USAID
FROM THE AMERICAN PEOPLE

HOSPITAL SPACE PLANNING and UTILIZATION

Arthur Hoey & Louise Myers

June 2012

USAID
FROM THE AMERICAN PEOPLE

Course Objectives

1. Define the elements of a Functional Program and explain why a Functional Program is the necessary first step in hospital space planning
2. Identify key hospital operational Data elements needed to build a Functional Program
3. Describe how a detailed Space Program is developed from the Functional Program.

USAID
FROM THE AMERICAN PEOPLE

Course Objectives

4. Describe Engineering and Information Systems impacts on hospital space planning
5. Understand Circulation patterns impact on infection prevention and control
6. Describe how design can impact on-going annual staffing Operational Costs

FUNCTIONAL PROGRAM

Functional Programming marks the Beginning of Planning and Design

Defines the Project in terms of

- Purpose
- Scope
- Functions

USAID
FROM THE AMERICAN PEOPLE

What are the Program Goals?

Implement new technology?

Increase patient satisfaction?

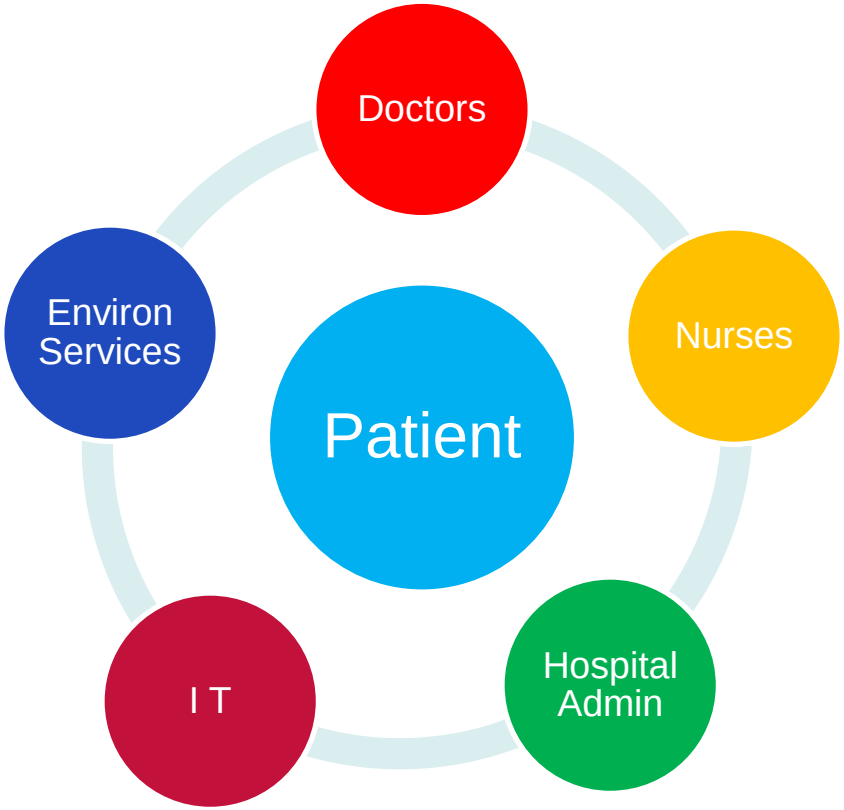
Improve staff efficiency?

Lower infection rates?

Change patient care protocols?

USAID
FROM THE AMERICAN PEOPLE

Who are the Stakeholders?



What Standards to Use?

What standards will be used for the project?

- WHO
- Joint Commission International
- U.S. – NFPA: National Fire Protection Association
- U.S. – Guidelines for Design and Construction of Health Care Facilities – The Facility Guidelines Institute
- Albania – Ministry of Health

What is the Patient Flow? Example - Maternity

- Registration
- Pre-Admission Exam
- Extended Observation/Admission?
- Labor Room
- Delivery Room
- Post-Delivery Observation
- Post-Partum

How are Operational Systems Organized?

- Registration
- Supply Delivery and Storage
  - Linen
  - Medical Supplies
  - Pharmaceuticals
- Waste Removal
- Patient Medical Record Charting

What Protocols Impact Space?

- Family Involvement in Delivery
  - Local Customs and Religious Practices
- Visitor Policies
- Emergency Response
- Baby Admission

USAID
FROM THE AMERICAN PEOPLE

Why is DATA Critical?

The functional program is a data driven document

- Clinical volume history and future projections used to develop space needs
- Forecast multiple for years in the future - Construction takes awhile!
- Look at trends
  - Volume growth vs. decrease
  - New staff, equipment, or services expected to change volume projections.

USAID
FROM THE AMERICAN PEOPLE

What Support Functions are Needed?

