focus toward health promotion has potential to stimulate public opinion favorably toward health promotion and in time, bring health benefits to community at large.\textsuperscript{24}

In western countries, hospitals are increasingly positioning themselves as the leading providers of health promotion services with in the community. In India this movement is yet to take off.

Many studies have demonstrated the benefits that patients realize from a planned and coordinated approach to health promotion through patient education. Reduction of length of stay in hospital, reduction in complications and reduction in admission and readmissions to hospital are the benefits to patient through health promotion.

Moreover, hospitals can realize numerous benefits by providing comprehensive health promotion packages. It can add to the profitability of a hospital by generating new revenues by charging some fees for health promotion related activities or by marketing health promotion packages of the hospital.

The concept of health promoting hospitals involves reorientation of health services, implementing the Ottawa Charter’s strategies of healthy public policy, creating environment that are conducive to health promotion involving community participation and developing personal skills for promoting the health of staff and community members.\textsuperscript{121}

For maximum output, hospital based health promotion services should be multidisciplinary, relying on the expertise of a variety of health professionals including physicians, nurses, physiotherapists, physiologists and nutritionists. Beside integrating health promotion policy for patients, staff and visitors into its vision, health promoting hospital requires, strong leadership and commitment at different levels, strategic, operational and evaluation plans, staff development and training and resource allocation.\textsuperscript{122-123}

Two factors mainly affect the outcome of health promoting hospital’s initiative; the degree of organizational commitment made by hospital and type of health
promotion activities undertaken. The significant about the health promoting hospital's approach is developing effective and collaborative working relationship with patients and their families, other service providers and broader community to achieve the best outcomes. The hospital based health promotion programmes typically include patient education and counseling services, clinical rehabilitation programmes and community as well as corporate wellness services to foster awareness, influence attitudes and identify alternatives so that individuals can make informed choices and change their behaviors in order to achieve an optimal level of physical and mental health and improve their overall ambience.24

PGIMER was also evaluated in this study as a health promoting hospital.

From environment and health promoting point of view, the location of a hospital building/service organization has a major role to play in avoidance of hazards to and from the Institutes. The PGIMER, Chandigarh is conveniently located on the Vidya Path, sandwiched between Punjab University and Engineering College. It also has a direct access from Madhya Marg, which is the main central road of Chandigarh feeding from Panchkula and various sectors of Chandigarh. It is ideally located, being just 3 kms from new ISBT bus stand and 8 kms from railway station as is evident from the location map of Chandigarh in Figure 5.3.
The Institute spread over an area of 277 acres was conceived in 1960 and was started in 1962 and the hospital now named 'Nehru Hospital' was inaugurated by Pt. Jawaharlal Lal Nehru on 7th July 1963. Over the years, the Institute has witnessed a systematic and phased expansion as is evident from the following data tabulated in Table No. 5.1.
Table 5.1
Phased Expansion of PGIMER

<table>
<thead>
<tr>
<th>Period/Phase</th>
<th>Buildings/Projects Inaugurated /started</th>
</tr>
</thead>
<tbody>
<tr>
<td>1971-1980</td>
<td>Administrative Block, Kairon Block, Doctors' Hostel D-Block, Nurses Hostel –A Block</td>
</tr>
<tr>
<td>1981-1990</td>
<td>Kidney Block, Gastroentrology Block</td>
</tr>
<tr>
<td>1991-2000</td>
<td>Advanced Pediatric Centre, Emergency Block, Dental Block, Married Doctors’ Hostel, New Library, Bank</td>
</tr>
<tr>
<td>2001-2005</td>
<td>New OPD, Nursing Institute, Shopping Complex, Bone Marrow Transplant Unit, Urology Centre</td>
</tr>
<tr>
<td>2006-2009</td>
<td>Advanced Eye Centre, Advanced Cardiac Centre, New Animal House, Drug de addiction Centre, School of Public Health, Engineering complex, Multilevel Parking near OPD, Advanced Trauma Centre (under construction)</td>
</tr>
<tr>
<td>2009-future plans</td>
<td>Modernization of Nehru Hospital, Modernization of Research Blocks, Expansion of Nehru Hospital –250 bedded hospital, Advanced Cardiac Centre Phase II, Advanced Trauma Centre Phase II, Advanced Eye Centre Phase II, National Institute of Paramedical Sciences, Campus Development, Renovation of hostels for doctors and nurses.</td>
</tr>
</tbody>
</table>

The execution of these projects has had a noticeable impact on the environment within the institute e.g. two decades back, the institute had just one main entrance on the Madya Marg road. This led to the overcrowding and concentration of traffic on the main entrance of the institute. The other gates were not used regularly and remained closed. Sector 11 gate opened only during day time. Now, with the coming up of many hi tech centers, the institute also has three entry/exit points on the Madya Marg road and one regular entry/exit point on the Vidya Path which has eased up the problem of overcrowding and pollution. Earlier,
all the clinical services were housed in Nehru hospital. As such, lot of rush of OPD patients used to disturb the indoor patients.

With the New OPD block (located towards Vidya Path entrance), becoming functional since 2000, major rush of patients has drifted there. With the inauguration of the Advanced Eye Centre in 2006 and Advanced Cardiac Center in 2008, a concerned flow of patients from New OPD has been shifted there. The Advanced Trauma Center which is under construction, is being built near Emergency Block and would be connected to Nehru hospital, has a separate entrance from Madhya Marg which would decrease the traffic density from the main gate.

Few years back, traffic and parking problem had assumed the size of insurmountable problem within the institute. With the developing of multilevel parking facility near New OPD, which has a capacity to park 300 cars and 400 scooters, this problem has been solved to a large extent. The Phase II work of multilevel parking, which would facilitate parking of another 300 cars and 200 scooters, is also in the pipeline. Moreover, one-way traffic concept introduced in the Nehru Hospital lately, has lent a clean, noise free and hassle free environment around it.

Certain engineering/ hospital building plan related decisions have been duly implemented in PGIMER which have had a direct and major environmental impact viz.

i. Provision for day light sensors in waiting areas and stairs in Advanced Eye Centre and Cardiac Centre so as to sense the availability of daylight and automatically control lighting in these areas leading to energy conservation. Light Reliable and appropriate lighting control systems are essential in all areas of the modern hospital. A good lighting system must offer centralized system architecture, multi-point programming and switching, the ability to operate with all types of standard and specialized lamps, as well as robust operation, ease of maintenance and superb product support, providing efficient energy management e.g. in Mumbai’s first & only NABH Accredited Hospital Dr LH Hiranandani Hospital, energy
saving is done by the day light sensors and double glazed window glass. Meyer Children Hospital in Italy has also installed day light sensors.

ii. **Separate invertors** have been provided at each floor for a few lights in corridors, lobbies, stairs, ramp, wards for giving minimum lighting during changeover from mains to DG power so as to avoid any untoward accident.

iii. All lighting is based on **tubular or compact fluorescent lamps** with electronic ballasts so as to save energy.

iv. **Acrylic emulsion paint** is done over the dado up to the bottom of false ceiling in wards and examination rooms so that it can easily be washed and kept infection free.

v. **Granite skirting with granite border** is provided in the corridors of Advanced Eye Centre so as to lend an aesthetic ambience.

vi. Flooring and dado of operation theatres, corridors, pre operative wards, postoperative wards have **vitrified tiles**. Flooring of corridors, main entrance, circulation area and waiting areas has baroda green marble with pattern in combination of granite tiles and Jaisalmer stones so as to lend a rich architectural touch.

vii. **Colour scheme** decided in Eye Centre has a soothing effect on the eyes of patients - beige and peach color tiles are used. It has been documented that proper color scheme gives a soothing effect to patients in a hospital e.g. in Bellevue Hospital Ambulatory Care Building, New York City, each patient floor combines a distinct color scheme with a mural developed by the architects using photographs from the hospital's rich historical archive. Color schemes for exam rooms vary and corridors terminate in daylight views, ensuring that patients encounter distinct environments on each visit.

viii. Provision for providing **channeled music** in certain areas of Advanced Cardiac Centre for relaxation of patients. Also in Dental Block, PGIMER, music is played while the patients get their teeth extraction. Music is widely used to enhance well-being, reduce stress, and distract patients from unpleasant symptoms. Although there are wide variations in individual preferences, music appears to exert direct physiologic effects through the autonomic nervous system. It also has indirect effects by modifying
caregiver behavior. Music effectively reduces anxiety and improves mood for medical and surgical patients, for patients in intensive care units and patients undergoing procedures, and for children as well as adults. It has changed the dull image of the hospital e.g. MiH, a charity organization has been bringing the joy and therapeutic benefits of live music to people in healthcare since 1948 in UK. Ca Marillo State Mental Hospital in California has also used this as a therapy to treat its patients.126-128

ix. Provision for rainwater drainage and sewerage disposal to avoid percolation of water in the rooftops. In this era of ever increase in water scarcity, there is emphasis on rain water harvesting. Three Government hospitals in Thiruvananthapuram in Kerala: have rainwater harvesting system in place as part of the World Bank-aided rainwater harvesting programme, 'Jalanidhi,' of the State Government. Spinal injury centre in New Delhi has recently installed a rainwater harvesting system. Karen Hospital in NAIROBI also has a rainwater harvesting system. Mumbai's First & Only NABH Accredited Hospital Dr LH Hiranandani Hospital utilizes rainwater harvesting and water recycling plant for gardening, cooling tower and flushing purposes.124,127-129

x. No public duct is provided near lift wells to avoid seepage problem at a later date.

