

## **1- Introduction**

Beyond the basic requirements for every hospital, our facilities must be designed to accommodate the specific needs of clinical staff, support hospital operations, and bring value to the local community.

The planning, design, and construction process requires understanding and input from all participants. Take a moment to think about all the people who are involved in this process: staff from the health care organization, who outline what is needed in a new or renovated facility; architects, who provide the vision for the design; contractors, who bring the vision to life; and hospital administrators, who are challenged with leading this team to deliver an optimal environment for their patients and staff. All this is intended to help meeting the challenges of creating environments in which health care providers can work effectively and efficiently and patients receive quality care.

Emergency departments must avail the staff and resources necessary to assess all individuals arriving at the emergency department (ED). Emergency departments must also be able to provide or arrange treatment necessary to for emergency patients who are found to have a serious emergency medical condition. Because of the unscheduled and episodic nature of health emergencies and acute illnesses, experienced and qualified physicians, nurses, and ancillary personnel must be available 24 hours a day to serve those needs.

Emergency departments also provide treatment for individuals whose health needs are not of an emergency nature, but for whom EDs may be the only accessible or timely entry point into the broader health care system. Accessing an ED for care is an option exercised by patients seeking quality and service availability The American College of Emergency Physicians (ACEP) believes that:

- Emergency medical care must be available to all members of the public.
- Access to appropriate emergency medical and nursing care must be unrestricted
- A smooth continuum should exist among pre-hospital providers, ED providers, and providers of definitive follow-up care.
- Evaluation, management, and treatment of patients must be appropriate and expedient.
- Resources should exist in the ED to accommodate each patient from the time of arrival through evaluation, decision making, treatment, and disposition.
- EDs should have policies and plans to provide effective administration, staffing, facility design, equipment, medication, and ancillary services.
- The emergency physician, emergency nurse, and additional medical team members are the core components of the emergency medical care system. These ED personnel must establish effective working relationships with other health care providers and entities with whom they must interact.

These include emergency medical services (EMS) providers, ancillary hospital personnel, other physicians, and other health care and social services resources.

## **1-1 Importance of research**

The study draws its importance from addressing the important topic of emergency departments in hospitals which are considered main sections that receive increasing interest in order to achieve the targeted health care .by increasing their capacity to accept the increasing cases of injuries and ailments, e.g., strokes, diabetic spells, traffic accidents, body scorching, besides other cases. The free movement of people from one place to another has its impacts on the spread of illnesses and hence, emergency departments started exhibiting shortage of services, inadequacy of areas, and the need for carrying out planning and designing studies to encompass such increases of emergency cases. Currently,

hospitals encounter hardships in providing integrated medical services for emergency cases. The importance of this study is there for derived from trying to deal with all these problems, which for clarity, are classified as follows:

- The phenomena of patients transfer from one hospital to another due to absence of adequate medical services.
- Crowdedness negatively affects the quality of medical services.
- Frustration amongst medical teams as a result of various obstacles that potentially hinder the provision of distinguished medical services (continual move of oxygen cylinders from one section to the other...ect) .
- Absence of adequate statistical data that would help in planning and designing of emergency departments to encompass the increase of urgent cases.
- The distance between emergency departments and diagnostic department is often too long.
- There are shortages of services in most parts of emergency departments, such as isolation, blood transfusion, and shock rooms.
- Absence of designing studies related to space and buildings in emergency departments and how to utilize and arrange them according to their functions, besides the choice of appropriate building and finishing materials that help in the flow of the medical services.
- Non –usage of modern utility designs, such as oxygen and gases supply lines.

### **1-2 Objective of the research: -**

The study aims at achieving several main and secondary objectives: -

- To understand in design and service problems in emergency departments in our local hospitals and bring them to international standards.
- To introduce more integrated designing projects that complies with international standards and specifications of hospitals in order to assist designers, planners, and researchers in their work.

- To find solutions to some complex problems in the framework of teamwork between hospital management and consulting engineers to provide a good environment service in hospitals in general and in the emergency departments in particular.
- To attract the attention of researchers and specialists to these issues in order to find or recommend solutions for them.

### **1-3 Hypothesis of Research:**

The study assumes that work should comply with specific standards of hospital designing, and absence of such standards would be the cause of a lot of trouble, which would negatively affect the occupational performance of a building with various sections.

The proposed standards should be based on the experience of other countries that have gone far in the domain of medical services and characterized by high specification of health utility building.

The increase in efficiency of health services in emergency departments in hospitals start by identifying points of shortcomings via field studies.

### **1-4 Methodology of Research:**

In order to achieve the goals and objectives of this research were follow the following methodology steps:

#### **1- Determine methodology of the study:**

This study aims to identify the international standards and specification for emergency department design and the international expertise in the domain to compare them with current status in Sudan in order to prepare a healthy integrated environment, to achieve all this it requires recognition of different concepts and terminology on this topic, what made the research depend on the following:

- Usage of the descriptive analytic method via deducting and analyzing the most vital literature review related to this topic, attempting to study and infer some of the standards and specifications used in emergency department from a theoretical point of view. With regard to field study the researcher visited some hospitals in Khartoum state to collect and analysis some data in their emergency departments.

## **2- Choose their place of the study:**

In the research chooses Khartoum teaching hospital and Khartoum north teaching hospital for field study due to the following:

- Both of them are among the biggest hospital in Khartoum state, which receive larger number of patients.
- These two hospitals suffer from overcrowded and some problem in design and medical services.

3- Summarized the field study in results and recommendation to find some practical and scientific solutions for the problems in these hospitals.

In order to achieve some results, the study covers three axes:

- First axis: An analytical study on emergency departments.
- The second axis: a study of international standards and specifications induced experiences of European countries.
- The third axis: focuses on field study of emergency departments in hospitals in Khartoum State and other countries.

## **2-Introduction**

Emergency medicine, one of the youngest specialties, has grown to become a challenging and increasingly popular career choice. It is the specialty defined by its patients rather than by any physician-derived classification system. It challenges the traditional medical model of maximizing knowledge of ever decreasing areas of the disease spectrum and in doing so challenges its practitioners to safely and expertly provide care for the broadest possible spectrum of disease.

Emergency care is an essential part of any healthcare system and as such must be available 24 hours per day.

The number of patients presenting to emergency departments in the developed world has been increasing significantly over recent years and departments have had to develop strategies to deal with overcrowding, difficulties with admitting patients into hospital beds and changes in workforce such as decreased doctors' hours of work.

Although emergency medicine has been practiced for decades, if not centuries, it has taken until the later third of the twentieth century for the specialty to establish itself independently. The Casualty Surgeons Association was formed in London in 1967. In 1972 the UK Department of Health funded thirty consultant posts creating a new specialty, accident and emergency medicine. In 1979, emergency medicine became the twenty-third recognized medical specialty in the USA, and was recognized as a medical specialty in Australia in 1993 and in New Zealand in 1995. In 2004, the name emergency medicine became official in the UK.

The challenges faced in the emergency care system include:

- Availability at any time for any complaint.
- Unfamiliarity of patients.
- A wide spectrum of presentations.
- Simple to complex problems.

- Neonates to the very elderly.
- Patients and relatives.
- A need to be able to act on limited Information and lack of patient Records.
- Expertise in trauma management.
- Time pressures and unpredictable numbers of patients.
- Differentiating trivia from subtle symptoms of serious disease.

All these challenges, not least the lack of prior knowledge of the patient, mean that each patient's problem requires careful attention, thoughtful enquiry and honest informed opinion.

When dealing with the patient who is actually or potentially critically ill or injured, an approach that differs from the traditional model is required.

To take a full history, perform a full examination, and order and review appropriate tests in a patient who may require immediate intervention and treatment, may threaten their very survival. Irrespective of the nature of the clinical emergency, maintenance of adequate oxygenation and ventilation, adequate blood pressure and adequate blood flow to vital organs are important guiding principles.

The approach adopted by the various life support courses is the one used instinctively by emergency teams for all patients:

- The primary survey (ABCDE).
- Airway (with cervical spine control in trauma).
- Breathing and oxygenation.
- Circulation (with hemorrhage control).
- Disability (neurology).
- Exposure and environment.
- Resuscitation and treatment of life threats.
- Secondary survey – history and examination.
- Emergency treatment and investigations.
- Disposition and definitive care.

This approach ensures that the most immediately life-threatening problems are recognized and treated in the order of their likely impact.

The ability to be able to treat recognized problems, even without a diagnosis, is key to the practice of emergency medicine. The mark of an emergency physician is the ability to manage the airway (incubate, provide a surgical airway), to manage the breathing of a patient (perform emergency respiratory interventions: ventilation, chest decompression) and to be able to provide cardiovascular support (such as Advanced Life Support).

## **2-1 History of Emergency Medical Service**

**1500 B.C.** - The development of EMS has been based on tradition and, to some extent, on scientific knowledge. Its roots are deep in history. For example, the Good Samaritan bound the injured traveler's wounds with oil and wine at the side of the road, and evidence of treatment protocols exist.

**1797** - Although the Romans and Greeks used chariots to remove injured soldiers from the battlefield, most credit Baron Dominique-Jean Lary, chief physician in Napoleon's army, with institution of the first pre hospital system designed to triage and transport the injured from the field to aid stations.

**1860's** - Flying ambulances (dressing stations) were made to effect transport, and protocols dictated much of the treatment. In the United States, organized field care and transport of the injured began after the first year of the Civil War, when neglect of the wounded had been abysmal.

**1865 & 1869** - Civilian ambulance services in the United States began in Cincinnati and New York City, respectively. Hospital interns rode in horse drawn carriages designed specifically for transporting the sick and injured.

**1911** - The first specialized trauma care center in the world was opened in 1911 in the United States at the University of Louisville Hospital in Louisville, Kentucky.



**1922** - The first volunteer rescue squads organized in Roanoke, Virginia, and along the New Jersey coast. Gradually, especially during and after World War II, hospitals and physicians faded from pre-hospital practice, yielding in urban areas to centrally coordinated programs. These were often controlled by the municipal hospital or fire department, whose use of “inhalators” was met with widespread public acceptance. Sporadically, funeral home hearses, which had been the common mode of transport, were being replaced by fire department, rescue squad and private ambulances.

**1960** - Cardiopulmonary resuscitation (CPR) was shown to be efficacious. Shortly thereafter, model EMS programs were developed based on successes in Belfast, where hospital-based mobile coronary care unit ambulances were being used to treat pre-hospital cardiac patients. American systems relied on fire department personnel trained in the techniques of cardiac resuscitation. These new modernized EMS systems spurred success stories from cities such as Columbus, Los Angeles, Seattle, and Miami.

**1990** - The Trauma Care System Planning & Development Act is passed by Congress.

Fire Department organizations join together in a resolution to expand into EMS.

**1991** - The Commission on Accreditation of Ambulance Services sets standards and benchmarks for ambulance services to obtain.

### **2-1-1 Brief History of the Health Care in Sudan:**

The evolution of the modern health care system in Sudan goes back to 1899, when it was being delivered by the army. Some hospitals were built and smallpox immunization programs were run. The Medical Department was established in the Northern Sudan in 1904, where the Southern areas remained under military

government. In 1905 the Central Sanitary Board was established to guard the public and curative health affairs.

In 1924 the Sudan Medical Services was established and managed by a director responsible for all health services, including military medical services. In 1949 the Ministry of Health was established.

Between 1951 and 1960, the health was managed according to the Local Government Act 1951, where the rural and civil councils represented the local government responsible for basic service delivery, including health. From 1960 to 1971, the health was managed according to the Province Administration Act 1960, which aimed at strengthening the provinces to activate an effective mid-level administration that represents the central government. At that time the health was represented by the governor assistant for health affairs. The province was responsible for supervising, promoting and financing the local authorities

This was followed by the Popular Local Governance Rule in 1971, which was also an effective administrative/political level where the province remained responsible for the basic services (education, public health, agriculture and community development), the provinces were under the local government affairs office under the Presidency of the Republic.

In 1979, seven central ministries were cancelled and the authorities of four ministries, including the ministry of health, were reduced and given to the provincial authorities. In 1980, The Local Government Act divided Northern Sudan, excluding Khartoum, into five regions, and Southern Sudan into three regions.

The adoption of the federal system started in 1991. The regions were upgraded into nine States that further became 26 in 1994. A single ministry for health and social affairs was found in each of the states while separate ministries for health and social affairs were found in Khartoum. The locality remained as an effective

administrative level with its own resources and responsible for basic services including health.

## **2-2 Background**

In the Sudan and in many countries, emergency departments (EDs) are confronted with overcrowding and budget restrictions. The discipline of emergency medicine (EM) has faced significant challenges from its inception to its successful establishment in many countries. Inherent to EM is the need to interact with many other specialties, and the results have been rewarding, disappointing, or questionable to almost equal extents. One of the most consistent frustrations for EM physicians is constantly overcrowded emergency rooms. The profile of the patient population is also changing and is highly dependent on cultural context and developments. Furthermore, there is an increasing need for more information on financial planning and health policy-making. These factors provide a stimulus to analyze and improve internal processes in ED. Traditionally, such design-relevant problems were solved by means of static (quantitative) estimates, but the use of a qualitative dynamic systems (DS) approach seems to be more appropriate.

The ED at the hospital in Berne, Switzerland, provides round-the-clock medical and surgical care. An increasing patient volume has resulted in difficulty in reaching elective admission and bed occupancy targets. We used data from our department to map the system conceptually based on patient pathways from admission to discharge. Patterns of activity, demand, and system bottlenecks were simulated with this map and used to construct a quantitative DS model. Our goal was to examine whether a DS model approach can help to solve strategic design challenges in emergency department capacity planning, and demonstrate the significance of such a design feature in achieving strategic and political success.

## **2-3 Definitions:-**

### **2-3-1 Emergency (e-mer'jen-se):**

(An unlooked for or sudden occurrence, often dangerous, such as an accident or an urgent or pressing need). <sup>1</sup>

### **2-3-2 Emergency Medicine (EM.):**

Emergency medicine is (the medical specialty dedicated to the diagnosis and treatment of unforeseen illness or injury. It encompasses a unique body of knowledge as set forth in the "Model of the Clinical Practice of Emergency Medicine). The practice of emergency medicine includes the initial evaluation, diagnosis, treatment, and disposition of any patient requiring expeditious medical, surgical, or psychiatric care. Emergency medicine may be practiced in a hospital-based or freestanding emergency department (ED), in an urgent care clinic, in an emergency medical response vehicle or at a disaster site.

Emergency medicine professionals provide valuable clinical and administrative services to the emergency department and other sectors of the health care delivery system. These may include and are not limited to:

- The coordination of out-of-hospital emergency medical response
- Out-of-hospital medical control system authorization and oversight
- Participating in community disaster preparedness
- Emergency department leadership and medical direction
- Active participation in emergency department EMTALA compliance
- Active participation in the direction of the emergency department patient intake process
- Active participation in the approval of emergency department equipment and physical plant

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<sup>1</sup>. Miller-Keane Encyclopedia and Dictionary of Medicine, Nursing, and Allied Health, Seventh Edition. © 2003 by Saunders, an imprint of Elsevier, Inc.

- Active participation in the planning of emergency department staffing levels
- Active participation in approval of emergency department policies and procedures
- Active participation in the emergency department budgetary process
- Participation in emergency department staff continuing education
- Oversight and direction of emergency department patient disposition
- The coordination of emergency department patient care among multiple providers and healthcare facilities

### **2-3-3 Emergency Department (ED.):**

(in a health care facility) a section of an institution that is staffed and equipped to provide rapid and varied emergency care, especially for those who are stricken with sudden and acute illness or who are the victims of severe trauma. The emergency department may use a triage system of screening and classifying clients to determine priority needs for the most efficient use of available personnel and equipment.<sup>1</sup>

(An area of a hospital especially equipped and staffed for emergency care. Popularly called emergency room)<sup>2</sup>

(The department of a hospital responsible for the provision of medical and surgical care to patients arriving at the hospital in need of immediate care. Emergency department personnel may also respond to certain situations within the hospital such cardiac arrests)<sup>3</sup>.

The Emergency Department is the dedicated area in a hospital that is organized and administrated to provide a high standard of emergency care to those in the community who perceive the need for or are in need of acute or urgent care

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<sup>1</sup>. Mosby's Medical Dictionary, 8th edition. © 2009, Elsevier

<sup>2</sup>. Miller-Keane Encyclopedia and Dictionary of Medicine, Nursing, and Allied Health, Seventh Edition. © 2003 by Saunders, an imprint of Elsevier, Inc

<sup>3</sup>. Last Editorial Review: 1/2/2000 8:28:00 PM

including hospital admission. (*Australasian College for Emergency Medicine, Policy Document – Standard Terminology (1993)*)

### **2-3-4 Emergency Room (ER.):**

#### ***N. Abbr. ER***

(The section of a health care facility is intended to provide rapid treatment for victims of sudden illness or trauma) .<sup>1</sup>

### **2-3-5 Emergency Medical Technician (EMT.):**

A provider of emergency care (health care at the basic life support level); this may include spinal immobilization, administration of oxygen, and control of bleeding. In some states there are modular training programs where an EMT can add skills to the basic level.<sup>2</sup>

## **2-4 Importance of Emergency Department:-**

The emergency department is a core clinical unit of a hospital and the experience of patients attending the emergency department significantly influences patient satisfaction and the public image of the hospital. Its function is to receive, triage, stabilize and provide emergency management to patients who present with a wide variety of critical, urgent and semi urgent conditions whether self or otherwise referred. The emergency department also provides for the reception and management of disaster patients as part of its role within the disaster plan of each region. In addition to standard treatment areas, some departments may require additional specifically designed areas to fulfill special roles, such as:

- The management of pediatric patients
- The management of major trauma patients
- The management of psychiatric patients

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<sup>1</sup> . The American Heritage® Medical Dictionary Copyright © 2007, 2004 by Houghton Mifflin Company. Published by Houghton Mifflin Company.

