CHAPTER 3

INPATIENT CARE FACILITIES

MICHAEL BOBROW AND JULIA THOMAS *Bobrow/Thomas & Associates*

INTRODUCTION

It is easy to lose sight of the calming influence that sensitive design can have on the emotional state of the patient, as well as family, visitors, and staff. Going to a hospital is stressful enough; there is no reason for the patient's physical surroundings to amplify that aspect of the experience. We can learn from the admonition to physicians "to do no harm" while trying to heal. The architect and hospital staff need only step back and visualize the most comfortable experiences and settings they have experienced and try to capture the poetry of those moments.

Nowhere is the opportunity to do this as great as in the patient room—whether for acute or intensive care, pediatrics, or women's services—and in the nursing unit. The patient room should be designed with the sensitivity one would desire for his or her own bedroom at home, and the floor environment should be as easy to use and understand as in the best of the great small hotels.

Clearly a calming environment can affect the emotional state of the patient. A patient and a family can better cope with their hospital experience if they have a greater sense of control over their stay. Such a supportive environment includes ease of wayfinding, privacy and ease of communications, control of light, sound, and temperature, as well as the opportunity to commune with nature in a calm and beautiful landscape.

Recognizing this, hospitals and architects have made a concerted effort to raise the level of awareness concerning the hospital environment and to create a greater sense of control for the family. This is reflected today in the training of hospital staff in sensitivity to the psychological needs of the patient and family and in the foregrounding of these issues in the planning and design of any building project.

There has been a growing body of research that documents the role of light, gardens, and control of the environment in the healing process. More information can be found through the AIA Academy for Health Care Design, the Planetree Organization, and the Symposium for Health Care Design. Each sponsors research and public meetings and documents findings for the architectural and healthcare communities.

We urge readers to internalize these humanistic concerns, and so create facilities that are not only highly efficient inpatient units but also restful, inviting refuges for the healing process.

BACKGROUND

The hospital is one of society's most important civic buildings. It is most often where we are born and where we die. In between, it is also a place of much emotional turmoil and much joy. The architecture of the hospital must respond to both this emotional context, of hope and tragedy, and the functional requirements of treatment and technology. Unfortunately, the design process is often overwhelmed by the functional needs of medical science, and too often the psychological needs of the patient and the family are overlooked while the body is treated.

Nowhere is a balance more critical than in the inpatient setting of a nursing unit, where the greatest amount of time is spent by patient and family. Today the patient room is seen as a place of sanctuary, privacy, and safety—the place where the patient and family are in control of their lives and environment. The patient room can now house the family, if necessary, and can be designed as an extension of the daily life of the patient, with total access to the world through the full range of communications tools such as phone, fax, and Internet.

The nursing unit is seen as a continuation of this environment, providing a family support system where spaces for family and staff are made as accessible, user-friendly, and important as the functional needs for nursing care. Hospital support services can now cater to the individual needs of the patient, through food selection and concierge-type services.

The original models for considering the hospital as healing architecture were Aalto's early work at Paimio, Finland, and Mendelsohn's work in Haifa and Jerusalem. This line was continued in the early studies of the role of architecture in enhancing the experience of family and patient by architects such as Edward Durell Stone at the Community Hospital of the Monterey Peninsula, Caudill Rowlett Scott (CRS) at Samaritan Hospital in Tempe, Arizona, and Bobrow/Thomas and Associates at Daniel Freeman Memorial Hospital in Inglewood, California, among others, and through research at the University of California at Los Angeles, Columbia, and Texas A&M graduate schools of architecture's programs in hospital design.

Further exploration of these concepts grew out of the concern of Planetree—an organization that developed a model for healthcare that supports and nurtures healing—for patients' sense of control of their experience, and in response to families' increased demands for a say in the care of patients, as well as new indications from marketing that distinction in architecture and service, as provided by the best hotels, can improve the success of a hospital in its community.

Finally, these ideas and practices have been stimulated and tested by the recent development of the Symposium for Health Care Design and its publication *Aesculapius*, which focuses strictly on ways in which architecture can influence a patient's experience. The concept has been formally tested in recent studies in which environmental factors of the kind we have been considering have been found to have a positive impact on the outcome of the patient's visit and on recovery time.

The success of early experiments with integrating gardens and providing a view from each room, offering single-bed accommodations, using warm, incandescent light, and providing family support space have created magical opportunities for further experimentation in designing units that integrate the power of evocative architecture into the healing process.

NURSING UNIT EVOLUTION AND TRENDS IN DESIGN AND PLANNING

Historically, the nursing unit has been the core of the hospital. Its purpose has been to house patients requiring care, often for long periods of time. Interestingly, because early hospitals were born out of the assumed responsibilities of religious orders, hospital design resembled the open bays and structures of church naves, a pattern that was repeated for centuries until the evolution of nursing care required new forms.

As technology and healthcare evolved over the centuries, so did the role and form of the nursing unit. The design of nursing units has responded to the needs of the era in which they were built, and many operating hospitals still have elements of these building forms and patterns. A discussion of the evolution of nursing unit design is therefore useful in understanding their potential roles and uses in the future.

The forces of their times are evident in the earliest unit designs. The layout of the hospital nursing unit underwent few changes in basic plans from the thirteenth through the nineteenth century. It was essentially a long, open space with beds located on the exterior walls.

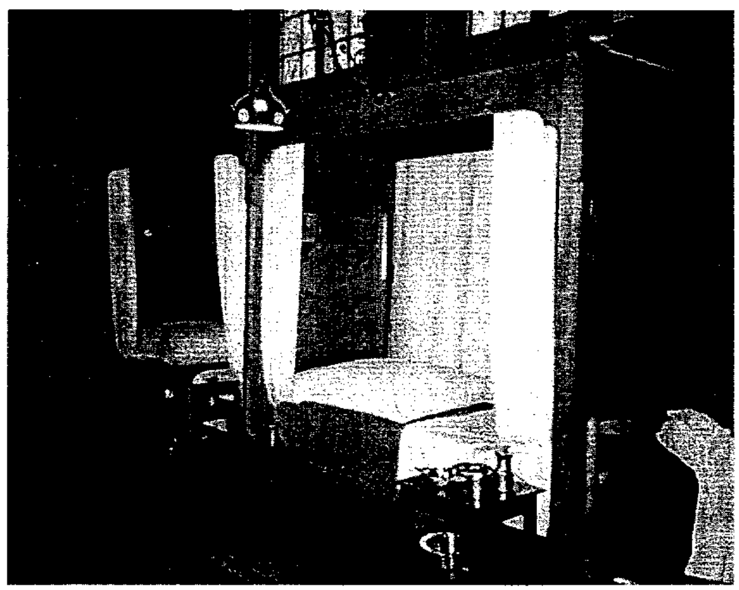
The design of the earliest nursing units was primarily determined by construction methods and limits. These included dominant forces such as the maximum practical structural span available for buildings and the need for natural ventilation.

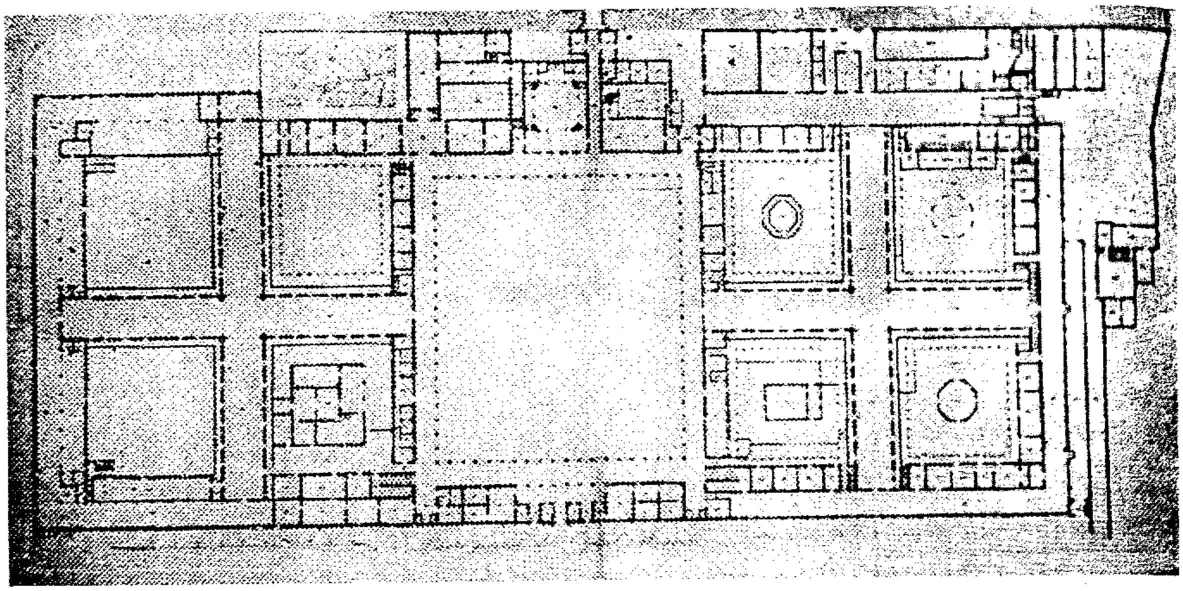
Because the nursing units were part of an abbey, the surrounding grounds were often used for agricultural purposes, particularly hospital herb gardens. Elements of this pattern have reappeared in recent times with the contemporary integration of landscape and hospital. Over the years, the size of hospitals grew, particularly in major cities. Existing examples are Brunelleschi's Ospedale Santa Maria Nuova in Milan and the Santo Spirito in Rome.

▲ *Hotel-Dieu, Beaune, France, 1443.*

Nursing units evolved over time to reflect patterns of care. In the Hotel-Dieu in Paris, which spanned the Seine, there were often four patients to a bed. Significant advances in development occurred with the Nightingale Plan,

▼ *Patient beds, Hotel-Dieu, Beaune, France.*





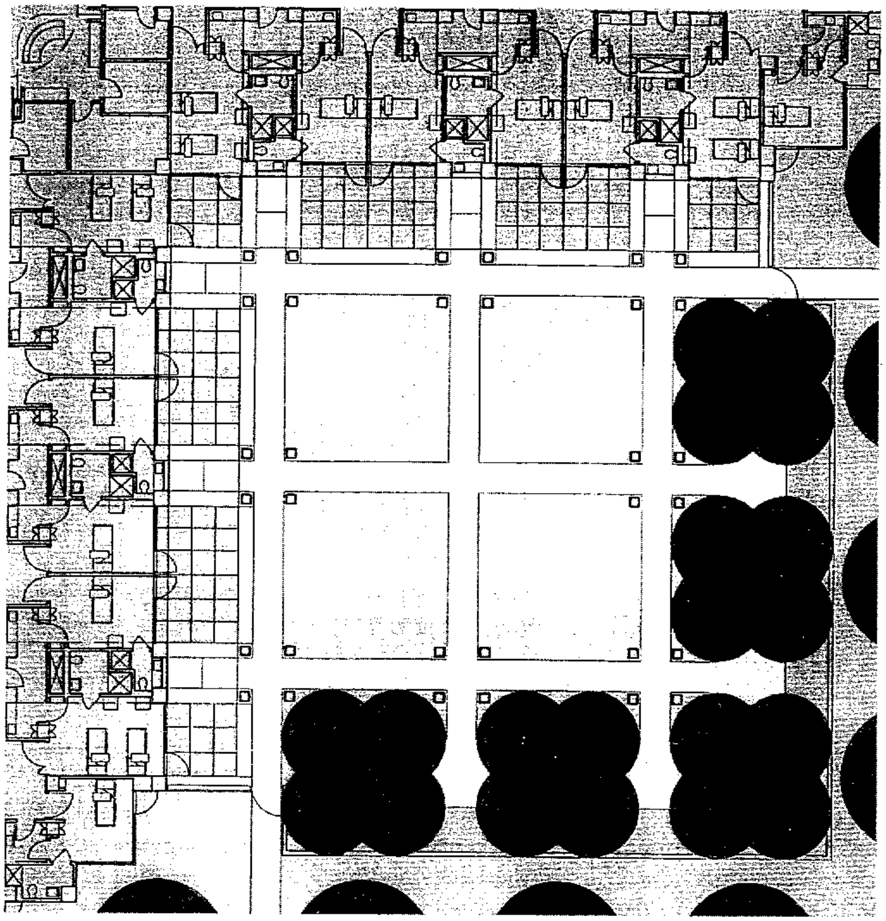
▲ *Ospedale Maggiore, Milan, plan with herbal gardens, 1456.*

which became the standard in hospital planning for many years. This open plan, with through ventilation and a nurses' station at the entry, proved to be highly efficient in providing care. During the Crimean War, with the need for rapid deployment of treatment facilities, mobile hospitals were designed by Brunel and established a plan that is used by architects today, with open-ended growth patterns laid out as part of the plan.

The main technological changes affecting nursing unit design were effected by the introduction, in the late nineteenth century, of long-span steel construction and elevators and, in the mid twentieth century, air-conditioning. These three developments had a major impact on the evolving role of the hospital in the realm of medical and nursing care and the treatment of disease.

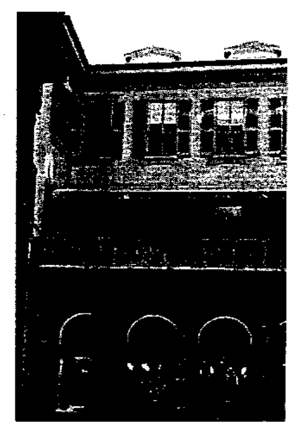
Nursing units could be stacked and connected by elevators at the same location at the support base of the

▸ *Brunelleschi's Ospedale San Maria Nuova, Milan, Italy.*



◀ *City of Hope National Medical Center patient pavilion plan and gardens (BTA).*

▼ *Santo Spirito, Rome, Italy.*

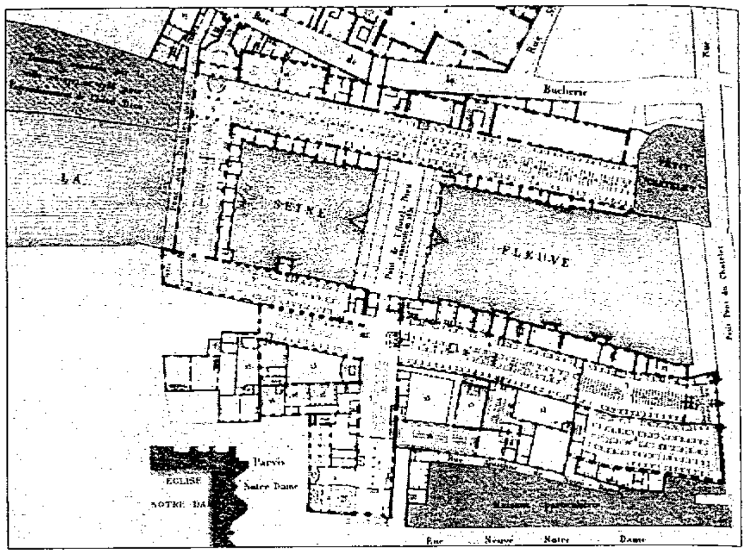


hospital to produce a single vertical circulation system. This provided greater efficiencies than in hospitals that grew by adding wards to wards in a longitudinal, horizontal pattern, taking up large areas of land and creating great walking distances for support staff and families.

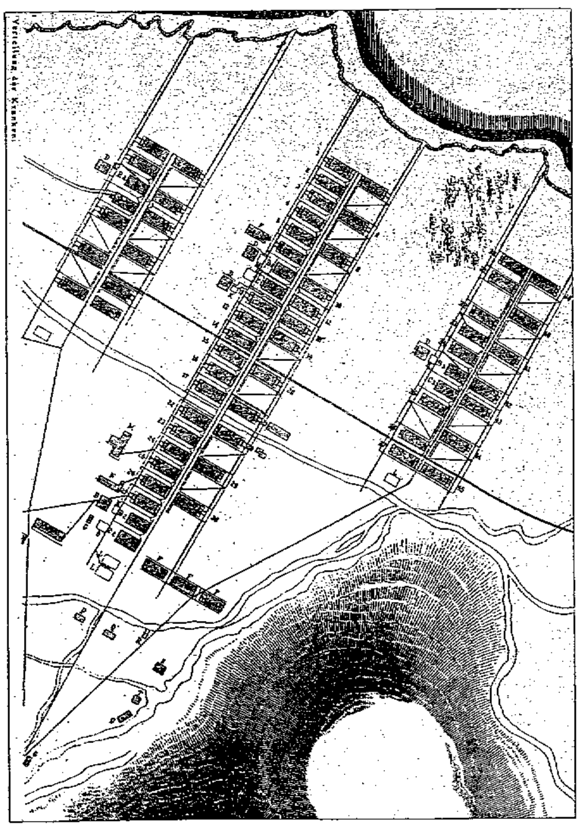
The introduction of air-conditioning allowed the nursing unit to be moved away from locations that provided natural ventilation, a traditional configuration that had often limited the widths of buildings to from 45 to 60 ft. Units could now be designed to follow functional and organizational demands, allowing for the creation of more efficient nursing units. These units often became so wide, however, as to confuse patients' and families' sense of orientation in the building.

With the increased use of hospitals owing to advances in research and medicine, nursing care evolved as well. The need for efficiency in operation became paramount, and this pressure yielded highly functional units. However, with this move toward efficiency, many hospitals lost their focus on the patient's

▸ *Hotel-Dieu, Paris, France.*



▾ *Hospital Renkioi on the Dardanelles, 1855–1856.*



and family's emotional needs, and the role of architecture in serving those needs.

PLANNING FOR EFFICIENT OPERATION

In 1875, at the hospital for the Johns Hopkins University of Baltimore School of Medicine, some bold new concepts emerged. Hospitals since the thirteenth century had had beds lining the exterior walls. Now new configurations were tried, including compact circular, square, and octagonal shapes, with all patients being visible from the central nursing desk. This allowed for direct observation, and the ability to care equally for all patients. This conceptual model was the basis for the circular units of the 1950s.

Although these early studies did not have a general effect on nursing unit design until three-quarters of a century later, progress was made in other important areas. Large, open wards came into disfavor. They were noisy, allowed patients little or no privacy, and made it virtually impossible to isolate infected patients.

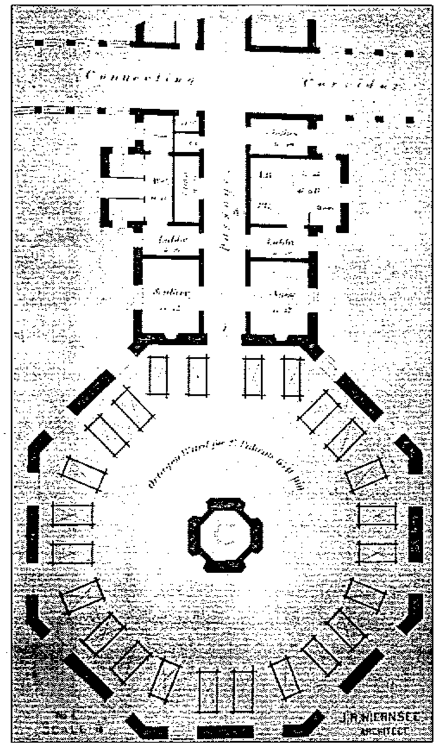
The open ward was gradually replaced by smaller rooms off a double-loaded central corridor. Because the design of accommodations for fewer patients per room necessarily increased the area and corridor length generated for each patient room, nurses reconciled themselves to miles of daily walking as they went about their duties.