xi. It is ensured that treated water is supplied for drinking purposes to all washbasins, kitchen supply and operation theatres. Other areas are served with municipal water.

xii. The chilled water is treated water and there is a separate line for it. The water is centrally chilled along with centrally air-conditioned system.

xiii. Food grade pipes have been used for treated cold water supply to avoid contamination of water.

xiv. Internal and external joinery is of aluminium in most of the buildings so that they are maintenance free.

xv. All external glazing is double glazing (double glass) so as to reduce heat load on A.C for OT's and Cath lab in cardiac center.

xvi. All external corridors are air conditioned with temperature condition of 26±1°C
xvii. It is ensured that all hardwares are zinc coated.
xviii. **Silicone treatment** over RCC walls is done to avoid dampness.
xix. **Stainless steel cladding** is provided from aesthetics point of view.
xx. **Polycarbonate roofing** has been provided to ensure daylight and reduce heat load.
xxi. All lab areas have been provided with at least one **fume cupboard** with exhaust to take care of air pollution.
xxii. **Proper space allocation** is done keeping in view the gravity of the problem e.g. in Advanced Eye Centre, retinal services are housed on first floor as the damage of retina can lead to blindness and glaucoma patients are checked on second floor which is relatively less serious reason to worry. Similarly, Physiotherapy Unit is located on ground floor in New OPD.
xxiii. Provision to dispose off dirty linen of ICU from dirty linen corridor by providing duct/chute in Advanced Cardiac Centre to prevent spread of infection in other areas.
xxiv. Adequate attention has been paid to the **ventilation system**. The waiting areas and ward areas have been designed for adding normal fresh air, which is approximately 40% of the total supply air. This additional fresh air is supplied intermittently to prevent the build up of foul odors, suffocation, excess humidity etc. during rush hours. The system also includes exhaust fans with ducting to discharge the foul air to atmosphere, thus maintaining odor free spaces and resulting in energy saving. 124
xxv. Use of controlled **air ozonation systems** result in the reduction of fresh air quantity and odor control.
xxvi. **Solar water heating system** has been installed on the roof top of Nehru hospital and dental block leading to saving of electricity.
xxvii. **Careful planning** has been incorporated in taking the levels of the road with respect to internal parking of the hi-tech centers so that there is no backflow of water during rains from surrounding areas to centers etc.

As is evident from above discussion, Engineering department has a major role to play in ensuring that a hospital has health promoting orientation. The Department of Hospital Engineering and Planning came into existence in PGIMER.
in the year 1969 with meager staff strength of three Assistant Engineers and three Sectional Officers.

The Department of Hospital Engineering and Planning exercises overall functional planning, a complete coordination, supervision and control for the successful implementation of these decisions. As a result, the institute now has many quasi-independent hi-tech centers opening with state of art facilities.

With the passage of time, there has been a tremendous increase in the scope of services undertaken by the engineering department which now includes maintenance of all the buildings and assets of the Institute and running and maintenance of infrastructural services such as roads, water supply, electricity, generator supply and lifts etc. etc. The department is also responsible for maintenance of hospital equipment’s and furniture, running and maintenance of central boiler house, incinerator, manifold gas system and for undertaking horticulture developments works.

Engineering services of PGIMER, with a total workforce of nearly 600 incumbents, comprise of:

**Civil Division:** This wing is responsible for the running and maintenance of civil and public health services in the Institute and residential colony of the Institute. Proper water supply and drainage is taken care of so as to have least environmental impact. Cleaning of manholes is done periodically.

**Biomedical Division:** This division is responsible for the maintenance of all the biomedical and mechanical equipments in the hospital thus ensuring safe and pollution free machines for the patients.

**Construction Division:** This division is primarily created for the construction of new major buildings in the Institute. The concept of ‘Green Buildings’ is adequately kept in mind.

**Planning Division:** It provides the basic technical support services such as approval of tenders, technical sanction of the estimates, administrative approval, allotment of works etc.
Architectural Division: It is responsible for designing in house projects besides working out the space and functional requirements of major upcoming projects. Use of environmental friendly construction material is incorporated in the drawings.

Electrical and Air-conditioning Division: This division is responsible for running and maintenance of electrical/air-conditioning services including substation, generating sets, lifts, E.I. work in hospital and residential area of the Institute. It also looks after the repair and maintenance work of all window AC’s, water coolers, cold rooms etc. in conformance to Environmental Protection Act 1986.

The engineering department has also been instrumental in the adoption of following innovative material and concepts in its projects

a) Wet services (e.g. water storage tanks, DG sets, substations etc.) have been placed on the periphery of the building and the dry services (e.g. manifold services etc.) have been placed in the inner part of the building for easy maintenance and pollution free environment.

b) Segregation of treated water / municipal water is done for different uses so as to provide safe drinking water to patients.

c) Provision for sewage treatment plants (STP’s) based on submerged fixed film aerobic reactor (SAF) and fluidized aerobic bio-reactors (FAB) technologies.

d) Rainwater harvesting concept introduced in Eye center so as to preserve water is under consideration.

e) Adoption of VSD motors for A.C’s & lifts for energy conservation.

f) Building Automation Services leading to saving of energy

g) Use of CFC and Electronic ballast fittings for energy conservation.

h) Duct cleaning through robot in operation theatres so as to control spread of infection.

i) State of Art elevators in New OPD and eye center have been installed lending rich aesthetic look.

j) Provision of Helipad in cardiac center and trauma center, which would facilitate the early medical aid for the critically wounded or ill patients.

k) Pressurized stair cases (Positive pressure) for fire safety.

l) Adoption of maintenance free materials. For e.g. aluminum glazing, stainless steel furnishing and minimizing the use of wood.
m) Use of plastic emulsion or washable oil-bound emulsion for clean and hygienic conditions.

n) Terrazzo flooring to reduce noise in hospital and acid resisting tiles for laboratories.

Some of the other major strengths and weaknesses pertaining to PGIMER, Chandigarh as a HPH standards were also noticed.

Strengths:
1. There is intra and inter sectoral collaboration of PGIMER with health and social care providers.
2. Patients are given follow up instructions, rehabilitation plan, if needed at OPD, referral and discharge.
3. Programmes like smoking cessation are successfully enforced.
4. Staff comply with health and safety requirements at work place.
5. Working condition of employees comply with directives.

Weaknesses:
1. Hospital aims and mission as a HPH are not formally declared e.g., Health promotion policies have not been declared. No specific existing HPH policy document is available.
2. No clearly labeled sets of health promotion activities are in force.
3. Information on formal assessment for patient satisfaction is not available i.e., feedback is not taken from the patients as a regular feature.
4. There is no evidence that staff is involved in HPH policy making, audit and review.

Besides above observations, other HPH indicators pertaining to PGIMER revealed following conclusion:

Green cover – It is a well-established fact that living plants have a beneficial psychological effect on humans. Studies have shown that patients in hospitals experience shorter recovery times when plants are present. Studies by NASA and other scientists have also produced documented evidence that interior plants and their root-associated microbes can remove harmful chemicals from sealed chambers. Studies also show that interior plants may reduce the levels of airborne microbes in the ambient air. Therefore, hospitals in Japan are adding plants to take
advantage of their air-cleaning properties. Takenaka Garden Afforestation, Inc. of
Tokyo is adding "Ecology Gardens" in hospitals.\textsuperscript{130}

The horticulture wing of the PGIMER with 90 sanctioned posts, out of which
35 posts are presently lying vacant, is headed by an Assistant Engineer
(Horticulture).

During the last few years, number of new centers and buildings have come
up in PGIMER campus. These buildings have open spaces and front lawns and
required to be maintained at the desired standard. The area under green cover is
36\% of the total area. With the available resources, it is not possible to maintain the
huge lawns/open spaces around various buildings/centers of the Institute.

A detailed agenda was presented to Standing Finance Committee meeting
held on 24-09-2008 for the approval of getting these lawns maintained through
public participation and has been approved. During the last few years, Chandigarh
Administration and Municipal corporation, U.T Chandigarh is also maintaining round
about/premises through public participation after signing MOU with these
firms/agencies.