<sup>2</sup> . Miller-Keane Encyclopedia and Dictionary of Medicine, Nursing, and Allied Health, Seventh Edition. © 2003 by Saunders, an imprint of Elsevier, Inc

- The management of patients following sexual assault
- The management of infectious patients
- The extended observation and management of patients
- The management of prisoners in custody
- The management of patients affected by chemical, biological or radiological incidents.
- Undergraduate, postgraduate teaching
- Transport and retrieval services
- Telemedicine

In addition to clinical areas, emergency departments require facilities for the following essential functions:

- Teaching
- Research
- Administration
- Staff amenities

Information which would assist in the planning of an emergency department include

- Annual census and trends
- Average daily census with peak patient volumes
- Triage categories of patient presentations
- Admission/transfer rate, including the number of cases requiring monitoring
- Average length of stay
- Turnaround times for radiology and pathology
- Patient mix, identifying those who are >65 years of age, and pediatric cases
- Additional information which pertain to the role delineation of the department i.e. (trauma service, regional referral service....etc).

In general planning, the physical design goals should not be confused with operational goals.

Designing a functional emergency department will not resolve access block. In order to maximize functional consideration, it is recommended that:

- The clinical areas are designed to accommodate higher acuity patients. All treatment Spaces should be wired for monitoring with access to the patient available from all sides.
- Pediatric clinical spaces require as a minimum the same space requirements if not more than adult patient care spaces to accommodate family members and /or careers, storage area for toys, books..... etc).
- The department design has the ability to respond to clinical demands.
- The central station or ‘arena’ department design concept is appropriate to certain department size. When this is exceeded modular design principles should be adopted to maximize operational practices i.e. Sub grouping patient care areas each with ready Access to its own clinical support areas and its own central station to avoid staff fragmentation.
- Overuse of specialty rooms is avoided. Maintain flexibility to cope with emerging advances in clinical care i.e. Staff access to computer wireless technology in clinical recording.
- Spatial consideration is made to accommodate family members and/or cares who will be accompanying the patient.
- Privacy and confidentiality be maximized.
- The clinical areas have the capacity to be isolated to prevent cross infection or cross Contamination in the event that an area becomes contaminated.

Once designed, the plan should be tested by using a number of clinical scenarios i.e. Multiple trauma, chest pain, pediatric resuscitation, mental health presentation with a behavioral problem, gynecological presentation, potentially infectious or poisoned patients i.e. MRSA, TB, SARS, "white powder", fracture, malaria, to ensure optimal patient flow.



## **2-6 Emergency Service:**

Emergency services are the front door of the health facility and, for many people, form their primary contact with the health care system, providing an important interface between the community and the health facility. Emergency services are responsible for the reception, triage, initial assessment, stabilization and management of patients of all age groups presenting with acute and urgent aspects of illness and injury.

The role and level of function of a hospital-based emergency service depends on various factors, including the type of facility in which it is located, geographical location, location in the public or private sector, and the place of the facility within a health system network. The level of emergency service provided will also vary depending on availability of support services, staffing expertise, physical design, activity and acuity. Rapid access to operating rooms, intensive care and coronary care units (if present) is highly desirable to minimize transfer times of critically ill patients.

Emergency departments are not stand-alone facilities. To provide safe and effective service delivery, emergency departments rely on a suite of support services from both within and external to the service. The scope of the Framework does not permit the inclusion of all Services necessary to support the adequate function of emergency departments. Therefore, this module concentrates on those support services that have a direct impact on the ability of emergency departments to deliver safe and high-quality care, and ensure patient flow.

The term emergency department is generally used to describe facilities ranging from high-level departments with emergency medicine specialists and trainees employed 24 hours a day, through to rooms in small rural and remote hospitals staffed by roistered local general practitioners and generalist nursing staff. Services will be referred to as emergency care centers, while higher level services will be known as emergency departments.

The use of the term emergency department to describe such a broad range of settings can lead to misunderstandings of service capabilities and delivery. A

hospital-based emergency service must have amenities and functions greater than the minimum standard for Rural Emergency Service role delineation to be considered an emergency department.

### **2-6-1 Emergency Service Requirements:**

In addition to the requirements outlined in the Fundamentals of the Framework, specific service requirements include:

- Must have a dedicated clinical and management information system, which records both presentation details and recognized clinical.
- The amount and type of space required for individual emergency units is dependent on a combination of activity, acuity and access to inpatient beds and alternative services
- Risk management strategies are developed, implemented and evaluated by qualified and registered health professionals in consultation with higher level health services where possible, and in accordance with established algorithms for specific clinical services.
- Documented processes guide assessment and management of mental health clients, which includes suicide risk and relevant referrals
- Formal quality improvement programs include review of morbidity, mortality and recognized emergency medicine clinical indicators.
- Quality improvement data are submitted to a recognized facility quality program such as the Australian Council on Healthcare Standards (ACHS) Evaluation and Quality Improvement Program (EQuIP).

### **2-6-2 Emergency Work Force Requirements:**

In addition to the requirements outlined in the Fundamentals of the Framework, specific workforce requirements include:

Where possible, medical, nursing and allied health staff are provided with the Opportunity to participate in a variety of identified emergency courses, which may Include:

- Advanced Life Support
- Acute and Complex Medical Emergencies
- Clinical Rural Skills Enhancement
- Early Management of Severe Trauma Course
- Emergency Crisis Resource Management
- Emergency Events Management
- Emergency Technical Skills Course for Doctors
- Pre-Hospital Trauma Life Support
- Trauma Nursing Core Course
- Trauma Nursing Program
- Advanced Pediatric Life Support Course
- Emergency Nurses Pediatric Course
- Pediatric Emergency Crisis Resource Management
- Pediatric Life Support.

### **2-6-3 Emergency Service level1:**

#### **2-6-3-1 Service Description:**

A Level 1 service, also known as a Level 1 emergency care centre, is primarily a nurse-run clinic with a registered nurse available 24 hours for emergency presentations and 24-hour access to a registered medical practitioner. The service is capable of providing limited treatment for minor injuries and illnesses, basic resuscitation and limited stabilization prior to transfer. There is no access to inpatient services at this level. However, short, inpatient-style service to children may be provided (for example, intravenous rehydration of a child or intravenous delivery of antibiotics and subsequent observation of a child for up to 4 hours). This level service may provide ongoing observation for up to 8 hours in consultation with a higher level service. Services that do not provide a 24-hour service (i.e. primary care centers) are not regarded as emergency care centers.

### **2-6-3-2 Service Requirements:**

- Documented processes with another health facility to review and report on all x-rays.
- Equipment to provide initial resuscitation measures for both adults and children.

### **2-6-3-3 Workforce Requirements:**

#### **✓ Medical**

- registered medical practitioner available 24 hours
- access—24 hours—to a registered medical practitioner with credentials in critical care(intensive care or emergency)

#### **✓ Nursing**

- Registered nurse with relevant clinical knowledge, demonstrated evidence of ongoing clinical competency and experience appropriate to the service being provided available 24 hours.
- Access to a registered nurse with or working towards Rural and Isolated Practice Registered Nurse (RIPRN) accreditation.

#### **✓ Allied health**

- Limited medication service by a pharmacist (or an approved registered nurse).

#### **✓ Other**

- Aboriginal and Torres Strait Islander health worker available 24 hours.

### **2-6-3-4 Support Service Requirements:**

A Level 1 service requires:

Table 2-1 (emergency services level 1)

(Clinical Services Capability Framework version 3.0)

Service	On-site	Accessible
Intensive care		<b>4</b>
Medical imaging		<b>1</b>
Medication		<b>1</b>
Pathology		<b>2</b>

## **2-6-4 Emergency Service level2:**

### **2-6-4-1 Service Description:**

A Level 2 service, also known as a Level 2 emergency care centre, has on-site, 24-hour access to nursing staff and triage of all presentations. This level service is capable of providing treatment for all minor injuries and illnesses and limited treatment of acute illnesses and injuries. This service provides basic resuscitation and limited stabilization, including short-term assisted ventilation prior to transfer to a higher level service

### **2-6-4-2 Service Requirements:**

- Documented processes with another health facility to review and report on all x-rays.
- Equipment to provide initial resuscitation measures for both adults and children.

### **2-6-4-3 Workforce Requirements:**

As per Level 1, plus:

#### **✓ Medical**

- Registered medical practitioner available on-site within 30 minutes in normal Circumstances—24 hours.

#### **✓ Nursing**

- Access to a registered nurse who is competent in providing adult advanced life support and pediatric life support.
- Access—24 hours—to a registered nurse who has successfully completed the Emergency Triage Education Kit (ETEK).

#### **✓ Allied health**

- Access to a pharmacist (or an approved registered nurse) on weekdays for medication services.
- Access to allied health professionals, as required.

#### **✓ Other**

- Access to patient support staff and security personnel.

#### **2-6-4-4 Support Service Requirements:**

A Level 2 service requires:

Table 2-2 (emergency services level 2)

(Clinical Services Capability Framework version 3.0)

Service	On-site	Accessible
Intensive care		<b>4</b>
Medical		<b>2</b>
Medical imaging		<b>1</b>
Medication		<b>2</b>
Pathology		<b>2</b>
Surgical		<b>2</b>

#### **2- 6 -5 Emergency Service level3:**

##### **2-6-5-1 Service Description:**

A Level 3 service, also known as a Level 3 emergency care centre, provides on-site, 24-hour access to designated emergency nursing staff and triage of all presentations. This level service is capable of providing initial treatment and care for all presentations, and advanced resuscitation and stabilization, including short-term assisted ventilation prior to transfer to a higher-level service. This service has the ability to assist in the care of minor trauma and enable the rapid transfer of major trauma.

##### **2-6-5-2 Service Requirements:**

- Documented processes with another health facility to review and report on all x-rays.
- Equipment to provide initial resuscitation measures for both adults and children.
- Access to a pathway for direct admission of children to a pediatric inpatient unit.

### 2-6-5-3 Workforce Requirements:

As per Level 1, plus:

#### ✓ **Medical**

- Registered medical practitioner available on-site within 30 minutes in normal circumstances—24 hours.

#### ✓ **Nursing**

- Access to a registered nurse who is competent in providing adult advanced life support and pediatric life support.
- Access—24 hours—to a registered nurse who has successfully completed the Emergency Triage Education Kit (ETEK).

#### ✓ **Allied health**

- Access to a pharmacist (or an approved registered nurse) on weekdays for medication services.
- access to allied health professionals, as required

#### ✓ **Other**

- Access to patient support staff and security personnel.

### 2-6-5-4 Support Service Requirements:

A Level 3 service requires:

Table 2-3 (emergency services level 3)

(Clinical Services Capability Framework version 3.0)

Service	On-site	Accessible
anesthetic	<b>3</b>	
Intensive care		<b>4</b>
Medical		<b>3</b>
Medical imaging		<b>1</b>
Medication	<b>3</b>	
mental health (relevant section/s)		<b>4</b>
Pathology		<b>3</b>
Surgical		<b>3</b>

## **2- 6 -6 Emergency Service level4:**

### **2-6-6-1 Service Description:**

A Level 4 emergency department provides a 24-hour service, which includes triage by qualified emergency staff and advanced care for all presentations. Depending on the medical staffing, a Level 4 service may be recognized as an emergency department under ACEM standards. this level service has the ability to provide high-quality trauma care to medium and minor level trauma patients and is capable of stabilizing trauma patients until transfer. A Level 4 service may provide a short-stay unit or equivalent functional area.

### **2-6-6-2 Service Requirements:**

A Level 4 service requires:

- a purpose-designed area with separate resuscitation facilities
- short-term assisted ventilation capacity
- Invasive monitoring capacity.

### **2-6-6-3 Workforce Requirements:**

A Level 4 service requires:

#### **✓ Medical**

- lead clinician responsible for clinical governance of the service who is, preferably, a Fellow of the Australasian College for Emergency Medicine (FACEM), or a registered medical specialist with credentials in emergency medicine with oversight provided by a FACEM
- at least one additional registered medical practitioner with credentials in emergency medicine to support the department director one FACEM or registered medical specialist with credentials and/or extensive experience in emergency medicine, or a senior registered medical practitioner with credentials and/or extensive experience in emergency medicine, on-site 8 hours a day, 7 days a week.



- one registered medical practitioner with experience in emergency medicine exclusively roistered to the unit 24 hours
- immediate, 24-hour access to a second registered medical practitioner where relevant, designated short-stay unit medical staff, in addition to emergency service medical staff

✓ **Nursing**

- Designated senior registered nurse or nurse manager (however titled) in charge of each shift
- Minimum of two registered nurses with experience in emergency medicine present in the department at all times.
- one of the two or more registered nurses is a dedicated triage nurse 24 hours
- Access to a registered nurse who is competent in providing advanced life support— on-site 24 hours a day.
- Registered nurse with successful completion of ETEK available on-site 24 hours.
- Access to additional registered nurses within the facility, as required.
- Where relevant, designated short-stay unit nursing staff in addition to emergency.
- Service nursing staff.

✓ **Allied health**

- Access to allied health professionals, as required
- Access to a specialized clinical social worker or health practitioner with competencies.
- in case management and counseling, as required

✓ **Other**

- As per Level 2 service.

#### **2-6-6-4 Support Service Requirements:**

A Level 4 service requires:

Table 2-4 (emergency services level 4)

(Clinical Services Capability Framework version 3.0)

Service	On-site	Accessible
anesthetic	<b>4</b>	
cardiac (cardiac care unit)		<b>4</b>
cardiac (cardiac diagnostic and interventional)		<b>4</b>
Intensive care	<b>4</b>	
Medical	<b>4</b>	
Medical imaging	<b>4</b>	
Medication	<b>4</b>	
mental health (relevant section/s)		<b>4</b>
Pathology		<b>4</b>
Surgical	<b>4</b>	

#### **2- 6 - 7 Emergency Service level5:**

##### **2-6-7-1 Service Description:**

A Level 5 service, also known as a Level 5 emergency department, provides comprehensive trauma care and stabilization of all trauma patients until transfer. A Level 5 emergency department should provide a short-stay unit/area to define patient diagnosis and determine continued hospitalization or discharge plan and destination for acutely ill patients, if required.

##### **2-6-7-2 Service Requirements:**

As per Level 4, plus:

- a structured nursing education program
- Evidence of all senior registered nurses progressing towards an emergency qualification.

### **2-6-7-3 Workforce Requirements:**

A Level 4 service requires:

#### **✓ Medical**

- A minimum 0.5 full-time equivalent designated lead clinician with responsibility for clinical governance of the service, which is a FACEM and is a registered medical specialist with credentials in emergency medicine on-site.
- At least one FACEM or registered medical specialist with credentials in emergency medicine or senior registered medical practitioner with credentials in emergency medicine on-site 16 hours a day, 7 days a week at least one FACEM or registered medical specialist with credentials in emergency medicine or senior registered medical practitioner with credentials in emergency medicine available for the remaining 8 hours a day, 7 days a week.
- In addition to the above, at least three registered medical practitioners exclusively roistered to the department 16 hours a day, 7 days a week, and at least one registered medical practitioner exclusively roistered to the department for the remaining 8 hours a day, 7 days a week, with immediate, 24-hour access to additional registered medical practitioners, as required.
- Where relevant, there must be designated short-stay unit medical staff directly responsible for the short-stay unit, in addition to emergency service medical staff.

#### **✓ Nursing**

- Designated nurse manager (however titled) with or working towards management and/or postgraduate qualifications in emergency nursing who has relevant clinical nursing experience commensurate with the position.
- Designated senior registered nurse/nurse manager in charge of each shift with relevant clinical knowledge, demonstrated evidence of ongoing clinical

competency and relevant clinical experience appropriate to the service being provided.

- Registered nurse competent in providing advanced life support on-site 24 hours.
- At least three experienced registered nurses present in the department at all times with access to additional acute care registered nurses, as required.
- where relevant, there must be designated short-stay unit nursing staff, in addition to emergency service nursing staff

✓ **Allied health**

- As per Level 4 service

✓ **Other**

- As per Level 2 service.

**2-6-7-4 Support Service Requirements:**

A Level 5 service requires:

Table 2-5 (emergency services level 5)

(Clinical Services Capability Framework version 3.0)

Service	On-site	Accessible
anesthetic	<b>5</b>	
cardiac (cardiac care unit)	<b>5</b>	
cardiac (cardiac diagnostic and interventional)	<b>5</b>	
cardiac (cardiac medicine)	<b>5</b>	
Intensive care	<b>5</b>	
Medical	<b>5</b>	
Medical imaging	<b>5</b>	
Medication	<b>5</b>	
mental health (relevant section/s)		<b>5</b>
nuclear medicine		<b>4</b>
Pathology	<b>4</b>	
Surgical	<b>5</b>	

### **3- Introduction**

Hospitals are the most complex of building types. Each hospital is comprised of a wide range of services and functional units. These include diagnostic and treatment functions, such as clinical laboratories, imaging, emergency rooms, and surgery; hospitality functions, such as food service and housekeeping; and the fundamental inpatient care or bed-related function. This diversity is reflected in the breadth and specificity of regulations, codes, and oversight that govern hospital construction and operations. Each of the wide-ranging and constantly evolving functions of a hospital, including highly complicated mechanical, electrical, and telecommunications systems, requires specialized knowledge and expertise. No one person can reasonably have complete knowledge, which is why specialized consultants play an important role in hospital planning and design. The functional units within the hospital can have competing needs and priorities. Idealized scenarios and strongly-held individual preferences must be balanced against mandatory requirements, actual functional needs (internal traffic and relationship to other departments), and the financial status of the organization.

In addition to the wide range of services that must be accommodated, hospitals must serve and support many different users and stakeholders. Ideally, the design process incorporates direct input from the owner and from key hospital staff early on in the process. The designer also has to be an advocate for the patients, visitors, support staff, volunteers, and suppliers who do not generally have direct input into the design. Good hospital design integrates functional requirements with the human needs of its varied users.

The basic form of a hospital is, ideally, based on its functions:

- bed-related inpatient functions
- outpatient-related functions

- diagnostic and treatment functions
- administrative functions
- service functions (food, supply)
- research and teaching functions

Physical relationships between these functions determine the configuration of the hospital. Certain relationships between the various functions are required—as in the following flow diagrams

These flow diagrams show the movement and communication of people, materials, and waste. Thus the physical configuration of a hospital and its transportation and logistics systems are inextricably intertwined. The transportation systems are influenced by the building configuration, and the configuration is heavily dependent on the transportation systems. The hospital configuration is also influenced by site restraints and opportunities, climate, surrounding facilities, budget, and available technology. New alternatives are generated by new medical needs and new technology.

### **3-1 Schematic Design/ Functional Requirements**

Based on international standards, AIA standards (American Institute of Architects), and proper medical planning, the schematic design for the ED was made to meet the functional requirements of the ED.