Evaluation of the Functional Plan

The increase in nurses' travel raised an important design issue, still addressed in all nursing unit designs today. How does the architect design for a balance between the need for individuals' privacy, or for added support space, and the size of the total unit and the goal of close nurse-patient access? Many units were built that were excessive in size and, therefore, very labor-intensive.

At the first American Hospital Association Institute on Hospital Planning held in Chicago in 1947, architect Lewis J. Sarvis stated, "Investigation indicated that nurses spend at least 40 percent of their time walking." A major goal in planning thus became the reduction of nurses' travel in order to increase direct nurse-patient contact.

A revolution in hospital planning occurred involving a wide range of plan organizations and forms. With the fortuitous introduction of the Hill-Burton Act after World War II, every community was given the opportunity to create a local hospital that reflected the latest trends. Unfortunately, many of them followed recommendations published by the U.S. Public Health Service as guidelines rather than standards, and many old patterns of planning were perpetuated. However, others were experimental, and a number of consultants and architects made major contributions to the evolution of the nursing unit, including Sidney Garfield, MD, the founder of the Kaiser Permanente System; Gordon Friesen, hospital consultant to many large orders of Catholic hospitals, and Jim Moore, a California architect.



◂ *Johns Hopkins Design Competition 1875—octagonal plan.*

Yale University Studies on Nursing Unit Efficiency

In the late 1950s, John Thompson and Robert Pelletier of the School of Public Health at Yale University developed the "Yale Traffic Index," which studied traffic patterns in many types of existing hospitals. The researchers identified 14 traffic links that made up 91 percent of nursing unit traffic. They then evaluated units in the light of these patterns.

The use of this tool gave architects an early method of evaluating the impact of design on hospital costs of operation. But the limitations of that survey emerged in another study in the mid-1960s. As Jan Koumans of the Netherlands pointed out, *The distance from patient room to service room is important only when this service* *room will be used with a constant frequency. A change of organization could make this service room disappear altogether, which will make any comparison with another nursing unit organized along different lines impossible. The points of contact should be chosen at the beginning and at the end of a certain kind of activity, which must be performed regardless of any change in the organization of the unit.*

This is particularly noted in later designs of nursing units that dispersed supply centers outside of each patient room.

A more recent study of nursing unit efficiency was made by Delon and Smalley at the Georgia Institute of Technology and the Medical College of Georgia. The investigators not only compiled *frequency* of travel in a typical hospital, but interpolated a factor representing cost of employee travel time and another financial factor: the prorated cost of construction. This indirectly led to today's important analysis of the per diem cost of construction, a very effective way of evaluating the relative insignificance of construction costs over the lifetime of a building.

YALE UNIVERSITY TRAFFIC INDEX FACTORS

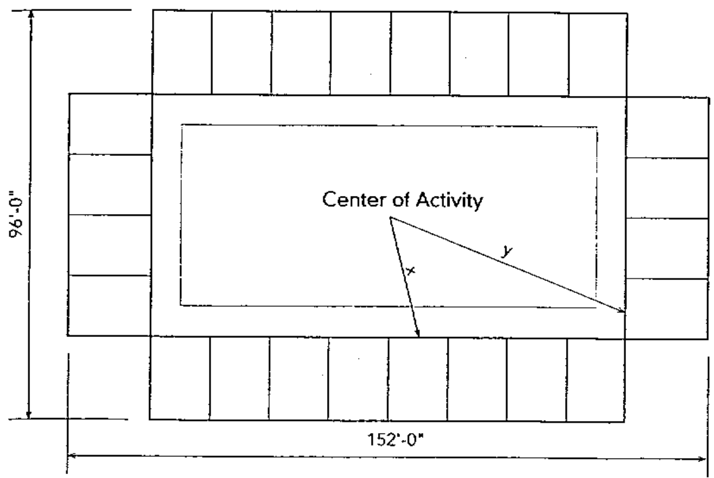
Percent of Travel Time	Nursing Staff Traffic Links
19.1	Patient room to patient room
16.7	Nurses' station to patient room
14.1	Utility room to patient room
9.8	Nurses' station to utility room
6.1	Nurses' station to elevator
5.8	Nurses' station to medical clinic
4.6	Patient room to pantry
3.7	Patient room to elevator
4.8	Medication room to patient room
2.5	Utility room to elevator lobby
2.8	Utility room to medical clinic
0.7	Utility room to pantry
1.1	Utility room to janitor closet
1	Nurses' station to pantry

MPA/BTA Nursing Unit Analysis Model, Plans and Technique

At Medical Planning Associates (MPA), and subsequently at Bobrow/Thomas and Associates (BTA), a simpler method was developed that does not require advanced mathematical analyses, although its results closely match those of the earlier methods. Its advantage as a design tool lies in its simplicity and convenience. It produces a useful indicator of the travel characteristics of nursing unit design—that is, the distance-to-bed factor, which is simply a summation of distances from nursing work centers to beds divided by the number of beds, and which serves as a proxy for more complex modelling.

This method recognizes one or more "nursing work cores" as centers of nursing activity containing the elements most used and most critically needed by the nurse. Measurements from these centers of nursing activity to each bedside are tallied and averaged for comparison. In previous years, a single work core often served an entire floor of beds. More recently, the work core was subdivided so that it could be located closer to patient room clusters and convenient to each nursing team. Figures indicate a range of 12 to 16 patients per individual team. Indeed, in some plans currently in operation much of the support space is adjacent to each individual patient room.

In planning, a clear recognition of each unit's organizational pattern is necessary.



Number of Beds per Floor	24
Number of Beds per Cluster	6
Shortest Distance from Center (x)	29
Greatest Distance from Center (y)	60
Total Corridor Length	304
Perimeter Length	336
Total Area	12,993 sf
Center Support Area	3,840 sf
Available Bed Area	6,720 sf
Corridor Area	2,432 sf
Percent of Support Area	29%
Perimeter to Total Area	1 : 38
Total Area/Number of Beds	360 sf
Distance to Bed Factor	19

▲ *Nursing unit analysis format (MPA/BTA).*

One of the most critical aspects is the variation in size, location, and makeup of the staff during all shifts. A scheme with support space fully dispersed, with a close patient-nurse link during the day shift, may be very inefficient with a reduced staffing of the night shift and a consequent repositioning of the nurses to a location accessible to a larger number of beds.

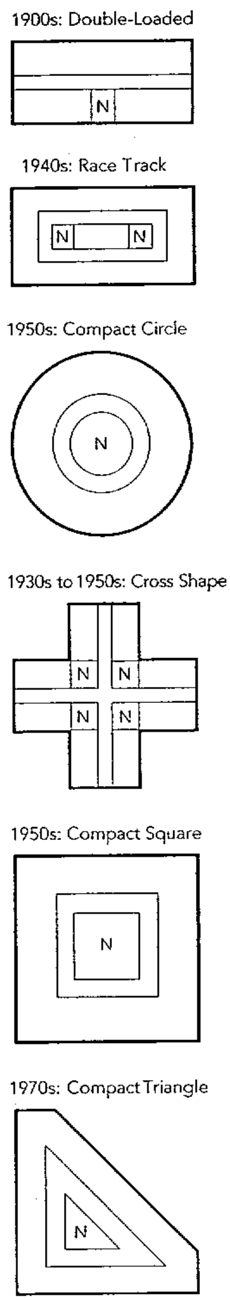
Maximum and minimum travel distances from the center of activity are as important as the average distance. With great distance variations, some patients may receive more nursing observation than others. Analysis of the maximum distance between patient rooms is an indicator of the inefficiency generated during lower staffing hours.

Current trends have eliminated inpatient care for patients who ten years ago would have been admitted to the hospital. This means that patients who are admitted are in far greater need of observation. Therefore, the primary goal is to minimize distance—the average distance of travel, the range of distance between the nearest and farthest patient rooms and the nurse work core, and the distances between all patient rooms. These distance calculations must be tempered by a factor relating to the number of beds per unit.

PLAN TYPES

The efficiency rankings of the general plan types are surprisingly consistent. A more compact, substantially concentric plan is generally more efficient; however, the exterior shape is less an indicator than the internal core organization and layout. Recently, very efficient plans have been established with groupings of concentric pods, and with the evolution of bedside computer charting and digitized imaging, as well as advances in distributing supplies and drugs from carts or dispersed support areas located adjacent to patient rooms, many of the reasons for travel between patient room and nursing stations are diminished.

Planners have tried many plan configurations with the goal of achieving efficient activity patterns; the following



▲ *Generic plans of common nursing unit forms.*

discussion shows key points in the evolution of the compact inpatient care unit.

The typical double-loaded corridor was the standard design for many years because of the need for cross-ventilation and natural lighting. However, it made for very long distances between the nurses' station and the end rooms of the unit.

Double Corridor (Race Track) Plan

Holy Cross Hospital in Los Angeles, designed in the fifties, reflects the freedom possible with economical air-conditioning and changing codes. This design demonstrated a far more efficient unit than the single corridor plan: it placed the nursing support area between two corridors in what has been called the "double corridor" plan. The core still contains space unrelated to nursing (elevator space) and is thus less compact than it could be.

This unit also shows a combination of one central work core with dispersal of some support functions in the form of a pass-through "nurseserver" adjacent to the door of each room to provide patient supplies for the convenience of staff. This concept, developed by hospital consultant Gordon Friesen, became a common element in the "Friesen" hospitals that emerged in the 1950s and 1960s. Although this design was highly efficient during the day, the distances from the ends of the floor created problems when staffing was limited at night.

Compact Rectangular Plan

The compact rectangular unit of Providence Hospital in Anchorage, Alaska (1950s), is much more flexible than the circular unit in terms of the ratio of patient rooms to amount of support space, because of the ease of changing the exterior dimensions on each side while maintaining the same bed count. Most compact rectilinear plans have an efficiency rating close to that of the circular plans and provide a higher degree of flexibility in planning the units.

Compact Circular Plan

In its first phase of construction, Valley Presbyterian Hospital in Van Nuys, California (1956), developed a compact circular unit with elevators removed from the center and located where they could also serve additional nursing towers in the future.

All 34 beds were arrayed around the nursing support space, and both average distance and range of distance to work cores were minimal. Another means of reducing nurse travel was to provide redundant circulation—that is, more than one route from point to point. This was recognized by the Yale evaluations as the most efficient plan designed to date in the study.

Working within a circle has a built-in problem, because the number and sizes of patient rooms dictated by program requirements controls the diameter of the circle. Codes often limit the number of beds per nursing station to 35, imposing yet another parameter. It is strictly a coincidence when the space in the center provides the area programmed for nursing support.

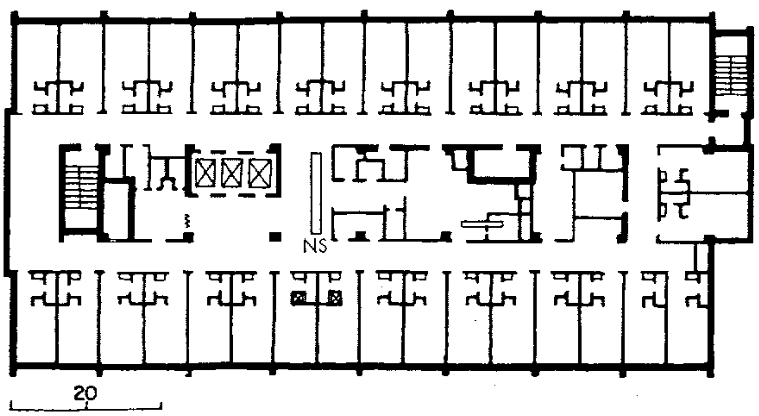
However, when the bed count and the support areas are in balance, as in Valley Presbyterian's Phase II tower (1960), the circular unit can be the most efficient model. In this second tower the diameter was increased from 88 ft to 96 ft to provide balanced support space for 19 two-bed rooms.

A larger-diameter third tower with 32 single-bed rooms was added in 1969. As discussed earlier, the nursing core was forced to be much larger than needed to accommodate all single-bed rooms. Consequently, efficiency dropped and patient observation was obscured.

This was a seminal project in the history of hospital planning, because it provided an early rational method for hospitals to grow and, at the same time, maintain organizational order. Designed by architect Jim Moore, this strategy has been applied countless times in the development of subsequent hospital plans.

Prior to the development of this plan, nursing units were added adjacent to one another, with their own separate elevator cores, creating disorienting circulation patterns for the visitor and staff searching for the right bank of elevators. Much of the work of recent years has been focused on clearing up this confusion of circulation caused by ill-thought-out patterns of nursing unit growth.

All towers are served from the same expanded elevator core. There is no compromise in nursing activities caused by the removal of the elevators from the nursing core. On the contrary, efficiency in the entire hospital's operation is higher because of the clear, simple circulation system. The Valley Presbyterian Hospital has grown from 63 beds to 360 beds in less than 15 years, maintaining the same efficient circulation system by adding elevators adjacent to the original core.

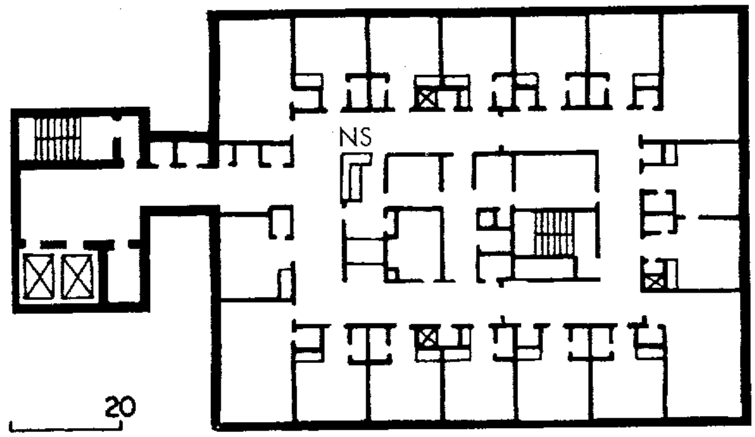


Double corridor (race-track) plan. Holy Cross Hospital, Los Angeles, California (Architects: Verge & Clatworthy. Consultant: Gordon Friesen.)

Bed Count:	1-Bed Room	2 = 2 BD
	2-Bed Room	32 = 64 BD
	3-Bed Room	0 = 0 BD
	4-Bed Room	0 = 0 BD
Total:		66 BD
Gross Area:		17, 250 SF
Gross Area per Bed:		262 SF
Supporting Services Area		2,650 SF
Circulation Area		4, 605 SF

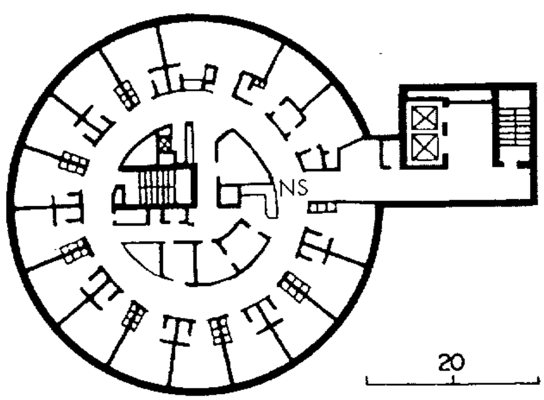
Patient Room Net Area:	169 SF
Average Distance from Center of Supporting Services to Patient Bed:	85.4 LF
Maximum Distance to Patient Bed:	248 LF
Minimum Distance to Patient Bed:	52 LF
Distance-to-Bed Factor:	1.29

▸ *Compact rectangular plan. Providence Hospital, Anchorage, Alaska. (Architect: Charles Luckman Associates. Consultant: MPA.)*

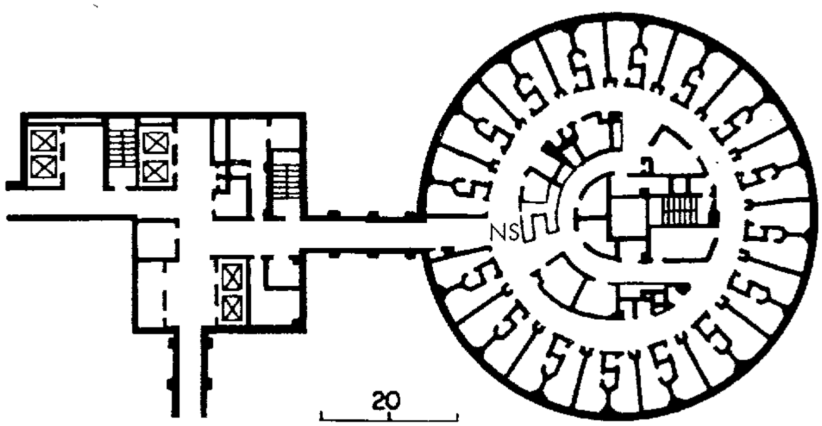


Bed Count:	1 Bed-Room	0 = 0 BD	Patient Room Net Area:	143 SF
	2 Bed-Room	13 = 26 BD	Circulation Area:	2,384 SF
	3 Bed-Room	2 = 6 BD	Average Distance from Center of Supporting Services to Patient Bed:	53.6 LF
	4 Bed Room	2 = 8 BD	Maximum Distance to Patient Bed:	68 LF
Total:		40 BD	Minimum Distance to Patient Bed:	32 LF
Gross Area:		8,360 SF	Distance-to-Bed Factor:	1.34
Gross Area per Bed:		209 SF		
Supporting Services Area:		1,230 SF		

▾ *Compact circular plan. Valley Presbyterian Hospital Phase I, Van Nuys, California. (Architect: Pereira and Luckman.)*



Bed Count:	1-Bed Room	0 = 0 BD
	2-Bed Room	15 = 30 BD
	3-Bed Room	0 = 0 BD
	4-Bed Room	1 = 4 BD
Total:		34 BD
Gross Area:		7,068 SF
Gross Area per Bed:		2,078 SF
Supporting Services Area:		954 SF
Circulation Area:		1,958 SF
Patient Room Net Area:		170 SF
Average Distance from Center of Supporting Services to Patient Bed		49.5 LF
Maximum Distance to Patient Bed:		60 LF
Minimum Distance to Patient Bed:		44 LF
Distance-to-Bed Factor:		1.43