All the open spaces/lawns in the campus have been divided into six pockets.
These pockets are: -

\begin{itemize}
  \item i) Area around Nehru Hospital and Residential Pocket I 4.91 Acre Approx.
  \item ii) Area around Research Block A and B, Cafeteria, Bhargava Auditorium and Residential Pocket II 5.08 Acre Approx.
  \item iii) Area around APC, Library and Residential Pocket III. 4.8 Acre Approx.
  \item iv) Area around Advanced Cardiac and Nursing Institute Pocket IV 5.88 Acre Approx.
  \item v) Area around New OPD Block and Residential Pocket V. 5.27 Acre Approx.
  \item vi) Area around Advanced Eye and DDTC and Residential Pocket VI. 3.20 Acre Approx.
\end{itemize}
Apart from the above area, it has been decided that open spaces in Residential area/Nursing Institute be also got beautified/maintained through public participation. Total area of each pocket includes the residential area.

A standard design of advertisement panel has been evolved having a size of 60’x12” and 36”x12” which will be allowed to these companies to have their advertisement Boards of any color and design, but without any slogan.

It has been decided that offer shall be invited by sending press advertisement in different leading newspapers. The agencies will be short-listed and their credential shall be checked and the site shall be offered to the agencies/firms to maintain and beautify these pockets for initial period of two years. After seeing their performance, their terms can be extended. At the first instance PGI shall not be charging anything from these agencies neither the Institute shall be paying any amount to these agencies.

The water shall be provided by the institute at the nearest pocket to be maintained, however, the agency shall born their own expenses if some line has to be extended for watering of lawns and other such areas. In case the electricity is required, the agency shall take separate connection from U.T Engineering Department, and pay its bill regularly. However, the Institute will extend full help in getting the connection release.

**Noise level** - A hospital must ensure a quiet, calm environment for patients by providing a physical setting conducive to recovery. This requires an organizational culture that supports patients and families by not multiplying through a noisy atmosphere, the stresses already being faced by the patients and their relatives’ viz. imposed by illness, hospitalization, medical visits, healing and bereavement.108

To accomplish this hospital employees must identify internal and external noise factors, whether it is due to people themselves, the equipment or the building. The staff must also discern which noise sources are controllable. The hospital must also measure and reduce the noise in patient rooms within defined compliance levels. Hospital is meant to ensure a quiet and calm environment for patient’s early recovery. The noise levels limits during daytime at a hospital should not exceed
Surprisingly, the noise level was found to exceed the laid down standards at the various locations in PGIMER. It was found maximum near the chemist shop at the ground floor of Nehru hospital due to ongoing construction works.

Since the unwanted sound produced in the hospital has an adverse impact on patients and their attendants, it is very necessary to curb the cause and adopt measures to reduce its impact.

Noise causes sleep deprivation and leads to increased anxiety and stress on the patients & their relatives who are already in a stressful state. Noise also has an impact on the hospital employees. It leads to depression, irritability, reduced efficiency, decrease in productivity & increased medical and nursing errors besides leading to hearing loss and affecting cardiovascular health.\(^{108-110}\)

A higher noise level produced in the PGIMER could be attributed to following sources:

a) There is unwanted and unnecessary movement of people (patients/employees) in the hospital area. Too many attendants and relatives of patients seek medical advice and other information from nursing and other official staff on duty. Sometimes they indulge in useless talks too. In nutshell, human voice is a primary source of noise.

b) Mishandling of equipments viz. trolleys and wheelchairs also produce rattling sound during the transfer of patients for various tests and checkups.

c) The hospital walls, floors and ceiling are hard. So they reflect sound rather than absorbing it.

d) In ICU buzzers, beepers, monitors also create noise.

e) The telephone sounds also disturbs the calm atmosphere in the wards.

f) Careless rattling of utensils and casual attitude of kitchen staff during distribution of food in the wards also is often a source of noise. Their trolleys are also noisy.

g) During the collection of dirty linen by the staff also, a lot of noise is produced.
h) Lack of display boards at certain points and low literacy level of the people visiting the hospital leads to unnecessary and avoidable enquiries.

i) Many renovation/construction activities were in progress in the campus.

j) Excessive student to patient ratio creates noise during clinical teaching. Since PGIMER is a research Institute of repute, and a center of various postgraduate studies, lot of noise is also produced during examination and care of the patients in the wards.

Following steps would help to reduce the noise level in the hospital.

a) All the equipments viz. trolleys, wheelchairs, beds etc should be subjected to regular maintenance and oiling. The engineering workshop of the hospital should be provided with raw material and inventory to tackle this problem. The equipment which have outlived their life must be replaced. Proper rubber padding should be provided in the wheels of chair and beds to ensure smooth operations.

b) The ceiling tiles can be changed periodically from sound reflecting to sound absorbing tiles. The walls can be given acoustic treatment. Since hospital is undergoing renovations this can be easily implemented in a phased manner. This in turn will allow the patients to sleep better and thus ensure early recovery.

c) An auditory impact query should be conducted for every equipment purchase, construction activity and staff event within hospital premises.

d) Light music can be played in wards to avoid noxious sounds. Music improves restfulness & sleep and induces relaxation.

e) The staff should be properly guided and instructed during staff training and employee orientation sessions on the importance of maintaining appropriate noise levels.

f) Proper signage and displays for patients and their attendants would reduce their queries for various locations of hospitals.

g) The waiting line in OPDs should be reduced. The consultation time for the patients should be scheduled and the appointment time with the physician can be given during registration time. The Institute is in the advanced stage of implementing centralized computerization system. The appointment can be
sought online. This will ensure less waiting queues at a particular time thereby reducing noise level in a hospital.

h) Place signs and slogans throughout the hospital viz. 'SILENT ZONE', 'SILENT ZONE HELPS HEALING BODY', 'SILENT HOSPITAL HELP HEALING' etc. to remind attendants, staff and visitors to maintain noise free atmosphere.

i) The doors of wards should be oiled from time to time to cut off irritable rattling sound.

j) The renovation/ repair activity should be done in a phased manner and at intervals to avoid cumulative noise disturbances and using a technology which reduces/ prevents sound.

k) The number of attendants accompanying the patients should be reduced.

l) The ambient noise levels should be recorded throughout the day by sound meters. This will help to identify noise factors and hence noise problems by adopting right measures at right time.

The problem of high noise level in hospitals is also found in developed countries. Noise is a problem inherent in every major hospital even in the United States according to Dr. Mathew Lee, medical director of the Rusk Institute of Rehabilitation Medicine at New York University Medical Center.112

It also has been established that excessive noise and sleep deprivation are believed to diminish the strength of the immune system, lower pain tolerance levels and extend hospital stays. A lack of sleep also may retard the body's ability to generate new cells to repair damaged tissue.113

As per a Mayo Clinic nursing team study published in the February issue of the American Journal of Nursing, peak noise levels as high as 113 decibels, about the same as a jackhammer or chainsaw, occurred at around 7 a.m. during the morning shift change. The 11 p.m. shift change also generated high noise levels.

A study conducted to record the noise level after making various changes, e.g. the nurses decreased the noise of shift turnover by having staff reports take place in an enclosed room and not at the nurses’ desk, noisy roll-type towel
dispensers were replaced with silent folded-towel versions, cardiac monitor settings were moved to lower volumes in patients rooms and the doors of the rooms were closed routinely, found that noise levels went down as much as 80 per cent. This resulted in reducing noise levels on the ward and increasing patients' chance of a decent nights sleep.\textsuperscript{114}

**Safe Water** - Safe drinking water is one of the world's greatest needs, according to the World Health Organization. More than 1 billion people lack safe water, and an estimated 2.2 million children die each year because of diarrheal diseases, many of which could be prevented by safe drinking water.\textsuperscript{131} Therefore, all hospitals must ensure that clean drinking water is available. Municipal water works inside PGIMER campus provide filtered, chemically disinfected safe water. The total water requirement of the Institute of 1159500 litres/day is adequately being met by fourteen numbers of pumps of different capacities installed in the Institute. Water coolers were found at required places inside hospital.

**Sanitation** –Commonsense dictates that general cleanliness is a part of civilized life. Hospitals are an epitome of cleanliness. Good hospitals are recognized by their clean sanitation. Dustbins and toilets were found clean and well maintained inside hospital and OPD.

**Traffic safety** –A good traffic design in a hospital would ensure minimum safety for the patients and their relatives besides providing pollution free atmosphere. Multilevel parking facility near new OPD has been constructed as shown in photograph no.30 to tackle heavy vehicular rush during peak hours. Speed level limit below 20 Km is displayed at number of places inside campus for traffic safety. There is one-way traffic outside the hospital as shown in photograph no.6. Also signage boards are displayed at various locations in the complex as shown in photograph no 1, 5, 7 and 8.