Doctor Sleep

Nurse Station

Nourishment Room

Family Waiting

Equipment Storage

SPACE PROGRAM

Converting the Functional Program into a Space Program

- ✓ Program statistics
- ✓ Staffing patterns
- ✓ Equipment use
- ✓ Support Functions
- ✓ Patient Flow

All translated into space requirements

Program Data – Example: Maternity Unit

Lezha Regional Hospital

- 1,112 annual births in 2011
- June through September - Peak Birth Months
- Average Length of Stay (ALOS) - 4 days
- C-section rate of 20.5% - 228 births per year
- Current Delivery Rooms: 2
- Current C-Section Rooms: 1 with 4-bed recovery

Program Data (2)

Lezha Regional Hospital (continued)

- 1,112 births per year / 365 days = 3.05 births per day average……round-up to 4 births per day
- Seasonal increase for June through September unknown- assume 1 additional birth per day = Average 5 births per day
- 5 births with an ALOS of 4 days =

20 post partum bed demand

Program Data (3)

Lezha Regional Hospital (continued)

- Turnover Rate of Delivery Room
  - 24 hours / 5 births per day average = 4.8 hours per birth
  - Verify average usage efficiency of current Delivery Rooms
- Current Delivery Room Demand Assumptions
  - 2 Delivery Rooms / 5 births per day = 2.5 births per Delivery Room or 9.6 hours per birth

Right Size = 2 Delivery Rooms

Challenges to the Data

- Projected births expected to increase/decrease?
- Seasonal adjustment assumptions accurate?
- Birthing trends will influence space needs
  - Traditional maternity unit design vs. LDR or LDRP?

USAID
FROM THE AMERICAN PEOPLE

Space Program – Maternity
C-Section (1)

C-Section	Qty	Sq Ft	Sq M	Total Sq M
Operating Rooms: C-Section -Includes infant resuscitation for twins	2	440	40.88	81.75
Recovery -shared space with privacy curtains	2	80	7.43	14.86
Instrument Decontamination -Acccessible from each OR	1	80	7.43	7.43
Anesthesia Workroom	1	100	9.29	9.29
Anesthesia Storage	1	80	7.43	7.43
Sterile Storage	1	100	9.29	9.29
Scrub -Adjacent to ORs -Three sinks	1	50	4.65	4.65
Male Locker/Changing -12-15 lockers -Accessible from outside STERILE zone -Opens to staff lounge	1	100	9.29	9.29

Space Program – Maternity C-Section (2)

Female Locker/Changing -12-15 lockers -Accessible from outside STERILE zone -Opens to staff lounge	1	100	9.29	9.29
Staff Toilet/Shower -opens to staff locker rooms	2	50	4.65	9.29
Staff Lounge -Include Pantry -Opens to STERILE zone -Opens to staff locker areas	1	150	13.94	13.94
Clean Utility	1	100	9.29	9.29
Soiled Utility	1	100	9.29	9.29
On-Call Rooms	5	80	7.43	37.16
Toilet/Shower for On-Call rooms	3	50	4.65	13.94
Sub-Total				**246.19**

USAID
FROM THE AMERICAN PEOPLE

Space Program – Maternity Labor and Delivery

Labor/Delivery	Qty	Sq Ft	Sq M	Total Sq M
Labor/Delivery/Recovery (LDR)	5	340	31.59	157.94
Patient Toilet/Shower -accessible from LDR	5	50	4.65	23.23
Extended Observation Bed (EOB) -Pre-admission/Triage	2	120	11.15	22.30
Patient Toilet/Shower -accessible from EOB	2	50	4.65	9.29
Staff Toilet	1	50	4.65	4.65
Medication Prep	1	80	7.43	7.43
Nourishment	1	60	5.57	5.57
Nurse Station	1	150	13.94	13.94
Head Nurse Office	1	80	7.43	7.43
Crash Cart	1	15	1.39	1.39
Family Waiting -Seating for 15-20 persons -include Pantry	1	350	32.52	32.52
Visitor Toilets	2	40	3.72	7.43
Equipment Storage	1	150	13.94	13.94
Medical Gas Storage	1	50	4.65	4.65
Stretcher Storage	2	25	2.32	4.65
Sub-Total				**316.33**

USAID
FROM THE AMERICAN PEOPLE

Space Program – Maternity Nursery (1)

Nursery	Qty	Sq Ft	Sq M	Total Sq M
Term Nursery (24sf/Bassinet)	25	24	2.23	55.74
NICU (24sf/Bassinet)	5	24	2.23	11.15
Isolation Nursery	1	150	13.94	13.94
Staff Chart/Workroom -Ante-room to Nursery	2	150	13.94	27.87
Infant Exam/Treatment	1	120	11.15	11.15
Nurse Station	1	150	13.94	13.94
Nurse Manager Office	1	80	7.43	7.43
Nourishment	1	150	13.94	13.94
Medication Prep	1	80	7.43	7.43
Equipment Storage	1	150	13.94	13.94
Staff Lounge -include Pantry	1	100	9.29	9.29
Staff Lockers -Ten lockers	1	80	7.43	7.43

Space Program – Maternity Nursery (2)

NICU On-Call	1	80	7.43	7.43
Toilet/Shower-NICU On-Call	1	50	4.65	4.65
Lactation -Including supply cabinet	1	80	7.43	7.43
Family Waiting w/Nourishment	1	180	16.72	16.72
Family Locker Storage -Eight lockers	1	60	5.57	5.57
Visitor Toilet	1	40	3.72	3.72
Sub-Total				**238.76**