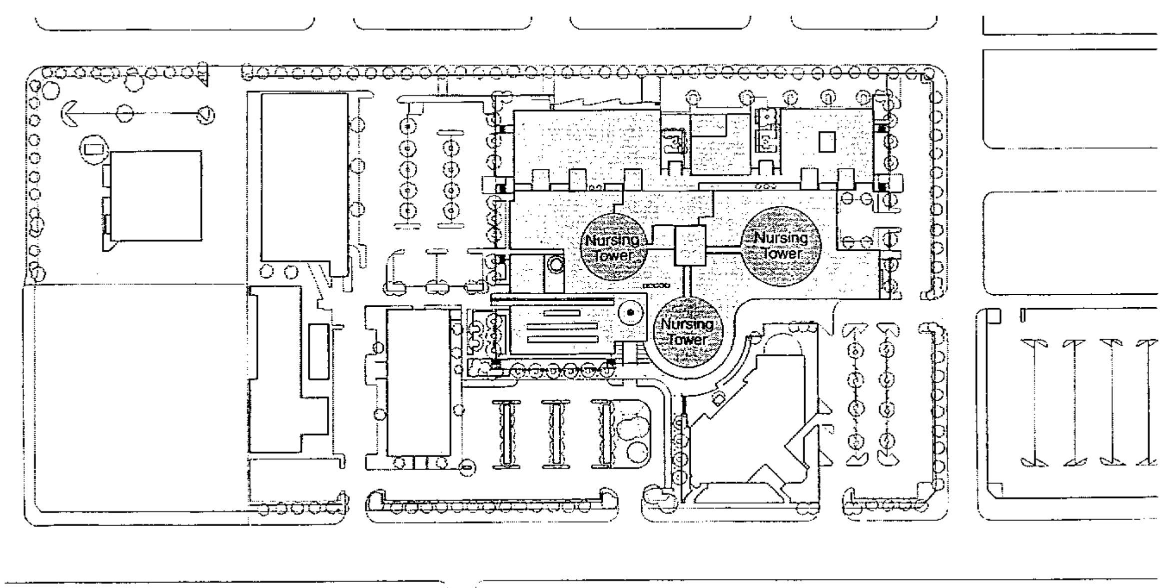


◀ *Valley Presbyterian Hospital Phase III, Van Nuys, California. (Architect: Charles Luckman Associates. Consultant: MPA.)*

Bed Count:	1 Bed Room	32 = 32 BD
	2 Bed Room	0 = 0 BD
	3 Bed Room	0 = 0 BD
	4 Bed Room	0 = 0 BD
Total:		32 BD
Gross Area:		10,607 SF
Gross Area per Bed:		3,211 SF
Supporting Services Area:		1,797 SF

Circulation Area:	3,146 SF
Patient Room Net Area:	110.8 SF
Average Distance from Center of Supporting Services to Patient Bed:	65 LF
Maximum Distance to Patient Bed:	84 LF
Minimum Distance to Patient Bed:	32 LF
Distance-to-Bed Factor:	2.03

▼ *Valley Presbyterian Hospital at full growth.*



◂ *A recent adaptation of the compact circular plan at Brigham and Women's Hospital, Boston, Massachusetts (TK&A).*

1 Single Patient Room
2 Single Patient Isolation Room
3 Anteroom
4 Nurses' Station
5 Patient Nurses' Station
6 Clean Utility
7 Soiled Utility
8 Physicians' Workroom
9 Office
10 Staff Conferencce Room
11 Elevator Lobby
12 On Call Area
13 Lounge
14 Procedure Room
15 Prep
16 Galley
17 Rehabilitation Gymnasium
18 Trash Room

MULTIBED VERSUS SINGLE-BED ROOMS

Patient accommodation had progressively moved from total openness and sharing of space with multiple patients in open wards, as in the Nightingale Plan, down to eight-patient, six-patient and four-patient wards, with toilet and bathing facilities often shared by a group of patient rooms. In a radical shift, the norm after World War II became the two-bed room with shared toilet. Shared showers and toilets between rooms still exist in many hospitals.

Surprisingly, the idea of providing private bedrooms in hospitals has been considered for years. In 1920, Asa S. Bacon, then the superintendent of Chicago's Presbyterian Hospital, published an article entitled "Efficient Hospitals" in the *Journal of the American Medical Association.* Bacon made a strong plea for the private room—from the standpoints of both the patient's privacy and comfort and the hospital's goal of maximum occupancy. He noted that the serious problem of contagion was greatly mitigated, and that the physician or nurse could give better examinations and take more complete histories in the single room.

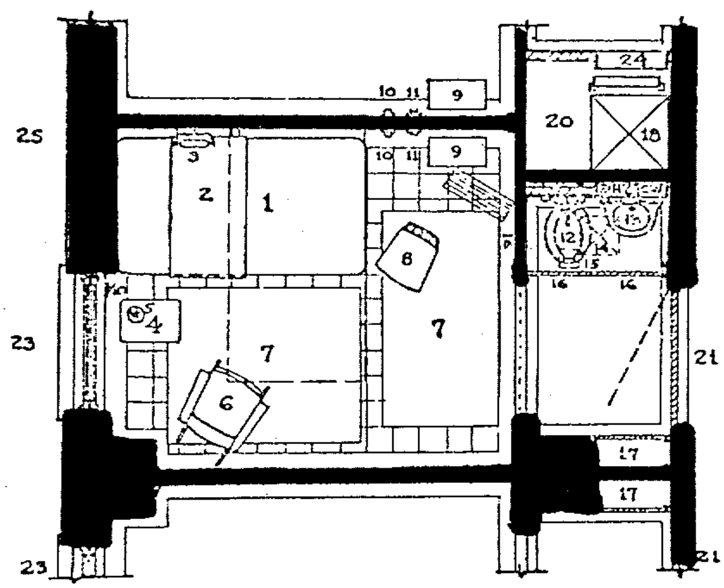
Although Bacon's ideas were virtually ignored for almost a half century, the concept of the all single-bed room hospital is now widely accepted. In recent years most hospitals planned to update their facilities in favor of maximizing single-bed rooms.

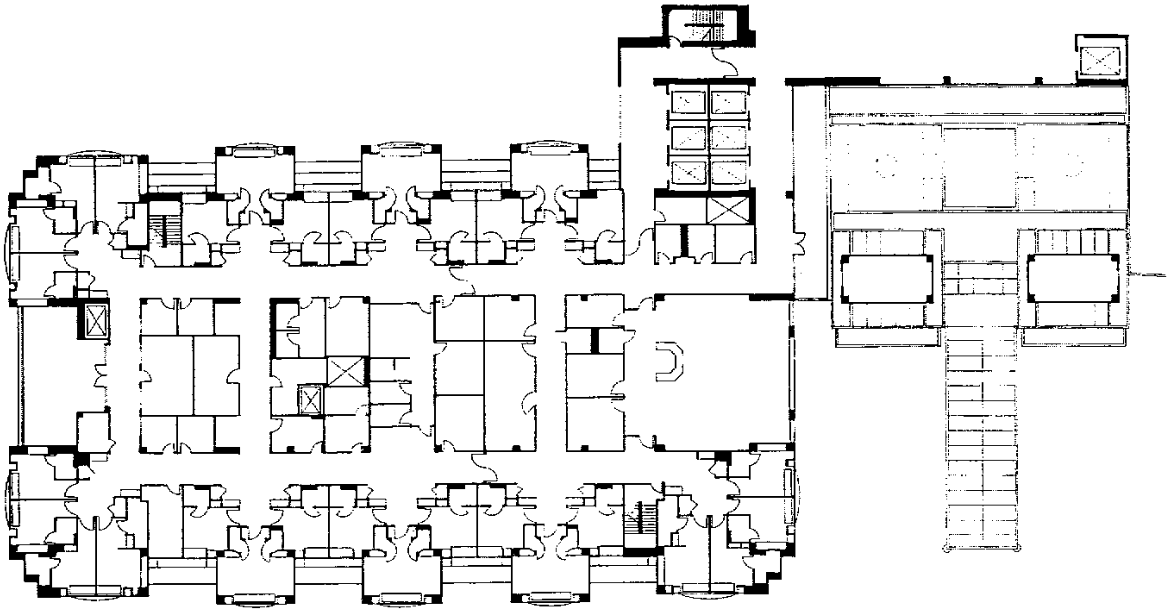
There are other advantages to single-bed-per-room nursing units. The patient can rest undisturbed by a roomate's activities. A patient can become ambulatory earlier when the toilet and shower are in the room, and such rooms can be used for many types of isolation. Because patients in single-bed rooms are rarely moved, medication errors are greatly reduced. Moreover, the hospital realizes some economies by the elimination of patient moves. In units with multibed rooms the number of daily moves has averaged six to nine per day, at a significant cost (in added paperwork, housekeeping, patient transport, medication instructions, etc.).

UCLA/Santa Monica Medical Center

The design of a hospital with only single rooms is not without its problems, however. If the single room is designed along the lines of the conventional patient room (with corridors running approximately 12.5 feet per room), the corridors can become too long, increasing nurses' travel distances. To overcome this problem, there are plans that overlap or stagger groups of three or four rooms

▾ Asa Bacon plan proposal for single-bed room.





▲ *Third floor plan, UCLA/Santa Monica Medical Center, Santa Monica, California (BTA).*

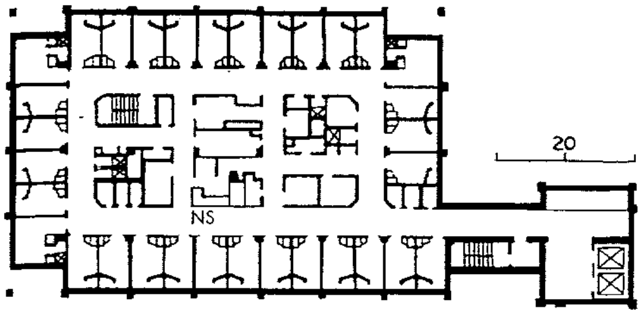
around alcoves, such as at the UCLA/Santa Monica Hospital Medical Center and at the Motion Picture and Television Fund Hospital, often made possible by providing nursing substations with computers.

In planning the single room as an alternative to the semiprivate room, the room must be made highly efficient. Early experiments by architect Jim Moore and nursing consultant Nina Craft, RN, showed that the room could be effectively compressed if the bed was located diagonally instead of parallel to the corridor. This reduced the corridor run per room by more than 25 percent, without compromising the function of the space. Many hospitals were designed with this innovative plan in the 1960s and 1970s, which proved to be highly efficient. Placing the bed at an angle created an uninviting bedroom, many designers felt. Unfortunately, over time these smaller rooms have proven inflexible to changes such as increased bed length and more staff and equipment congregated around the patient.

A compromise solution, developed in several hospitals by Rex Whittaker Allen, FAIA, provided two-bed rooms divided by a movable partition. These partitions are often closed (at patients' preference). However, it has been found that some patients do enjoy the ability to converse with another person and still have control over the sliding door. Variations of this combination are being planned today.

Providence Hospital, Medford, Oregon

The preference for privacy was borne out by several surveys of patients. At Providence Hospital in Medford, Oregon, one of the first all single-bed room hospitals (built in 1965), a survey showed that 92 percent of the doctors and



▲ *Providence Hospital, Medford, Oregon. (Architect: Edson & Papas. Consultant: MPA.)*

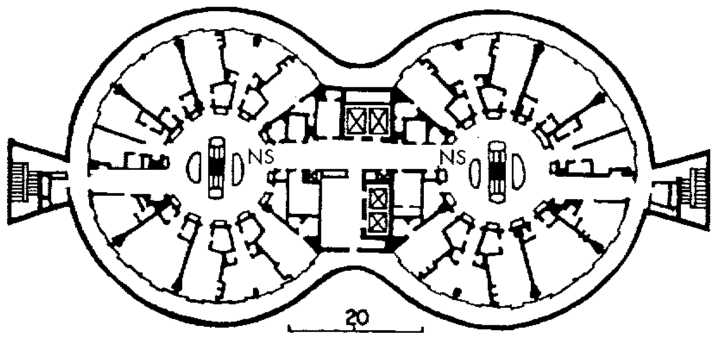
Bed Count:	1-Bed Room	32 = 32 BD
	2-Bed Room	0 = 0 BD
	3-Bed Room	0 = 0 BD
	4-Bed Room	0 = 0 BD
Total:		32 BD
Gross Area:		12,153 SF
Gross Area per Bed:		380 SF
Supporting Services Area:		1,848 SF
Circulation Area:		4,470 SF
Patient Room Net Area:		115 SF
Average Distance from Center of Supporting Services to Patient Bed:		70 LF
Maximum Distance to Patient Bed:		100 LF
Minimum Distance to Patient Bed:		36 LF
Distance-to-Bed Factor:		2.19

hospital employees believed that their work was easier when patients were housed in single rooms, and 95 percent of the patients indicated that if costs were equal, they would select a single room for any future hospitalization.

Hospitals have realized further cost benefits from utilizing single rooms. Even with higher unit costs based on construction, furniture, maintenance, housekeeping, heating and ventilation, linen changes, and nursing, units with single rooms can match the per diem cost of multibed rooms because of the very high occupancy factors possible. Occupancy of multibed rooms generally reaches a maximum of 80 to 85 percent, whereas single-bed rooms can reach 100 percent occupancy. This allows for the provision of fewer beds to take care of the same size population. For example, an 80-to-85-bed, all single-bedroom hospital can care for the same number of total patients as a 100-bed hospital with 2-bed rooms.

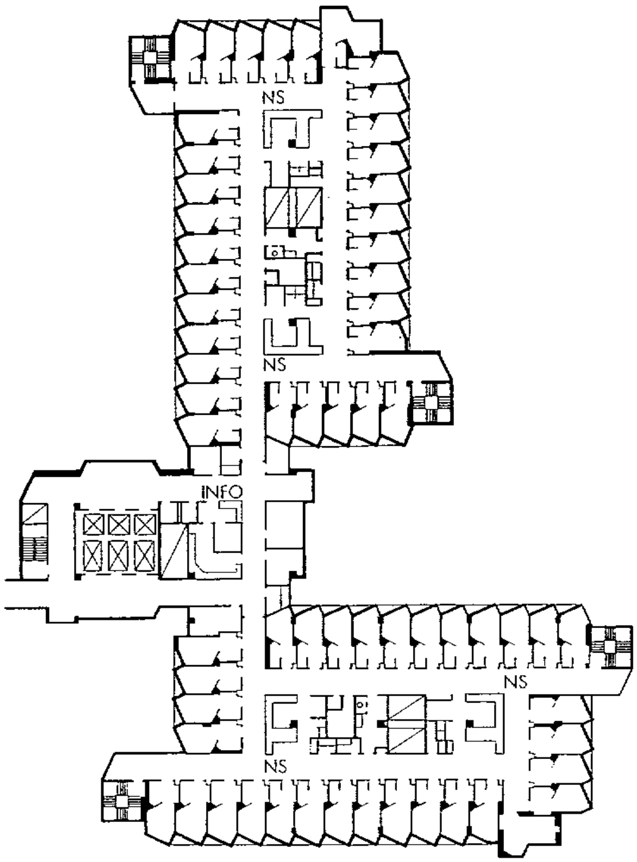
Kaiser Foundation, Panorama City, California

The Kaiser Foundation Hospital in Panorama City, California (1960s) was



▲ *Kaiser Foundation Hospital, Panorama City, California. (Architect: Clarence Mayhew. Consultant: Sidney Garfield, MD.)*

Bed Count:	1 Bed Room	6 = 6 BD
	2 Bed Room	12 = 24 BD
	3 Bed Room	0 = 0 BD
	4 Bed Room	4 = 16 BD
Total:		46 BD
Gross Area:		15,850 SF
Gross Area per Bed:		345 SF
Supporting Services Area:		1,811 SF
Circulation Area:		7,246 SF
Patient Room Net Area:		198 SF
Average Distance from Center of Supporting Services to Patient Bed:		47.5 LF
Maximum Distance to Patient Bed:		60 LF
Minimum Distance to Patient Bed:		24 LF
Distance-to-Bed Factor:		1.03



▲ *St. Vincent's Hospital, Los Angeles, California (DMJM, MPA, and BTA).*

Bed Count:	1-Bed Room	32 = 32 BD
	2-Bed Room	0 = 0 BD
	3-Bed Room	0 = 0 BD
	4-Bed Room	0 = 0 BD
Total:		32 BD
Gross Area:		10,643 SF
Gross Area per Bed:		332 SF
Supporting Services Area:		3,128 SF
Circulation Area:		2,688 SF
Patient Room Net Area:		120 SF
Average Distance from Center of Supporting Services to Patient Bed:		45.5 LF
Maximum Distance to Patient Bed:		60 LF
Minimum Distance to Patient Bed:		24 LF
Distance-to-Bed Factor:		1.42

also a landmark building, conceptualized by its founder Sidney Garfield, MD. It was notable for several developments in the evolution of the compact unit.

Although it provided two-bed rather than single-bed rooms, the design shows an intent to provide only necessary functions near the patient and to remove all spaces and equipment not required for direct patient care from the center to the unit. These spaces have been relocated in the link connecting the two 23-bed units on each floor. Thus, although the nurses' station was completely open in the center of the unit for optimum visibility between the station and the patient rooms, it did not realize all of the benefits of the open plan because many of the beds were hidden behind the toilet rooms located inboard on the corridor side of the patient rooms.

A significant feature of the plan is the separation of visitor and staff traffic, with visitors routed from a control point near the elevators, around balconies on the outside of the nursing towers. This was replicated in several projects in more temperate climates, such as in Hawaii. Today's codes often do not allow the openness of this plan, however, because of requirements for fire separation and appropriate exiting, and these units, when undergoing upgrading to meet today's standards, are often forced to eliminate this innovation.

St. Vincent's Hospital, Los Angeles, California

To maximize the patient-nurse link, St. Vincent's Hospital in Los Angeles (1973) eliminated all noncare functions from the nursing unit and relocated them in a central freestanding service core adjacent to the unit.

The architects further reduced the nursing core area by sharing functions among the 16-, 32-, and 64-bed modules of each floor.

For the module of 16 beds (St. Vincent's established 16 as the number to be effectively served by one nursing team) the shared items included doctors' and nurses' charting, dictation, medications, clean/sterile supply, and linen (the last three items on carts).

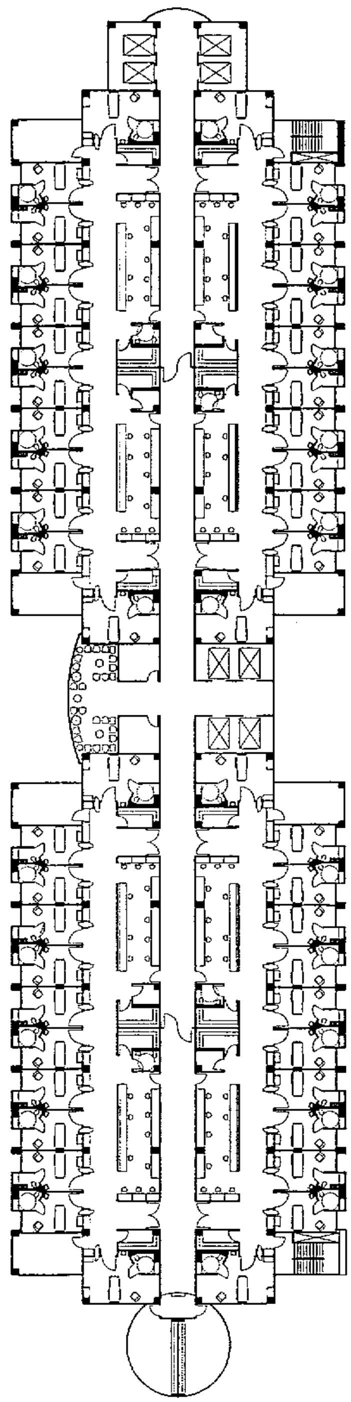
The following items were shared between two 16-bed modules: nurses' lounge and toilet, clean/sterile supply backup, soiled utility, and a nourishment unit.