**Aesthetic design of hospital architecture**– All services should be planned well in synchronization with all materials and design and should be comfortable to use. Knowledge of appropriate styles of architecture and furniture should be utilized in designing a hospital.
Assess to natural light and fresh air at all level inside New OPD and other hi-tech centers has been provided. See through windows from top to bottom in advanced eye centre provides eye catching view in addition to providing natural light and fresh air as is evident from photo no 45 and 46.

**Disabled friendly nature-** The National Policy recognizes that Persons with Disabilities are valuable human resource for the country and seeks to create an environment that provides them equal opportunities, protection of their rights and full participation in society. The focus of the policy is to provide **Barrier-free environment** that enables people with disabilities to move about safely and freely, and use the facilities within the built environment. In view of this policy, beside ramps as shown in photograph no.31, lifts for disabled patients are installed inside hospital and wheel chairs are present in adequate numbers in all blocks for them.

**Seating facility-** In hospitals, patients are accompanied by their relatives and have to wait for their turn for hours. Therefore, adequate seating facility is provided for patients inside hospital and OPD as shown in photo no 44.

**Recreational and health educational activities-** Recreational and health educational activities boost up the image of the hospitals. Therefore, posters and panels are displayed inside hospital and OPDs for awareness of patients and their relatives. There are eye-catching fountains as shown in photograph no.32 inside and outside OPD that provide soothing effect to ailing patients. Besides this, flourishing flowerbeds and flowerpots in and around campus relieves everyone.

**Spiritual Health-** Religious sentiments of patients are also taken care of in PGIMER campus. There are temples, gurudwara and church inside campus giving effect of spiritual well being to patients and their relatives as depicted in photograph no. 33. The gurudwara inside campus provides free breakfast and meals to needy patients.

**Work place health promotion-** In order to ensure minimum distraction of the employees from their household and other concerns, steps should be taken so that they devote their attention thoroughly to the Institute.
There is 6-lane swimming pool inside campus for staff and their families as shown in photograph no. 34.

**Free yoga camps** are also organized for staff from time to time.

There are **two schools** inside PGI campus promoting education of children of staff.

Besides number of messes providing nutritious food according to menu suggested by residents, there is Verka milk booth, Vita booth supplementing quality milk products to add to the diet of doctors.

Strategies to reduce health risk to staff are also in place with the provision of adequate facility of gloves, masks, gowns, and needle destroyer at required place. Aprons are compulsory while at work.

**Social and cultural activities**- In order to get rid of hectic and monotonous schedule, social and cultural activities should be a part of every organization. One week long spring festival is celebrated every year inside PGIMER campus. Month of February month is celebrated as sports month every year. Various inter and intra departmental as well as inter college championships are organized. Beside there is traditional celebration of Diwali, Christmas, New Year and fresher’s day, Saraswati Puja etc. Photograph no. 35 shows director, PGIMER participating in a football match.

**Welfare activities for staff**- There is working woman’s hostel, employees welfare canteens, community centre inside campus for celebration of social and cultural functions. There is a creche for children of staff as shown in photograph no. 36. Besides, to support employees financially in their hour of need, there is provision of employees welfare fund scheme, income generating programme for women particularly stitching of hospital linen and gowns by women, vocational training for families for staff.

**Health promotion services for patients and their relatives**- Hospital services extend beyond the traditional ‘cure’ oriented approach. So HPH approach is required. There are free counseling centers like VCTC and DDTC to help patients have their choice in their diagnosis and treatment. Various self-help groups like Sewa Bharti are operating in PGI to help needy patients in getting medicines and basic needs during stay in hospital. There is meeting place for voluntary groups like
Alcohol Anonymous, Breath Free group. Beside there is a Blood bank society, Thalasemia society to help needy patients.

The baby friendly hospital and well baby clinics inside advanced pediatric centre and hospital are pillars to health promotion among neonates, small children and antenatal mothers. New improved dental centre provides free demonstration on correct brushing technique to one and all.

The phone in programme is aired on All India Radio comprising interviews of different faculty of PGI to create awareness among masses about their health and well-being. There is free shuttle service for patients and their relatives inside campus from hospital to OPD. Besides this, there are Sarais and Dharamshalas inside PGI campus to facilitate the stay of patient's relative.

Patient's perspective of PGI as HPH:

65% patients and their relatives were satisfied with preventive and health promoting services of PGIMER, 90% said they were educated about their disease and prevention and other 65% said they were counseled for diet and hygiene.

Though the score of WHO standards of HPH was only 35 out of 80 (objective criteria as per the scoring parameters of scale), lot of health promoting aspects of PGIMER were witnessed during study (not tailored as per scale but own initiative of the hospital administration). The low score obtained by PGIMER, Chandigarh can be attributed to the lack of a declared ‘Healthy Public Policy’ and related strategies.

In India, the concept of HPH is evolving rather slowly. Three hospitals in India namely Sanjay Gandhi Post Graduate Institute of Medical Sciences (SGPGIMS) - Lucknow, JIPMER- Pondicherry and Ram Manohar Lohia Hospital- New Delhi have joined the WHO movement of health promoting hospital. SGPGIMS & JIPMER have started health promotion activities through hospital, schools and colleges.

As a part of the HPH package various healthy lifestyle campaigns are being organized to promote healthy lifestyle and habits in community and amongst the staff of SGPGIMS & JIPMER. For example in to JIPMER & SGPGIMS health survey of the employees was conducted based on WHO- NCD risk factor surveillance,
STEP-I & STEP-II. Sessions on stress management, healthy diet, lifestyle modification, diabetes, hypertension, free health check ups etc. were organized for the employees of hospital. Evaluation of the quality of food and satisfaction level of people eating at various cafeterias was carried through questionnaire. Health promoting sessions were also organized for the cafeteria staff on cooking hygiene and healthy menu options for special groups; like diabetes & hypertensive patients and employees. Various health awareness campaigns for the staff of the hospital were organized and health talks on Diabetes, physical activity and yoga were arranged for staff members.\textsuperscript{133-135}

These hospitals now conduct yoga classes for doctors and patients, a small gym for the health-conscious, a hygienic pantry with waste management system, one that can give the kitchen at a 5-star hotel run for its money.

The five main indicators for health promoting hospitals are management policy, patient assessment, patient information and intervention, promoting healthy workplace, continuity and cooperation. Based on these five core indicators of WHO HPH, the score of SGPGIMS and JIPMER were 68 and 54 respectively as compared to a score of 35 of PGIMER.

In accordance with India's commitment to the World Health Organization (WHO), quality assurance should systematically be introduced in Indian hospitals. However, many of the people responsible for this task still lack the know-how, which is necessary to translate a quality assurance scheme into a practical reality.

A survey was conducted to assess the awareness level about environmental issues among doctors, paramedical staff and general public in which most of the people reported that they experienced suffocation and foul smell in the hospital building off and on. This indicates that the ventilation system needs further improvement. However, quality of outdoor air in the campus was reported to be fresh and quite good. When asked about its solution, people knew that the restriction on the number of attendants will help. But they were not aware of 'sick building syndrome' phenomena.
In spite of the fact that “No Smoking” signboards are displayed at various locations in the Institute, yet many people were found smoking in the hospital premises. This indicates that people do not bother about statutory warnings and take them casually.

Majority of the PGI employees felt that water supplied through the PGI water supply was fit for drinking but surprisingly, none had ever bothered about the water quality report of PGI. Most of the employees were not even aware whether wastewater emanating from hospital needs any treatment or not.

Although most of the doctors and the paramedical staff were aware of the waste categories, various stages of treatment of BMW, usage of colored bins in the hospital yet many aspects were not as per the desired level. The general public although aware about the different color coded bins but was not being guided properly about their usage and purpose by the hospital staff, as reported.

Overall, the level of awareness regarding environmental issues needs to be raised among the doctors, paramedical staff and general public by adequately training them in the areas of BMW safe management.

In addition, to direct observation and EMS, various hospital environment related Acts/Policies were also analyzed. Available evidence suggests that the government is mainly concerned about biomedical waste management in hospitals because BMW Act is being implemented rather seriously and there have been many training, prosecutions regarding this Act. Other Acts and Policies as enumerated in Table 4.15 do not deal specifically with hospital environment.115

Over the years, an increasing emphasis is being given to environment related concerns all over the country in different spheres. CPCB and SPCB have been established. There have been related discussions and action has been initiated in hospitals also but not to the desired extent.136

In spite of the efforts made by Central Pollution Control Board for enforcing them in hospitals, the rules/norms are being openly flouted everywhere as is evident from the newspaper clippings (Annexure P).
The pollution control policy of India can be characterized as command and control regime. The emphasis is on criminal jurisprudence rather than encouraging sustainable development. Enforcement of the law is generally weak because of information problems relating to prosecution and conviction of non-complying organizations. From an economic angle, the enforcement problem arises because the penalties are unrelated to the extent of compliance. As the cost of compliance increases with the level of pollution abatement, we need a penalty structure where the penalty may be linked to the extent of violations.