Space Program – Maternity Post-Partum

Post Partum Unit	Qty	Sq Ft	Sq M	Total Sq M
Patient Rooms (Single)	20	120	11.15	222.97
Patient Toilets/Shower -accessible from patient bedroom	20	50	4.65	92.90
Nurse Station	1	150	13.94	13.94
Office-Nurse Manager	1	80	7.43	7.43
Medication Prep	1	80	7.43	7.43
Nourishment	1	60	5.57	5.57
Crash Cart	1	15	1.39	1.39
Staff Lounge -including Pantry	1	100	9.29	9.29
Staff Lockers -Ten lockers	1	80	7.43	7.43
Clean Utility	1	100	9.29	9.29
Soiled Utility	1	100	9.29	9.29
Examination	1	120	11.15	11.15
Storage	1	150	13.94	13.94
Sub-Total				**412.02**

USAID
FROM THE AMERICAN PEOPLE

Space Program – Maternity Administration

Administration	Qty	Sq Ft	Sq M	Total Sq M
Office-OB Director	1	100	9.29	9.29
Office-OB Assistant Director	1	100	9.29	9.29
Office-Clerical	1	150	13.94	13.94
Office-OB Administrator Office	1	80	7.43	7.43
Office-NICU Attending	1	80	7.43	7.43
Office-Physician Assistant	1	80	7.43	7.43
Consult-NICU	2	80	7.43	14.86
Conference	1	225	20.90	20.90
Staff Toilets	2	50	4.65	9.29
Sub-Total				**99.87**

Space Program – Maternity - SUMMARY

Summary	Total Sq M
C-Section	246.19
Labor/Delivery	316.33
Nursery	238.76
Post Partum Unit	412.02
Administration	99.87
Net Total	**1313.18**
Net to DGSF at 40%	525.27
DGSF Total	**1838.46**
DGSF to BGSF at 15%	275.77
BGSF Total	**2114.23**

Net-Net Floor Area

DGSF-Departmental Gross Square Feet-Provides for corridors, stairs, electric closets, telecommunication and nurse call closets, HVAC shafts, plumbings shafts, etc

BGSF-Building Gross Square Feet-Provides for exterior walls, etc

SCHEMATICS

Converting the Space Program into Schematic Design

Example: C-Section Schematic Design Development

- ✓ Functions and Relative Sizes
- ✓ C-Section Space Program
- ✓ C-Section Room Function Groupings
- ✓ C-Section Schematic Layout

Note: Schematic Layout File

HEALTH INFORMATION SYSTEMS

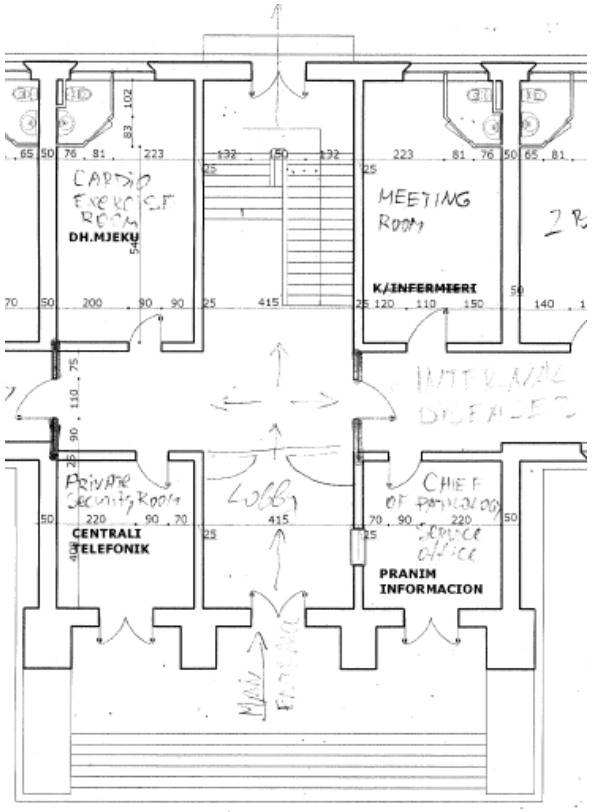
HIS Implementation – Space Implications -

Information the Architect needs for Space Program

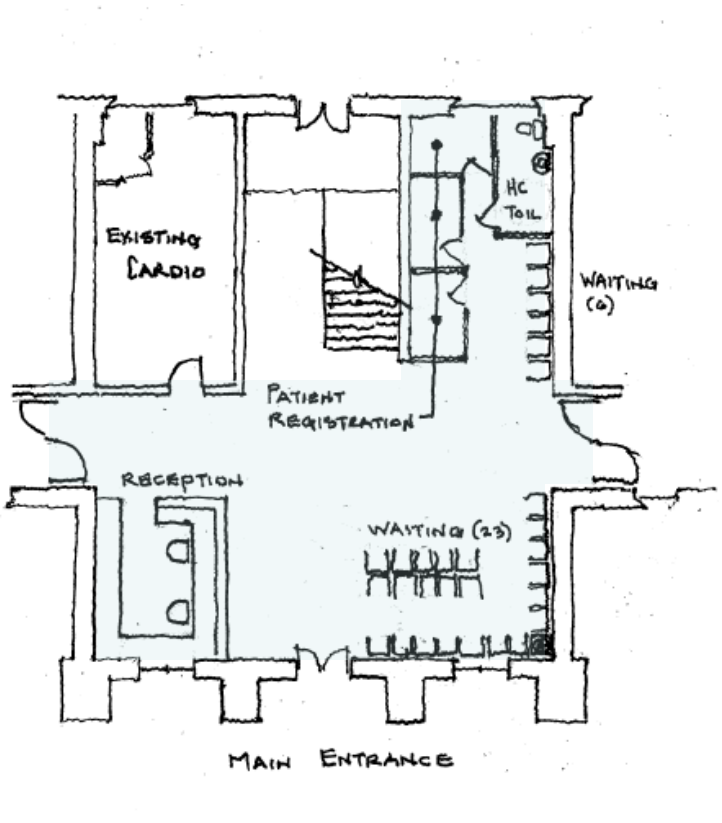
Example: Patient Registration:

- Type and Quantity of Equipment to be used in the space
- Number of People Working in the Space
- Requirements for Patient Confidentiality
- Furniture for Patients and Visitors waiting for Admission

Korce – Main Entrance Existing



Korce – Main Entrance Patient Registration



Health Information System – Patient Units

Patient Care Unit

- Bedside Medical Record Charting?
  - ✓ Fixed Stations in Hallway
  - ✓ Computers on Wheels
  - ✓ Tablets
- Nursing Station – Terminal, Reader, Scanner and Printer Requirements

Signage

General Sign Recommendations:

- ✓ “You are Here” Map including Fire Egress Plans
- ✓ Exterior Directional Signage
- ✓ Exterior Parking Signage
- ✓ Interior Signage – Entrance and Exit
- ✓ Interior Way-Finding – Room Numbering
- ✓ Interior Way-Finding - Directional

USAID
FROM THE AMERICAN PEOPLE

ENGINEERING

Too often an architectural design is chosen without attention given to elements that are *more* critical to the proper functioning of the hospital

USAID
FROM THE AMERICAN PEOPLE

Electrical Systems

- Power Supply/Power Distribution
- Emergency Generator/UPS Capacity
- Lighting Systems
- Low Voltage Systems
  - Nurse Call
  - Telephone
  - Data

Electrical Power Systems

- Anticipate Future Demand
- Request Two Service Entrances from Power Company
- Emergency Generators – Power Load Shedding
  - Help Power Company during times of peak power demand

    Negotiate and Reduce Your Cost!
  - Minimize threat of “Brown Outs” and full power failure

Note: Generator maintenance and testing is very important with routine testing monthly and testing under a full load annually. Detailed service logs must be maintained.

USAID
FROM THE AMERICAN PEOPLE

Emergency Power – Dividing Power Loads

1. • Critical Branch
   • Power loss could result in loss of life
2. • Life Safety Branch
   • Inability to evacuate building
3. • Equipment Branch
   • Normal operations affected
4. • Alternate Branch (Optional)
   • Power loss only an inconvenience

Lighting

- Good Design – Reduce injury, increase productivity, improve facility
- Occupancy sensor switching – reduces cost
- Light-Emitting Diode (LED) most efficient
- UVGI reduce spread of bacteria (TB)

Low Voltage Systems

- Telephone Systems
- Nurse Call and Nurse Locator Systems
- Public Address and Audible Paging Systems
- Data and Information Technology Infrastructure including WiFi
- Closed Circuit Television Entertainment/Education Systems
- Security Systems-Closed Circuit TV, Card Reader Entry, Remote Access
- Facility Management Systems-HVAC monitoring and control

Mechanical Systems

- Fire Safety - (Electric and Mechanical)
- Distilled, De-ionized, Reverse Osmosis Water Purification
- Medical Gases – O2, Vacuum, Compressed Medical Air, N2O
- Fuel - Oil/Natural Gas
- Elevators

USAID
FROM THE AMERICAN PEOPLE

Fire and Smoke Alarm Systems

U.S. – Systems centrally monitored from fire station

- Smoke sensors in every room and throughout corridors and open spaces

Fire Alarm pull stations on each floor at point of egress

- Audible and Visible (strobe light) alarms

Central alarm control panel at main entrance

- Staff trained -what to do when alarm sounds

Fire System Suppression Systems

New hospitals - full sprinkler system

- Holding tank if water supply or pressure an issue

Sprinkler connection exterior of building

- Glycol Anti-freeze or pressurized air avoids pipe freezing

Monitored by building electronic fire alarm system

- Flow sensed – fire alarm activated

Water Purification

- Laboratory – Newer testing systems eliminates required acid waste piping and neutralizing
- De-Ionized, Distilled and Reverse Osmosis Purified Water
  - Laboratory and Renal Dialysis
  - Processed at or near point of use

.

Medical Gas Systems (1)

- Current standard - Central medical gas systems piped throughout hospital
- Minimally, Oxygen and Suction (vacuum) piped to every bed
- Nurseries/ ICUs – Medical air to refine mix/blend and concentration of oxygen
- Operating Theatres – High pressure nitrogen to operate specialized equipment.