The emergency department schematic design cover the level of services specific to the Emergency Department, including:

- Ambulance and ambulatory entrances
- Reception/Triage/Waiting area
- Administrative area
- Resuscitation area
- Acute Treatment area (of non-ambulant patients)
- Consultation area/fast track area (for ambulant patients)
- Staff workstations
- Specialty areas, e.g.
- Pediatric areas.
- Distressed relatives/interview room.
- Procedure room(s).
- Plaster room.
- Pharmacy/drug preparation.
- Ophthalmology/ENT.
- Mental Health Assessment.
- Isolation room(s).
- Decontamination areas.
- Teaching areas.
- Tutorial room.
- Support services.
- Storage.
- Clean and dirty utility.
- Shower/bathroom/toilets.
- Staff rooms.

- Linen trolley bay.
- Mobile equipment bay.
- Mobile X-Ray equipment bay.
- Cleaner's room.
- Lounge/beverage preparation area.
- Emergency services officer/lounge.
- Offices and administration area.
- Diagnostic areas e.g. medical imaging unit/ laboratory area (optional).
- Emergency department short stay/observation ward (optional)
- Circulation space.

Each item will be discussed in relation to its physical structure, furniture, equipment, supplies and medications, whenever it is relevant.

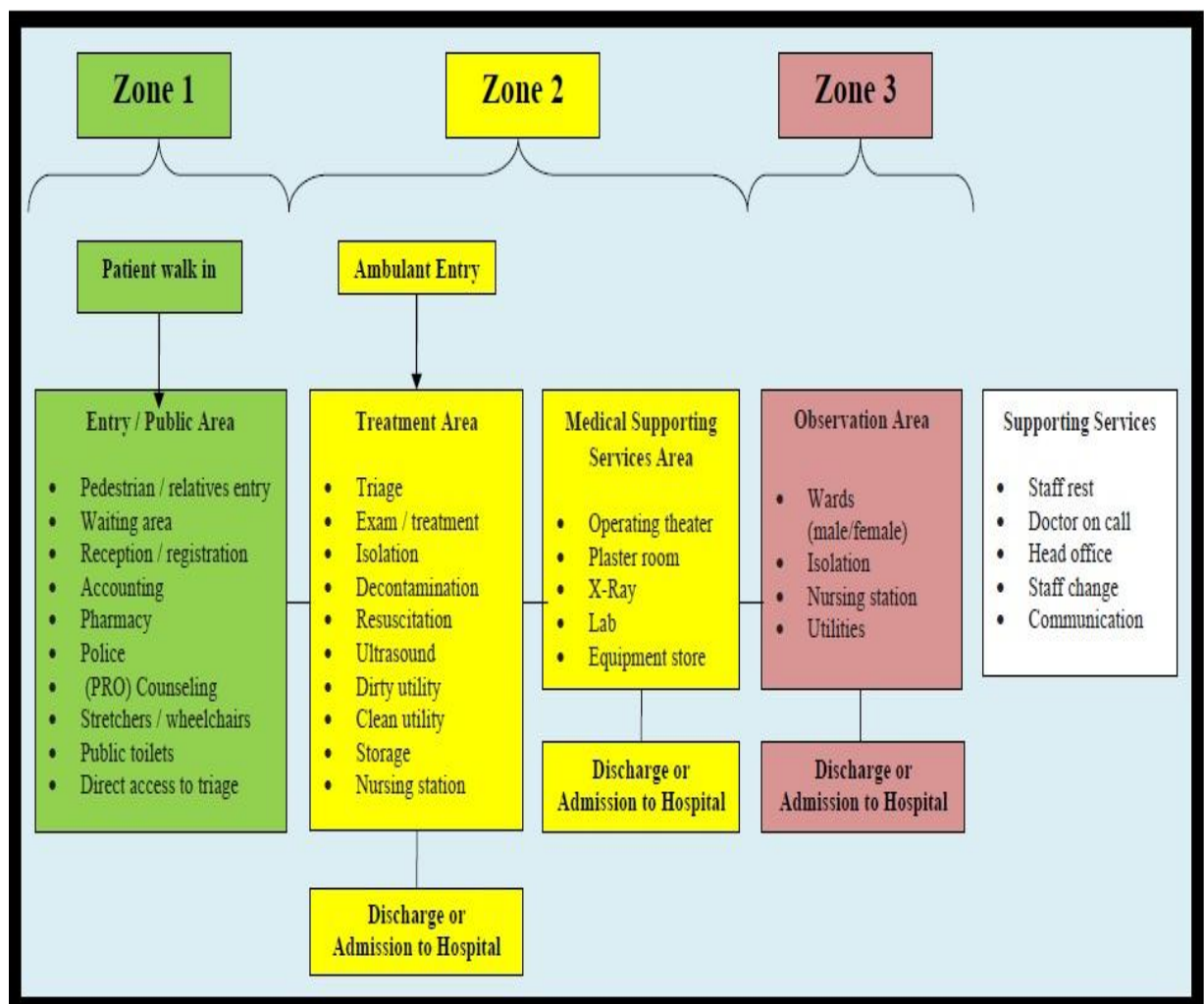


Diagram 3-1 Emergency Department Zones



### **3- 1-1 Emergency Department Layouts:**

A typical emergency department has several different areas; each specialized for patients with Particular severities or types of illness.

Upon arrival to the ED, an individual typically undergoes a brief triage (sorting) interview to help determine the nature and severity of their illness or injury. Individuals with serious illnesses or injuries are then seen by a physician more rapidly than those with less severe symptoms or Injuries.

After initial assessment and treatment, patients are admitted to the hospital, stabilized and Transferred to another hospital, or discharged.

In the triage area, patients are seen by a triage physician/nurse, who completes a preliminary evaluation, before they are transferred to another area of the ED or a different department in the hospital. Patients with life- or limb-threatening conditions may bypass triage and may be seen directly by a physician.

The resuscitation area is a key area of an emergency department. It usually contains several individual resuscitation bays, usually with one specially equipped for pediatric resuscitation.

Each bay is equipped with a crash cart (defibrillator, airway equipment, oxygen, intravenous lines and fluids, and emergency drugs). Resuscitation areas also have monitor, ECG machines, and often limited X-ray facilities to perform chest, skull, and pelvis films. Other equipment may include noninvasive ventilation (NIV) and portable-ultrasound devices.

The general medical area is for stable patients who still need to be confined to bed (note that a "bed" in the ED context is almost always a trolley rather than a full hospital bed). This area is often very busy, filled with many patients with a wide range of medical and surgical problems. Many will require further investigation and possible admission.

Patients who are not in need of immediate treatment are sent to the minor's area. Such patients may still have been found to have significant problems, including fractures, dislocations, and lacerations requiring suturing.

A pediatric area for the treatment of children has recently become standard, to dedicate separate waiting areas and facilities for children. Some departments employ a play therapist whose job is to put children at ease to reduce the anxiety caused by visiting the emergency department, as well as provide distraction therapy for simple procedures.

Contemporary EDs typically do not maintain a dedicated area for obstetrics. Such patients who present to the ED are sent to the obstetrics/maternity ward or the Labor and Delivery suite, unless there is another medical condition that requires treatment first.

Many hospitals have a separate area for evaluation of psychiatric problems. These are often staffed by psychiatrists and mental health nurses and social workers. There is typically at least one room for people who are actively a risk to themselves or others (e.g. suicidal).

### **3-1-2 Total Size**

The total internal area of the emergency department, excluding observation ward and internal medical imaging area if present, should be at least 50m<sup>2</sup>/1000 yearly attendances or 145m<sup>2</sup>/1000 yearly admissions, whichever size is greater. The minimum size of a functional emergency department that can incorporate all of the major areas is 700m<sup>2</sup>. These figures are based upon access block being minimal. Emergency Departments may take extended amounts of time from conception to completion, therefore allowances for future growth and development must be made in the design process.

The total size and number of treatment areas will also be influenced by factors such as: patient numbers, case mix and activity; projected population growth and changing population demographics; anticipated changes in technology; laboratory and medical imaging turnaround time; inpatient bed accessibility; and staffing number and structure.

### **3-1-3 Total Number of Treatment Areas**

The total number of patient treatment areas should be at least 1/1100 yearly attendances or 1/400 yearly admissions, whichever is greater in number. Areas such as procedure, plaster and interview rooms are not considered as treatment areas nor are holding bays or observation unit beds for admitted patients. The number of resuscitation areas should be no less than 1/15,000 yearly attendances or 1/5,000 yearly admissions and at least 1/2 of the total number of treatment areas should have physiological monitoring.

## **3-2 DESIGN CONSIDERATIONS:**

### **3-2-1 General:**

This should allow rapid access to every space with a minimum of cross traffic. There should be close proximity between the Resuscitation/Acute Treatment areas for non- ambulant patients and other treatment areas for ambulant patients, as staff may require relocation at times of high workload. Visitor and patient access to all areas should not traverse clinical areas. Protection of visual, auditory and olfactory privacy is important whilst recognizing the need for observation of patients by staff.

### **3-2-2 Site Selection**

Decisions regarding site location have a major influence on the eventual cost and operational efficiency of the department and should be made in conjunction with emergency department staff. The site of the emergency department should, as much as possible, maximize the choices of layout. In particular, sites of access points must be carefully considered.

### **3-2-3 Access and Car Parking**

The emergency department should be located on the ground floor for ease of access, should be close to public transport, and adequately signed to ensure ease of way finding (ACEM Guidelines on ED Signage). Car parking should be close to

the entrance, well lit and available exclusively for patients, their relatives and staff. Protected proximate parking areas should be available for urgent call in staff. Appropriate physical barriers should protect “drop off” zones.

**Undercover parking should be available for:**

- Appropriate number of ambulances. This will be determined by case load and availability of ambulance access to other parts of the hospital for non-emergency patients.
- On call duty emergency physician.
- Taxis and private vehicles which drop off/pick up patients (including those with limited mobility) adjacent to the ambulance patient entrance.
- Police vehicles.
- Fire Brigade.

The emergency department should be clearly identified from all approaches. Illuminated signage is required for some signs to ensure visibility at night. The use of graphic and character display (e.g. a white cross on a red background with the word "emergency") is encouraged. Multilingual signage may be required in departments with a significant caseload of culturally and linguistically diverse patients.

**3-2-4 Safety for staff**

The designated area should be within close proximity of other continuously staffed areas of the department, with ready access to assistance when required. As far as possible, the facility should not contain objects that could be thrown at staff. There should be two separate exits to allow escape of staff if one exit is blocked. The exit doors should open outwards, and should be lockable from the outside but not from inside. If a window is incorporated, it should be made from shatter-proof material. All window furnishings such as shading devices etc., should be appropriately designed and located so that they cannot be accessed by patients and used for

potential self harm. All areas should have readily accessible duress alarms. Mobile, wireless duress alarms may be worn by staff.

### **3-2-5 Safety for patients**

As far as possible, the area should be free of heavy or breakable furniture, sharp or hard surfaces which could injure an uncontrolled patient, and should also incorporate tamper resistant electrical fittings. It should also incorporate interior design features that promote calmness, such as muted colors and soft furnishings and appropriate lighting.

### **3-2-6 Intravenous sedation**

An appropriate clinical space should be available for the rapid and safe IV sedation of uncontrolled patients. This must include sufficient space for a bed or trolley, several staff, and appropriate monitoring for the care of a heavily sedated patient. According to departmental policy, this may be a clinical bay in the acute treatment area, or a separate facility may be provided in the mental health area. Operational policies should ensure that any patient who has received sedation which impairs their level of consciousness should be managed in a clinical area with appropriate monitoring and observation.

### **3-2-7 Grouping of Rooms - Functional relationships**

An emergency department is comprised of the following functional areas:

Entrance/Reception/Triage area	}	and associated workstations
Resuscitation area		
Acute Treatment area		
Consultation area		
Staff/amenities		
Administration area		

The main aggregation of clinical staff over 24 hours will be at the staff station in the Acute Treatment/Resuscitation area. This should be the focus around which the other clinical areas are grouped. The Entrance/Reception/Triage area is the focus of initial presentation and hospital administrative functions. The Administration area should be accessible to the clinical areas but should not impair the clinical function of the department. These support areas are best arranged around the periphery of the department.

### **3-2-8 Bed Spacing**

In the Acute Treatment area there should be at least 2.4 meters of clear floor space between beds. The minimum length should be 3 meters.

### **3-2-9 Lighting**

It is essential that a high standard focused examination light is available in all treatment areas.

Each examination light should have a power output of 30,000 lux, illuminate a field size of at least 150mm and be of robust construction.

Clinical care areas should have exposure to daylight wherever possible to minimize patient and staff disorientation.

### **3-2-10 Sound Control**

Clinical care areas should be designed so as to minimize the transmission of sound between adjacent treatment areas and sound levels should conform to World health organization guidelines. Distressed relatives/Interview rooms and selected offices should have a high level of sound control to ensure privacy.

### **3-2-11 Service Panels**

Service panels should be minimally equipped as follows:

#### **a. Resuscitation room (for each patient space)**

- 2x oxygen outlets

- 1x medical air outlets
- 2x suction outlets
- 16 x GPOs in at least two separate panels
- 1 x nitrous oxide outlet (optional)
- 1 x scavenging unit

**b. Acute Treatment bed - adult and pediatric**

- 2 x oxygen outlets
- 1 x medical air outlet
- 2 x suction outlets
- 8 x GPOs in two separate panels
- 1 x nitrous oxide outlet (optional)
- 1 x scavenging unit

**c. Procedure room/suture room/plaster room**

- 2 x oxygen outlets
- 1 x medical air outlet
- 1 x suction outlets
- 8 x GPOs in two separate panels
- 1 x nitrous oxide outlet
- 1 x scavenging unit
- d. Consultation room
- 1 x oxygen outlet
- 1 x suction outlet
- 4 x GPOs

**e. External service panels**

- 3 x oxygen outlets
- 2 x medical air outlets
- 2 x suction outlets
- 12 x GPOs in at least two separate panels
- 1 x nitrous oxide outlet (optional)

- 1 x scavenging unit

### **3-2-12 Physiological Monitors**

Each Acute Treatment area bed should have access to a physiological monitor. Central monitoring is recommended. Monitors should have printing and monitoring functions which include a minimum of:

- ECG
- NIBP
- Temperature
- SpO<sub>2</sub>

### **3-2-13 Storage around Bed**

Adequate storage space for disposable and non-disposable medical equipment should be available near each bed space. Storage space may consist of modular plastic type bins or other materials involving a similar design concept. There should be adequate consideration for the temporary holding of patient belongings.

### **3-2-14 Cabling**

Adequate cabling should be provided to ensure availability of GPOs to all clinical and non-clinical areas. Provision should also be made for cabling of telephone, patient call, emergency call, and computers to areas where these are necessary. Wide bandwidth cabling should be installed for electronic imaging systems telemedicine and internet applications. It is anticipated the availability of wireless applications will increase, and this will complement the above applications.

### **3-2-15 Medical Gases**

Medical gases should be internally piped, to all patient care areas.

### **3-2-16 Doors**

All doors through which patients may pass must be of sufficient size to accommodate a full hospital bed with attached intravenous flasks and traction



apparatus with ease and must be designed in accordance with Standards. There should be at least one pathway through the emergency department to key areas (imaging, OR, ICU) that will accommodate pediatric bed.

### **3-2-17 Corridors**

In general, the total corridor area within the department should be minimized to optimize the use of space. Where corridors are necessary, they should be of adequate width to allow the cross passage of two hospital beds or a hospital bed and linen trolley without difficulty. There should be adequate space for trolleys to enter or exit any of the consulting rooms, and to be turned around. Standard corridors should not be used for storage of equipment, linen, waste or patients.

### **3-2-18 Air Conditioning**

The emergency department should have a separate air system capable of rapid change from recirculation to fresh air flow. Special purpose rooms (e.g. Infectious Disease Isolation Room) or areas (i.e. pediatric waiting area) may have special flow and filtering requirements.

### **3-2-19 Information/Communications Support**

Emergency departments are high volume users of telecommunications and information technology. Telephones should be available in all offices, at all staff stations, in the clerical area and in all consultation and other clinical rooms. A central communications area for the disposition of all incoming calls is recommended. The use of multifunction, wireless communication devices should be considered. Additional phone jacks should be available for the use of facsimile machines and computer modems where required. A dedicated telephone to receive admitting requests from outside medical practitioners is desirable. Cordless phones or phone jacks should be available for access to patients' beds.

An intercom or public address system that can reach all areas of the emergency department should be available. Public telephones with acoustic hoods should be

available in the waiting area. A direct line to a taxi company is desirable. Direct telephone lines bypassing the hospital switchboard should be available. They would be used in internal and external emergencies or when the hospital PABX is out of service. The staff station should have a dedicated inward line for the ambulance and emergency services. There should be facsimile lines in clinical as well as administrative areas. Direct radio communication should be available between the ambulance service and the emergency department.

An electronic emergency department information system should be installed to support clinical management, patient tracking and departmental administration. Sufficient terminals should be available to ensure that queuing does not occur, even at peak times. Computer terminals and telephones need to be co-located to optimize staff efficiency. Workspace design should include sufficient bench-widths or suitable suspension devices for screens, keyboards, drives and printers. Additional computer terminals, software and peripheral devices should be installed to enable other departmental functions. The increasing use of electronic medical records should be anticipated and access to electronic knowledge bases should be routine.

### **3-2-20 Patient Call Facilities**

All patient care areas including toilets and bathrooms require individual patient call facilities.

Emergency department bed spaces should have call buttons that can be easily reached by a patient on the emergency department trolley.

### **3-2-21 Emergency Call Facilities**

All bed spaces and clinical areas, including toilets and bathrooms, should have access to an emergency call facility so staff can summon urgent assistance. The emergency call facility should alert to a central module situated adjacent to the staff station as well as to the Staff and Tutorial rooms.

### **3-2-22 Duress Alarm**

A duress alarm system should be available to staff working in any area with potentially aggressive patients, particularly those in isolated areas, to ensure safety.

### **3-2-23 Hand washing facilities**

Hand washing facilities should comply with health facilities Standards. Alcohol hand rubs should be available at each bedside. Basins for hand washing should be available within each treatment area and should be accessible without traversing any other clinical area.