Some of the reasons for the non-implementation of environmental regulation in India are lack of appropriate law and non-application of it, conflicts between law and traditional practices, institutional weaknesses and inadequacy leading to non-enforcement and malpractice, ignorance of objectivity of the law and absence of environmental quality standard.

Most of these Acts are silent as to the timing and manner of implementing its framework provisions. The agencies or board cannot prosecute independently from the ordinary courts leading to the delay in implementation of relevant legislation.

The process to set standards remains vague in the absence of guidelines on how to balance economic and environmental considerations.

The regulatory framework for the protection of environment is very loose, full of loopholes and vague enough to aid rather than deter the polluters.

In the following paragraphs, various aspects of Environmental Management Systems of PGIMER as evaluated by the investigator are discussed.

**WASTE WATER:**

The effluent water/waste water at the 11 outlet points of the institute was tested for the parameters as enumerated below:

1. **pH:** The pH was found to be within normal limits (6.5-9.0) at all 11 outlet points. It is an indicator of the alkalinity of effluent. The value of pH is significant as
efficiency of any treatment method adopted depends upon availability of suitable pH value.

The fresh sewage/effluent is generally alkaline in nature but as the time passes its pH tends to fall due to production of acids by bacterial action in anaerobic environment or due to nitrification processes. However, the pH rises on treatment of sewage. It is an important quality parameter of wastewater. The concentration range suitable for the existence of most of the biological life in sewage water is narrow and critical. Wastewater with an adverse concentration of hydrogen ion is difficult to treat by biological means. If the concentration is not altered before discharge of the wastewater, the effluent may alter the concentration of natural waters. If the value of pH is less than 5.5 or more than 9.0, the biological life cannot survive.\(^{137}\)

2. TSS: - The value of TSS exceeded at all the 11 outlet points. The value ranged from 118 to 460mg/l exceeding the permissible standard value of 100mg/l. This implies that the effluent is polluted at every outlet point and needs effective removal of TSS at all outlet points prior to its disposal into municipal public sewer. High value of TSS causes sluggishness in the movement of effluent, causing sludge deposits. Suspended solids damage to fish life by causing asphyxiation by injuring the gills and also affect the rate of dissolved oxygen replenishment as they diminish light penetration into the water and thereby retard photosynthesis.

3. Oil and grease: The value exceeded the standard limit at all 11-outlets.

Fats and oils are the third major component of foodstuff. The term grease as commonly used includes the fats, oils, waxes and other related constituents found in wastewater. Fat and oils are contributed to domestic wastewater through butter, lard, margarine and vegetable oils and fats. Fats are also found commonly in meats, the germinal part of cereals, in seeds, in nuts and in certain fruits. Fats are among more stable of organic compounds and are not decomposed by bacteria. Mineral acid attacks them resulting in the formation of glycerin and fatty acid.

Such matter forms scum on the top of the sedimentation tanks and clog the voids of the filtering media. Thus, they interfere with the normal sewage treatment process and hence need proper detection and removal.
In fact, the grease content of waste matter can cause many problems both in sewer and waste treatment plants. If grease is not removed before discharge of the waste, it can interfere with the biological life in surface water and cause unsightly floating matter and films.

Replenishment of dissolved oxygen after it has been consumed or reduced occurs naturally by reaeration of the stream through its surface, and by floating solids that decrease the amount of surface available. Oil films retard this reaeration process.137-138

4. BOD (Biological Oxygen Demand): This is the most important parameter of wastewater quality. If sufficient oxygen is available in waste water, the useful aerobic bacteria will flourish and cause the aerobic biological decomposition of waste which will continue until oxidation is completed. The amount of oxygen consumed in this process is the BOD. BOD indicates the amount of putrescible organic matter present in water. Therefore, a low BOD is an indicator of good quality water, while a high BOD indicates polluted water. Dissolved oxygen (DO) is consumed by bacteria when large amounts of organic matter from sewage or other discharges are present in the water. DO is the actual amount of oxygen available in dissolved form in the water. When the DO drops below a certain level, the life forms in that water are unable to continue at a normal rate. The decrease in the oxygen supply in the water has a negative effect on the fish and other aquatic life. Moreover, invasion and growth of certain types of weeds can cause dramatic changes in a stream or other body of water. Energy is derived from the oxidation process. BOD specifies the strength of sewage. In sewage treatment, to say that the BOD has been reduced from 500 to 50 indicates that there has been a 90 percent reduction in strength of sewage.

The BOD test serves an important function in stream pollution-control activities. It is a bioassay procedure that measures the amount of oxygen consumed by living organisms while they are utilizing the organic matter present in waste, under conditions similar in nature. The other traditional tests or indicators for water quality are chemical oxygen demand (COD) and pH.

For results of the BOD test to be accurate, much care must be taken in the actual process. For example, additional air should not be introduced. Temperature
must be 20°C, which is the usual temperature of bodies of water in nature. A five-day BOD test is used in environmental monitoring. This test is utilized as a means of stating what level of contamination from pollutants is entering a body of water. In other words, this test measures the oxygen requirements of the bacteria and other organisms as they feed upon and bring about the decomposition of organic matter. Time and temperature, as well as plant life in the water, will have an effect on the test. High BOD burdens or loads are added to wastewater by food processing plants, dairy plants, canneries, distilleries and similar operations, and they are discharged into streams and other bodies of water.\textsuperscript{137-138}

High biochemical oxygen demand can be caused by:
- high levels of organic pollution, caused usually by poorly treated wastewater;
- high nitrate levels, which trigger high plant growth.

BOD value is used:
1. To determine the approximate quantity of oxygen that will be required to biologically stabilize the organics matter present.
2. To determine the size of waste treatment facilities
3. To measure the efficiency of waste treatment methods.
4. To determine compliance with wastewater discharge limits.

The value of BOD was found to be alarmingly high in all the 11 outlet points of PGIMER. The higher value can be due to the discharge of medicines, which are synthetic organic molecules, toilet waste, blood, skin parts and other body organs from the hospital.

5. COD (Chemical Oxygen Demand): This value determines the extent of readily oxidisable organic matter present in sewage that contains compounds that are toxic to biological life. The COD of waste is, in general higher than the BOD because more compounds can be chemically oxidized than can be biologically oxidized. For many types of wastes it is possible to correlate COD and BOD. Once the correlation has been established COD measurements can be used to good advantage for treatment plant control and operation.
The value of COD was also found to be alarmingly high at all the 11 sewage outlet points of PGIMER.

6. Bioassay Test: The nature of the effluent at all the 11 outlet points shows that less than 90% of the fish survived after 96 hours in the effluent implying that the effluent is highly toxic for aquatic life. This is due to the high load of BOD and TSS in the sewage.

7. Sulphates: In aerobic digestion of sewage the aerobic and facultative bacteria oxidize the sulphur and its compounds present in sewage to initially form sulphides which ultimately breakdown into sulphates ions which is stable and an objectionable end product. The initial decomposition is associated with formation of hydrogen sulphide gas, causing bad smell and odour, besides causing corrosion of sewage pipes. This gas also ultimately gets oxidized to form sulphate ions.

   In anaerobic digestion of sewage, however, the aerobic and facultative bacteria reduce the sulphur and its compounds to sulphides, which evolve hydrogen sulphide gas along with methane and carbon dioxide causing obnoxious smells and odours. Hydrogen sulphide released into atmosphere above wastewaters and sewers that are not flowing full tends to accumulate at the crown of pipe. The accumulated hydrogen sulphide can be oxidized biologically to sulphuric acid, which is corrosive to sewerage pipes.

   The sulphate values were found to be below permissible limits in PGIMER sewage outlets. Thus, the hospital is not producing any bye products like that of sugar industry, paper industry and tanning industry.

8. Chloride: Chlorides in natural water results from leaching of chloride containing rocks & soils with which the water comes in contact and in coastal areas from salt-water intrusions. In addition, agricultural, industrial and domestic wastewaters discharged to surface waters are a source of chlorides. Chlorides present in municipal water are derived from the kitchen waste, human faeces and urinary discharges etc. High chloride content in sewage indicates presence of industrial waste or infiltration of sea water, thereby indicating strength of sea water.
The values of chlorides at all 11 sewage outlet points in PGIMER were found to be below permissible limits.

9. **Ammonical Nitrogen**: The values were found to be far below permissible limits.

10. **TDS**: The dissolved solids consist of both organic and inorganic molecules and ions that are present in the solution in water. The value determines the strength of sewage.