Medical Gas Systems (2)

- Low pressure alarms for each gas zone annunciated at local nurses station
  - Wall mounted shut-off valves for each zone
  - Staff trained how to respond to gas alarms
- Storage of Medical Gases - Stringent codes
  - Large Oxygen storage tanks require distance and blast protection

USAID
FROM THE AMERICAN PEOPLE

Fuel Systems – Oil and Gas

- Consumption Logging – Analyze Trends
- Equip tanks with leak detection systems

Elevators

- Multiple banks in new hospital designs.
  - Outpatient and Visitor Elevators – Designed for high volume
  - Patient Elevators - Sized to accommodate a gurney/stretcher or hospital bed. Finishes are impact resistant to avoid damage from wheeled equipment.
  - Service Elevators - Sized to accommodate supply carts, mobile x-ray units, food service delivery cabinets, etc. Finishes are impact resistant to avoid damage from wheeled equipment.
- Separation
  - Improves infection control
  - Enhances user experience

Heating, Ventilation and Air Conditioning

- Equipment - Size, Weight, Location, Ease of Maintenance
- Design Temperatures
- Filter Efficiencies
- Ventilation Requirements by functional area
    - Air movement relationship to adjacent areas
    - Air changes per hour
    - Air exhaust to outdoors
    - Relative humidity control

Air Filtering Requirements

- Typical hospital ventilation systems provided for a two stage filtering of supply air.
- Pre-filter at 30% efficiency (MERV 7)*-Changed Frequently
- Final Filter at 90% efficiency (MERV 14)*-Changed Less Frequently

***M**inimum **E**fficiency **R**eporting **V**alues - MERV ratings

USAID
FROM THE AMERICAN PEOPLE

Air Filtering Requirements

Minimum **E**fficiency **R**eporting **V**alues - MERV ratings				
MERV Value	The filter will trap Average Particle Size Effiency 0.3 - 1.0 Microns	The filter will trap Average Particle Size Effiency 1.0 - 3.0 Microns	The filter will trap Average Particle Size Effiency 3 - 10 Microns	Types of things these filters will trap
MERV 1	-	-	Less than 20%	Pollen, Dust mites, Standing Dust, Spray Paint Dust, Carpet Fibers
MERV 2	-	-	Less than 20%	
MERV 3	-	-	Less than 20%	
MERV 4	-	-	Less than 20%	
MERV 5	-	-	20% - 34%	Mold Spores, Hair Spray, Fabric Protector, Cement dust
MERV 6	-	-	35% - 49%	
MERV 7	-	-	50% - 69%	
MERV 8	-	-	70% - 85%	
MERV 9	-	Less than 50%	85% or better	Humidifier Dust, Lead Dust, Auto Emissions, Milled Flour
MERV 10	-	50% - 64%	85% or better	
MERV 11	-	65% - 79%	85% or better	
MERV 12	-	80% - 89%	90% or better	
MERV 13	Less than 75%	90% or better	90% or better	Bacteria, Most Tobacco Smoke, Proplet Nuceli (sneeze)
MERV 14	75% - 84%	90% or better	90% or better	
MERV 15	85% - 94%	90% or better	90% or better	
MERV 16	95% or better	90% or better	90% or better	

Ventilation Requirements

TABLE 7-1 Design Parameters

Function of Space	Pressure Relationship to Adjacent Areas (n)	Minimum Outdoor ach	Minimum Total ach	All Room Air Exhausted Directly to Outdoors (j)	Air Recirculated by Means of Room Units (a)	RH (k), %	Design Temperature (l), °F/°C
SURGERY AND CRITICAL CARE							
Classes B and C operating rooms, (m), (n), (o)	Positive	4	20	N/R	No	30–60	68–75/20–24
Operating/surgical cystoscopic rooms, (m), (n) (o)	Positive	4	20	N/R	No	30–60	68–75/20–24
Delivery room (Caesarean) (m), (n), (o)	Positive	4	20	N/R	No	30–60	68–75/20–24
Substerile service area	N/R	2	6	N/R	No	N/R	N/R
Recovery room	N/R	2	6	N/R	No	30–60	70–75/21–24

ACH-Air Changes per Hour
N/R-Not Required
RH-Relative Humidity
Design Temperature-Optimal Temperature Range

Reference: ANSI/ASHRAE/ASHE Standard 170-2008

Waste Management

Segregation – Collection – Transport – Storage

Different Types

- Normal
- Re-Cycle
- Medical
- Hazardous
  - Contaminated Biological
  - Radiation

Accessibility

Spaces easy to use by patients with temporary or permanent handicaps

- Grades
  - Flat enough to allow easy movement
  - Sidewalks and corridors wide enough for two wheelchairs to pass easily
- Entrance areas
  - designed for patients with slower adaptation rates to dark and light
  - glass walls and doors marked

Renovation vs. New Construction

- Strengths and Weaknesses of existing site and plant
  - Capacities measured
  - Maximum build-out
- Age of Systems
- Estimated Useful Life
- Cost of Upgrades/Replacement
- Conformance with standards/code

INFECTION CONTROL

Infection Control Risk Assessment

- Multi-disciplinary, documented process BEFORE construction begins
- Proactively identifies risks from infection that can occur during construction
  - Transmission of various air- and waterborne biological contaminants
- Risk remediation recommendations and monitoring

Minimizing Risk During Construction

- Review location of exhaust discharge relative to existing fresh air intakes
- Projects in high-risk areas – maintain at a positive pressure differential from hospital clean areas to construction dirty areas
  - Visual display of airflow direction
- Installation of clean materials not damaged by water
  - Ductwork, drywall, wood/paper materials