There should be basins at a ratio of 1 for every 4 beds and at the ratio of 1 to 1 for every Procedure/Resuscitation/Consulting room/Triage/Isolation area. Taps in clinical areas should be fitted with anti-splash back devices and operated hands free. Dispensers for non-sterile latex gloves face masks and gowns should be available in the vicinity of each hand basin and each treatment area to assist staff compliance with standard precautions.

### **3-2-24 Emergency Power**

Emergency power must be available to all lights and GPOs in the Resuscitation and Acute Treatment/Observation areas of the department. Emergency lighting should be available in all other areas. All computer terminals should have access to emergency power. In the event of a total power failure, sufficient space and power points should be available to enable a backup system of lighting to be stored and maintained.

### **3-2-25 Wall Finish**

Hospital beds, ambulance trolleys, and wheelchairs may cause damage to walls. All wall surfaces in areas which may come into contact with mobile equipment should be reinforced and protected with buffer rails or similar. Bed stops should be fitted to the floor to stop the bed head from coming into contact with and damaging fittings, monitors, etc.

### **3-2-26 Floor Covering**

The floor covering in all patient care areas and corridors should have the following characteristics

- Non slip surface
- Impermeable to water, body fluids
- Durable
- Easy to clean
- Acoustic properties that reduce sound transmission
- Shock absorption to optimize staff comfort but facilitate movement of beds.

Office(s), Tutorial, Staff rooms, Clinical areas and the Distressed Relatives' room should be carpeted.

### **3-2-27 Wall Clocks**

A wall clock should be visible in all clinical areas and waiting areas. Time-elapse clocks are desirable in the resuscitation, procedure and plaster rooms. Times displayed in all areas and on computers must be synchronized.

### **3-2-28 Electricity Supply**

The electricity supply to the emergency department should be surge protected to protect electronic and computer equipment. The Resuscitation area should be cardiac protected and the Acute Treatment area body protected and the electricity supply to other patient care areas should be in accordance Standards.

### 3-3 Description of Patient Flows:

The following diagram outlines the various pathways that a patient may follow when (s) he Enters the emergency department:

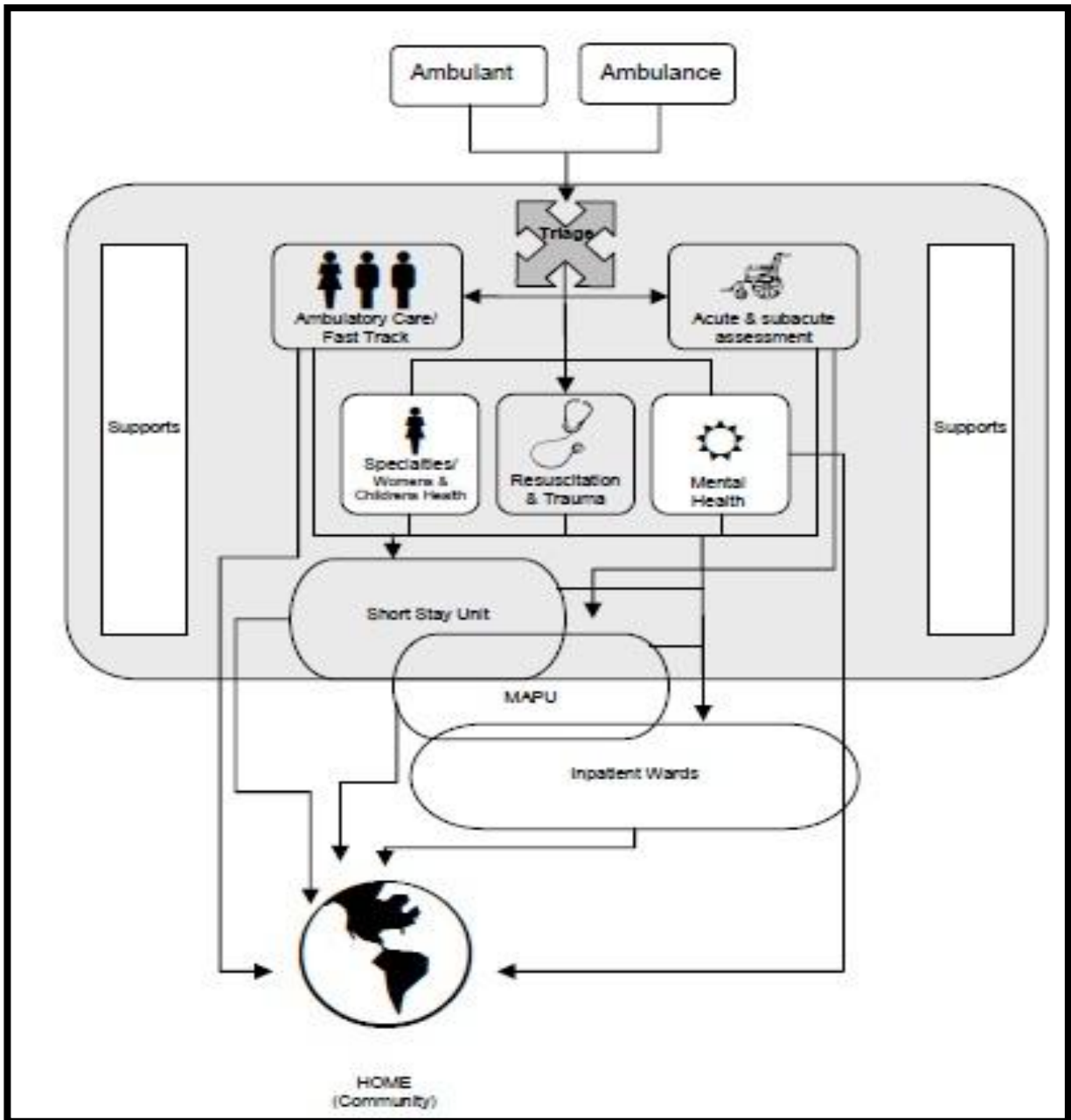


Diagram 3-2 Description of Patient Flows

(Australasian College for Emergency medicine, Guidelines on Emergency Department Design)

### **3-3-1 Triage**

Patients may present self-referred or via emergency services (ambulance, police etc). All patients should be triaged through a single point. The aim of triage is to "sort" patients in order to provide optimum care consistent with their medical need and to ensure the efficient utilization of the available resources. All patients are allocated to a Category of the Australasian Triage Scale.

### **3-3-2 Reception**

There is a close operational relationship between Triage and reception. After triage, patient details are recorded by the clerical staff and a medical record either raised or a previous medical record retrieved.

### **3-3-3 Treatment**

Patients may be directed to:

- a. Resuscitation area.
- b. Acute Treatment area.
- c. Consultation/Fast Track area.
- d. Medical Imaging.
- e. Waiting area.

In areas a. - c., consultation/examination/investigations/treatment will be performed either in sequence or concurrently, depending on the severity of the patient's condition. Support services and, in certain cases, specialized areas, e.g. plaster room, may be utilized. After assessment and treatment, patients are admitted, transferred or discharged.

### **3-3-4 Patient and Visitor Exit Routes**

Patient and visitor exit routes out of the emergency department should be clearly sign posted from within the emergency department. In situations where doors with electronic locks are utilized, manual locks or release switches are mandated.

### 3-3-5 Disasters - Chemical Biological, Radiation Incidents

In these circumstances, plans may provide for Reception, Triage and initial treatment, including wet and dry decontamination to occur outside the Emergency Department.

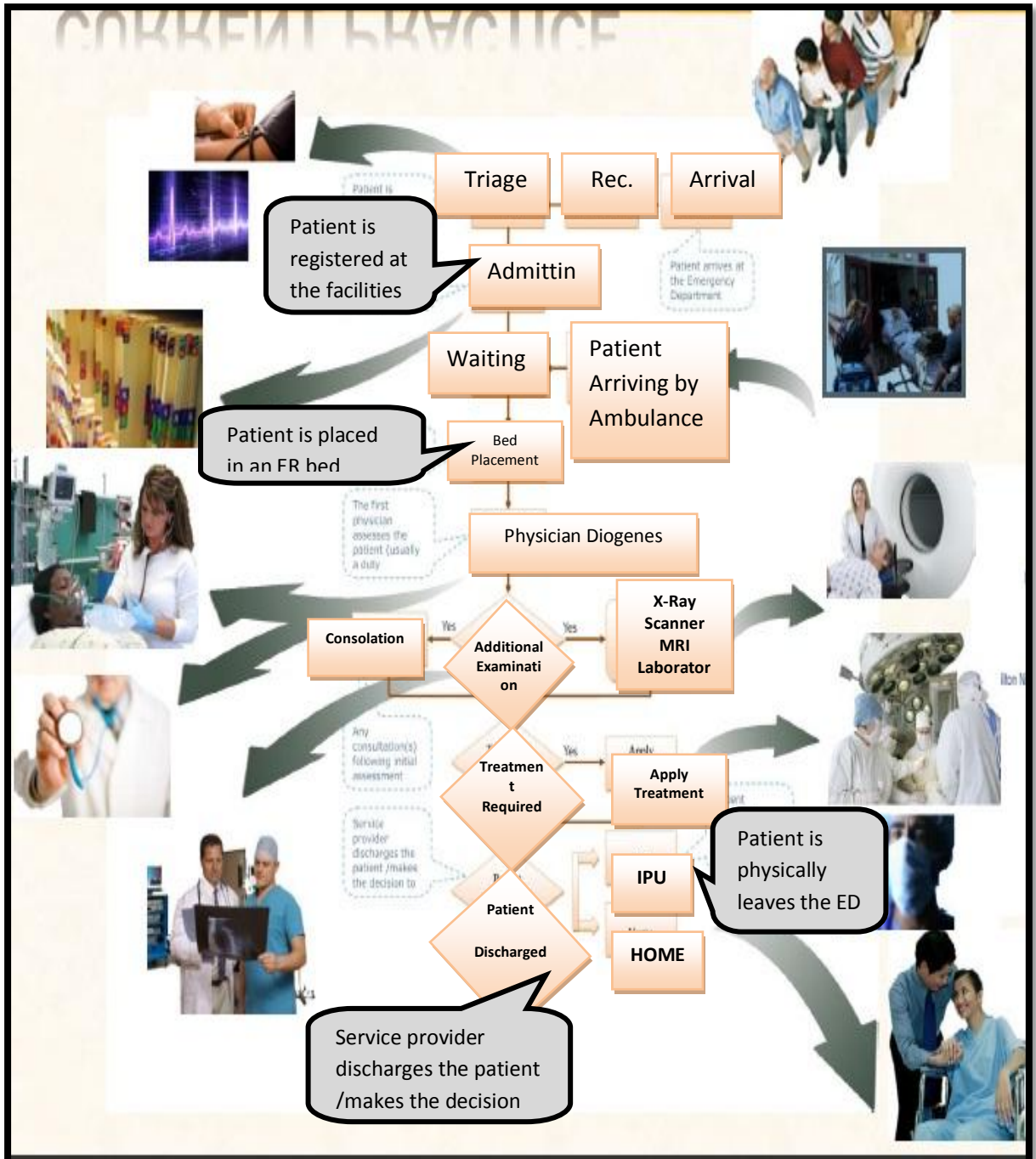


Diagram 3-3 Description of Patient Flows

(University of Alberta, Architectural design and Reducing Waiting Time in Emergency Department)

### 3-4 Functional Relationships

The functional relationships may be summarized by the following

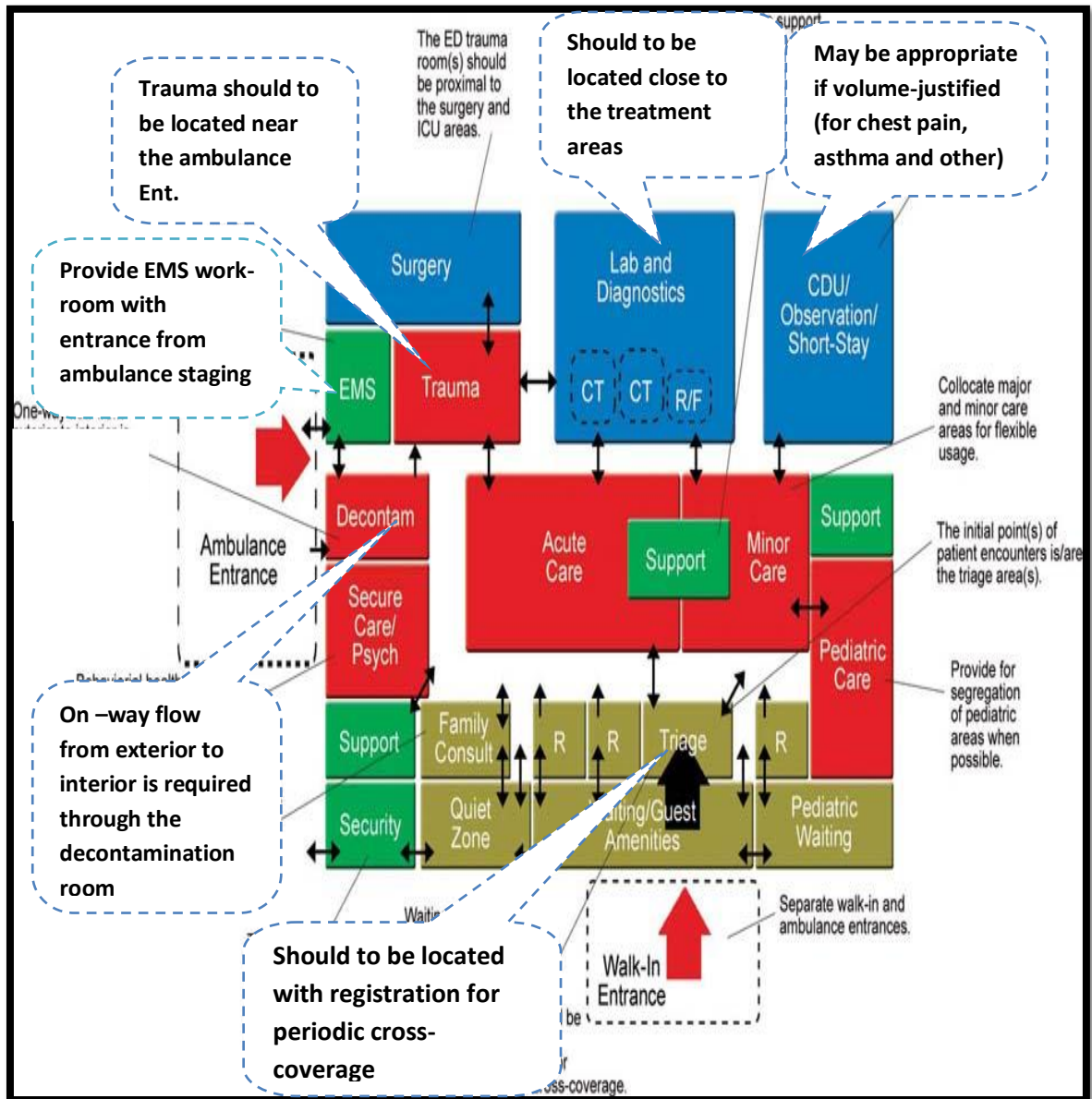


Diagram 3-5 Functional Relationship in ED

(Australasian College for Emergency medicine, Guidelines on Emergency Department Design)



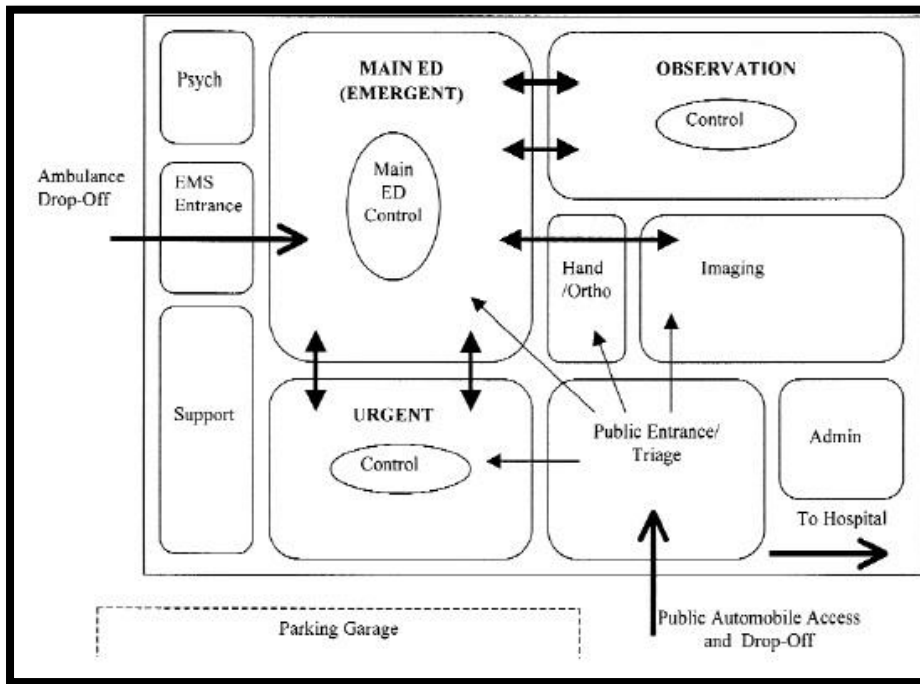


Diagram 3-6 Functional Relationship in ED.