<table>
<thead>
<tr>
<th></th>
<th>Strong</th>
<th>Medium</th>
<th>Weak</th>
</tr>
</thead>
<tbody>
<tr>
<td>TS</td>
<td>1230</td>
<td>810</td>
<td>405</td>
</tr>
<tr>
<td>Suspended solids</td>
<td>Total</td>
<td>435</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>volatile</td>
<td>270</td>
<td>150</td>
</tr>
<tr>
<td>Settleable solids</td>
<td>7</td>
<td>5</td>
<td>2.5</td>
</tr>
<tr>
<td>Ether soluble matter such as oils, fats &amp; grease</td>
<td>20</td>
<td>14</td>
<td>6</td>
</tr>
</tbody>
</table>

Sewage normally contains very small amount of solids in relation to huge quantity of water (99.9%). It only contains 0.05 to 0.1% of total solids i.e. 500 to 1000mg/ml. Solids present in sewage may be in any of the four forms: suspended solids, dissolved solids, colloidal solids and settleable solids.

The solids in sewage comprise of both organic as well as inorganic solids. The organic matter works out to be about 45% of total solids and remaining 55% is the inorganic matter. Inorganic matter consists of minerals and salts, gravel, debris, dissolved salts, chlorides, sulphates etc. Organic matter consists of 1) carbohydrates such as cellulose, cotton fibre, starch, sugar etc. 2) fats and oils received from kitchen, laundries, garages and shops etc. 3) Nitrogenous compounds like proteins and their decomposed products including waste of animals urea, fatty acids and hydrocarbons. The presence of inorganic acids in sewage is not harmful. They require only mechanical appliances for their removal in the treatment plant. On the other hand, suspended and dissolved organic solids are responsible for creating nuisance if disposed off untreated. Suspended solids can lead to development of sludge deposits and anaerobic conditions if untreated wastewater is discharged in the aquatic environment.\(^{138}\)

The TSS values were found to be far below permissible limits in PGIMER sewage.
A study conducted to study the waste management in the three hospitals of Mauritius namely the Jeetoo Hospital, the Sir Seewoosagur Ramgoolam National (SSRN) Hospital and the Clinic Mauricienne also found that the wastewater was polluted with chemical oxygen demand (COD), biological oxygen demand (BOD$_5$), total suspended solids (TSS) and coliform content well above permissible limits.  

**BIOMEDICAL WASTE**

India’s population of 1.08 billion is expected to reach 1.53 billion by 2050, making it the most populated country in the world. Therefore, adequate management of waste assumes tremendous importance in a country like India whose economy forces the poverty stricken and ignorant “rag pickers” to sift and sort through dumped waste material, in order to eke out a living. Time and again, the audio-visual and print media has highlighted the desperation and pathetic conditions of these people, but the apathy of the people at decision level is that they have managed to give this problem less importance than what it deserves. So much so, that unscrupulous element has moved in and “recirculation” of waste has become one of the “leading” industries in the unorganized sector. A number of documentaries have been made and reports have been compiled regarding improper waste management in the majority of health care institutions. But in most cases the lack of significant steps in this regard is due to apathy at the levels of decision-making.

Therefore, the top management should be made aware of the various types of wastes, their generation, segregation, collection, transport and final disposal. The onus should primarily be on the “generators” of hospital waste, and proper segregation of the wastes at source is the “sine qua non” of a successful waste management programme. It was probably this factor, which had led the Ministry of Environment and Forests to come out with rules under the Environment (Protection) Act, 1986, named as Bio-Medical Waste (Management and Handling) Rules of
1998, which are applicable to all health care institutions generating Bio-Medical Wastes. These rules ensure that all such organizations implement safe and effective waste management systems.

Studies on public health implications of medical waste in developed nations like USA, have revealed that medical waste poses virtually no infection hazard to the public. This could be attributed to the fact that standard practices with regard to personal protection are very strictly followed. So much so that the theoretical estimates of the “beach washups” (which occurred in the summer of 1987 and 1988 in New York) causing HIV infection in one person from infected needles is one in 15 billion to one in 300 billion a risk too small to be of any significance. Besides this, there are some reports of health workers/ persons associated with waste management getting infected mostly through “sharps”. 45

As reported by the committee on Urban Solid Waste Management in India, there are no reliable epidemiological data from developing countries on the health impacts of poor Hospital Waste Management. Some of the problems identified are:

i. Injuries from sharps to all categories of hospital personnel and waste handlers.

ii. Nosocomial infections in patients from poor infection control practices and poor waste management policies.

iii. Risks of infection outside hospitals for waste handlers and scavengers and at times general public.

iv. Risks associated with hazardous chemicals, drugs being handled by persons handling wastes at all levels.

v. “Disposables” being re-packed and sold by unscrupulous elements, without even being washed.

vi. Drugs that have been disposed, being repacked and sold off to unsuspecting buyers.

Due consideration must be given to the impact on environment, especially to risk of pollution of water, air and soil, besides aesthetics of the biomedical waste generated in the hospital. In order to minimise these environmental problems,
action should be taken to deal with pollution at source, i.e. waste should be segregated and concentrated within health care institutions, and whenever possible it should be disposed off safely.

Current Scenario of Biomedical Waste Management in India

Presently, the hospitals and other health care institutions have just gradually started to implement proper waste management principles; there are a number of health care institutions, which dump their wastes in the municipal garbage dumps without any segregation whatsoever. In fact, it is common place to find large heaps of “Bio-medical” wastes in the vicinity of a number of hospitals, containing human tissues, blood soaked items, excreta, drugs, swabs, disposables syringes and needles, bandages etc.

These dumping sites are regularly visited by “rag pickers” who scan and sort these wastes manually, to pick out plastics, disposable syringes and needles, other disposables like catheters, etc., so that they can be “resold” to people who ‘recycle’ them. The ragpickers, who come from the poorest of the poor sections of the society, incur the risk of accidental infections either by sharp or through non-intact skin. The potential for profit from this waste magnifies the risks, at it is prone to be used by:

- Drug addicts who do not have access to safe and sterilised syringes.
- Unscrupulous people who make a profit by reselling the disposables drugs to illiterate and unsuspecting users.

HEALTH HAZARDS AND RISKS ASSOCIATED WITH POOR HOSPITAL WASTE MANAGEMENT

Infection

Infections are the most common health hazard associated with poor Hospital Waste Management. This has been magnified with the advent of AIDS, Hepatitis ‘B’ virus infection, and the increases in the prevalence of these diseases in health care workers working in hospitals and other health care institutions. Among all hospital wastes, the “sharps” i.e. the needles, scalpels, blades, etc. are the most common culprits, mainly because of their propensity to cause accidental pricks or cuts thereby providing direct entry of pathogenic organisms into blood stream. Used
needles are very good reservoirs of infection in which pathogens remain for a long time. Studies in USA reveal that of all workers who come in contact with medical waste, those in sanitary services report highest "on the job injuries". The annual injury rates varied from 10-20 per 1000 workers, in other categories, compared to 180-200 per 1000 workers in sanitation department (refuse collectors). Although there are no exhaustive well-documented studies on health hazards associated with poor hospital waste management, some indicators like progressive increase in hospital infection rate, increasing resistance of organisms to wide variety of antibiotics are pointers to the way in which poor hospital waste management can contribute to the ill health plaguing the health care institutions.

**Modes/ Routes of Transmission of Infection**

a) Through a “break" in skin surface, i.e. either pre-existing cuts or raw areas, or by cuts or puncture of skin.

b) Through mucous membranes, such as splashing into eyes.

c) Through inhalation of dust particles containing micro-organisms.

d) Through ingestion of food/water by contaminated hands, or consumption of contaminated food/water.

**Categories of Persons Exposed to Risk of Infection**

The following categories of persons are exposed to the risk of infection from potentially infectious wastes, if they are not properly managed:

a) Patients attending the health care institution who are at special risk from infectious and other complications resulting from exposure to microbial pathogens and sharps that may arise from breaks in waste disposal system chain are:

- Immunno-suppressed patients whose host defence mechanisms are otherwise altered (e.g. patients with AIDS)
- Patients with bleeding/clotting disorders
- Patients on dialysis.
- Intravenous drug abusers/ addicts
- Patients who have chronic debilitating diseases.

b) Medical and paramedical persons who are providers of medical care.
c) Sanitation staff who are involved in collection, segregation transportation and final disposal of waste.

d) Staff working in support service areas like laundry or central sterile supply department.

Types of Risk

Physical Injury
Physical injury occurs due to improper handling of various biomedical wastes at various steps of waste management. Out of the various categories of waste, the sharps are most prone to cause physical injury especially when they are intermixed with other wastes.

Chemical Injury
Chemical injury occurs due to hazardous –toxic, corrosive, flammable, reactive and genotoxic wastes which can produce chemical burns on accidental exposure, or cause toxicity to cells (cytotoxic materials).

Radiation Injury
Radiation injury occurs due to exposure to various forms of radioactive waste, e.g. vials, syringes contaminated with radio-active substances; radioactive spills, clothes and other accessories from isolation rooms (nuclear medicine), exhaust from stores of radium, sealed sources of radioactive materials, spent nucleotide generation, etc.