USAID
FROM THE AMERICAN PEOPLE

Minimizing Transmission

- Isolation Rooms - Number and location
  - Negative Air Pressure - airborne infection isolation **from** patient
  - Positive Air Pressure -protective environment room **for** patient
- Hand-Washing Stations –Number and location
  Standard = every patient room
- Design to limit *Legionella* and waterborne opportunistic pathogens

HVAC – Airborne Contamination

HVAC Design Issues

- Capacity (Volume of Air)
- Filtration
- Air Changes per hour
- Pressure Relationships
- Directional Flow

- Ease of Maintenance and system cleaning
- Location of Air Intake and Exhaust Outlets

Finish Selections

Surface Characteristics

- Easy to maintain, repair, clean
- Does not support microbial growth
- Non-porous and smooth
- Seamless
- Durability

Controlled Circulation (1)

Hospitals = complex system of interrelated functions requiring constant movement of people and goods.

- Outpatients going to diagnostic and treatment areas should not travel through inpatient areas
- Outpatient routes should be simple and clearly defined
- Visitors should have a direct route to each patient nursing unit without penetrating other functional areas

Controlled Circulation (2)

- Separate patients and visitors from logistical areas or floors
- Outflow of trash, recyclables, and soiled materials should be separated from movement of food and clean supplies; both should be separated from routes of patients and visitors
- Dedicated service elevators

COST IMPACTS

Life Cycle vs. Initial Cost

Always A Big Debate

Example: Air Conditioning System

Equipment Life Expectancy = 20 Years for both options

Option One:

Initial Cost = $100,000

Annual Operating Cost = $10,000/Year for Ten Years

Total Cost for 10 Years = $200,000

Life Cycle vs. Initial Cost

Option Two:

Initial Cost = $150,000

Annual Operating Cost = $5000/Year for Ten Years

Total Cost for 10 Years = $200,000

Question: What happens years 11-20?