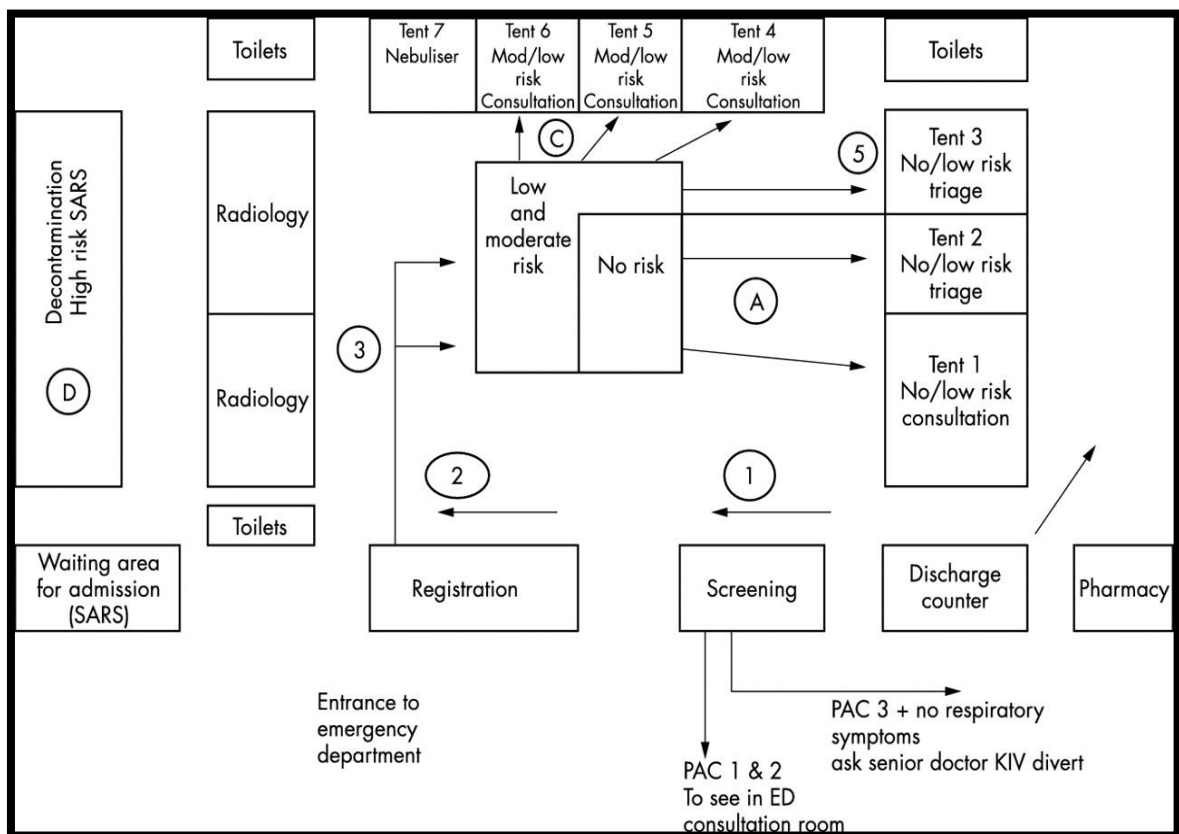


Diagram 3-7 Functional Relationship in ED.

## **3-5 Emergency Department Waiting Times**

### **3-5-1 MAIN POINTS**

- Emergency physicians are committed to providing high-quality emergency care as quickly as possible to all patients.
- A federal report last year found that patients who need to be seen in 1 to 14 minutes are being seen in twice that timeframe (37 minutes) (GAO, 2009).
- An ambulance is diverted every minute in the United States, delaying care for critically ill patients.
- The gridlock in emergency departments is caused by "boarding," not by too many patients with routine minor problems.
- Everyone is only one step away from a medical emergency.

### **3-5-2 the reasons patients wait in emergency departments:**

Everyone who comes to an emergency department will be seen, regardless of the ability to pay or insurance status. Studies show the reasons patients wait include:

- A triage process, which means critically ill patients are seen first and less critically ill patients, must wait. In most cases, a triage nurse will assess the severity of a patient's condition upon arrival, based on symptoms; personal and medical history; and vital signs, such as body temperature, heart rate and blood pressure.
- Boarding of patients. Hundreds of emergency departments have closed in the United States. At the same time, the number of emergency department visits have increased to 119.2 million in 2006 (up from 110.2 million in 2004). Many of the remaining hospitals lack capacity, which means critically ill or injured patients, may have extended stays in the emergency department until hospital beds become available. This practice is known as "boarding," and it is a major factor in overcrowding. Boarding also contributes to ambulance diversion and

limits a hospital's ability to meet periodic surges in demand, such as those from disasters.

- On-call physician shortages. Emergency physicians are available 24 hours a day; 7 days a week, but other medical specialists, such as neurosurgeons, cardiologists and orthopedic surgeons, provide "on-call" backup services as needed. An increasing number of these specialists are not available due to frivolous lawsuits, increasing premiums, inability to obtain insurance and inadequate reimbursement.
- Local crises and disasters. In an emergency department, many patients may arrive at once, needing immediate medical care. This can happen when multiple motor vehicle crashes occur and during natural disasters or local epidemics, such the recent H1N1 flu.

### **3-5-3 patients be harmed because of waiting**

- Long waits can affect patient outcomes. Patients may get tired of waiting and leave. Some patients may wait longer than optimal, but emergency departments work hard to make sure the sickest patients are seen first and all patients are seen in a timely manner.
- In 2008, 200 emergency physicians said they personally knew of patients who had died because of the practice of "boarding," or patients waiting for their inpatient hospital beds.
- In 2006, the Institute of Medicine released reports, which found timeliness of care to be "a growing concern" that could "result in protracted pain and suffering and delays in diagnosis and treatment."

### **3-5-4 time to be expected in an emergency department**

- If you have a minor illness or injury, and the emergency department isn't crowded, you may wait 1 to 2 hours to see a physician. If you require extensive diagnostic tests, your visit may be longer because it will take time to obtain the results. If an emergency physician needs to consult with other medical specialists, your wait may be extended. If you need to be admitted to the hospital, you may wait until an inpatient bed is available.
- In 2007, U.S. emergency patients spent an average of 4 hours and 5 minutes in the emergency department, a 5-minute increase from the previous year (Press Ganey Associates, 2009). South Dakota had the shortest waits (165 minutes) and Utah had the longest waits (385 minutes).
- Almost 400,000 patients waited 24 hours or more; patients admitted to the hospital, or referred for drug or alcohol treatment, were in the emergency department about 6 hours on average. (Press Ganey Associates, 2009).

### **3-5-5 steps for improve customer service in emergency departments**

- Some hospitals have stopped "boarding" patients in emergency departments and move them directly to the floors after admittance, even if it means "boarding" in the hallways there. This spreads the burden of overcrowding throughout the hospital and often results in beds becoming available quicker.
- Some are decreasing waiting times by using such measures as registering people at bedsides, streamlining systems that speed specimens to laboratories, computerizing tracking systems, and developing alternative systems for improving patient flow and processing laboratory tests. Other hospitals are establishing fast-track systems to expedite diagnosis and treatment for patients with less critical conditions. Many hospitals are hiring patient advocates to improve communication, increase the flow of information and better address patient concerns.

- New technologies using rapid tests to evaluate patients have helped reduce waiting times. Some are using sophisticated computer systems to give complete, up-to-the minute status reports on every patient in every emergency bed. A few emergency departments have customer-friendly services, such as valet parking and computer outlets, and guarantees a doctor will see patients within specified amounts of time.

### **3-5-6 Lack of space**

All the study participants clearly reflected lack of space in the emergency department, as a major obstacle to service delivery, patient care, health and safety, and infection control. This is clearly articulated in the narrative of nurse below.

Nurse: “The building wasn’t designed when it was planned however many years ago; it wasn’t designed to cater for people on trolleys. It was designed as a working Casualty Department with a minor and a majors area, and as it happens all our overnight stays, we try and accommodate them in the minor department, which therefore leaves us with reduced space for the doctors to see their patients which in turn causes longer delays for the patients that are waiting... Also we feel when the emergencies come in, sometimes number one their route is blocked, their actual way in to get into the department sometimes can be blocked because trolleys are put in every conceivable space available”.

The Emergency Department is not designed nor has the facilities to nurse patients for long periods of time. The issues of infection control, and health and safety within the emergency department are articulated by nurse.

Nurse: “If you have two or three patients bundled into where there should only be a couple of patients then the facilities are being stretched. That surely is not right. And again you have people in a hurry to get things done and you know hand washing goes out the window in some instances. Health and safety issues, if there was a fire, God forbid and if there was a cardiac arrest and you had to push other patients out of the way to get to that patient who might be, as I said before sharing oxygen and suction”.

## **4- General**

The service standards are the criteria for the procedures, supplies, and conditions essential for quality health care services. Each standard is considered to be essential for full, effective provision of the services. The Emergency Department Service Standards are based upon nationally- approved clinical protocols for the diagnosis, management and prevention of common health problems. This document includes “Protocols for Emergency Department Teams”. These clinical protocols and service standards were developed from international research on the most medically effective and cost-efficient practices. If followed correctly by health providers, the number of deaths from major medical, surgical and child emergencies can be reduced by a significant estimated percentage.

The Emergency Department Service Standards are organized into the three levels of care that are provided within a medium size general hospital. (NOTE: Not all Facilities provide the full range of services as listed below for each level of care, some facilities may provide more and some facilities provide fewer services.) A "generic" organizational structure for (General Hospitals), Emergency Department is illustrated.

### **4-1 Ambulance Entrance**

Apart from vehicular access considerations, signage and weather protection, the Ambulance Entrance and environs may become an important reception and treatment area in the event of a disaster or chemical/biological/radiation incident. The public address system should be switchable to include these areas. The requirement to perform wet decontamination on ambulant and non-ambulant individuals and groups should be available including the deployment of modesty screening. All hospitals should have external service panels. Direct access to an internal decontamination room should be available.



Figure 4-1  
Ambulance Entrance



Figure 4-2  
Ambulance Parking

## 4-2 Reception and Registration Office

Administrative staff at the reception counter may receive patients arriving for treatment and direct them to the Triage area. After assessment at the Triage area, patients or relatives will generally be directed back to the Reception/Clerical area where clerical staff will conduct registration interviews, collate the medical record, and print identification labels. When the decision to admit has been made, clerks interview patients or relatives at the bedside or at the reception counter to finalize admission details.

The counter should provide seating and be partitioned for privacy at the interview. There should be direct communication with the Reception/Triage area and the Staff Station in the Acute Treatment/Observation area. The area should be designed with due consideration for the safety of staff, and access for the disabled.

### Forms used:

#### ❖ Out-Patient Form

The form must include:

- Patient's personal data
- Patient's complaint
- Diagnosis
- Treatment

#### ❖ Observation Form

The form must include:

- Patient's diagnosis
- Patient's vital signs
- Patient's physical examination
- Fluid chart
- Medication chart
- Investigations (laboratory, radiology, blood bank requests)
- Consultation request

❖ **Register for Inpatient Admission**

The form must include:

- Diagnosis in Emergency Department
- Service to which patient is admitted
- Name of attending specialist/consultant
- Patient's documents and investigation results
- Patient's condition upon transfer:
  - Stable
  - Unstable
  - Critical
- Patient's transfer from Emergency Department done by:
  - Porter
  - Nurse
  - Doctor

❖ **Consultation Form**

The form must include:

- Name, position, specialty of requester physician and requested physician
- Diagnosis
- Reason for consultation
- Urgency of consultation (urgent, ASAP, routine)
- Reply



### ❖ Mortality Register

This must include:

- Date and time of admission
- Date and time of death
- Diagnosis
- Treatment
- Investigations
- Cause of death.

The Reception/Clerical office should have access to the following equipment and fitments:

- Computer terminals
- Telephones
- Facsimile machine
- Photocopier
- Computer printers
- Storage space for stationery and medical records
- Work bench

The combined area of the reception/triage/clerical area should be at least 1.8m<sup>2</sup> /1000 yearly attendances (not including storage areas for medical records).

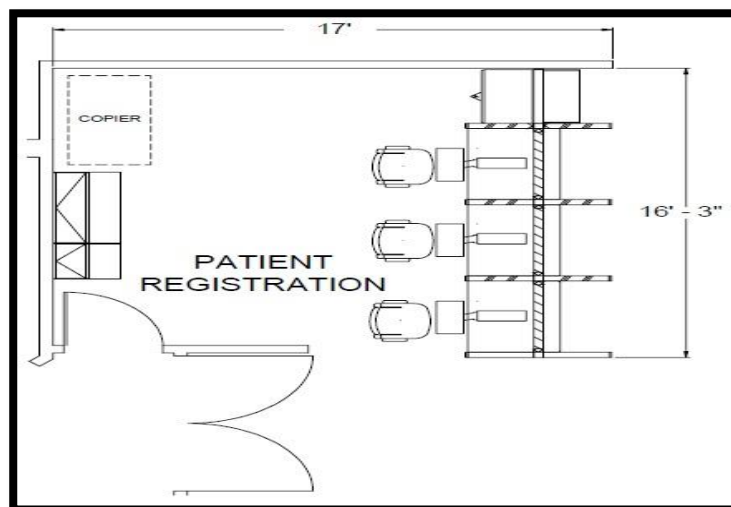


Figure 4-3 Patient Registration Office Design



Figure 4-4 Registration Area

### 4-3 Triage Area

The department should be accessed by two separate entrances; one for ambulance patients and the other for ambulant patients. It is recommended that each entrance area contains a separate foyer that can be sealed by the remote activation of security doors. Access to treatment areas should also be restricted by the use of security doors. The ambulance entrance should be screened as much as possible for sight and sound from the ambulant patient entrance. Both entrances should direct the patient flow towards the Reception/Triage area. The Reception/Triage area should have clear vision to both the waiting room, the children's play area (if provided) and the ambulance entrance. Assessment, observation and first aid are provided in the Reception/Triage area which should have visual and auditory privacy.

The goal of triage is to rapidly assess and identify life, or limb threatening emergencies. All patients who present to the Emergency Department (ED) for care will be seen by a physician.

#### ❖ Expected Activities

- To establish priorities for patient care, classify patients into emergent, urgent and non urgent.
- To respond quickly to possible life threatening illness or injuries and escort them immediately to the resuscitation room with an ongoing appropriate care.

- To provide access for all people seeking medical care.
- To provide a safe, assuring environment while awaiting therapeutic interventions for minor complaints.

#### ❖ **Physical Structure**

##### **a- Room Specifications:**

- One room (at least) should be available to be used as triage room.
- The room should not be less than 20 m<sup>2</sup>.
- Floors must be covered by porcelain tiles or plastic tiles.
- Walls must be painted with a washable paint.
- Paint and/or ceramic tiles must be light in color to facilitate observation of cleanliness.

##### **b- Illumination**

- Sufficient lights must be available, considering room area, including natural light (windows with screens to keep insects out).
- Electric lights must be in good condition (all bulbs/tubes functioning, securely fixed, with safe wiring and switches).

##### **c- Ventilation**

- Adequate ventilation considering room area, including natural sources (e.g. windows) must be available.
- Electrical fans or air conditioners must be in good condition.

##### **d- Electrical Sockets**

- Three sockets (at least) must be available, appropriately distributed in the room considering placement of equipment, and in good condition (i.e. securely fixed and without hazards).

##### **e- Sink**

- Hand washing facilities must be available.
- Adequate drainage of the basin must be observed.

## ❖ Furniture

The furniture listed below must be present in the triage room in the indicated minimum quantities. The following conditions must be observed:

- All furniture must be clean (free of dirt, dust, stains, fluids, etc.).
- All plastic or cloth fabric must be intact (no holes or tears).
- Metal surfaces must be free of rust or stains.
- All furniture must be in sturdy condition (no loose or unstable parts).
- Painted surfaces must be intact and free of major scratches.
- If furniture has wheels, the wheels must be present and in working condition.

### a- Examination Table (Adult)

- Two-Three examination tables
- Each table must be allocated at least 7.4 square meters of room area.
- The table must be covered with foam and plastic sheet without any tears.
- The table must be covered with a clean sheet.

### b- Privacy Screens

- One privacy screen for each bed in the room must be available.

### c- Waste Receptacles

- One waste receptacle for each bed in the room must be available.
- Plastic liner must be in the receptacle.
- One waste receptacle for medical waste.

### d- Instrument Cabinet

- One cabinet at least must be available. Glass panel and shelves must be free of cracks.

## ❖ Equipment

The equipment listed below must be present in the triage room in the indicated minimum quantities. The following conditions must be observed:

- All equipment must be clean (free of dirt, dust, stains, fluids, etc.).
- Metal surfaces must be free of rust or stains.
- All equipment must be in sturdy condition (no loose or unstable parts).
- Painted surfaces must be intact and free of major scratches.

- On equipment with wheels, the wheels must be present and in working condition.
- Instruments ready for use must be sterilized.
- All electrical equipment must be observed to be properly operational, with working switches, safe wiring and secure plugs.

The Triage area should have access to the following equipment and fittings:

- NIBP monitor.
- SpO2.
- GPOs.
- Computer terminal with printer, security mounted.
- Hand basin for hand washing, equipment for standard precautions.
- Towel rail.
- Examination light.
- Mobile examination trolley.
- Telephone.
- Chairs and desk.
- Scales.
- Storage space for bandages, basic medical equipment, stationery.
- Whiteboard.
- One Ambo Bag with Adult and Pediatric Size Masks.
- Central Suction System.
- Central Oxygen Supply System.
- One Sphygmomanometer, Adult and Pediatric Cuffs.
- One Stethoscope, adult.
- One Stethoscope, Pediatric.
- Thermometers.

#### ❖ **Supplies**

- Disposable Plastic Syringes
- Disposable Latex Gloves
- Wooden Tongue Depressors

- Antiseptics (Beta dine – Alcohol)
- Medicated Cotton
- Adhesive Surgical Tape (Plaster)
- Strong Plastic Bags for Garbage
- Soap (Sterile)
- K-Y Jelly
- Torch

❖ **Standing Orders**

a- Patient complaints, vital signs, and level of consciousness are recorded by the nurse within 5 minutes.

b- Emergency department residents assess the case within 10 minutes and triage cases into A, B, C according to urgency and severity of the case:

- Emergent (A): (A) cases will be shifted to resuscitation rooms
- Urgent (B): (B) Cases will go either to observation room or be treated in the treatment room.
- Non-urgent (C): (C) Cases will be treated in the treatment room.

c- Emergency department specialist will assess all (A) cases in the resuscitation room within 5 minutes.

d- Emergency department specialist will see (B) and (C) cases on request of the resident within 10 minutes.

e- All pregnant women will be send to the obstetric room to be seen by the resident & or specialist within 5 minutes.

f- Urgent cases will be shifted to resuscitation room and will be managed by Emergency department resident and specialist within 5 minutes.

g- Timing of consultation will be recorded in every room in a log book.