The following items were centralized to serve a 64-bed nursing floor (four modules): space for the floor's administrative manager; reception; nursing service office; floor pharmacy; visitors' lounge; consultation, examination, and conference rooms; and tub rooms.

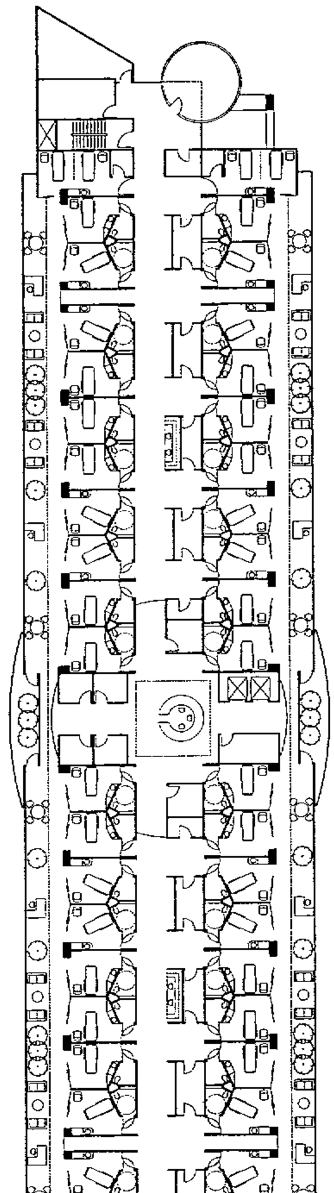
As patients have been drawn away from the acute hospital to other types of facilities by the forces of managed care and improvements in outpatient capabilities, the level of acuity (the degree of illness and the corresponding level of care needed) in general hospital patients has risen; so have the numbers of staff and the need for closer patient observation and monitoring. As a result, the number of beds per 1,000 population (a standard industry measurement) has dropped drastically, and the design of today's nursing units has moved closer to that of intensive care and step-down units—a unit providing a level of care between intensive care and normal patient care.

St. Luke's Medical Center, Milwaukee, Wisconsin

At St. Luke's Medical Center in Milwaukee, Wisconsin (1991–1999), two alternative experimental designs were recently mocked-up and evaluated, testing new precepts of plan organization. The plan compared a typical contemporary compact unit (Scheme A) with internal patient/visitor access, to one that provided a perimeter family and patient solarium–living room surrounding the beds (Scheme B). Nursing stations were placed in this zone, but all service activities were taken out of public view within an interior service zone with separate access to each bedroom.



Scheme A: Prototypical nursing unit, St. Luke's Medical Center, Milwaukee, Wisconsin (BTA).



Scheme B: Prototypical nursing unit, St. Luke's Medical Center, Milwaukee, Wisconsin.

Flexibility of Room Use/Bed Reductions

As discussed previously, hospitals have realized cost benefits from utilizing single rooms. Because single-bed rooms can be virtually 100 percent occupied, whereas multibed rooms have maximum censuses of 80 to 85 percent, fewer beds can be provided to handle the same daily census and greater efficiency in nursing unit staffing can be achieved.

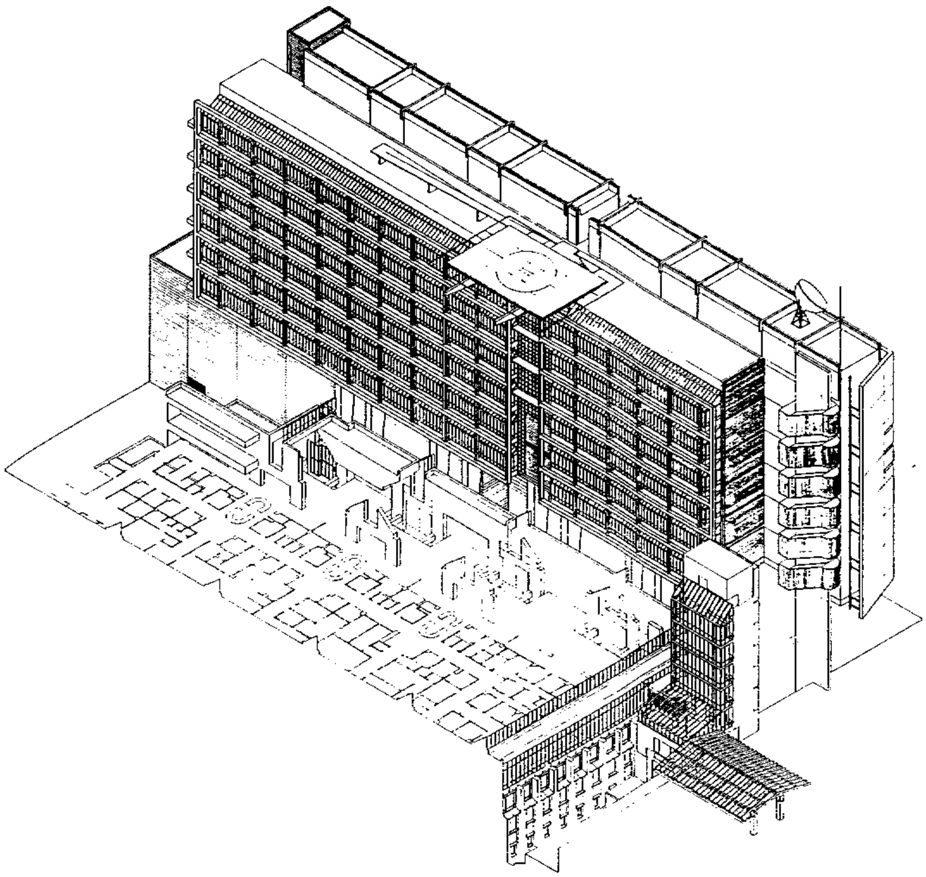
Aside from the need for fewer beds, flexibility is a key factor in the new design equation, as it can provide maximum utilization of space. For example, designing patient rooms that can be easily converted from general acute care to highly acute care or even critical care rooms will provide maximum flexibility and utilization, particularly given the trend toward increasing inpatient acuity levels and the resultant need for higher staff ratios.

Single-bed rooms have also become an important marketing tactic for hospitals in their attempts to create a "noninstitutional" environment. Patients prefer the privacy of a single-bed room, the ability to control the environment (light, sound, view) and to have accommodations for family.

Whereas in the past patient rooms were designed as highly specialized for particular diagnoses and acuity levels, today's designs include "universal rooms," which can be easily converted to accommodate a range of acuity levels. This is accomplished by designing single-occupancy patient rooms large enough to accommodate increasing numbers of complex bedside treatments, providing electronic service cores to allow for changes in patient monitoring, and by situating rooms to allow for maximum patient visibility by the nursing staff.

Larger Single-Occupancy Rooms

In some instances, larger single-occupancy rooms have been included in a hospital plan. For example, at City of Hope National Medical



St. Luke's Medical Center, Milwaukee, Wisconsin.

Center in Duarte, California, nursing units were designed with four 8-bed pods. Two 32-bed units, constituting one nursing floor, were then able to share such support services as physical therapy, treatment rooms, and multiple staff offices.

For purposes of a more detailed exploration of the design of nursing units, a recently designed hospital has been chosen as a case study. Although many innovations have been applied here, the design should be considered only as one in a line of design evolutions in the development of the nursing unit. Only time will tell whether its innovations will last.

Case Study: The San Bernardino County Arrowhead Regional Medical Center Nursing Units

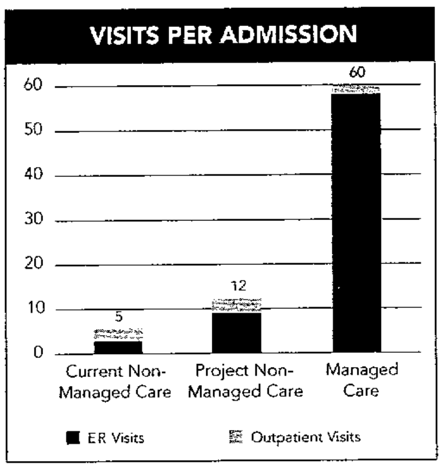
As hospitals continue to reduce the number of beds in operation to match changing utilization patterns, the conversion of multibed rooms to larger single-occupancy rooms has become the norm. The trend toward the single-occupancy room is epitomized by the Arrowhead Regional Medical Center, the $470 million, 1 million sq ft replacement facility for San Bernardino County, California. Completed and occupied in 1999, it is the first instance of a county facility planned for all single-occupancy rooms.

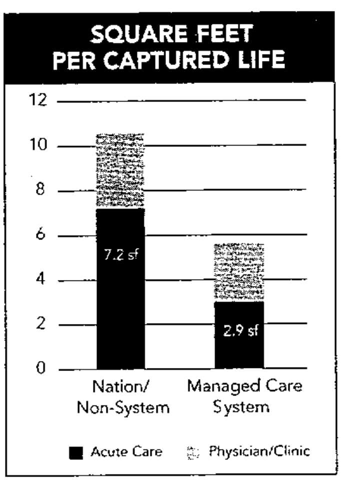
The county of San Bernardino is the largest county in the United States. With major responsibility for both highly specialized tertiary and community care for a dispersed population, in a location close to three active seismic faults and with existing buildings failing to meet current standards, the county made a bold decision to invest in a totally new facility.

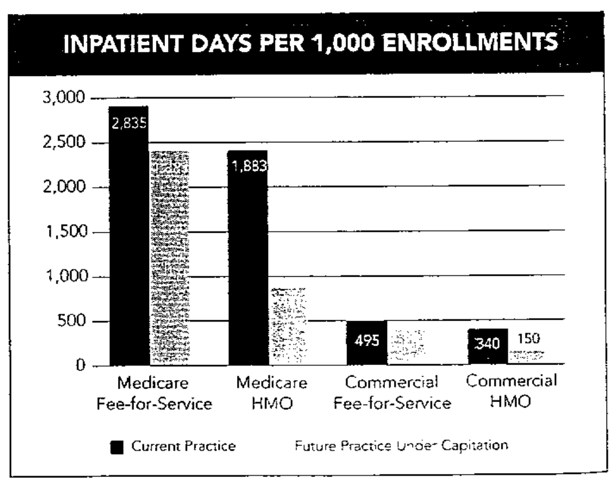
The charge to the design team (Bobrow/Thomas and Associates, Executive and Design Architects with Associate Architects Perkins and Will) was to create a state-of-the-art facility that would be most efficient to operate, offer maximum flexibility, and provide a healing environment for families and patients in a technology-intense facility.

The planning of this medical center, and specifically its nursing units, provides an insight into the considerations and criteria for design and the decisions that were made. The charge to create the most efficient nursing unit possible led to a detailed analysis of the optimal floor size for economic efficiency and the choice among plans that would allow high nurse-to-patient visibility, flexibility in bed assignment, and efficiencies through all shifts of hospital operations.

Flexibility in nursing units was achieved through the design of multiple "pods" of patient rooms, enabling the size of the units to respond to such variables as occupancy count, patient types, and models of nursing care.





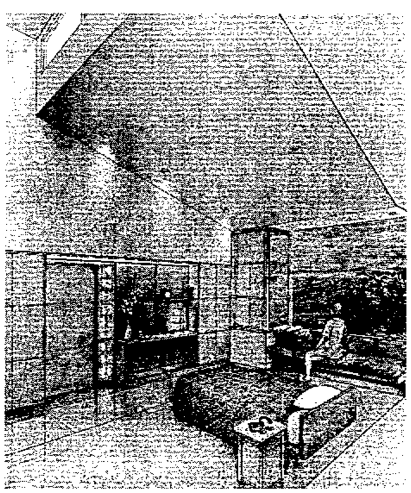


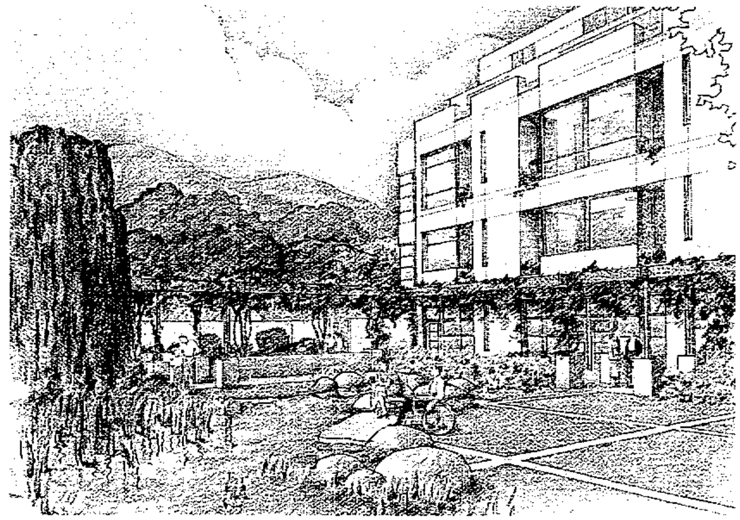
After research on staffing efficiencies for various nursing and support disciplines and analyses of plan alternatives, the final plan was designed as a cluster of units connected by a continuous band of beds on the perimeter to allow for flexibility in assignment to individual nursing stations.

The floor is organized around three 24-bed nursing units, which share an adjacent common support and vertical circulation core. Each nursing unit has three nursing substations each with a general assignment of eight beds, all visible from the station. With substations providing small charting areas, medications, and supplies, the nursing staff is "freed" from the central nurses' station.

This efficiency in turn creates economies of scale, which can allow for specialized support spaces on each nursing floor, such in as the previously noted St. Vincent Hospital. Based on the MPA/BTA model, the average distance to each bed is 19 feet at Arrowhead Regional Medical Center. This allows the nursing unit to house the most intensely ill patients.

The use of single-bed rooms accommodates changing acuity levels and increases





in bedside treatments and provides maxi-mum flexibility in assigning patients to rooms as occupancy levels fluctuate. This concept is enhanced by the use of comput-erized charting stations for patients' med-ical records, located at bedside and in nurs-ing substations situated within each pod.

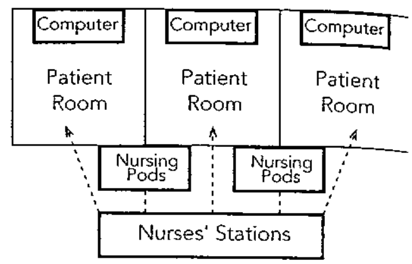
The floor plan is also notable in that several other contemporary concepts have been applied. The grouping of three units connects at a central service core, which allows for a single point of floor control. Banks of elevators separately assigned for the public, service, and patients are given separate floor lobbies to allow for the appropriate separation of traffic and con-nections to other portions of the hospital. Common shared areas are clustered at the center, such as reception, waiting and administrative, and support spaces.

Each corridor partition for each patient room was designed to be glazed or solid, depending on the needs for observation. The partitions can be modified quickly by the hospital's own staff.

▲ *City of Hope National Medical Center, rendering of patient nursing unit (BTA).*

◄ *City of Hope National Medical Center, rendering of single-bed patient room.*

▸ *Diagram of monitored care.*

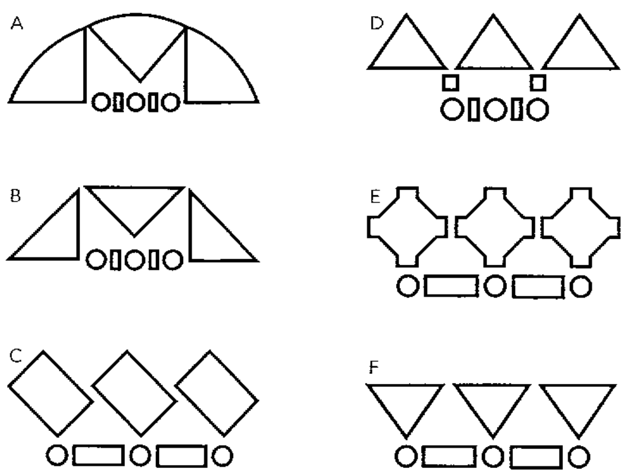


In a departure from the normal mechanical servicing of floors, which is accomplished through vertical shafts, to maximize flexibility all vertical ducts were eliminated from the nursing floors by the creation of separate mechanical service rooms on each floor. Air distribution is achieved through a ceiling plenum space, with floor-to-floor heights of 17 ft, and as a result the floors are totally free to be modified over time within the constraints of the floor plan's configuration.

To further this concept, the patient room was designed to place all vertical services at the periphery of the building. This was accomplished by locating all patient toilets and showers on the external band of the building. This feature became part of the energy-efficient design of the hospital by providing an extra zone of insulation from the desert heat and the western exposure.

Finally, this placement of patient room elements allowed the patient to be viewed directly from the corridor for ease of communication with the nursing staff, thus reducing the use of nurse call systems.