PGIMER has its own Biomedical Waste Management programme comprising own incinerators, autoclaves, shreddder and well-trained staff to handle different type of wastes. As depicted in photograph no.14, 17,19, 22, 23, 28 and 29.

The Biomedical waste generated in the Institute is classified into various categories as per the Bio-medical waste (Management & Handling) Rule 1998.

The approximate quantity of the various types of hospitals waste generation per month in PGIMER for the year 2005 is given in Table No.4.1.

i.e Total waste is 18380 kg to 21770 kg / month

= 613 to 725 kg / day.
Taking the bed strength of the hospital as 1350 the biomedical waste generation rate comes to 0.45 kg / bed / day to 0.53Kg / day / bed.

The biomedical waste generation rate in PGIMER is quite less than the hospital waste generated in some developed countries of the world (Table 2.4). However, the generation rate is quite comparable with most of the hospitals of the country where roughly 1-2 kg of waste is generated per bed per day (Table 2.5). Also, wastes generated in developing countries like India, contain much less disposable articles and plastics than waste generated in developed countries. This can be explained by differences in lifestyle and less use of disposables in India.

The BMW generated is collected from OTs, wards, OPDs and research centres in different bins and then taken to garbage collection point from where the waste is sent to the incinerator for burning and the general waste is sent for land filling and the plastic waste is sent to the shredder. The sanitation staff and the engineering personnel deployed at the incinerator site were at times found working without proper protective clothing as is depicted in photograph No.20. Also, the hospital administration has not made any efforts for the vaccination of contractual labour deployed in collection and transportation of biomedical waste. They are very prone to receiving injuries from sharp wastes.

It was noticed that most of the waste treatment & disposal practices in PGIMER conformed to the Biomedical Waste (Management & Handling) Rules 1998 (ANNEXURE C). However, the process of segregation of waste needs improvement. The patients and their attendants need to be guided in a proper manner about the usage of different colored bins. Simply, putting posters on walls where the bins are located does not serve complete purpose.

Moreover, sharps should be collected in puncture proof bags. It was observed that the sharps were thrown along with other hospital waste even in red and yellow bags. This resulted in injury to the sanitation workers. It was also found that, at times, the bags used for collecting biomedical waste were overflowing during transportation from the wards to the garbage collection centre. It was also noticed that one colored bag was found tied in another colored bag, killing the very purpose
of designating different colors for different categories of waste as depicted in photograph no. 19.

The amount of waste incinerated ranged from 461.94Kg/day to 685.7Kg/day in 2006 and 467.03Kg/day to 900 Kg/day in 2007. The annual BMW treated in the incinerator in the year 2006 was 206800 Kg and annual BMW treated in year 2007 was 244542Kg. The stand by incinerator unit was in working condition in PGIMER as per the laid down guidelines. Two incinerators are presently enough to tackle the BMW generated by the institute.

However, the role of incinerators in BMW disposal is being debated nowadays. All the developed countries and even some of the developing countries have banned the use of incinerators in their countries because of the toxic emissions from incinerators, which include:

**Dioxins:** A group of chemicals created by incinerators which have been linked with: cancer, IQ deficits, disrupted sexual development, birth defects, and immune system damage. There are no safe levels of dioxins.\(^71\)\(^\text{-72}\)

**Particulate Matter:** Fine particles released from incinerators, which have been linked with: asthma, decreased lung function, other respiratory ailments, disruption of heart function, and increased mortality rates. There are no safe levels of particulate matter.

**Mercury:** This potent neurotoxin released by the incinerator has been linked with: birth defects, nerve disorders, heart failure, autism, mental retardation, seizure disorders, cerebral palsy, blindness and deafness. Mercury builds up in the food chain and in people.

**Other Toxics:** Additionally, the incinerator leads to the releases of: acidic gases, lead, cadmium, and arsenic. This can further lead to toxic groundwater pollution.

Foreign environmental groups in Korea warned about it way back in 1999 that it was is in danger of becoming a dumping ground for obsolete incinerator technologies that could lead to the increase of dioxin levels in the air. As incinerators are losing its ground in industrialized nations, incinerator companies are targeting overseas markets where people are not aware of the serious health problems associated with incinerators,” said the Multinationals Resources Center.
(MRC) in a letter to a local consumer group. The Washington-based environmental group MRC used Korea as an example of countries that have contracted with the U.S.-based company "AMCO" to supply and install incinerator technology. In particular, the contract mentioned refers to an incineration project in Taejon, according to the letter sent to the Citizens' Alliance for Consumer Protection of Korea (CACPA). The MRC also claimed in the letter that "the building of municipal waste incinerators in Asia is a clear case of double standards in which the health of Americans is protected more than the health of Asians." In the U.S., municipal and medical waste incineration has been identified as among the top sources of dioxin, the most toxic man-made chemical known, the MRC claimed.70-71

Health Care Without Harm, a coalition of 433 organizations in 52 countries working to reduce the environmental impact of health care has supported the resolution to phase out the use of incineration as a waste treatment method as it is an outdated, polluting, and expensive technology. In Illinois, many hospital incinerators have been already closed since incineration is unpopular and obsolete. The reason for this is clear - medical waste incinerators harm people. They pollute the air we breathe and the environment in which we live, posing serious health risks. Incinerators release dioxin, mercury, and other toxic pollutants, and expose workers and communities to these poisonous chemicals. Making it even less popular, incineration also costs significantly more than cleaner, less dangerous waste treatment technologies.70

However, India has yet to launch a wholehearted campaign against it.

Lately, India too has become aware of it. Recently, all the hospitals in Chandigarh including PGIMER have agreed for the common biomedical facility, which would come up in Dadumajra, which is about 5 Kms from PGIMER. This means that all the waste produced would go there and the incinerators would become a thing of past. There would be no pollution from incinerators in hospitals. The project would be completed within six months time as per the Chandigarh Administration’s plan of schedule.
The importance of environmental health in the hospital and its relationship to the safe biomedical waste management practices has been noted throughout history. This is evident from a number of studies been conducted in this direction.

A study conducted by NEERI, Nagpur found that the authorities had failed to install appropriate systems for a variety of reasons, such as non-availability of appropriate technologies, inadequate financial resources and absence of professional training on waste management.98

Even in developed countries like UK where the segregation of waste is being followed properly but the hospital waste is not being transported safely in waste carts. The study conducted found that overall security arrangements for waste carts were largely inadequate. Proper containment of clinical waste in hospitals breached several codes of practice and operational ‘good practice’ guidelines.86

The studies carried out in developing countries like Bangladesh, Pakistan, Tanzania and South Africa have revealed that there is a dire need for adequate training and awareness programmes for the staff and the top management so that they are aware of the importance of safe management of BMW and prevent gross anomalies being carried out.89,90,94,99 A study conducted to check the level of awareness of various aspects of BMW in a district of Gujarat concluded that although doctors were aware of laws related to BMW but the details were not known to them. The auxiliary staff had very poor knowledge.91

The case studies reveal that the process of segregation which is the key step in the BMW management is not followed properly in 90% hospitals. This is the scenario not only in India but also in other countries like Mauritius, South Africa, Kuwait Pakistan and Bangladesh 73,80,74,70,71.A study conducted in Pakistan found that only 25% of the hospitals are doing segregation. 89

A case study of bacterial flora of different types in hospital waste undertaken in AIIMS, New Delhi strongly suggest that the waste should not be stored beyond 24 hrs to prevent environmental contamination caused due to accidental spillage of waste.
A case study undertaken by Institute of Pharmacy, Bundelkhand University, Jhansi to assess the waste handling and treatment system of hospital bio-medical solid waste at J. N. Hospital and Medical Research Center, Belgaum, India found that the overall good management practices were prevalent.97

AIR

As far as hospitals are concerned, most of the air pollution results from emissions from incinerator. However, in PGIMER, Chandigarh it has been ensured that incinerators have been designed specifically for the purpose and that they comply with the accepted norms of emissions.

Sulphur dioxide and nitrogen dioxide values at the 16 air stacks were found to be below permissible levels whereas the value of SPM exceeded at 9 stacks. The values of SPM were found well within permissible level at the incinerator site due to the installation of venturiscrubber. However, air pollution does not seem to be a major concern in a hospital as the emissions from various sources get diluted in the envelope of air surrounding it.

As per discussions held with the Hospital Engineer (Refrigeration & Air-conditioning), PGIMER, it was found that all efforts are directed to minimize the risk from airborne microorganisms is in the wards and operating theatres of the institute by:

- Filtration of supplied air
- By dilution of contaminated air in the theatre
- By preventing entry of contaminated air from areas outside the theatre and wards.