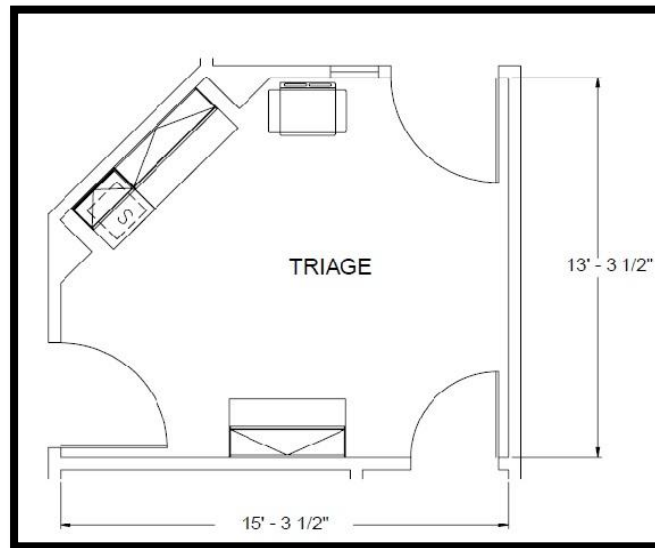


Figure 4-5 Triage Room Design



Figure 4-6 Triage Area

#### 4-4 Decontamination Room

A decontamination room should be available for patients who are contaminated with toxic substances. In addition to the requirements of an isolation room, this room must:

- Be directly accessible from the ambulance bay without entering any other part of the department.
- Have a flexible water hose, floor drain and contaminated water trap
- Have storage space for personal
- Protective and decontamination equipment.

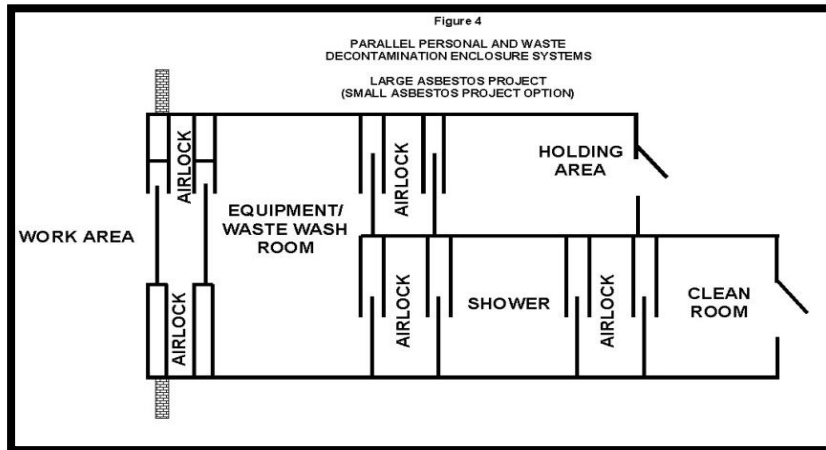


Figure 4-7 Parallel personal and waste decontamination enclosure system

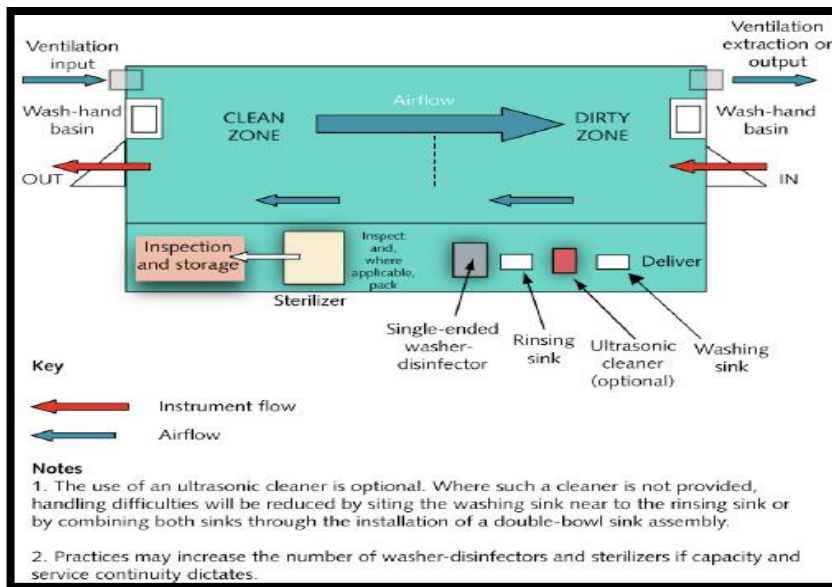


Figure 4-8 Parallel personal and waste decontamination enclosure system



Figure 4-9 Decontamination Room



## **4-5 Examination Rooms**

### **❖ Expected Activities**

- Examining patients
- Recording Vital Signs
- Give treatment to minor cases

### **❖ Physical Structure**

#### **a- Room Specifications:**

- To rooms at least must be available; one for males, the other for females.
- The room area must be not less than 30m<sup>2</sup> (7.4m<sup>2</sup> for each bed).
- Each patient bed area shall have space at each bedside for visitors, and provision for visual privacy from casual observation by other patients and visitors.
- Hand-washing stations shall be provided for each four treatment cubicles.
- Toilet room. One toilet room shall be provided for each eight treatment cubicles.
- Shower room. One shower room shall be provided for each sixteen cubicles. May be combined with the toilet room.
- Nourishment area. It shall include a sink, work counter, refrigerator, storage cabinets, and equipment for hot and cold nourishment between meals.
- Floors must be covered by porcelain tiles or plastic tiles.
- Walls must be painted with a washable paint.
- Paint and/or ceramic tiles must be light in color to facilitate observation of cleanliness.

#### **b- Illumination**

- Sufficient lights must be available, considering room area, including natural light (windows with screens to keep insects out).
- Electric lights must be in good condition (all bulbs/tubes functioning, securely fixed, with safe wiring and switches).

### **c- Ventilation**

- Adequate ventilation considering room area, including natural sources (e.g. windows) must be available.
- Electrical fans or air conditioners must be in good condition.

### **d- Electrical Sockets**

- Six sockets (at least) must be available, appropriately distributed in the room considering placement of equipment, capable of handling required electrical loads of equipment, and in good condition (i.e. securely fixed and without hazards).

### **❖ Furniture**

The furniture listed below must be present in the examination room in the indicated minimum quantities:

- Six (or More) Beds: The bed must be furnished with mattress, linens, Macintosh oilcloth, and pillowed bed cover.
- One desk and one chair (Glass panels and shelves must be free of cracks).
- One or two instrument cabinets.
- Three or more Instrument tables.
- One x-ray viewer.
- Five or more Privacy Screens.
- Six waste receptacles (the receptacle must have a lid).
- IV stands (at least one for each bed).

### **❖ Equipment**

The equipment listed below must be present in the examination room in the indicated minimum quantities.

- Six sphygmomanometers (fixed at each bed), adult).
- Two sphygmomanometers Pediatric Cuffs
- One stethoscope, adult and Pediatric.
- Central suction system (at each bed).
- Twelve Lead ECG machine.

- Medical thermometers central Oxygen supply system (pipe, O2 regulator, wrenches, O2 mask and cannulae) at each bed.

❖ **Supplies**

- Disposable plastic syringes (different sizes).
- Disposable examination gloves.
- Sterile surgical gloves.
- Cannulae (different sizes).
- Infusion sets.
- Disposable urinary catheters (different sizes).
- Urine collection bags.
- Wooden tongue depressors.
- Strips to detect sugar, acetone, and albumin in urine.
- Antiseptics (butadiene - alcohol).
- Medicated cotton.
- Adhesive surgical tape.
- Strong plastic bags for garbage.



Figure 4-11 emergency room bed bay  
in the main room



Figure 4-10 main room in emergency  
from west side

#### **4-6 Resuscitation Room/ Bay**

This room is used for the resuscitation and treatment of critically ill or injured patients. It has the following requirements:

- Minimum size for a single bed resuscitation room is 35m<sup>2</sup> or 25m<sup>2</sup> for each bed space if in a multi bed room (not including storage area).
- Area to fit a specialized uninterrupted resuscitation bed
- Space to ensure 360° access to all parts of the patient for procedures
- Circulation space to allow movement of staff and equipment around the work area.
- Space for equipment, monitors, storage, wash up and disposal facilities.
- Appropriate lighting, equipment to hang IV fluids etc.
- Maximum possible visual and auditory privacy for the occupants of the room and other patients and relatives.
- Floors must be covered by porcelain tiles or plastic tiles.
- Walls must be painted with a washable paint or covered by ceramic tiles.
- Paint and ceramic tiles must be light in color to facilitate observation of cleanliness.
- Sufficient light must be available, considering room area, including natural light (windows with screens to keep insects out).
- Ceiling mounted operation light with good range mobility and adequate power to allow the different interventional procedures (other ceiling light of adequate power may be used)
- Electric lights must be in good condition (all bulbs/tubes functioning, securely fixed, with safe wiring and switches).

The Resuscitation area should be easily accessible from the ambulance entrance and separate from patient circulation areas and must be easily accessible from the staff station in the Acute Treatment/Observation area. The Resuscitation area should have a full range of physiological monitoring and resuscitation equipment. The rooms should be equipped with work benches, storage cupboards, hand basins, X-Ray viewing facilities (or digital imaging system) and computer access. The

Resuscitation area should have solid partitions between it and other areas. Movable partitions between bed spaces in multi-bed are recommended.

**Each Resuscitation bed space should be equipped with:**

- Service panel as described. Service pendants or pods should be used to maximize access to patients.
- Physiological monitor with facility for ECG, printing, NIBP, SpO<sub>2</sub>, temperature, invasive pressures, CO<sub>2</sub> and printing.
- An operating room light with a minimum illumination of 80,000 lux.
- Radiolucent resuscitation trolley with cassette trays.
- Wall mounted diagnostic set (ophthalmoscope).
- Overhead IV track.

**The Resuscitation area should also have:**

- A full range of airway management equipment.
- X-Ray viewing box - 4 panels for each bed, or digital imaging system.
- Wall clock with real time and stop clock function.
- Pediatric open care unit for the resuscitation of neonates (in departments that see pediatric patients) with oxygen/suction facilities and an overhead radiant heater.
- Computer outlet and terminal.
- A minimum of 2 standard telephones.
- Hands free telephone.
- Cardiac arrest/resuscitation drug and equipment trolley.
- Portable monitor/ defibrillator.
- Transcutaneous pacemaker.
- Infusion pumps.
- Fluid warming devices including infusers and warming cupboards.
- Portable ventilator with invasive and noninvasive functions.
- Whiteboards.
- Restricted drugs cupboard.
- Humidifier.

- Patient warming devices (i.e. Bair Hugger)

**The following should be immediately accessible:**

- Intravenous access trolleys.
- Thoracotomy tray.
- Intercostals catheter.
- Urinary catheterization tray.
- Airway management tray (including surgical airway equipment).
- Invasive vascular access insertion tray.
- Pediatric resuscitation equipment.
- Refrigerator (to Australian Standards for maintenance of cold chains).

**Imaging facilities should include:**

- Overhead X-Ray.
- X-Ray screening (lead lining) of walls and partitions between beds.
- Resuscitation trolley with X-Ray capacity.
- Portable ultrasound.



Figure 4-12 Resuscitation Room

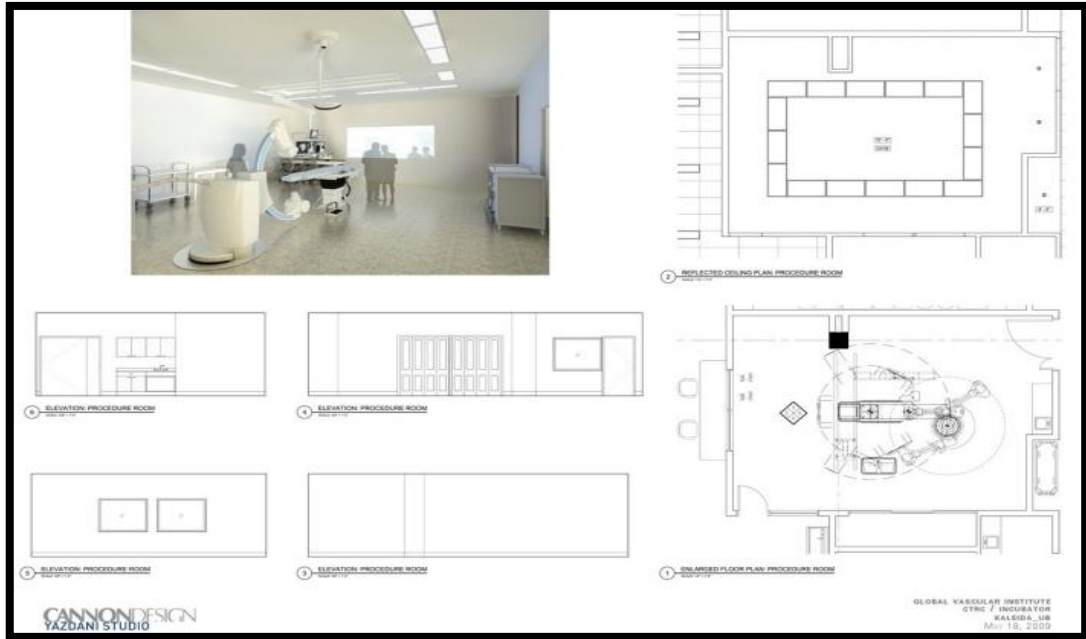


Figure 4-13 Resuscitation Room Design

#### 4-7 Operation Room (for minor surgery)

##### ❖ Physical Structure

##### a- Room Specifications

- The room must be at least 5m x 7m (35 m<sup>2</sup>).
- The room must be used exclusively for minor surgery.
- Floors must be covered by porcelain tiles or plastic tiles.
- Walls must be painted with a washable paint or covered by ceramic tiles.
- Paint and ceramic tiles must be light in color to facilitate observation of cleanliness.

##### b- Illumination

- Sufficient light must be available, considering room area, including natural light. (Windows with screens to keep insects out).
- Electric lights must be in good condition (all bulbs/tubes functioning, securely fixed, with safe wiring and switches).

##### c- Ventilation

- Adequate air conditioning or fans must be available, considering room area.
- The air conditioner must be in good working order with observed ability to adequately cool the delivery room.

- To maximize the efficiency of the air conditioner, doors and windows in the delivery room must be able to be securely closed.

#### **d- Electrical Sockets**

- Five sockets (at least) must be available, appropriately distributed in the room considering placement of equipment, capable of handling required electrical loads of equipment in the delivery room, and in good condition (i.e. securely fixed and without hazards).

#### **e- Basin**

- A basin with hot and cold water, soap, and clean towel must be available in the room.
- The faucet levers must be capable of being turned off with the elbow.
- Adequate drainage of the basin must be observed.

#### **❖ Furniture**

The furniture listed below must be present in the operating room in the indicated minimum quantities.

- One Operating Table
- One Instrument Cabinet (Glass panels and shelves must be free of cracks).
- One Drawer Cabinet.
- Two Instrument Tables (Mayo Stands)
- One table for sterilized instruments.
- One table for contaminated instruments.
- Two IV Stands (may be part of operating table).
- One Examination Lamp.
- Good Ceiling Light (Operation).
- One Swivel Stool.
- One Step Stool.
- One Wheel Chair.
- One X-ray viewer.
- Two Waste Receptacle
- The receptacle must have a lid.



- Plastic liner must be in the receptacle.

### ❖ Equipment

The equipment listed below must be present in the operating room in the indicated minimum quantities:

- Central & Mobile Suction Device
- Central Oxygen Supply System (Pipe, O2 Regulator, Wrenches, O2 Mask and Cannula).
- Spare cylinder must be completely full.
- Must indicate that the cylinder to which it is attached is at least partially full.
- One Sphygmomanometer, Adult and Pediatric Cuffs.
- One Stethoscope, Adult.
- One Stethoscope, Pediatric.
- One Handling Forceps.
- Instrument Set Packs.
- Scalpel and blade size 11 and 15.
- One needle holder.
- One toothed forceps.
- One stitch scissors.
- Four sterile drapes (towels).
- Sterile gauze swabs.

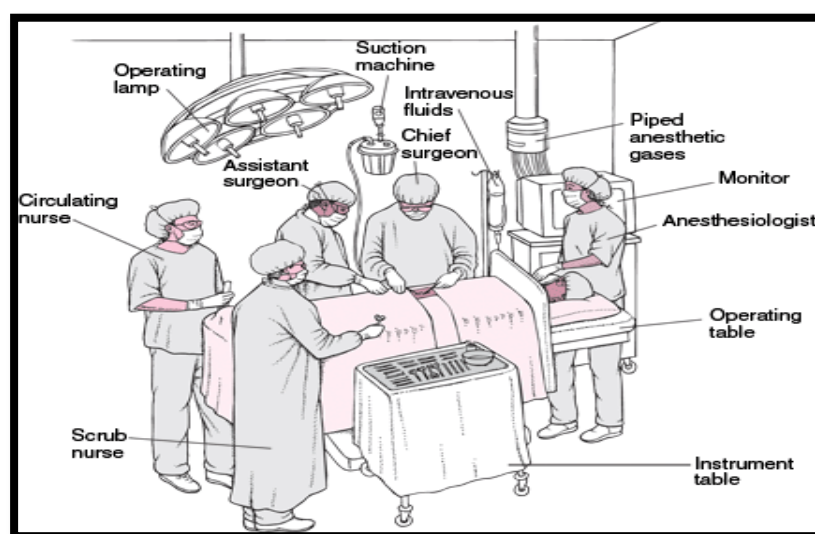


Figure 4-14 Operation Room Design



Figure 4-15 Operation (for minor surgery) Room Design

#### **4-8 Isolation Rooms**

Isolation rooms should be provided for the treatment of potentially infectious patients. They should have negative ventilation, an ante room with scrub up facilities and be self contained such that they have en-suite facilities, compliant with Australian Standards. The spaces themselves should be fitted as per Acute Treatment areas. Position of these rooms should be adjacent to areas where patients are received i.e. Triage to allow for the immediate isolation of potentially highly infectious patients. Each Department should have one Type 5 isolation room with additional requirements being determined by hospital location, role and patient demographics.