Option One = $100,000 Operating Cost

Option Two = $ 50,000 Operating Cost

Savings by selecting Option Two = $50,000

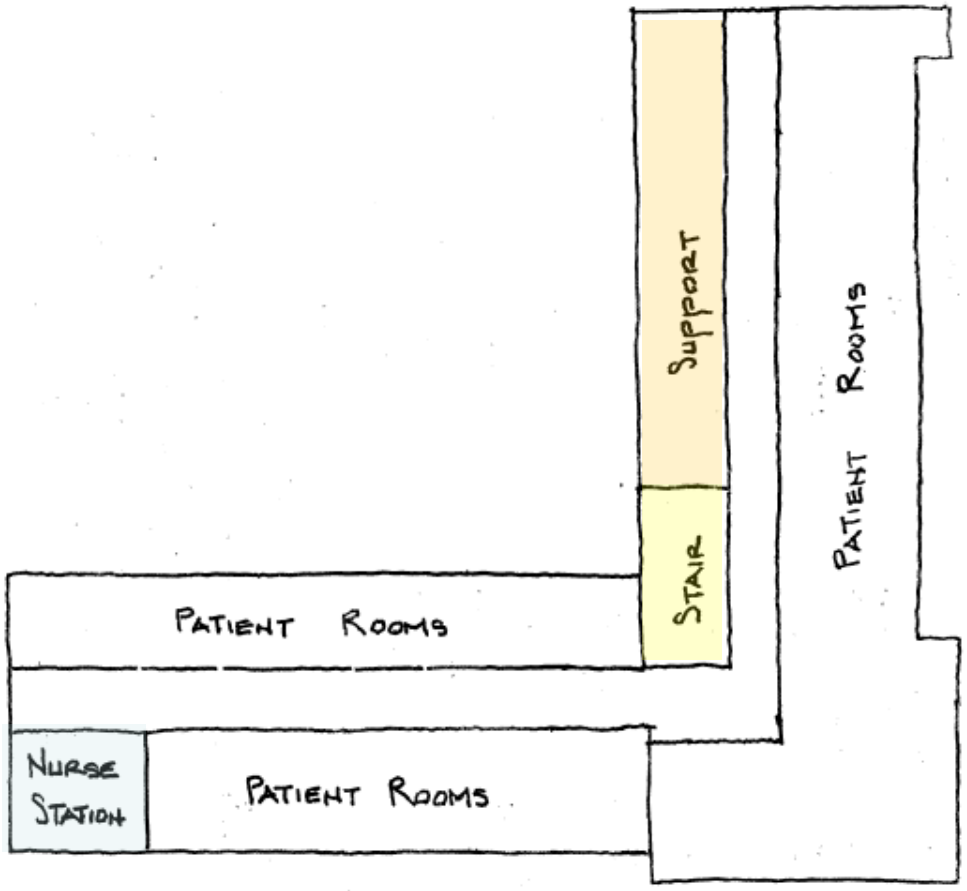
Design Impact on Staffing Costs

Cut Staffing Costs For Years with Good Design

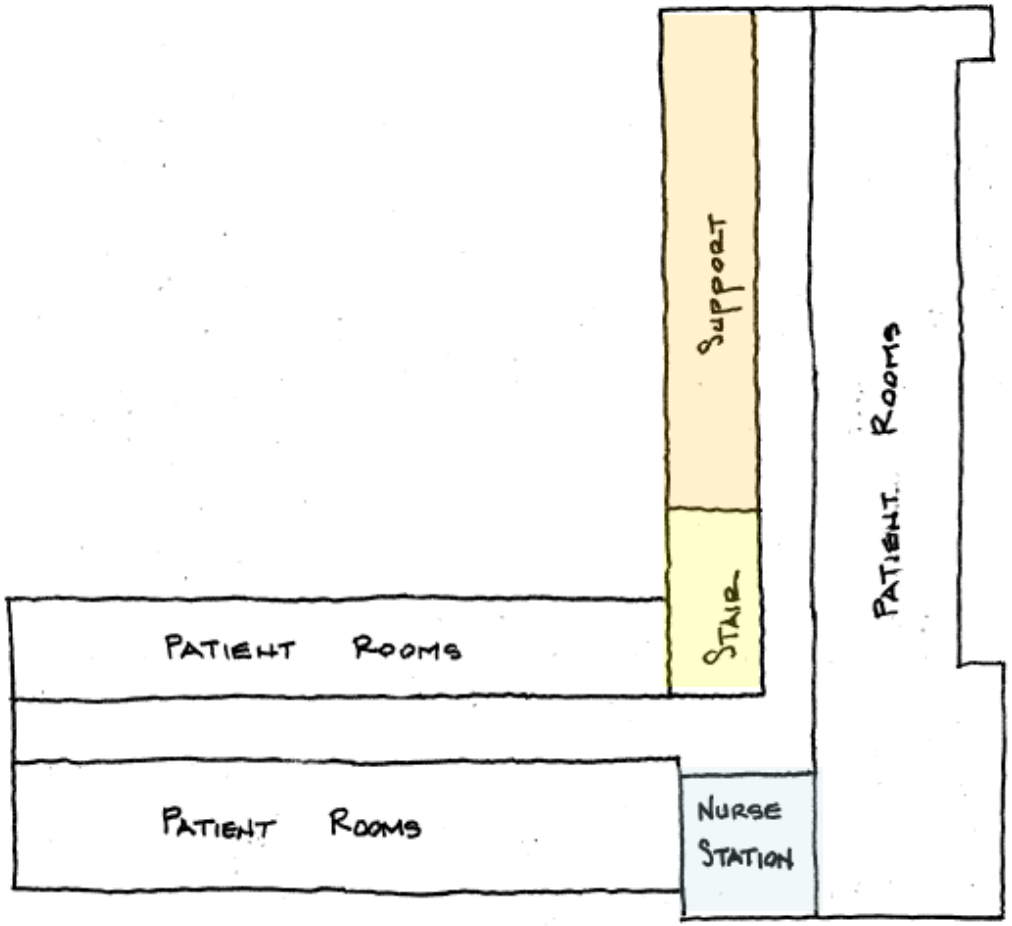
- Minimize travel distance between frequently used spaces
- Allow easy visual supervision of patients by limited staff
- Provide optimal functional adjacencies – maximize use of professional personnel with special skills

  Example: Locate surgical intensive care unit adjacent to the Operating Theatre.

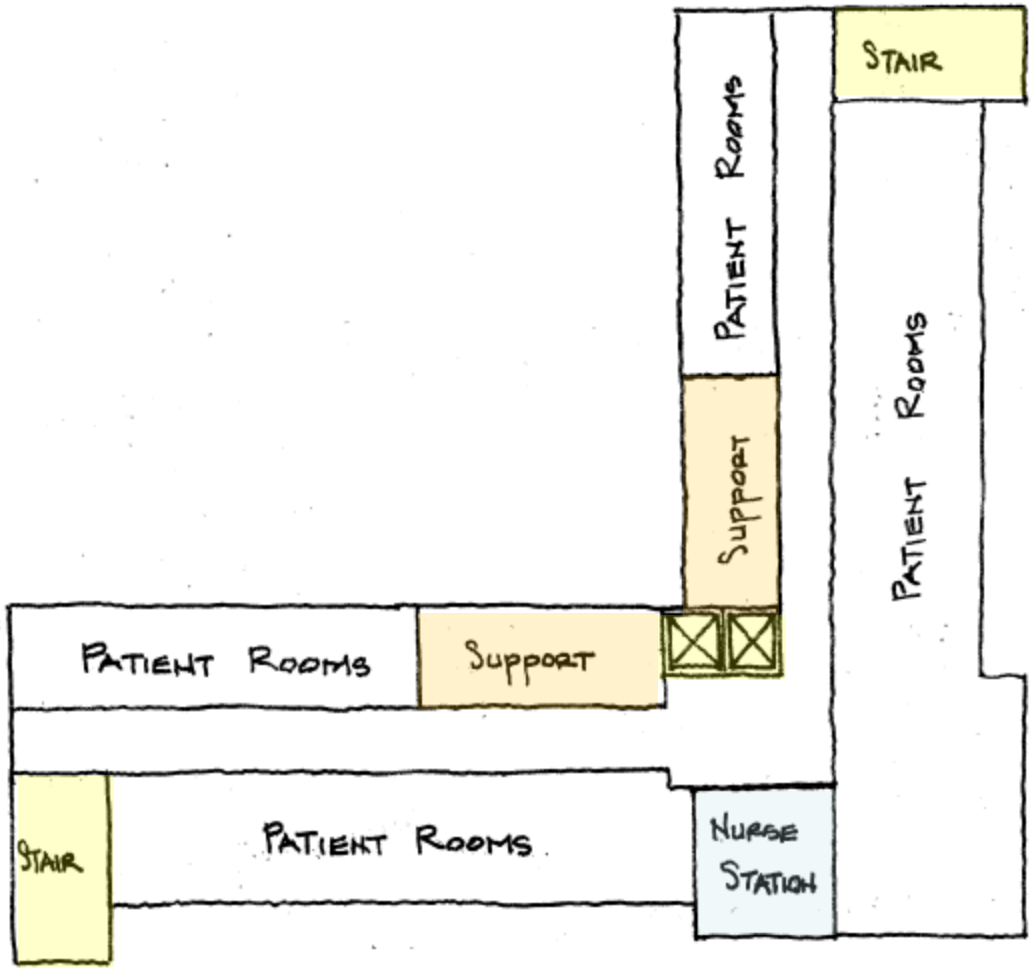
Unit Design Impact on Staffing (1)