▾ *Nursing unit alternative analysis.*



Nursing Unit Option	Total Area (3 Units)	Area per Bed	Average Distance of Bed to Nursing Station	Bed Continuity	Easy Hierarchical Orientation	Shared Support	Natural Light Introduced at Intersections
A	34,860	484	19'	X	X	X	X
B	37,575	521	19'		X	X	X
C	40,455	561	30'				
D	35,100	487	19'		X	X	
E	41,775	580	27'				
F	35,100	487	19'	X	X		X

Functional Issues

A number of major contemporary functional issues were addressed and satisfied in the design of the Arrowhead plan:

Larger, single-bed patient rooms

- Ability to convert medical/surgical beds to intensive care beds, including monitoring capabilities
- Provision of space for charting and procedures in room
- Continuity of care on each floor

Shared common services and spaces

- Procedure room/treatment room in acute patient areas
- Physical therapy/treatment room on the floor
- Decentralization of nursing stations

ANALYSIS OF NURSING UNIT ALTERNATIVES

		24 Series					
		A-24	B-24	C-24	D-24	E-24	F-24
A	Number of Beds per Floor	24	24	24	24	24	24
B	Number of Beds per Cluster	6	8	8	6	6	8
C	Shortest Distance from Center (x)	29'	10'	26'	42'	42'	45'
D	Greatest Distance from Center (y)	60'	28'	68'	54'	74'	82'
E	Average Distance from Center	47'	19'	41.5'	48'	54'	67'
F	Total Corridor Length	304'	294'	288'	304'	303'	583'
G	Perimeter Length	336'	336'	336'	336'	336'	336'
H	Total Area (Square Feet)	12,992	12,151	11,522	13,776	15,731	21,410
I	Center Support Area (Square Feet)	3,840	3,076	2,498	4,624	4,608	6,198
J	Available Bed Area (Square Feet)	6,720	6,720	6,720	6,720	8,045	7,141
K	Corridor Area (Square Feet)	2,432	2,344	2,304	3,032	3,077	4,686
L	Percent of Support Area	29%	25%	21%	29%	29%	29%
M	Perimeter of Total Area (G:H)	1:38	1:36	1:34	1:41	1:46	1:63
N	Total Area/# of Beds (H/A) (Square Feet)	360	506	506	574	655	892
O	Distance to Bed Factor (E/A)	1.9	1.84	1.73	2.0	2.25	2.75

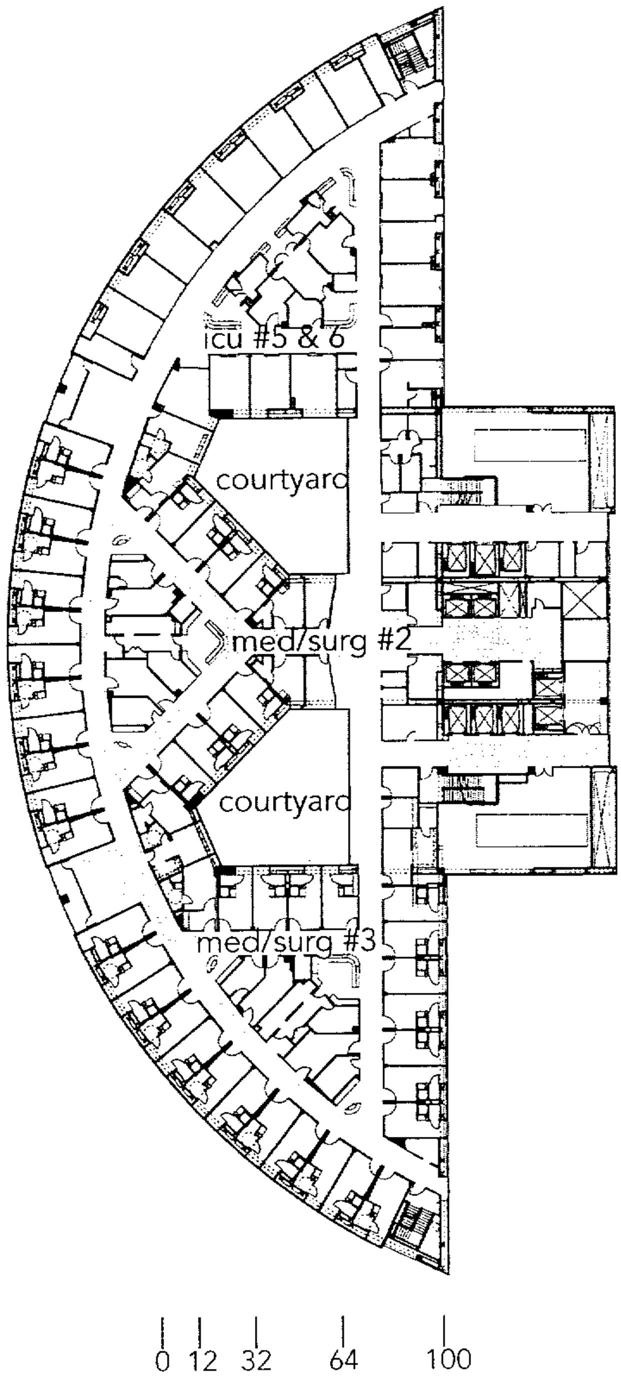
		28 Series					
		A-28	B-28	C-28	D-28	E-28	F-28
A	Number of Beds per Floor	28	•	•	28	28	•
B	Number of Beds per Cluster	7	•	•	7	7	•
C	Shortest Distance from Center (x)	35'	•	•	51'	49'	•
D	Greatest Distance from Center (y)	69'	•	•	64'	77'	•
E	Average Distance from Center	55'	•	•	56'	59'	•
F	Total Corridor Length	360'	•	•	360'	448'	•
G	Perimeter Length	392'	•	•	392'	392'	•
H	Total Area (Square Feet)	16,660	•	•	17,444	19,396	•
I	Center Support Area (Square Feet)	5,940	•	•	6,724	6,704	•
J	Available Bed Area (Square Feet)	7,840	•	•	7,840	9,165	•
K	Corridor Area (Square Feet)	2,880	•	•	2,880	3,525	•
L	Percent of Support Area	45%	•	•	38%	34%	•
M	Perimeter of Total Area (G:H)	1:42.5	•	•	1:44	1:49	•
N	Total Area/# of Beds (H/A) (Square Feet)	595	•	•	623	692	•
O	Distance to Bed Factor (E/A)	1.9	•	•	2.0	2.1	•

		30 Series					
		A-30	B-30	C-30	D-30	E-30	F-30
A	Number of Beds per Floor	•	30	30	•	•	•
B	Number of Beds per Cluster	•	10	10	•	•	•
C	Shortest Distance from Center (x)	•	44'	32'	•	•	•
D	Greatest Distance from Center (y)	•	75'	88'	•	•	•
E	Average Distance from Center	•	55'	56'	•	•	•
F	Total Corridor Length	•	689'	383'	•	•	•
G	Perimeter Length	•	420'	420'	•	•	•
H	Total Area (Square Feet)	•	16,887	16,338	•	•	•
I	Center Support Area (Square Feet)	•	5,459	4,869	•	•	•
J	Available Bed Area (Square Feet)	•	8,400	8,400	•	•	•
K	Corridor Area (Square Feet)	•	3,028	3,068	•	•	•
L	Percent of Support Area	•	32%	29%	•	•	•
M	Perimeter of Total Area (G:H)	•	1:40	1:39	•	•	•
N	Total Area/# of Beds (H/A) (Square Feet)	•	703	544	•	•	•
O	Distance to Bed Factor (E/A)	•	1.85	1.86	•	•	•

		32 Series					
		A-32	B-32	C-32	D-32	E-32	F-32
A	Number of Beds per Floor	32	•	•	32	32	•
B	Number of Beds per Cluster	8	•	•	8	7	•
C	Shortest Distance from Center (x)	42'	•	•	56'	56'	•
D	Greatest Distance from Center (y)	78'	•	•	74'	90'	•
E	Average Distance from Center	63'	•	•	64'	68'	•
F	Total Corridor Length	416'	•	•	416'	504'	•
G	Perimeter Length	448'	•	•	448'	448'	•
H	Total Area (Square Feet)	20,720	•	•	21,504	23,452	•
I	Center Support Area (Square Feet)	8,432	•	•	9,216	9,193	•
J	Available Bed Area (Square Feet)	8,960	•	•	8,960	10,285	•
K	Corridor Area (Square Feet)	3,328	•	•	3,328	3,973	•
L	Percent of Support Area	40%	•	•	42%	39%	•
M	Perimeter of Total Area (G:H)	1:46	•	•	1:48	1:52	•
N	Total Area/# of Beds (H/A) (Square Feet)	647	•	•	672	692	•
O	Distance to Bed Factor (E/A)	1.9	•	•	2.0	2.1	•

		36 Series					
		A-36	B-36	C-36	D-36	E-36	F-36
A	Number of Beds per Floor	36	36	36	36	36	•
B	Number of Beds per Cluster	9	12	12	9	9	•
C	Shortest Distance from Center (x)	49'	49'	38'	63'	49'	•
D	Greatest Distance from Center (y)	87'	91'	108'	84'	94'	•
E	Average Distance from Center	71'	66'	76'	71'	67'	•
F	Total Corridor Length	472'	462'	476'	472'	504'	•
G	Perimeter Length	504'	504'	502'	504'	504'	•
H	Total Area (Square Feet)	25,172	22,301	21,794	25,956	22,084	•
I	Center Support Area (Square Feet)	11,316	8,521	7,930	12,100	6,704	•
J	Available Bed Area (Square Feet)	10,080	10,080	10,050	10,080	11,405	•
K	Corridor Area (Square Feet)	3,776	3,700	3,813	3,776	3,973	•
L	Percent of Support Area	75%	38%	36%	46%	30%	•
M	Perimeter of Total Area (G:H)	1:50	1:44	1:39	1:51	1:43	•
N	Total Area/# of Beds (H/A) (Square Feet)	699	929	605	721	613	•
O	Distance to Bed Factor (E/A)	1.97	1.85	2.1	1.9	1.87	•

▸ *Fourth floor nursing unit at Arrowhead Regional Medical Center (BTA/P&W).*



- Unit flexibility for occupancy and nursing practices/swing capability
- Digital imaging stations for image viewing on units

Patient environment

- Space for family and visitors in the room
- Provision of education, lounges, consult areas for patients/family
- Views of nature and/or outdoor access, natural light
- Enhanced control of environment by patient, such as lighting, noise, television, views, and visitors
- Patient view of corridors
- Reduced noise levels

The search for the appropriate nursing unit for each hospital evolves from a careful study of the critical design issues at each institution and its particular site. The evolution of the plan for this unit is an example of that process at Arrowhead Regional Medical Center. The specifics of each new project will dictate a new solution, benefited by the research and analysis of plans developed earlier.

INTERIOR CONSIDERATIONS AND ARCHITECTURAL DESIGN ISSUES

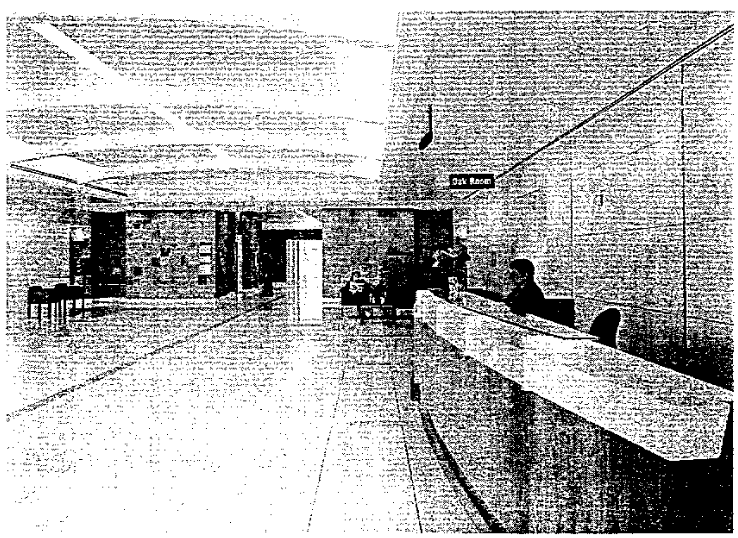
Contemporary design of interior spaces in hospitals is based on creating welcoming environments, with the goal of making the inpatient hospital a friendlier, more responsive place. Within the limitations imposed by codes, economics, and maintenance issues, the change in the "look" of hospitals over the past ten years reflects the recognition that they must be sensitive to patients' needs for comfort, control, and other psychological requisites. Models for this change have derived primarily from hospitality (hotel) industry designs as applied to hospitals.

There is still room for improvement in applying these concepts to the traditional separation between the "back of the house" and "front of the house" mentality whereby hospitals are perceived strictly as functional machines and systems. Designers and hospital managers are becoming aware that the entire hospital must be designed to increase its comfort, appearance, and efficiency for patients, family, and visitors, as well as for physicians, nurses, and all hospital staff members.

Daylighting

One of the chief improvements in the design of interior spaces has been to incorporate natural light into the hospital, particularly in areas that are programmatically dense. An early example can be found at Daniel Freeman Memorial Hospital in Inglewood,

Hospital lobby at Arrowhead Regional Medical Center.



▲ *The dining room at Arrowhead Regional Medical Center.*

▼ *Single-loaded corridor at Arrowhead Regional Medical Center.*

California (BTA), where courtyards tie together three levels of the hospital, including the basement, with lush landscaping. Located along one side of the main corridors and at major intersections, the courtyards provide orientation for visitors and staff (a concept further developed at many hospitals, including Arrowhead).

Where natural light is not available, or to supplement it, a variety of contemporary fixtures are available that mimic daylight or incandescent light, creating a far warmer experience than that provided by standard cool fluorescent fixtures.

Configurations

Most intractable to significant change (with the exception of the progress made in women's centers) is the standard patient room. With the gradual conversion of most hospitals to all single rooms, a more comforting environment for patient and family is provided. Too often, however, the designs of these rooms center on the placement of the bed, the head wall, and visual access to nursing staff, rather than the needs of the patients and family. The introduction of a second bed as a window seat allows a family member to stay overnight with the patient, normalizing the patient's experience and, in fact, relieving nursing staff of many simple nonnursing activities.

The earliest experiments in this area occurred in women's services. Two landmark projects set the pace in this market-driven, highly competitive niche of healthcare. At Cottonwood Hospital in Salt Lake City, KMD architects set a standard for the design of women's centers. At UCLA/Santa Monica Hospital Medical Center, BTA evolved the concept to include courtyards where new mothers could enjoy candle-lit dinners with their husbands, celebrating their experience, and lay windows were designed to include a sleeping area for fathers.

Breakthroughs came early in the design of labor/delivery/recovery/postpartum rooms. In these rooms, concern for family needs, and reconception of the birthing experience as one shared with the family, has led to homelike settings. Such a room may include a view to an outside garden, a sleeping area for the husband in the form of a window bed, or a double bed for both parents.

Opportunities to apply these ideas throughout the hospital are now being explored further. An early experiment at Daniel Freeman Memorial Hospital created a gathering place for patients, staff, and visitors around a small kitchen area, known as the "Village Pump," which the book *Pattern Languages* described as the equivalent of the meeting place at the water pump in European villages. Corridors were made wider than the required 8 ft to allow for ambulation and further congregation.

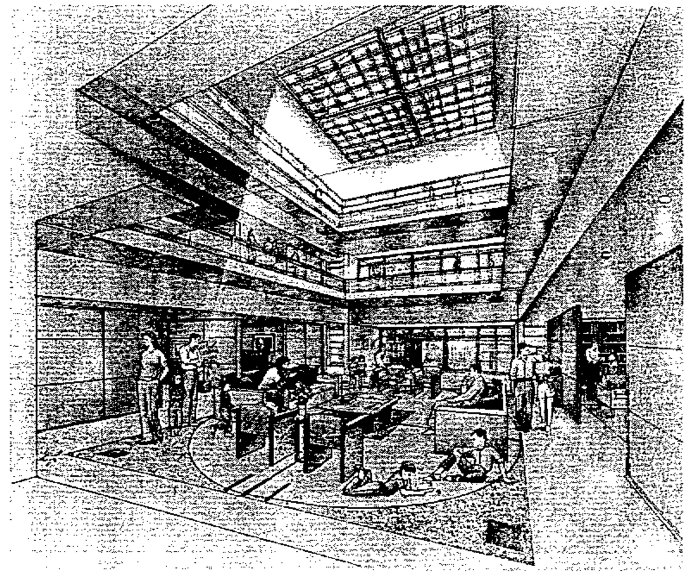
A second concept tried at Daniel Freeman was the use of a freestanding circular table that served as both a nurses' charting area and a place for patients to congregate and discuss care plans with staff. This nonthreatening circular table removed a significant barrier to the humanizing of the patient and family experience.

Hospitals developed recently by the Planetree organization follow these precepts and take the humanizing of the design to greater levels of detail, with each hospital building on the experiences of those preceding it.

Finishes and Floor Treatments

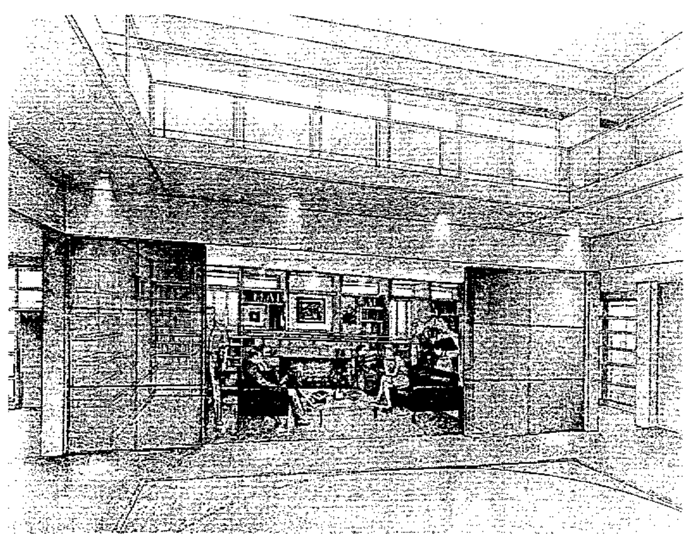
Although the choice between carpets and no carpets is still an issue for some hospitals (for reasons relating to cleanliness and infection control), there are many opportunities to use floorings that create attractive solutions to problems of maintenance and cost.

Arrowhead mandated stringent requirements for durability and maintenance of all of its interior finishes. The hospital lobby illustrates the culmination of months of testing finish materials. This is an area of very high traffic, which may be subjected to abuse and vandalism. Although all the finishes, terrazzo floors, and limestone and slate walls were selected to withstand extreme wear, they also

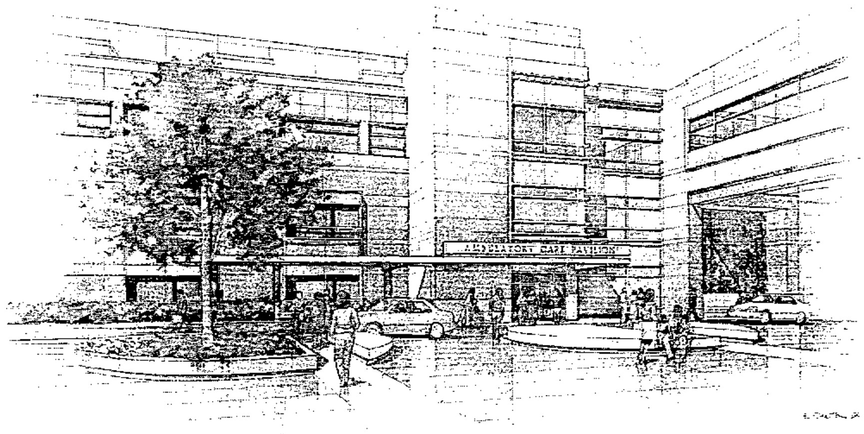


▲ *City of Hope National Medical Center patient living room (BTA).*

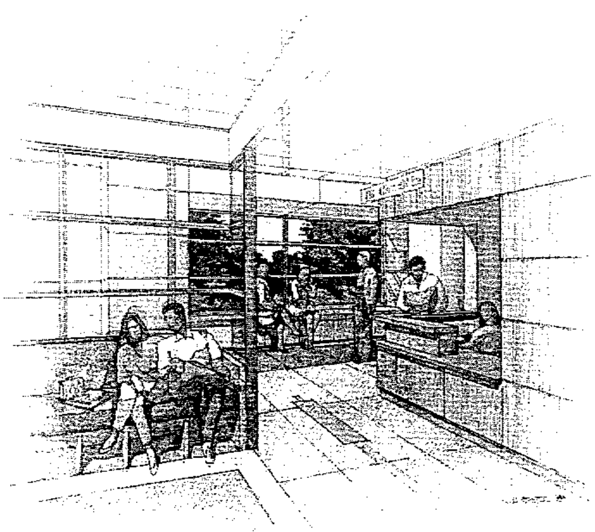
▼ *City of Hope National Medical Center patient living room.*



▸ *Entry to UCSF Stanford Health Care, Center for Cancer Treatment and Prevention/ambulatory care pavilion (BTA).*



▾ *Clinic waiting area at UCSF Stanford Health Care, Center for Cancer Treatment and Prevention/ambulatory care pavilion.*

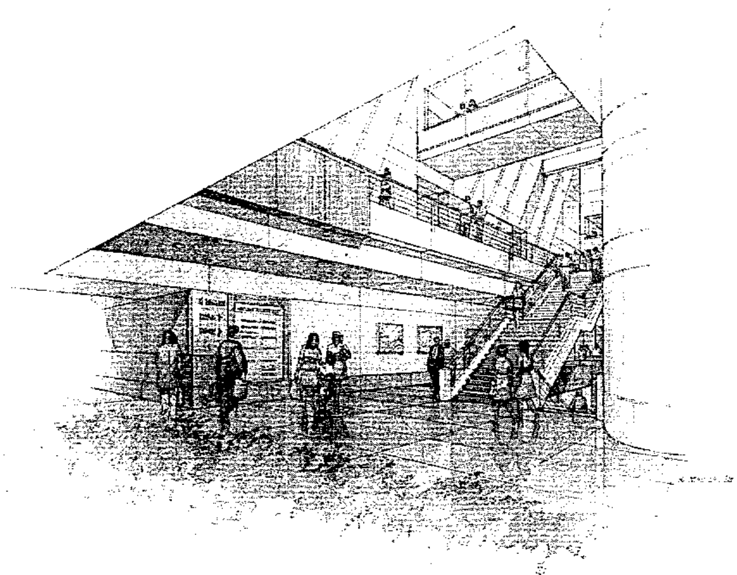


are beautiful, providing a tactile experience and an air of permanence, and allow natural light to penetrate deeply into the spaces.