Isolation rooms may also be used to treat patients with conditions that require separation from other patients e.g. patients who require privacy for clinical conditions, or who are a source of visual or auditory distress to others. Deceased patients may be placed there in the company of grieving relatives. These rooms must be completely enclosed by floor to ceiling partitions and have a solid door. Each department must have at least 2 single rooms, with at least one room/10,000 annual attendances being recommended. The requirement for single rooms will be increased in departments which have a significant case mix of obstetric/gynecological condition

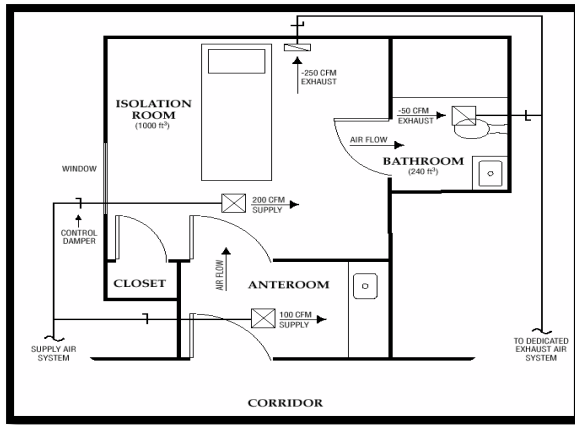


Figure 4-16

Isolation Room Design

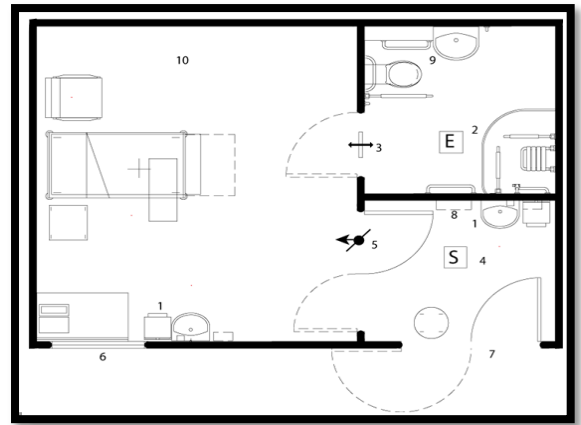


Figure 4-17

Isolation Room Design

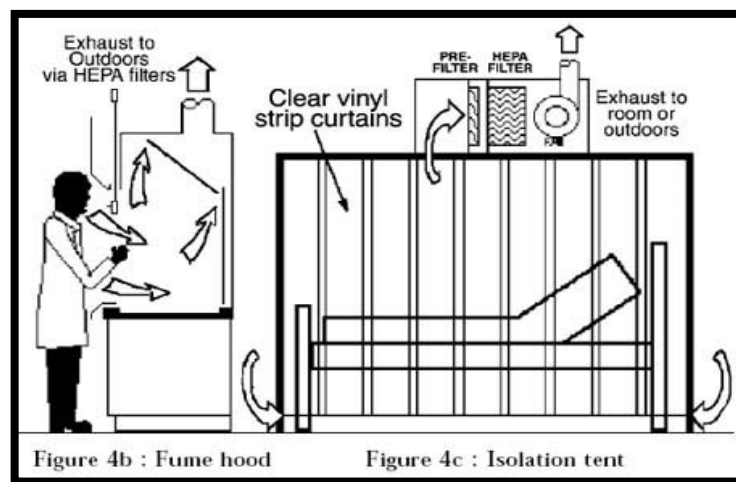


Figure 4b : Fume hood

Figure 4c : Isolation tent

Figure 4-18 Isolation Tent



Figure 4-19 Isolation Room with anti-room to right

## 5- General

Khartoum State is the capital of Sudan. It is situated centrally and surrounded by seven other states. Its surface area is 2800 square kilometer with a population of about 5,548,784 and an annual growth rate of 3.67% (97% of its population live in urban centers and only 21% live in peripheries and rural parts). The federal ministry of health is responsible for providing health care through federal hospitals. It provides tertiary health care as well as primary and secondary health care, in collaboration with the different state ministers of health all over the country.

There are 18 federal hospitals in Khartoum State alone. These are classified into hospitals that contain all specialties and hospitals that contain only one specialty.

A new organizational structure has been recently established in Khartoum, Omdurman and Khartoum-north teaching hospitals. The accident and emergency department (ED) is a relatively new organizational addition. It contains:

- Room D: for cold (non-emergency) cases.
- Rooms A and B: These are resuscitation rooms, equipped to receive critically ill patients: e.g. patients in shock and patients with cardiac and respiratory distress.
- Room C: this contains a series of rooms with different specialties. In these rooms' the emergency cases, which are stable and are attended and managed by the relevant specialist unit.
- Room T: This is for surgical and trauma cases.
- Asthma Room: This is equipped and prepared to receive patients with bronchial asthma. It has diagnostic facilities including X- ray, laboratory and pharmacy.
- The ICU: It has six beds each with a cardiac monitor and a ventilator.
- The short stay ward (24 hours): this is a general ward for all departments.
- There are also the main pharmacy, laboratory and x-ray rooms in addition to administrative offices.

## 5-1 KHARTOUM TEACHING HOSPITAL:

### 5 -1-1 GENERAL

Khartoum Teaching Hospital is one of the largest hospitals in Sudan and it contains a lot of medical departments and medical complexes such as the surgery complex, which was constructed in March 2010 and is now the largest surgery complex in Sudan. It comprises a center for dialysis and the medical investment complex. It also comprises a service complex that contains a rest room for doctors, a centre for professional development, ongoing training and other departments and medical complexes. The most important of these sections are the emergency and accidents departments where visitors are between 800-1000 patients per day and 60% of them come from other States. The number admitted into the emergency department is between 300-450 cases per day, and more than 50% of them are related to Esotericism.

The emergency department, which was promoted to be Khartoum hospital for emergency and accidents, the delivery section was also separated and promoted to become Khartoum hospital for emergency delivery. After the upgrade of services it has changed back to Khartoum hospital for emergency and accidents which receives between 450-600 cases per day and is divided into different sections.



Figure 5-1 Aerial view of Khartoum Teaching Hospital and emergency and injuries building





Figure 5-2 Khartoum Teaching Hospital

**5 -1-2 Emergency and accidents department Components:**

The emergency and accidents department contains six major sections:

- 1 - The entrance and reception.
- 2 – medicine Department.
- 3 - Surgery Department.
- 4 – Laboratories Department.
- 5 - Department of Radiology and Imaging.
- 6 - Section of wards (short stay wards).



Figure 5-3 Sections of Emergency Department

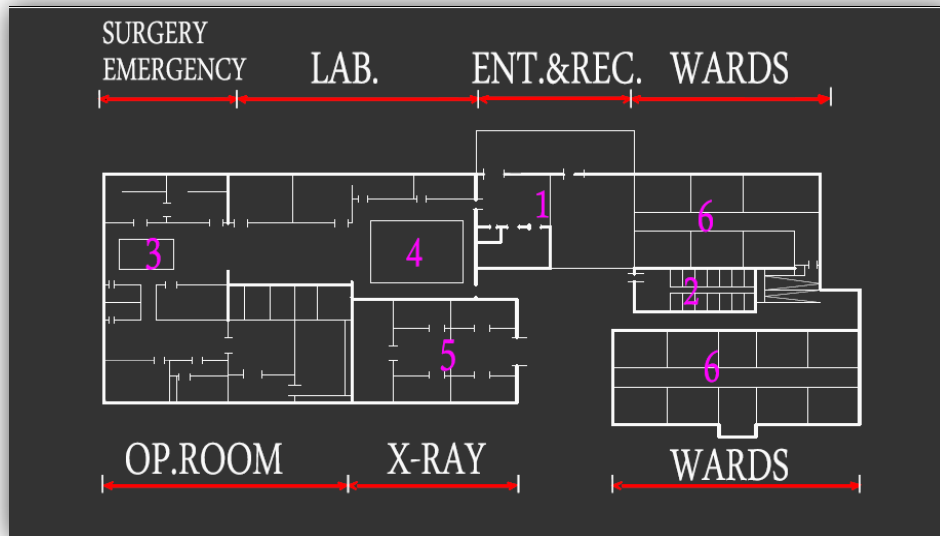


Figure 5-4 Sketch shows the sections of the emergency and injuries department

### 5-1-2-1 The entrance and reception:

The main entrance is located to the north side of emergency department where there are two entrances, the entrance for medical staff and ambulances and the entrance for non-emergency cases. There is also at the entrance of the emergency department a police office, reception, registration and classification of patients coming to the department, The area of this office about 25m<sup>2</sup>.



Figure 5-5 Shows the emergency department and injuries entrance (ambulance ent.)



Figure 5-6 Shows the emergency department and injuries entrances



Figure 5-7 Shows the reception and police office

### 5-1-2-2Emergency medical department:

This section receives approximately 100-150 patients per day. It consists of a hall for examination; its total area is 100 m<sup>2</sup> containing 12 beds for examination and observation which are separated by aluminum curtains. It also contains a small blood lab.



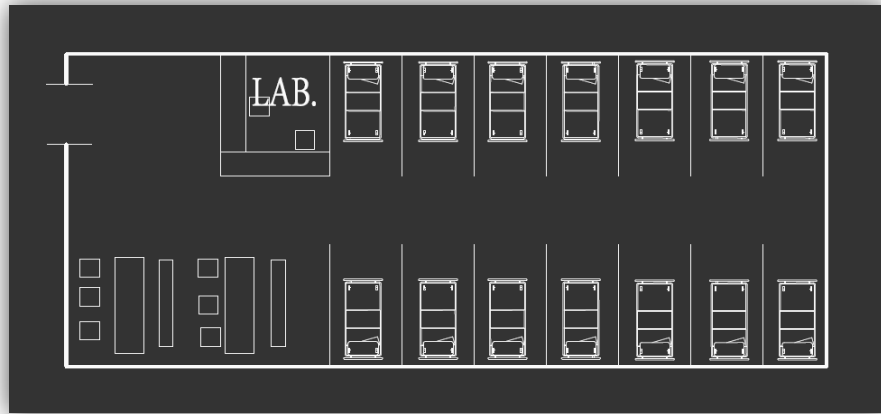


Figure 5-8 Sketch shows the lay out of medical emergency department



Figure 5-9 Shows the medical emergency department entrance



Figure 5-10 Shows the medical emergency department

### 5-1-2-3 Emergency Department of General Surgery:

The section receives approximately 150-200 patients per day, classified to hot and cold cases. Cold cases are estimated to be 150 cases per day and hot cases between 50 - 75 per day. This section contains the following:

- Examination room for the hot cases (urgent cases). The room has an area of about 16m<sup>2</sup> approximately and contains two beds for examination and assessment of the cases.
- Examination room for the cold cases (non-urgent cases). The room has an area of about 16m<sup>2</sup> approximately and contains two beds for examination and assessment of the cases.
- The operation complex contains the emergency operating room and a small room for non-urgent operations.
- A surgical ward for short stay (12-hour -24 hours) includes ward for women of an area of 35m<sup>2</sup> approximately which contains 6 beds. There are also men's ward areas of 35m<sup>2</sup> approximately which contain 6 beds.

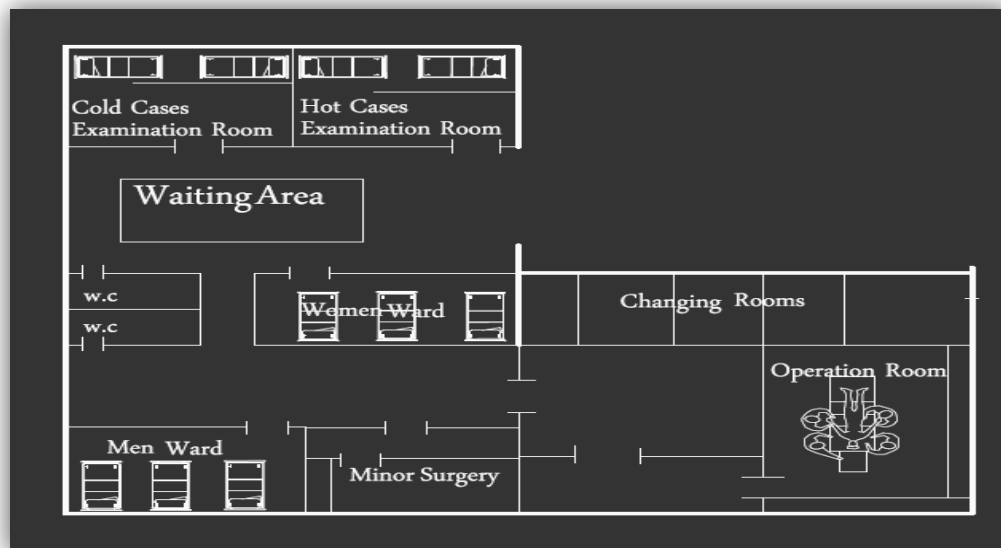


Figure 5-11 Sketch for the general surgery section



Figure 5-12 General surgery section (examination room)



Figure 5-13 General surgery section (women ward)



Figure 5-14 General surgery section (men ward)

#### **5-1-2-4 Laboratories Department:**

Laboratories section contains labs for blood and urine. The area of each lab is about 25m<sup>2</sup>. The sample from the patient is handled through a small window. Patients wait for the test result in the waiting hall of the lab which has an area of 30m<sup>2</sup>.The hall is designed to accommodate about 20 persons.



Figure 5-15 Laboratories section



Figure 5-16 Laboratories section (showing samples windows)





Figure 5-17 Laboratories section (waiting hall)



Figure 5-18 Laboratories section

#### **5-1-2-5 Radiology and Imaging Department:**

The area of the X-ray and imaging departments is about 60m<sup>2</sup> and contains almost Laboratory CT scan, x-ray and ultra, sonic, equipment and offices for technicians.



Figure 5-19 X-ray section

### **5-1-2-6 Short Stay Wards Department:**

This section is divided into two wards, the Department of Internal Medicine and the Department of surgery where the wards sections contain approximately 60-80 beds which are distributed into inner wards and surgical wards on the three floors of each building. Access to these sections is by a ramp located in the center of the two buildings, and more recently by an elevator which transfers the patients from the emergency department to the inpatient wards



Figure 5-20 Short stay wards



Figure 5-21 Ramp link between wards



Figure 5-22 Lift under construction



Figure 5-23 Wards from inside

## **5-2 Khartoum North Teaching Hospital:**

### **5 -2-1 General**

This hospital is located in Khartoum North (Bahri). Khartoum North Teaching Hospital is the largest hospital in the Khartoum North city. Its site area is more than 60000m<sup>2</sup>, and it contain a lot of medical departments, such as delivery Hospital and a surgery complex, Department of Physical Therapy , Dental Hospital, a private sector, and other sections and medical services. But the most important of these sections is the emergency and accidents department, which receives the largest number of patients- ranging between 400 and 600 patients per day.





Figure 5-24 Khartoum north teaching hospital location

### **5 -2-2 The Emergency and Accidents Department Components:**

The section consists of the emergency and accidents department .The main building consists of two floors with an area of approximately 300m<sup>2</sup> and labs building and services building (cafeteria, mosque). The ground floor contains the following:

- 1 - The entrance and reception.
- 2 - The main building (emergency and injuries room)
- 3 – Laboratories’ building.
- 4 – Services building (cafeteria, mosque)



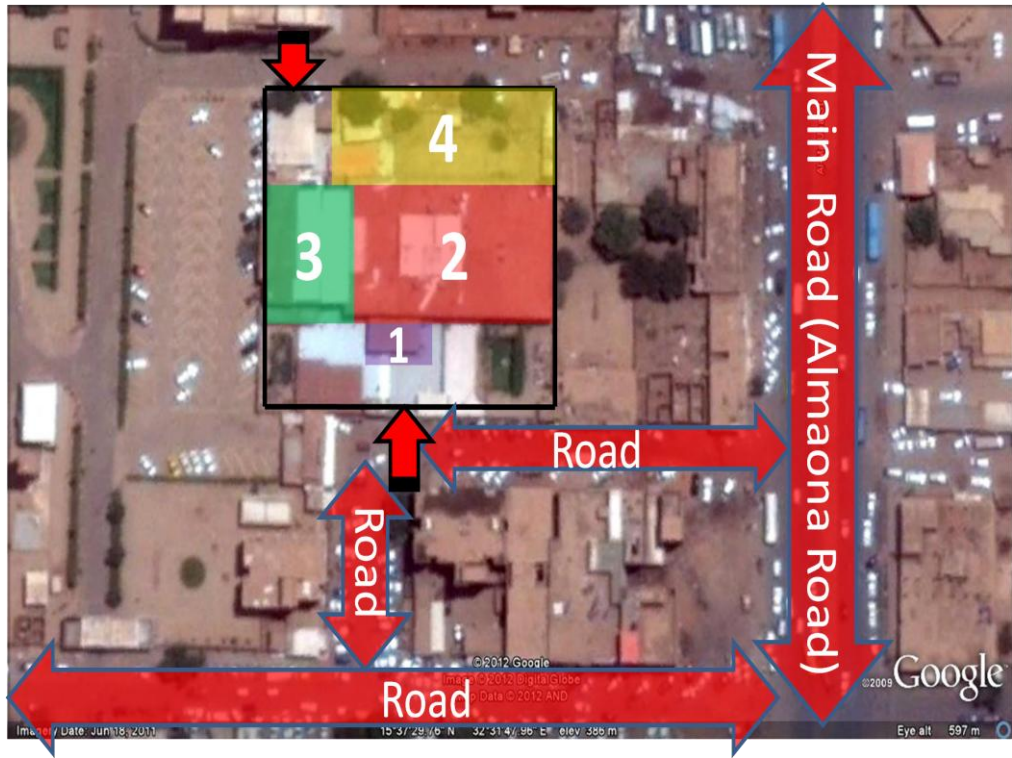


Figure 5-25 Khartoum north teaching hospital location

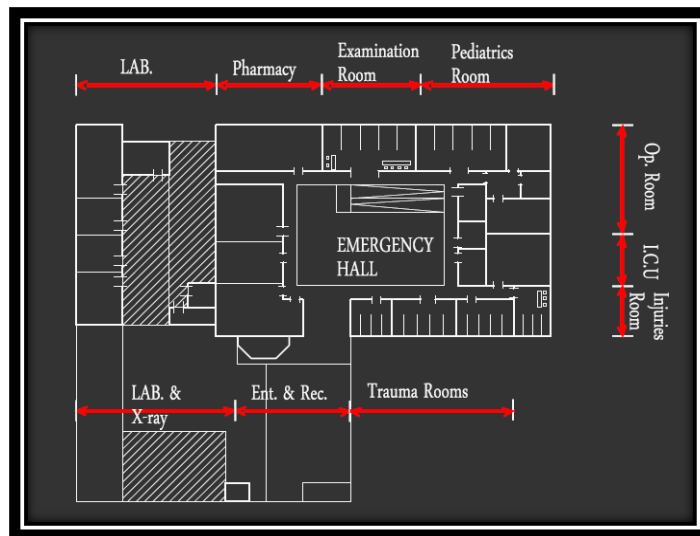


Figure 5-26 Sketch for emergency and accidents department

### 5-2-2-1 The entrance and reception:

There are two entrances: the first entrance leads to the emergency department (patients with emergency ambulance entrance), and the second entrance is for non-emergency patients. Also it has an office for reception and registration at the entrance to the emergency room



Figure 5-27 Emergency entrance and reception

The main building consists of two floors, the ground floor which contains: -

#### **5-2-2-2 The cold cases department:**

It contains the four clinics for examination and diagnosis for those who leave the hospital immediately and the department which receives about 367 cold cases per day.