This is achieved by having properly designed HVAC systems, which include provision of exhaust systems, to add fresh air from 20%-40% of the total supply in wards and waiting areas. The exhaust fans with ducting discharge the foul air to the atmosphere. The air-handling units have motorized fresh air dampers to increase the fresh air, whenever required. This additional fresh air is supplied intermittently and prevents buildup of foul odors, suffocation, excess humidity etc. during rush hours.
The following environmental infection-control and ventilation measures are implemented in PGIMER for operating rooms.

- Positive pressure ventilation with respect to corridors and adjacent areas.
- Minimum of 20 air changes are maintained, of which ≥3 air changes are of fresh air.
- All recirculated and fresh air is filtrated through the appropriate filters, providing minimum 90% efficiency.
- The operating room doors remain closed except for the passage of equipment, personnel and patients and limited entry for essential personnel.
- Filtration systems (Air handling units) designed to provide clean air have HEPA filters in high-risk areas. The temperature and humidity is maintained between 20-22°C and 30-60%, respectively to inhibit bacterial multiplication.
- The direction of airflow between rooms in a theatre suite is such that there is no backflow of air from either dirty rooms in the suite or from contaminated areas in the hospital.

Incorporating environmental management into the running of hospitals is essential for improving standards in healthcare institutions along with increasing efficiency, satisfying legal requirements and reducing costs. But, it is really unfortunate, that the hospital administrators readily make cost cutting compromises, when called upon to meet environmental compliance standards.

There has been an emerging trend in developed countries to consciously change the image of hospitals as far as their environment is concerned e.g. in Canada, a hospital is no longer a model of ‘curing the sick’ only. Rather it embraces the health and wellness of the local environment too. This has been possible with Environmental management systems (“EMS”), which have become the coin of the environmental compliance realm.

Despite the shift in image and various initiatives taken by the Institute, the low score (32/100) obtained by PGIMER as per ISO: 14000 checklists is also a matter of concern. However, it should be clear that this low score is mainly due to non-declaration of policy, objectives and mechanism of EMS. Lack of documentation is also a reason for low score.
It is suggested that a clear environmental and HPH policy and related mechanisms should be established for efficient EMS in PGIMER. Although PGIMER has taken steps towards effective management of biomedical waste and other environmental parameters viz; air, water, energy etc. but it has no well-defined formal environmental policy. Testing of air emissions, effluent water samples, noise level etc. should however be conducted regularly and steps to mitigate their possible detrimental effects should be taken. Environmental auditing should also be a regular feature.

The results of the EMS audits should be linked to the corrective action system. Bulk of the scoring components of ISO14000 proforma are linked to policy, objectives and mechanism. Thus, a hospital will score high if it has a declared policy (with documentary evidence) and objective i.e. intention should be explicit. The scoring is based on an assumption that a planned approach has been followed in hospital construction and functioning i.e. first a policy was framed for safe hospital environment, objectives were framed, structure was created and mechanism was established. So, a low score implies that this sequence was not followed in PGIMER.

In nutshell, PGIMER should work upon the following elements of an ISO 14001 EMS in order to achieve high scoring:\[^9-30]\(^\text{319}\)

- **Environmental policy** — There is a need to develop a statement of organization’s commitment to the environment and use of this policy as a framework for planning and action.
- **Environmental aspects** — The Institute should identify environmental attributes of products, activities and services and to determine those that could have significant impacts on the environment.
- **Legal and other requirements** — There is a need to identify and ensure access to relevant laws and regulations (and other requirements to which the organization adheres).
- **Objectives and targets** — PGIMER should establish environmental goals for their organization, in line with its policy, environmental impacts, views of interested parties and other factors.
• **Environmental management program** — The Institute should plan actions to achieve objectives and targets.

• **Structure and responsibility** — In order to establish/carry out these activities, roles and responsibilities of staff should be specified and resources should be provided.

• **Training, awareness and competence** — PGIMER should also ensure that the employees are trained for carrying out their environmental responsibilities.

• **Communication** — There is a need to establish processes for internal and external communications on environmental management issues.

• **EMS documentation** — It is necessary to maintain information on EMS and related documents.

• **Document control** — Personnel need to be identified who should ensure effective management of procedures and other system documents.

• **Operational control** — It is imperative to identify, plan and manage operations and activities in line with policy, objectives and targets.

• **Emergency preparedness and response** — PGIMER needs to identify potential emergencies and develop procedures for preventing and responding to them.

• **Monitoring and measurement** — PGIMER must monitor key activities and track performance.

• **Nonconformance and corrective and preventive action** — It needs to identify and correct problems and prevent recurrences.

• **Records** — It is necessary to keep adequate records of EMS performance.

• **EMS audit** — PGIMER should periodically verify that EMS is operating as intended.

• **Management review** — The Institute needs to periodically review EMS with an eye to continual improvement.

While these requirements relate directly to an organization’s compliance management, each of the seventeen elements of the ISO 14001 Standards can contribute to enhance compliance (e.g., communication, training, documentation, records, nonconformance and corrective/preventive action, EMS audits, management review, etc.). An EMS based on the ISO 14001 Standard can
complement and improve the organization’s compliance management and help it to meet objectives and targets that go “beyond compliance.” An EMS based on the ISO 14001 Standard can also help the organization to meet objectives and targets that address issues that are not subject to regulation. Conformance to EMS would certainly yield rich dividends in the following areas of the Institute -

- Infection Control
- Housekeeping
- Occupational Health and Safety
- Surgical Services
- Purchasing
- Laboratory
- Linen Service

The fruits of implementation of EMS may not be available instantly, like magic tree, but it is sure to show improvements in health standards over a period of time. Also quality of health care can be assured if the government introduces accreditation of hospitals in the 21st century as it is going to be beneficial to both the providers and receivers of the services. Providers would be clear as to what standard are to be maintained and the receivers would know what to expect from the particular hospital. In this way, there can be race among hospitals to get accreditation for better marketing of their services. Environmental management must be an integral part of an organisation’s overall management system. The design of an environmental management system must be an ongoing and interactive process. The structure, responsibilities, practices, procedures, processes and resources for implementing environmental policies, objectives and targets can be co-ordinated with existing efforts in other areas such as general operations, finance, quality and occupational health and safety.

An organization should implement an effective environmental management system in order to protect human health and the environment from possible impacts of its activities, products or services. It should assist in maintaining and improving the quality of the environment.
The goals of the future are “Total Quality Management” and “Continuous Quality Improvement”, which means that everyone involved must place quality at the heart of their working methods and consider the point of view of patients, while not forgetting the efficiency of relevant actions and processes.

The accompanying increase in the sophistication and complexity of healthcare and hospital administration becoming complex has escalated the technical performance required of the staff in successfully meeting the environmental health requirements of the modern hospital. While the hospital sanitarian or hospital environmental health specialist (HEHS) has been a noted and separate professional in the hospital, at least since the 1960s, the number of hospitals utilizing this professional in performing environmental health tasks has been limited.139

Technological advances made in the field of medicine in the recent past have introduced many new dimensions to the image of health care in the hospital. With the result, the role of necessary engineering services in the hospital have increased manifold.

It is, therefore, necessary that the persons charged with the efficient running of the hospitals are trained in the managerial techniques and tools which may be applied by them for getting the best out of the resources available. Against this background, a Diploma in Health and Hospital Administration was started by the PGIMER in collaboration with the Punjab University (Department of Public Administration). It continued for two years – 1975-96 and 1976-77. However due to unavoidable circumstances, it was discontinued later on.

In view of the major role engineering department plays in reducing the adverse environmental impact on and due to hospital, it is important that an apex medical institute like PGIMER should demonstrate the evidence for utility of such engineering services. For this, teaching and research related to hospital engineering should be initiated within the Engineering department i.e. Engineering department should have academic orientation. It should run diploma, graduate and postgraduate
courses in Hospital Engineering, Environmental Health planning and Medical 
Architecture in order to promote research and development in related field.140

The course content of such academic degree/ diploma courses should include-

1.  Assets/Property Management.
3.  Clinical Engineering.
5.  Rehabilitation Engineering.
7.  Radiation Protection.
8.  Environmental Protection Control.
11. Safety & Reliability Engineering.
13. Laundry Engineering.
15. Diagnostic Engineering.
17. Biometry.
18. Landscape and Interior Design
19. Fire and Accident Prevention.
20. Disaster Management.
22. Communication Engineering.
23. Hospital and Nursing Administration.
24. Illustration etc.

These courses can help hospital engineer to play his/her role in increasing 
the turnover of patients in the institute by providing-

2.  Better Environmental Comfort.
4. Adequate Selection of Equipment.
5. Continuity of Work
7. Permanent Vigilance.
8. Collaboration in Master Plans etc.
10. Good Maintenance.

In fact, liaison/collaboration may be established between Punjab University, Punjab Engineering College, College of Architecture and PGIMER to run such courses.