The corridors at Arrowhead Regional Medical Center are adjacent to interior courtyards, which allows natural light to enter and provides a layer of light patterns that change throughout the day. The use of an impervious panel up to the wainscot, and above that an applied textured hard wall coating, provides a durable and washable surface as well as a contrast to the gloss of the terrazzo floors. These materials were thoroughly tested in mock-up rooms over the years of design development before final selection.

Color has long been recognized as a tool for wayfinding; different colors can be used to delineate departments and buildings or to call out an area of importance, such as a nurses' station.

The dining room at Arrowhead Regional Medical Center is a place where families, patients, and staff can gather and enjoy a



◀ *Atrium Lobby at UCSF Stanford Health Care, Center for Cancer Treatment and Prevention/ambulatory care pavilion.*

departure from the clinical experience. Although it is located in a subterranean space, natural light enters through skylights in the soaring ceilings. Planters and dramatic color, commonly used in hospitality design, are appropriate here as well. The art program features historical photographs of the region and people instrumental to the development of the original San Bernardino County Hospital (now Arrowhead Regional Medical Center).

The current trend in patient room design is to provide opportunities for personalizing space with tackable surfaces and shelves for photographs, flowers, or books. Window seats can be used for contemplation as well as sleeping space for spouses. The patient rooms at City of Hope National Medical Center were designed to maximize garden views, and access to operable windows allows the patient a feeling of control over the environment—scent, sound, and light.

It is important to design gathering spaces for patients and family members outside the patients' rooms. These spaces can be designed to resemble a living room, with finishes such as wood, carpeting, and stone. A fireplace and intimate areas for conversation create a unique respite from the conventional hospital experience.

SPECIALIZED INPATIENT NURSING UNITS AND THEIR UNIQUE PLANNING ISSUES

There are a variety of units designed to handle special groupings of patients, the most common of which are the acute medical/surgical unit, the critical care unit, the obstetrics/gynecological unit, and the pediatric unit. As the size and role of an institution increases, there may be additional specialty units.

In large tertiary or teaching hospitals and in specialty hospitals there can be a further level of distinction based on the need to cluster similar patients to care for them effectively. Other types of units include rehabilitation, psychiatric, and many variations of critical care units. For purposes of this general volume on hospital design, we will discuss briefly the most common types of units and one recently developed specialty unit. All of these units share certain common planning patterns; variations in design respond to the type of patient and the care needed.

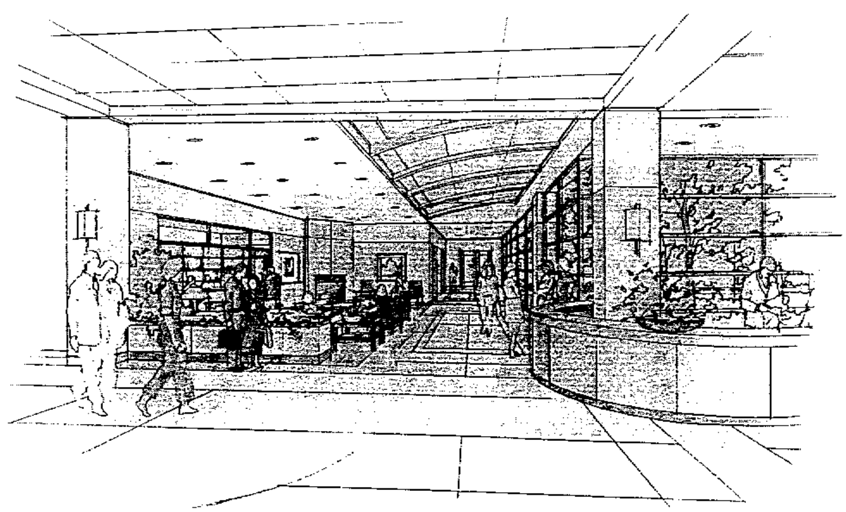
Intensive and Coronary Care Units

Early intensive care and coronary care units closely resembled the postanesthesia recovery areas from which they evolved. Beds were lined up in open wards with little space between them and no provisions for patient privacy other than cubicle curtains. More recent units provide privacy while maintaining high visibility from the nursing station. These units have evolved permutations, most comprised of single-patient rooms, with maximum visibility, flexibility of bed location, and complex utility support. Gases, air, vacuum, and electronic monitoring are often provided from a movable service column. These rooms now are much larger than standard patient rooms to allow for the many staff needed during an emergency.

Maternity and Women's Health

Specialty care units can provide valuable marketing opportunities for the hospital, not only through the services they provide but through their design as well. Maternity units constitute one of the most popular marketing "niches" of today. Maternity (i.e., obstetrical) units can be designed with a strong emphasis on "high touch," with a homelike, noninstitutional ambiance.

Large single-patient rooms utilized for labor, delivery, and recovery (LDR) are designed as cozy bedrooms, with obstetrical equipment hidden away. These rooms quickly convert to high-tech procedure rooms as delivery progresses, simply with the necessary equipment and lighting pulled in. Although the trend



Women's Health Services Building, West Allis, Wisconsin (KS/BTA)

The living room area, immediately adjacent to the main entry, serves as the heart of the Women's Health Services Building. Careful attention was given to the space to create a residential character. Here patients and visitors can congregate, sit by the fireplace, or read in the library.

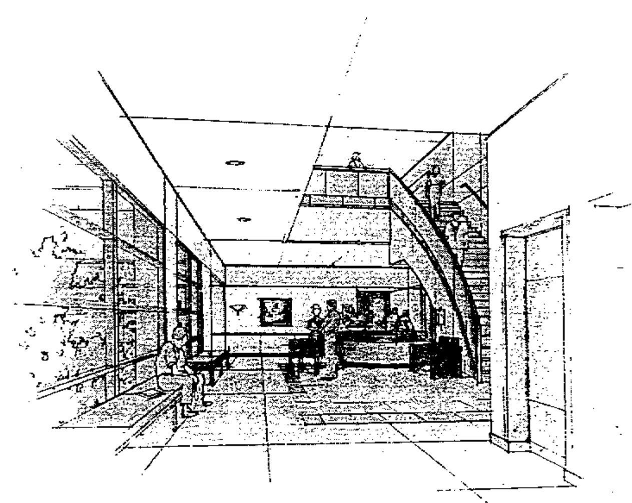
◀ *One of the highest priorities in the design of the Women's Health Services Building was to bring light and nature into the building as far as possible. The Cafe Bookstore, opening onto a healing garden, is one of several public areas where visitors are encouraged to sit or to wander and browse. Current information on women's health issues is available at the bookstore. In this store, reflecting the trend in bookstore design, visitors can read while having a beverage or something to eat.*

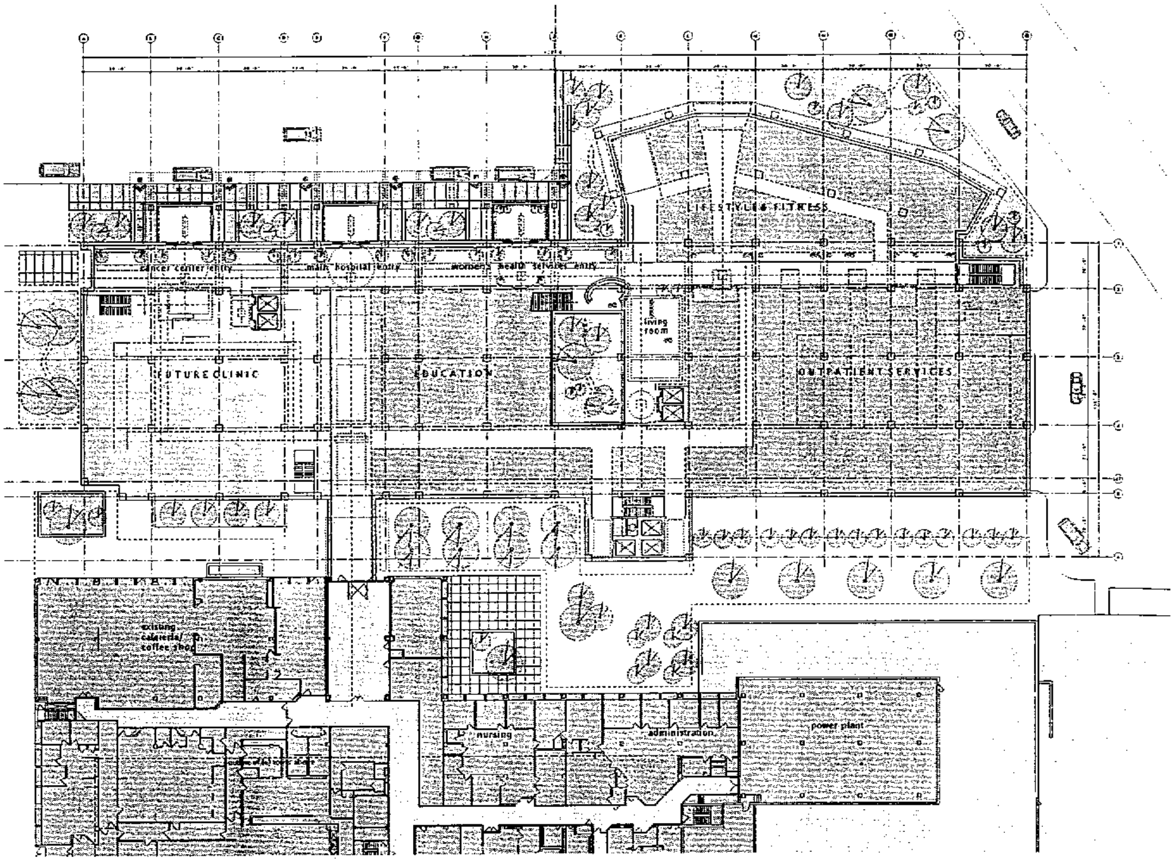
until recently was to use these rooms as postpartum beds as well, this practice has changed because of several issues: inefficiency in room utilization, difficulties with nurse cross-training, and patient preferences to continue recovery in a quieter setting. Consequently, many postpartum beds are located adjacent to LDR areas, in their own quiet rooms, frequently with newborns rooming-in with their mothers and with double beds provided for the fathers.

Postpartum rooms, as well as many other inpatient women's services areas, are now designed to include many comforts that enhance the patient's recovery and positive experience with the hospital. These amenities may range from lounges located on the floor (for patients and families) to small reading areas, sitting rooms with computers, and access to an electronic library (including books and items available from the hospital gift shop).

Similar design concepts are being applied to other women's nursing units, with various services (gynecology, cancer,

▼ *There was a definite desire at West Allis for the postpartum patient area to have a strong literal connection with the birthing floor, and this was provided with an open mezzanine and connecting stair.*





▲ *The first-floor plan of the Women's Health Services Building illustrates the organization of the outpatient services. Exercise and alternative treatments are located "in the garden," with an indoor/outdoor component to their programs. Clinic functions are located so as to maximize shared support spaces.*

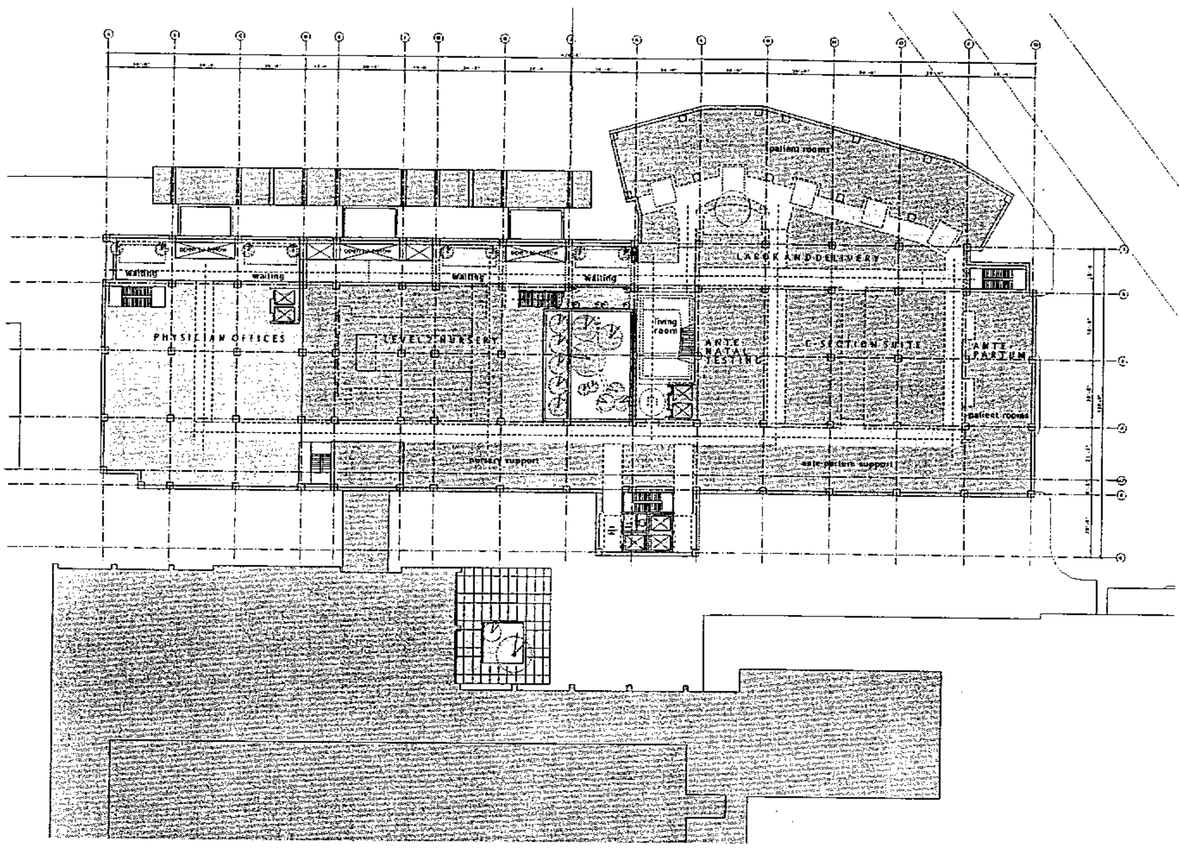
and urology, for example) consolidated into a single specialty unit. The ambiance in these units is one that promotes healing and tranquility, the antithesis of institutional environments of the past.

The West Allis Women's Health Services Building (KS/BTA) in West Allis, Wisconsin, is an excellent example of how the evolution of care has now holistically blended the inpatient and outpatient experience. The design was based on several visioning sessions used to establish the appropriate feelings the center should evoke and the physical elements that would support them.

Pediatric Patient Units

A pediatric unit is one of the most specialized inpatient units, with obvious requirements for children. How can a pediatric patient unit be designed to reduce the fear and anxiety inherent to hospitalization for children? Attention must be paid not only to the needs of the children but to the needs of their family members as well.

Pediatric nursing units require design of appropriate scale for children. Designing rooms that contain nooks and crannies, areas in which the child can play, hide, and feel secure, can help to allay fears and



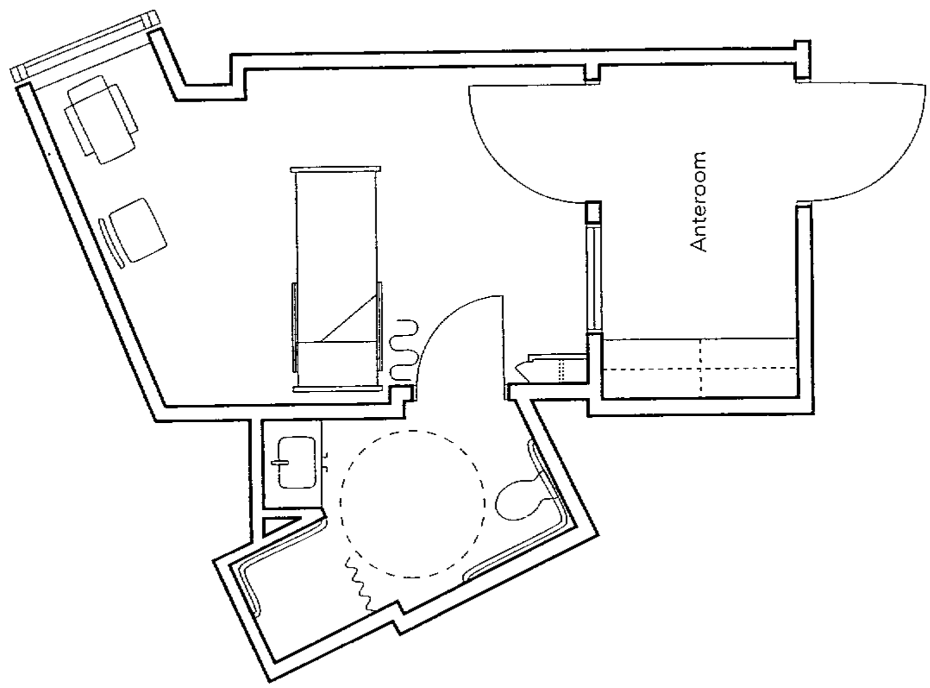
▲ *The second floor houses LDR rooms, the caesarean section suite, and the Level II nursery, departments that have critical functional adjacencies in order to provide the highest level of care during the birthing process. The LDR rooms are situated so as to take advantage of garden views.*

reduce boredom. Views of the outdoors, scenes of nature, and various colors enhance healing and feelings of well-being for the child, as well as for the parents.