Unit Design Impact on Staffing (2)



Unit Design Impact on Staffing (3)



NEW TRENDS IN HOSPITAL DESIGN

- Medical Mall-Public space and waiting with amenities (cafe, gift shop/retail, retail pharmacy, quiet rooms, educational library, etc.) opening to a wide range of outpatient oriented medical service units.
- Outpatient diagnostic services provided in hospital setting; radiology, endoscopy, etc.
- Treatment services provided as an outpatient in hospital setting; dialysis, minor surgical procedures, etc.

Medical Mall Concepts

Outpatient Reception and Registration

USAID
FROM THE AMERICAN PEOPLE

Outpatient Dialysis and Endoscopy

Outpatient Surgery and Invasive Procedures

- Stage 1 and Stage 2 (Sit-Up) Recovery

NEW TRENDS IN HOSPITAL DESIGN (2)

- Shift to private (single) patient rooms from multi-bed rooms.
- Reduction of inpatient beds as hospital moves towards outpatient/day procedure emphasis in delivering care.

Private Patient Rooms

NEW TRENDS IN HOSPITAL DESIGN (3)

- Further transition to 100% Electronic Medical Record
- Adoption of new electronic devices for data input and retrieval: tablet computers, smart phones, etc.

Electronic Medical Record and Order Entry

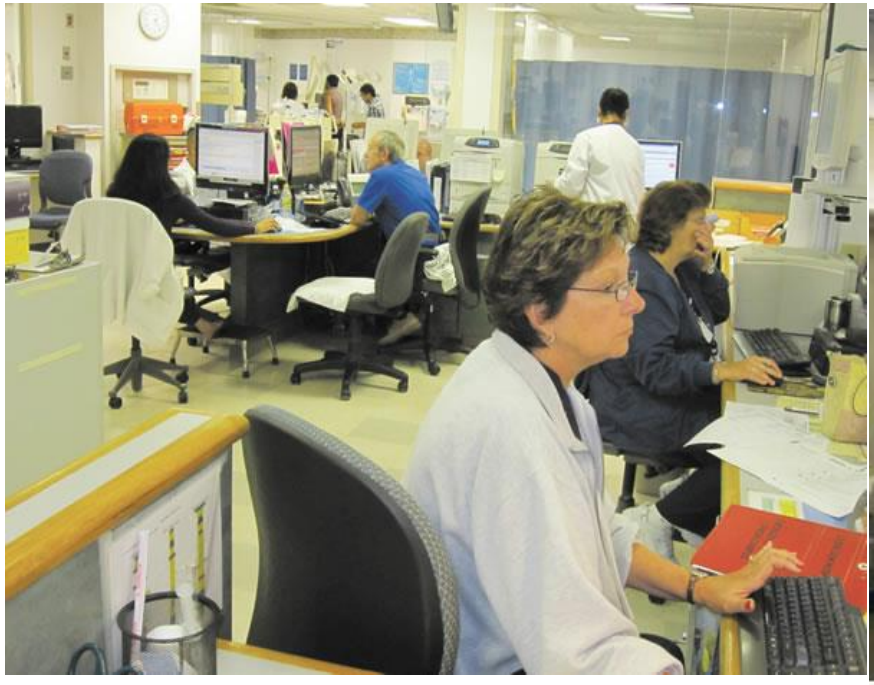


PHOTO BY BRAD FEINKNOPF

Electronic Medical Record and Order Entry (2)

NEW TRENDS IN HOSPITAL DESIGN (4)

- Adoption of specific "Centers of Excellence" within the hospital, recruiting specialist caregivers and marketing to surrounding community.

Centers of Excellence

Flexible and Adaptable

Design for the Future

- New technologies – the rise of Telemedicine
- New treatment methodologies
- Changing demographics and disease patterns

Utility spaces sized and arranged for potential expansion

Plan “soft spaces” next to “hard spaces”

Evaluate initial capital cost vs. renovation

- Example: Cabling – do it now!

Facilities Goals

- Provide and maintain a facility environment that is clean, efficient, and attractive.
- Facility and equipment should support the caregiver mission for professional quality medical diagnosis and treatment.
- A positive patient and visitor medical care visit is complimented by the facility experience.