#### **5-2-2-3 Emergency Department (Hot Cases):**

This section contains:-

- Examination room for internal medicine patients. The area of this room is about 30m<sup>2</sup>. It contains 5 beds for examination and observation. This section receives 119 cases per day.
- Examination room for the surgery and injuries. The area of this room is about 20m<sup>2</sup>. It contains almost 3 beds for examination and observation. This section receives 85 cases per day.
- Examination room for pediatrics. The area of this room is about 30m<sup>2</sup>. And it contains 5 beds for the examination and observation. This section receives about 111 cases per day.
- Three rooms for intermediate care (trauma rooms). The area of this room is about 60m<sup>2</sup>. It contains 10 beds for observation, dedicated to heart patients, and stroke and trauma. It is equipped with measurement, oxygen and rescue kits.



Figure 5-28 Examination rooms

#### **5-2-2-4 Laboratories Department:**

This is located outside the main building of the emergency and limb department. It contains two laboratories for all tests and a room for CT scan (x-ray), in addition to the waiting area.

The first floor is also accessible from the ground floor by a ramp in the center of the emergency department hall and contains the following:

#### **5-2-2-5 Operations department: It contains:**

- Room for large operations (urgent cases), it contains rooms for preparing patients and change room for physicians and nurses.
- Small operating room (UN –urgent cases).
- Intensive care Room (I.C.U), which contains 3 beds.

#### **5-2-2-6 Short-Stay Wards Department which contains of:**

- Medical wards one for men and one for women, each ward contains about 10 beds.
- Tow surgery wards one for men and one for women and each ward accommodates about 10 beds.
- Ward for children which accommodates about 10 beds.



Figure 5-29 Ramp to link the floors



Figure 5-30 Wards section

### **5-3 Royal Care Hospital:**

#### **5 -3-1 General**

It is one of the most modern and the largest private hospitals in Sudan. It is located in the eastern part of Khartoum city (Buri area). The hospital has more than 700 doctors and technicians from the Philippines, Germany, Ireland, Egypt, Sudan and



other countries. The hospital recruits trained medical staff. The area of the Royal Hospital Care is about 24 thousand square meters and it has

150 beds. It contains:

a- 8 of specialized centers

} Phase I

b- 51 clinics

c - The second phase is currently under construction. It contains 400 beds, 40 clinics and 18 specialized centers. It is the largest center for the treatment of patients with tumors and cancer and is located in the northern part of the hospital.



Figure 5-31 Royal care hospital location

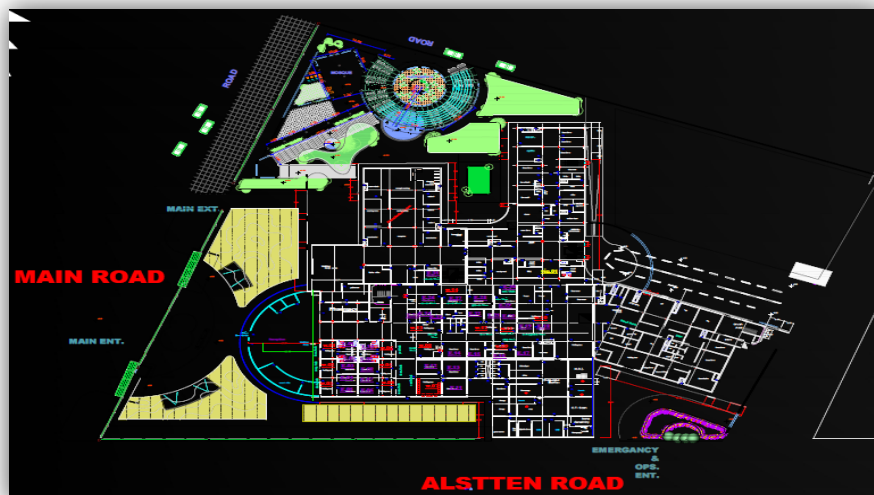


Figure 5-32 Royal care hospital (ground floor plan)



Figure 5-33 Royal care hospital

### 5-3-2 Emergency Department – Royal Care Hospital

The work in the emergency department in Royal Care Hospital began in February 2012. The section receives about 20 patients per day and contains the following sections:



Figure 5-34 Emergency Department

- The reception and waiting area of approximately 70m<sup>2</sup>.
- Triage room with area of 12 m<sup>2</sup> is used for the initial examination of the patient to determine the case.
- The resuscitation and trauma room which has an area of 36m<sup>2</sup> and contains four beds ,medical equipments and supplies of oxygen, sensors of heart and suction devices and others.
- Patient's observation room has an area of about 36m<sup>2</sup>. It contains four beds with full equipment, where the patients under go observation by the nursing unit after coming out of danger. After 24 hours the patients are either moved to specialized section in the hospital or discharged if they are fully healed
- Children's room has an area of 20m<sup>2</sup>, and it contains four bed rooms equipped with full medical services. Children find special decorative cartoon graphics on the walls and TV screens to view animation films.
- A private room for delivery in emergency situations. The room contains beds for normal and abnormal deliveries. The new born children are then moved to the state Department of Obstetrics and Gynecology in the hospital. The room area is about 12m<sup>2</sup>.
- Laboratory Department: contains the blood and X-ray labs which are also used by other sections.
- Doctors Office.
- Doctors rest room.
- Private store for emergency department.
- Two ambulances Intensive Care rooms full of equipment.
- Private helicopter landing pad on the roof hospital.

## 5-4 Sanlurafa-Ceylanpınar Hospital (Sanlurafa-Ceylanpınar Hastani):

### 5 -4-1 General:

The hospital is located in Turkey, with an area of 12,818 m<sup>2</sup> it has can 75 beds and is comprised of three floors:

- The ground floor contains a center for dialysis and an emergency department in addition to specialized clinics.
- The basement floor contains the laboratories and X-ray department as well as medical services, laundry centers and a central kitchen, in addition to the private shelter in case of emergencies (earthquakes).
- The first floor contains the patient rooms and central sterilization.
- The second floor contains general surgery sections and patients rooms.

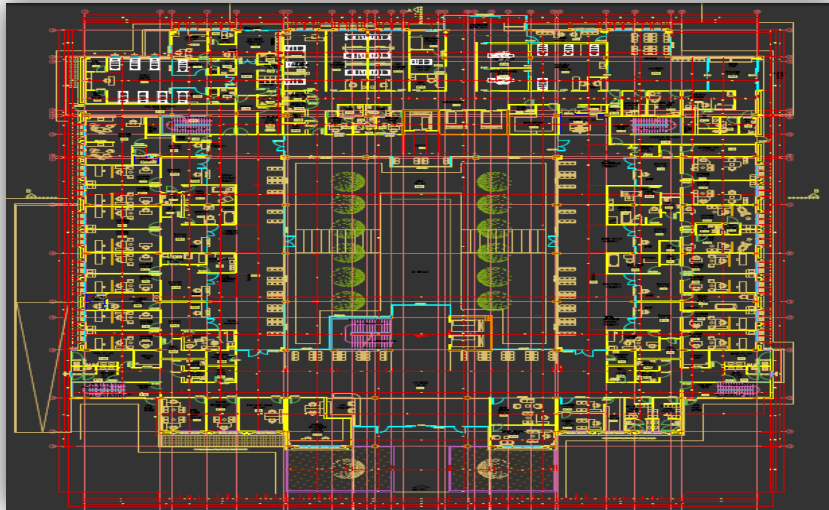


Figure 5-35 Sanlurafa-Ceylanpınar Hospital (ground floor)



Figure 5-36 Sanlurafa-Ceylanpınar Hospital





Figure 5-37 Sanlurafa-Ceylanpinar Hospital

**5-4-2- Emergency department in hospital:**

The emergency department of this hospital contains the following: -

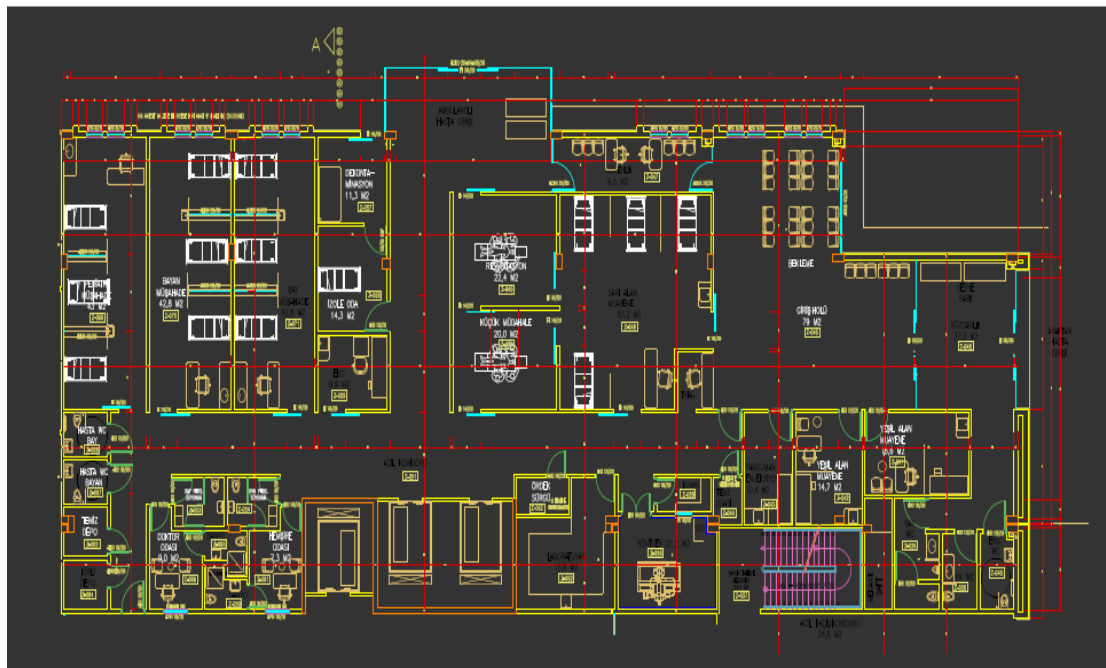


Figure 5-38 Emergency department

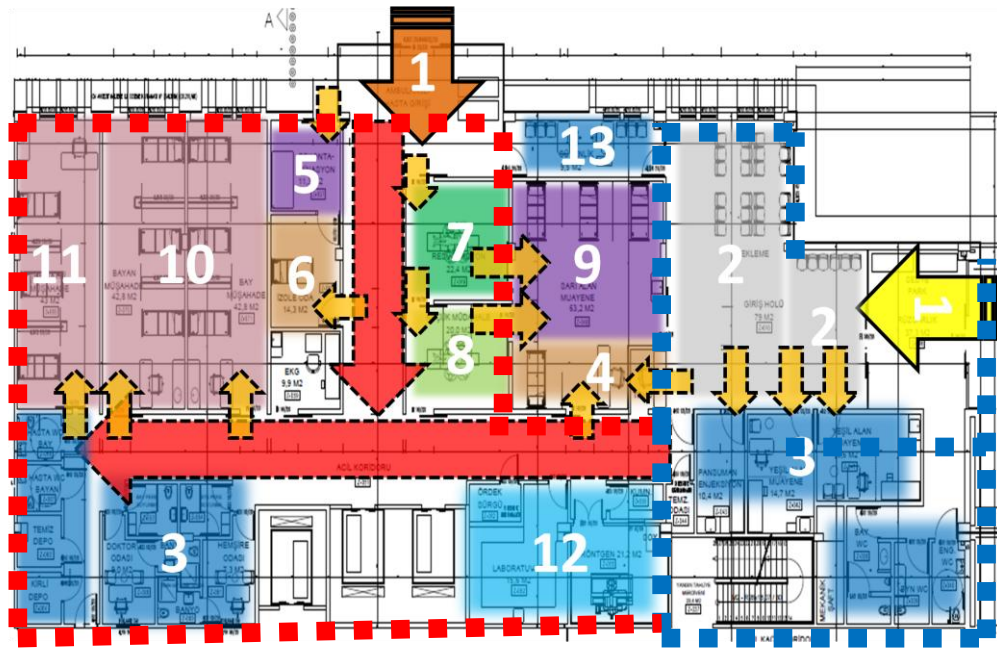


Figure 5-39 Emergency department

- 1 - The entrance to emergency cases section.
- 2 - The entrance to non-emergency cases section.
- 3 - Emergency cases section contains:
  - Decontamination room and has external entrances with an area of 15 m<sup>2</sup>.
  - Isolation Room with an area of about 15m<sup>2</sup>.
  - Resuscitation and trauma room consists of a room for the examination and treatment with an area of 22m<sup>2</sup> with full equipment, medical equipment and a room for observation. The area is about 63m<sup>2</sup> containing a nursing unit and four beds.
  - Small operating room with an area of about 20m<sup>2</sup>.
  - Observation men's room with an area of about 42m<sup>2</sup> which contains 3 beds in addition to a nursing unit.
  - Observation women's room the area about 42m<sup>2</sup>. It contains 3 beds in addition to a nursing unit.

- Observation men's room with an area about of 42m<sup>2</sup>. It contains 3 beds in addition to a nursing unit.
- Specialist doctors' rooms.

4 - Non-emergency cases Department contains:

- Triage room with an area of about 10m<sup>2</sup>.
- Reception and waiting with an area this area about 79m<sup>2</sup>.
- Two rooms for examination with an area of about 30m<sup>2</sup>.
- Doctor Rooms.

5-Laboratories Department which contains:

- Blood lab with an area of 15m<sup>2</sup>.
- CT scan laboratory with an area of 21m<sup>2</sup>.

## **5-5 The results of the field study**

The field study for some of emergency departments in local hospitals and study of the designs of some hospital emergency departments show that:

- Most of the emergency departments at government hospitals are under great pressure through receiving large numbers of disease conditions and injuries cases mostly coming from outside the State of Khartoum, which explains that there is a shortage in hospitals in general emergency departments, in particular, within the State of Khartoum and in other states.
- Most emergency departments lack international standards for emergency departments as we have mentioned in earlier sections of this research, especially in the following fields:

### **5-5-1 Architect Design:**

This is the most important part and the focal point of this research, which it became clear to the researcher when comparing international standards and universal designs for emergency departments with designs and specifications of emergency departments in large hospitals in Khartoum. Those sections have been

designed and constructed without reference to the international standards adopted in many countries, with particular reference to:

- There are differences in the architectural designs and spaces within the emergency departments in terms of the different functional requirements and areas and the relationship of functional connectivity between spaces. The researcher found that the paths of movement of patients are not clear because they do not separate the emergency and non-emergency cases which would lead to congestion of patients in emergency departments and spaces that hinder the work of doctors.
- The lack many of the emergency departments in hospitals in this country, whether in government or private hospitals for many functional spaces that have been identified by the AIA standards (American Institute of Architects). The spaces which are essential in the emergency department are: -
  - A- Triage room and primary examination room.
  - B - Decontamination room.
  - C - Resuscitation and trauma room.
  - D – Isolation rooms.
  - E - Nursing units.
- The construction and finishing elements used in emergency departments do not comply with the specifications. An example is the Department of Medicine, in Khartoum Hospital, which was constructed with panels of aluminum, zinc, and the building is unstable and disproportionate to the country's environment and health needs.

#### **5-5-2 Medical Services:**

- Through the study and the visits to some public hospitals the researcher found that all hospitals have no central stations of oxygen and medical gases that supply examination rooms' trauma rooms and wards and patient rooms, where they are the important factors for patients' treatment. This caused many

cases of death, as happened in the emergency departments in Khartoum North teaching hospital where they are still using oxygen cylinders.

- Also no laboratory services are integrated in emergency departments.
- Emergency departments also lacked nursing units that inform each organization and observation center of what is happening in the emergency department

## **6- Conclusion & Recommendations Study**

### **6 -1 Conclusion:**

- There is a big difference between the current status of health service buildings in Sudan and in developed countries in general, and those in the western countries, the forerunner in setting standards of design and preparation of hospitals.
- Standards and specifications in western countries have reached precision at all levels and in all components of hospitals.
- It is observed that existence of international specifications in hospitals helps in:
  - Availability of good environment for treatment.
  - Avoidance of performance problems caused by inefficient design of spaces.
  - Achievement of flexible mobility between sections.
- An emergency section can change gradually into integrated hospitals that contain all the necessary medical equipment, and can as well be an ambulance units distributed in peripheral areas of the state to support central hospitals.
- There are some standards set to meet the ideal state of emergency sections. These standards have been scientifically deducted from theoretical studies, experiments and standards of other countries.

### **6-2 Recommendations of the study:**

The research recommends the following:

#### **6-2-1 Classification of emergency and accidents departments:**

1 – Hospital of emergency and injuries includes the following:

- Medicine unit for hot and cold cases.
- Surgery section for both hot and cold cases.
- Delivery unit.
- Pediatrics unit.

2 - Emergency departments in general, governmental and private hospitals.

3 - Ambulance units distributed in far areas and in outskirts to support central hospitals.

#### **6-2-2 The location of emergency department:**

- The location should be easily reachable through main roads.
- The emergency department should be near to the general surgery department in the hospital.
- Should be very near to the intensive care unit.
- Should be very near to the central laboratory of the hospital.
- Entrances of hot and cold cases should be separated.

#### **6-2-3 Determine the required size and area in emergency department:**

- Statistical and mapping study should be carried out to determine the required areas to make use of all spaces and medical equipments.
- International standards should be followed in determining the allocated area for emergency department inside a hospital.

#### **6-2-4 Proposals future research and studies:**

The researchers recommend future researches and studies that would add to this study, which is considered as a starting point for future studies for the most important of the following:

- Study of standards and specifications of emergency departments in Sudan.
- Study of the impact of architectural design on reduction of waiting time in emergency department.
- Study of the architectural role in managing operational system of emergency department.

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