Pediatric patient rooms must also include amenities to make children and parents feel as comfortable as possible. Providing pull-out beds or other furniture to allow for rooming-in enables parents to become active caretakers, thus reducing their anxiety. One of the most overlooked areas of pediatric unit design is the impact on care providers. Nursing staff, for example, must have the ability to keep patients both entertained and quiet; both needs are affected by design. Providing nursing staff with the necessary visibility to pediatric beds is critical, as it is on many specialty adult units.

The highly stressful nature of pediatric nursing also requires planning for staff areas that enable caregivers to "regroup." Providing nursing staff with areas that have access to the outdoors or to views of nature is a highly effective means of ameliorating stress and reducing burnout.

Several questions typically arise in designing pediatric units, which are often



▶ *Patient isolation room at Arrowhead Regional Medical Center.*

answered by the specific hospital. These include the question of private versus shared patient rooms, as children often benefit from peer companionship, and questions concerning pediatric unit designations. For example, should pediatric intensive care be a separate unit, part of the pediatric unit, or integrated into adult intensive care? And should pediatric bed distributions be categorized according to age or diagnosis?

These questions often require a great deal of thought by a variety of user groups within the hospital to determine the most appropriate decisions, based on nursing models, market trends, and competitive factors. Each, however, will influence the design of the pediatric nursing unit, again reaffirming the need for overall flexibility in hospital design.

AIDS/HIV, Cancer, and Infectious Disease

In the 1980s, when acquired immunodeficiency syndrome (AIDS)/human immunodeficiency virus (HIV) became recognized as an epidemic, there was a rush to create not only AIDS inpatient units but specialized AIDS hospitals as well. However, as patients were increasingly treated in outpatient settings, the need for these units began to decline and those requiring hospitalization were admitted to various inpatient units pending the manifestations of their disease.

One of the most significant needs of these patients when they do require hospitalization is for appropriate safeguards for their often compromised immune systems.

"Immunocompromisation" is a condition experienced not only by patients with AIDS, but by many cancer patients as well, particularly those undergoing intensive chemotherapy.

Such patients are universally at risk of becoming infected by "general" contagion, let alone by increasingly common instances of infectious disease. Consequently, inpatient unit design must provide a small percentage of rooms with positive air exchanges in order to protect at-risk patients. Positive airflow means that the air pressure in the patient room is positive in relationship to the air pressure in adjacent rooms. Thus, air flows from the protected area, reducing the chances of infection not only from airborne illness but also from certain environmental elements inherent to buildings, such as mold and aspergillus, a frequent byproduct of building construction.

Other rooms requiring special air-handling mechanisms include those for patients with infectious disease. These rooms have a negative airflow (opposite to the positive airflow of the rooms described earlier), which is exhausted directly to the outside of the building. Many healthcare futurists believe that an onslaught of infectious disease, with increasing drug-resistant bacteria, may appear in the not-too-distant future and travel to and from third-world and other distant countries. We are already seeing increases in drug-resistant staph and tuberculosis, not to mention the potential for Ebola and other viruses.

To contain the spread of infectious disease, particularly in hospitals, where patients are already so vulnerable, patient units should contain rooms with negative airflow, as well as with anterooms for visitors/staff to change clothing. In the future many rooms may be designed with the ability to be adjusted to both positive and negative pressure, allowing for flexibility but adding significantly to their costs. This will require the cooperation of code authorities and the careful attention of hospitals to the day-to-day operation of mechanical systems.

FUNCTIONAL AND SPACE PROGRAMMING ISSUES

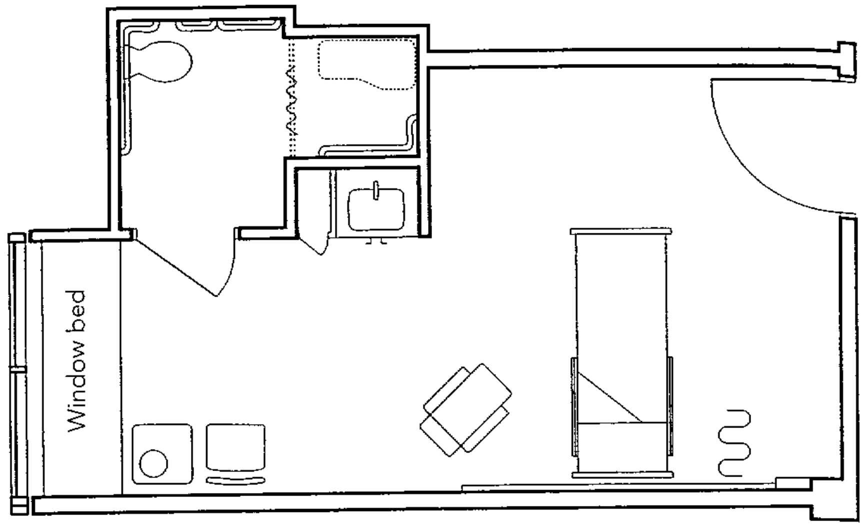
As the forces of change continue to have an impact on healthcare delivery, the design of the hospital's inpatient areas will continue to be affected. Whereas "bigger is better" was the mode until the 1980s, reduced inpatient capacity, higher intensity of care, efficiency, and flexibility have become the new design drivers.

Hospitals designed in the 1970s and earlier have proven to be highly inefficient in the new environment of healthcare delivery. Consequently, many recent design projects have consisted of retrofitting hospital facilities in order to deliver outpatient care efficiently. The majority of today's design projects reassess initial planning assumptions, which often results in a reduced number of patient beds.

As more medical treatment was delivered on an outpatient basis, the need for inpatient beds continued to decline drastically. Overall reductions in patient lengths of stay, dictated by the more stringent reimbursement policies of managed care, furthered this decline. Managed care drove a nearly 50 percent reduction in bed need, with demand decreasing from 927 beds per 100,000 population in 1992 to 498 per 100,000 in the year 2000.

BTA's work with Cook County

▶ *Universal patient room at Arrowhead Regional Medical Center.*



Hospital in Chicago, Illinois, resulted in a reduction of beds in the proposed new facility from 900 to 464. The Arrowhead project reduced beds from 500 to 373, and in Salinas, California, Natividad Medical Center's replacement facility reduced beds from 219 to 163.

To promote flexibility and address the need for nursing units with increased staffing levels, patient rooms can be designed to accommodate a range of acuity levels and diagnoses. This is accomplished by designing single-bed patient rooms, sufficiently sized to accommodate increasing numbers of bedside treatments, by providing appropriate wiring for patient monitoring capabilities, by situating rooms to allow for maximum patient visibility by nursing staff, and by placing toilets on the exterior wall of the rooms. All of these elements enable patient rooms to be easily converted from general medical/surgical beds to more acute, monitored, critical, or intensive care beds.

Single-Patient Occupancy

An additional advantage to the flexible, "universal" room design is its focus on single-patient occupancy. While bed numbers have been decreasing nationwide, census rates have been increasing as the availability of beds declines. Single-bed patient rooms provide the ability to increase room utilization—from a 75 to 85 percent average to, theoretically, 100 percent. This is due to the elimination of patient "incompatibility" factors such as differences in sex, diagnoses, and disease communicability.

Furthermore, single-patient rooms enable more treatments to be administered at bedside, thus reducing the need to transport patients to procedure rooms off the unit, and can accommodate changing levels of care to be provided in one location, rather than transferring patients to different nursing units.

Finally, single-bed patient rooms give

TYPICAL DEPARTMENTAL SPACE ALLOCATION TABLE					
Code	Room Name/General Quantity Component	Room Name/Specific	Quantity	Area	NSF Comments
22 General Patient Care					
22 General Patient Care - Unit 9					
22K. 10A.1	Private patient room		6	212	1,272
22K. 12A.1	Semiprivate patient room		7	250	1,750
22K. 15A.1	Isolation patient room		4	212	848
22K. 77A.1	Toilet	Patient (M/F)	17	54	918
22K. 87A.1	Anteroom		4	40	160
22K. 56A.2	Nurse substation		2	172	344 1 per 12 beds
	2 Charting				
	1 Medication				
	1 Nourishment				
	1 Sink alcove				
	1 Supply/linen				
22K. 56A.1	Nurse station		1	327	327
	6 Charting				
	1 Monitor				
	2 Viewing station				
	1 Crash cart				
	1 Pneumatic tube				
22K. 70A.2	Conference room	Team	1	140	140
	7 Conference seats				
22K. 61A.2	Workroom	Resident/student	1	120	120
22K. 83A.1	Storage	W/C stretcher	1	80	80
22K. 83A.2	Storage	Equipment	1	120	120
22K. 91A.1	Soiled utility		1	185	185
	Total Subdepartment NSF				6,264
	Total Subdepartment GSF	(conv. factor) 1.55			9,709

hospitals a competitive edge, providing more desirable "private" patient rooms, which can be personalized and offer "move in" space for patients' visitors and family members. Patient rooms increasingly include family amenities, such as pull-out beds or reclining areas for overnight stays. This has had a beneficial effect on the demands on staff. The appeal of such rooms is further enhanced by the provision of small kitchen areas, located on the nursing floors, specifically for the use of visiting family members or friends.

Design that fosters the image and delivery of "high-tech" services is countered by a new, strong focus on human elements, the classic "high-touch" counterpart to technology. Inpatient design now seeks to facilitate the creation of noninstitutional environments, fostering healing according to the concept of holistic treatment of the individual—that is, treatment of mind, body, and soul. These factors have a subtle but significant impact on space programming.

Bed Projections/Bed Need Analysis/Inpatient Support Services

Before the advent of managed care and the surge in outpatient care delivery, projections of the number of beds required were not only critical to determining the sizes of nursing units, but essential to determining the sizes of most other hospital departments as well. Today this priority has changed drastically; beds have become almost ancillary to the space required for hospital services. Department sizing is now highly dependent on outpatient visits, as well as the role of the hospital within its system or community and its unique service demands and requirements.

Inpatient bed projections are, however, necessary to determine the anticipated sizes and types of inpatient units, again with an emphasis on flexibility, in order to accommodate changing acuity and service needs. Bed projections are derived from patient-day estimates, based on trends and demographics, market and system share, physician referrals, annual admissions, and average lengths of stay. Patient days are divided by both the total days per year and anticipated occupancy factors, determined by the type of bed (acuity level/diagnosis) and patient room type (private versus shared).

Although patient bed projections are no longer the major indicators of many ancillary department space needs, they are relevant to the requirements of certain support services, such as dietary services, admissions, housekeeping, materials management, autopsy/morgue, and certain laboratory and pharmacy requirements.

The size and type of nursing unit will determine the need for certain satellite facilities, such as a pharmacy, food heating and delivery systems, supply distribution, patient records and charting, transport systems, and imaging systems, as well as the size and shape of nursing stations and substations.

Finally, bed demand will strongly determine the role of the inpatient component of the hospital. Will demand suffice to create separate inpatient and outpatient service areas/locations for a specific service, creating sufficient work loads to justify service replication or redundancies? Will future bed demand point to new groupings of inpatient beds, creating new types of units yet to be seen?

Certainly, if we look at demographic projections pointing to significantly longer life spans and envision technologies we have not even dreamed of, the potential for new and creative inpatient unit design is remarkable.

Programming Steps

Prior to designing any nursing unit, several predesign steps must be accomplished. One of the most detailed of these steps is the development of the department space program. Space programming is a process in which the specific requirements of a department are identified, including such elements as specific room requirements and dimensions, descriptions of the department's operations and unique functional requirements, and departmental adjacency requirements as they affect operational flow.

Frequently, this phase of work also includes a preliminary cost analysis—providing an assessment of the completed project cost or costs for various options that may be developed—block floor diagrams, and work load analyses, used to determine the sizes, numbers, and types of rooms required in the future. A work load analysis ensures that the space program is created to address future needs, so that it will be able to fulfill the hospital's requirements at the time of construction completion, well in the future. Supplemental information required includes typical room layout and room criteria sheets identifying basic room layouts and requirements, an equipment inventory, and special code analyses.

A department space table is developed to identify the specific rooms and spaces required for efficient departmental operations, based on anticipated future demands. The process is both statistical and judgmental, inasmuch as each institution is different. Space tables, developed through discussions with department managers and medical and nursing staff, should be aligned with the strategic directives of the hospital. When possible, staffing and operating simulation are utilized in planning the unit.

The space tables are organized by room/space type and function and include the specific net square foot (NSF) requirement for each room, a total NSF for all rooms constituting the department, and a department-specific conversion factor that accounts for circulation through the department.

Circulation/conversion factors average about 40 to 50 percent for most inpatient departments. Once the conversion factor is applied to the total departmental NSF, a departmental gross square footage summary (DGSF) is derived.

Total building gross square footage (BGSF) is computed for the entire building, consisting of structure, mechanical/electrical, and circulation factors, with a typical conversion factor of 25 percent added to the total DGSF of all departments.

At all hospitals a functional program is developed to describe the functional operation of the proposed facility. A functional program identifies a department's functional requirements, often including an overview of planning and design issues, relationships between departments and within each department, staffing requirements and work load/volume projections. In addition, descriptions of departmental operation and flow, along with flow diagrams, are provided.

The functional program serves as a narrative for both the architect and the future user, describing how the department is planned to operate, what constraints or directives were inherent to the planning of the department, and what the operational and work load assumptions were at the time of program development. This document is particularly important in planning nursing units, owing to the impact of critical assumptions on design. These may include, for example, assumptions regarding bed demand and utilization, types of nursing models and nurse: patient ratios, implementation of computers or other types of electronic patient monitoring, and the future role of the hospital itself within its system or specific market (i.e., tertiary hub, community hospital, teaching/research facility).

An extracted example of a recent functional program of a major teaching hospital follows.

TYPICAL FUNCTIONAL PROGRAM

General Patient Care

General patient care units provide general acute nursing care to all hospital inpatients. These units will serve all medical and surgical specialties and subspecialties, adult and pediatric. The following discusses specific operational requirements for general patient care units.

Currently, general acute care beds are dispersed throughout the hospital. The majority of general patient care beds (acute care) are located in multibed wards, designated by specialty and separated by sex. This results in reduced utilization rates, insufficient isolation capacities, and limited flexibility to accommodate changing patient acuity levels.

Continued trends in the patient population indicate increasing inpatient acuity levels and continued high incidence rates of contagious diseases such as tuberculosis, both of which render the current configuration of patient beds insufficient for providing appropriate care. In addition, many beds within the hospital are currently utilized for observation purposes. The new hospital will contain dedicated observation beds for stays of less than 24 hours. These beds will not be located within nursing units, but in locations more proximal to their related services.

To attain maximum utilization of patient beds in the new hospital, maximum flexibility of beds is required. This will be accomplished by: (1) creating patient units that are generic rather than specially configured per specialty; (2) providing patient beds with the ability to be utilized for a range of acuity levels, via provision of adequate space and wiring for telemetry; and (3) providing sufficient numbers of single and isolation patient beds to accommodate increasing patient acuity, immunocompromization, and communicable diseases.

Intermediate care will be provided either in general patient care units or intensive care patient units. The degree of care will be determined by the type of monitoring and nursing care required. General patient care units used as intermediate care units will utilize bed telemetry monitors and can increase nurse to patient ratios to provide a higher level of care.

Pediatric patient care will be provided a distinct identity within the hospital and will include special pediatric amenities and support. The pediatric patient care units will be separate from adults units and should have good access to pediatric intensive care units and pediatric emergency.

In addition to providing flexibility, patient units should provide maximum efficiency for staff and optimum care and comfort for the patient. Consequently, nurse travel distances should be minimized, including distances from nursing stations and supply areas to patient rooms; efficient supply delivery and sufficient storage/holding areas should be provided; traffic within the patient care unit should be minimized and controlled; and patient travel off the unit should be reduced whenever possible. To achieve these objectives, the following key concepts should be implemented:

- Patient care units should be decentralized into smaller bed clusters or "pods," with two to three clusters constituting a larger unit. Each cluster will contain decentralized nursing substations, providing increased visibility of patient beds and reduced congestion at the central nurse station appropriated for the larger unit. Computerized charting will further the efficiency of this configuration, reducing the need for paper charting in the nursing station.
- A nurse server should be provided adjacent to or within each patient room in order to provide immediate access to nursing supplies. Nurse servers will be replenished by materials management staff, who will stock them from a central exchange cart holding area on each patient unit.
- Traffic on the unit should be reduced through the provision of supply holding areas adjacent to service elevators, and through the provision of sufficient space within patient rooms to accommodate multiple family members and staff. In addition, dedicated visitor waiting areas will be located central to each patient floor, reducing the number of visitors in corridors and at nursing stations.
- Providing space on patient units for frequently utilized ancillary and support services will reduce patient transport off the unit. Patient floors consisting of two to three patient units should provide sufficient space for utilization of certain ancillary and support services, such as rehabilitation therapy (PT/OT) and patient education. These "multi-purpose" rooms should be generic and utilized as needed.

Patient/work flow

The flow of patients and work must deal with the following concerns:

- The majority of patients will come to the patient care unit directly from Admitting/Bed Control. Certain patients will come to the patient care unit from Emergency, or less frequently, the Trauma Department. These patients either will have been admitted by Admitting staff located in the Emergency Department or will have been transported directly to a patient bed and admitted directly on the floor. Transfer patients (from other hospitals) will be admitted directly on the patient unit. A smaller segment of patients will be unscheduled, admitted directly on the unit from various outpatient ancillary procedure areas or observation areas.

- Once a patient is admitted to a bed, the patient's travels off the unit should be limited. Although transport to certain ancillary services will be required, many services will be provided directly on the unit, either at bedside or in general multipurpose rooms. Single-patient rooms and more spacious semiprivate rooms should enable many procedures to be provided within the patient room.
- Patient transport off the floor should be provided by a dedicated patient transport elevator.
- Visitors should be directed from the information area on the first floor of the hospital to the appropriate patient floor. A clerk/reception station on the floor will direct them to the patient rooms or to the visitor waiting area located on each floor.
- Clean supplies should be delivered via service elevator to clean utility rooms on each patient floor. An exchange cart system will be utilized, stocked on the floor by materials management staff, who will then replenish nurse servers located adjacent to patient rooms.
- Linen should be delivered by materials management staff daily, and should be collected daily from soiled utility rooms, centrally located on each patient floor.
- Trash and waste should be collected by environmental services staff from soiled utility rooms located near service elevators, central to the patient floor.
- Dietary carts will be transported to a dietary rethermalization kitchen, centrally located on each patient floor.
- Pharmaceutical supplies will be provided by pharmacy staff. An automated dispensing cart should be located on each patient unit. Stat. pharmaceutical supplies should transported via pneumatic tube.
- Laboratory specimens should be transported via pneumatic tube. A tube station should be located in each central nursing station on the unit.
- Patient records are anticipated to be fully electronic, accessed via computer.

Adjacency requirements

Space adjacencies have a major effect on the efficiency of patient care.

- Functionally similar patient units should be located adjacent to each other, or on the same floor, to accommodate shifts in census, accommodate overflow, and share equipment and staff if necessary.
- All general patient care floors should be vertically contiguous for enhanced flexibility as well as operational efficiency (i.e., supply transport).
- All general patient care units should have direct access to patient transport elevators and key ancillary services such as inpatient surgery and inpatient diagnostic imaging.

Key functional requirements

The hospital's general patient care floors should comprise three key functional areas. Patient bed clusters of approximately 10 to 12 beds should be aggregated into a standard patient care unit (20 to 24 beds), which should, in turn, be aggregated into a patient floor

(60 to 72 beds). A hierarchy of necessary support spaces should be provided at each functional level.

Patient bed clusters should be effective for the majority of nursing models and should work effectively with most general acute care nursing ratios. Patient rooms should be distributed as follows: 25 percent isolation rooms, 75 percent single-patient rooms. This distribution is planned to accommodate rising patient acuity levels as well as the increasing incidence of communicable disease. Each patient cluster should contain the following:

- *Patient room (single).* Each patient room should be sufficiently sized to accommodate increasing amounts of bedside treatments and staff administering them. Rooms should also contain sufficient space for family members or other visitors. Each patient room should contain a dedicated toilet and shower. Each room should contain a closet for patient belongings. In anticipation of increasing inpatient acuity levels, each bed should be capable of telemetry wiring in order to be used as an intermediate care bed if necessary. Visibility into the room should be provided from nursing substations outside the patient room. Because of the anticipated use of portable renal dialysis machines, special plumbing requirements should not be needed in patient rooms.
- *Patient isolation room.* Patient isolation rooms should provide the same amenities and space accommodations as general patient rooms; however, each room should contain an anteroom to the outside for contamination control. Rooms should be equipped with special air handling to prevent the spread of communicable disease. Access to the isolation room should be provided through the anteroom, following gowning procedures which will occur there. Linens and nurse servers should be located in the anteroom, allowing for supplies to be accessed without exiting the room. When not required for isolation, this room type may be used for nonisolation patients.
- *Support areas.* Each bed cluster should contain a nurse substation with space for charting, medications, nourishment, supply/linen, and hand washing. In addition, nurse servers should be provided for each patient room.

Each *patient care unit* should comprise two to three patient bed clusters and should contain the following support components:

- *Nurses' station.* A central nurses' station should include telemetry viewing if beds are monitored, pneumatic tube station, staff charting, and crash cart holding.
- *Staff support areas.* Staff support areas located on the immediate patient care unit should include dictation/viewing, team conference, resident/student workroom, and a small teaching/education room.
- *Storage/utility.* Storage areas should be provided for wheelchair/stretcher holding and general equipment. A soiled utility room should also be located on each patient care unit.

Each *patient care floor* should consist of two to three patient units and should include support that can be shared by all units on the floor. Floor support should consist of the following:

- *Waiting reception.* Visitor waiting, as well as family consultation rooms, should be centralized on the general patient care floor. Reception, information, and public flow should be controlled at an adjacent reception/clerk area.
- *Staff offices/work areas.* Staff offices for nurse managers and attending physicians should be located in a central administrative area. A multidisciplinary staff workroom should accommodate other staff participating on the care team, including social workers, dietitians, therapists, and those of other disciplines.
- *Staff support areas.* Central staff support areas should include a staff lounge, locker rooms, on-call rooms, and a teaching/education room.
- *Storage/utility.* Centralized floor storage should be provided for additional equipment and supplies. A clean utility room and a central holding room for hazardous, medical, recyclable, general waste, and soiled linen holding should be provided.
- *Multipurpose/rehabilitation therapy room.* A multipurpose room should be accessible from all patient care units on the floor for physical and occupational therapy that cannot be conducted in the patient room.
- *Kitchen.* A large kitchen for rethermalization and dietary cart holding should be located central to the floor.

Intensive/Critical Care

The intensive/critical care units include all medical and surgical specialties accommodated in coronary, medical, pediatric, surgical, neurology, burn and trauma, and neonatal intensive care units. The existing units, dispersed throughout the hospital, require additional isolation room capacity to accommodate increasing incidence of contagious and immunocompromised patients.

As with general patient care units, intensive care unit (ICU) configurations should remain consistent among units to maximize flexibility and allow for future census changes. Intermediate levels of care will be provided in either general patient care units or in intensive/critical care patient units. The degree of care will be determined primarily by the type of monitoring and nursing care required. Intensive care units should accommodate intermediate care by reducing nurse-to-patient ratios on the unit.

In addition to providing flexibility, intensive care patient units should provide maximum efficiency for staff and optimum care and comfort for the patient. Pediatric intensive care should be a distinct unit, segregated from adult areas. Pediatric intensive care units should have direct access from general pediatric patient care units, and from the pediatric emergency room.

Patient and work flow

- Patients will come to the unit either from inpatient admitting, the emergency department (including transfers), the trauma department, general or intermediate patient care units, or other ancillary services—such as surgery or cardiac catheterization departments. Because of the high acuity level of many of these patients, admission directly on the unit will be frequent, with admitting staff going to the patient room.

- Because of the acuity of these patients, transport off the unit should be limited. Any required transport will be through a dedicated patient transport elevator, equipped with emergency code buttons.
- Visitors should be directed from the information area on the first floor of the hospital to the appropriate inpatient floor. A clerk/reception station on the floor will direct them to the patient room or to the visitor waiting area centrally located on each floor.
- Clean supplies should be delivered via service elevator to clean utility rooms on each patient unit. An exchange cart system will be utilized, stocked on the patient floor by materials management staff. Materials management staff will distribute supplies from exchange carts to nurse servers located adjacent to each patient room.
- Linen should be delivered by materials management staff daily via vertical lift, and should be collected daily from soiled holding rooms.
- Trash and waste should be collected by environmental services staff from soiled utilities located near service elevators, central to the patient floor.
- Dietary carts should be held and food reheated by dietary staff in rethermalization kitchen located central to each patient floor. Carts will be transported via service elevator.
- Pharmaceutical supplies will be provided by pharmacy staff. An automated dispensing cart should be located on each patient unit. Emergency pharmaceutical supplies should transported via pneumatic tube.
- Laboratory specimens, including those for blood gas analysis, should be transported via pneumatic tube. A tube station should be located in each patient unit nursing station.
- Patient records are accessed via computer.

Adjacency requirements

- Intensive care patient units should be located in the same area in the hospital. Functionally similar units should be located adjacent to each other or on the same floor, to be utilized for overflow and to share staff and equipment, if necessary.
- The majority of intensive care units should be directly accessible to the emergency department.
- The burn ICU should be directly adjacent to inpatient surgery for access from the burn operating room.
- The trauma ICU should be directly adjacent to trauma resuscitation for shared nursing staff.
- If possible, the trauma ICU and burn ICU should be adjacent or proximal to each other for shared staffing and to accommodate overflow.

Key functional requirements

Each intensive care unit should contain single-patient rooms, including one to two isolation rooms provided for contagious or immunocompromised patients. Each unit should contain the following:

- *Intensive care room.* Intensive care rooms should be single-patient rooms with good visibility from the nursing station. The use of breakaway glass doors should increase visibility, with curtains used when privacy is required. Rooms should contain either showers/toilets or pullout toilet. Further studies entailing mock-up rooms will be made to determine the most desirable type of toilet; to create ultimate flexibility for a "universal room" concept, consider showers. Room entrances should be sufficiently large to immediately accommodate emergency equipment and mobilizers. Because of the anticipated use of portable renal dialysis machines, special plumbing should not be needed in patient rooms.

- *Patient isolation intensive care room.* Patient isolation intensive care rooms should contain the same amenities and space requirements as general intensive care rooms, but should also contain anterooms for contagion control. Nurse servers, linen, gown, and masks should be located in the anteroom, where gowning should occur prior to entering the room. Appropriate air-handling systems should be provided.
- *Support areas.* Each patient room should contain a nurse server located adjacent to the patient room.
- *Nurses' station.* A central nurses' station should include staff charting, telemetry viewing, remote diagnostic image viewing, pneumatic tube station, and crash cart holding.
- *Staff support areas.* Staff support areas on the unit should include dictation/viewing, team conference, family consultation, staff lounge, and offices.
- *Storage/utility.* Storage areas should be provided for wheelchair/stretcher holding, general equipment, general supply, and portable X-ray (alcoves). Clean and soiled utility rooms should be provided on each unit.

Each patient care floor should consist of two to three patient units and should contain support that can be shared by all units on the floor. Floor support should consist of the following:

- *Waiting/reception.* Visitor waiting should be centralized on each patient care floor. Reception, information, and public flow should be controlled at an adjacent reception/clerk area.
- *Staff support areas.* Central staff support areas should include a staff lounge, locker rooms, on-call rooms, and a teaching/education room.
- *Storage/utility.* Centralized floor storage should be provided for additional equipment, including PT/OT and respiratory therapy equipment. Janitor closets, a clean utility room, and a soiled utility room for hazardous, medical, recyclable, and general waste should also be provided.
- *Rethermalization kitchen.* A large kitchen for meal rethermalization and dietary cart holding should be located central to each floor.
- *Burn unit.* The burn unit has special requirements, including special air handling (positive air exchange or laminar airflow), to prevent infection. In addition, this unit should contain a hydrotherapy area and gowning rooms for all staff and visitors. Rehabilitation requirements on this unit are more extensive than on other units and include additional equipment storage for physical and occupational therapy.

INTERDEPARTMENTAL RELATIONSHIPS AND DEPARTMENTAL GROUPINGS

The location of nursing units is driven by their need for support from diagnostic and treatment facilities, the link to the emergency room, the need for service and support, and the possible clustering of many units together.

As a rule, nursing units are stacked to allow for economies of construction through a simplified structure and stacking of mechanical, electrical, and plumbing systems. Complexities in stacking arise when the units are of different sizes and special studies are necessary to ensure compatibility.

The other major variables affecting location are the size of the units and the position of the nursing function in the master plan. Studies of recent units indicate that for a variety of reasons, primarily economic, nursing units of this era tend to be larger, creating "superfloors" (i.e., floors of 70–120 beds) of many nursing units.

Often the design of a nursing unit or tower of units is severely affected by the master plan. Because hospitals continue to evolve and are always to considered incomplete, the ability to simply tie into a single vertical service core is critical. Hospitals can look at the strategy developed at Valley Presbyterian Hospital, which allowed it to grow from 63 to 360 beds with three towers in a 15-to-20-year period (see pages 142–143).

INTERNATIONAL CHALLENGES

The variations in international culture, economy, governmental role in healthcare delivery, insurance, technology, service, and demography make the design of inpatient units difficult in countries outside the United States. Although most nations aspire to the levels of design of contemporary American hospitals, one can see similarities only in the most economically developed countries. In these countries variations are minor, with the exception of the use of single-bed rooms. Most of these countries still

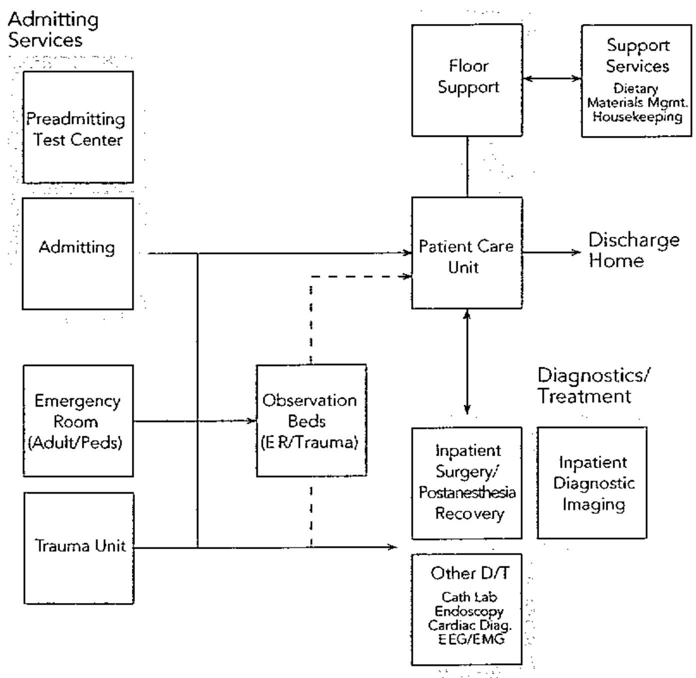
OPTIMAL STAFFING/SERVICE RATIOS

Position / Service			Annual Cost/Unit*
Nursing team (11.5 FTEs)	$10,000/bed	$10,000/bed	$348,714
Clerk	$640/bed		23,500
Nurse manager	$1,040/bed		50,000
Pharmacist		$1,000/bed	80,000
X-ray technician		$625/bed	37,500
Phlebotomist	$790/bed		39,500
Therapist	$880/bed	$630/bed	39,500
Food service			19,000
Supply distribution			23,000

20 30 40 50 60 70 80 90 100

Maximum utility — Number of beds — Optimal Range

*1997 data



▲ *Interdepartmental relationship diagram (BTA).*

provide care in multibed settings.

In the economically developed countries, notably in western Europe and parts of Asia and the Middle East, the factor that differentiates them most is the ability to provide service (and maintenance) for complex technological systems.

In many developing cultures, economic concerns may keep design at a level experienced in this country earlier in the twentieth century. Cultural differences are also evident. In some countries the role of the entire family must be accounted for in the development of space for nursing units. Families often stay with sick relatives, cook in their rooms, and provide much of the care to support the understaffed facilities. Thus, spatial requirements must be adjusted.

In countries where air-conditioning is not possible, the design of the units reverts back to long, narrow wings to allow for through ventilation.

In many Islamic countries, separation of the sexes must also be accounted for, not only in providing separate accommodations but in preventing views from wing to wing.

The ability to provide immediate backup support for technological elements is a further challenge to the designer. Many projects built in the Middle East were unusable in their early development until they had backup systems and staff to service the complex technology.

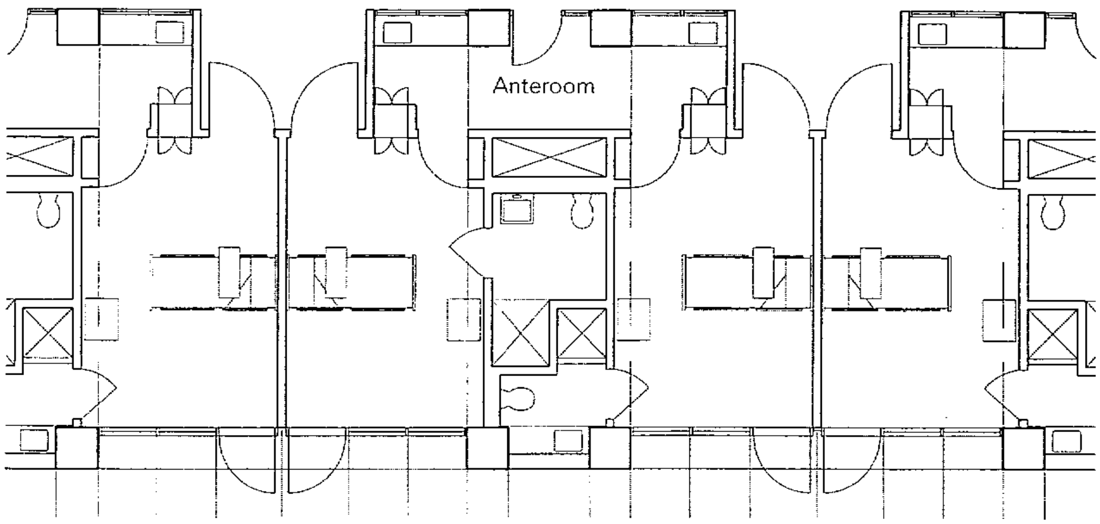
DETAILED TECHNICAL ISSUES

Structural Issues

In California, because of the recent Loma Prieta and Northridge earthquakes, a new replacement policy has been established for all structures housing inpatients. To be phased in over 30 years, this will require all facilities to remain operational after an 8.0 earthquake. The only large hospital designed to that standard and operating at the time of publication with that technology is San Bernardino County's Arrowhead Regional Medical Center, designed by Bobrow/Thomas Associates, Executive and Design Architects in association with Perkins and Will.

Building structure

In considering the structural system for a facility devoted to inpatient care, it is important to select a column grid that will accommodate the narrow dimension of the patient room. A 30 ft square module will typically allow two patient rooms between column lines. For some



▲ *Bone marrow replacement therapy room at City of Hope National Medical Center.*

rooms (LDRs, for example) a slightly larger module may be better, dictating this grid throughout the building. Alternatively, LDR rooms can be oriented differently, with the long dimension against the outside wall.

The building structure, typically, is steel frame or reinforced concrete. Steel frame construction, fireproofed, is most common in seismically active areas. A steel frame can be either moment resisting or braced. For braced frames, the plan layout will have to contend with location of cross-bracing, which limits future flexibility. For moment-resisting construction, special welded connections are required at beam-to-column intersections. Moment frame construction is therefore more expensive.

Concrete construction is also common throughout most of the country. Concrete construction may also consist of moment-resisting frames or, more commonly, may include shear walls, which, like cross-bracing, will limit flexibility. Floor construction may be flat slab or may include concrete joists.

Because of the need to withstand seismic forces and remain operational after a major earthquake, some inpatient facilities are now being designed with base isolation. This relatively new technology places isolation media between the columns of the building and its foundation, diminishing the effect of ground movement. Base-isolated buildings suffer less internal shaking in a major earthquake, lessening damage to buildings systems.

Designed on 380 base isolators with horizontal viscous dampers, as well as other technology to allow for a movement range of 8 ft, the Arrowhead Center is a model that will be studied for future projects. Although California is far ahead with seismic design, other parts of the country along the Pacific plate and in the Midwest may find this a driving force in redesign. This is an opportunity for many hospitals to change the structure of future facilities into a contemporary model where ambulatory care is a dominant component and inpatient care is reduced but far more intense in services and care.

Safety Issues

Even as hospitals change, the inpatient component must still be licensed. The design of hospitals, including the inpatient components, is among the most code regulated of any building design type. Because these buildings directly affect the health and welfare of people, they are licensed by each state and must meet minimum requirements for both operation and construction. Designers must comply with the individual state licensing regulations.

In addition, the inpatient facility is considered to be an "essential building," which must be able to continue in operation despite local disasters. Therefore, it must meet higher standards for structural safety and for preventing the interruption of mechanical and electrical services. In California, for example, the structural resistance of essential facilities to the ground motion of earthquakes must be significantly stronger than that required for conventional buildings. There are specific code requirements for provision of emergency power supply, as well as priorities for electrical services that must be on emergency power.

Inpatient units must also meet life safety requirements, which are conditioned on the presumption that bedridden patients may not be able to exit the building on foot. Codes require that floors occupied by patients be divided approximately equally into two or more separate smoke compartments, which are sealed off from each other with fire-rated smoke partitions including combination fire/smoke dampers in the HVAC ducts. In the event of fire, patients from one smoke compartment can be wheeled, in hospital beds, into the adjacent smoke compartment to await rescue. Because of the prospect of moving patients in beds, corridors are required to be a minimum of 8 ft in width, and cross-corridor doors between smoke compartments are required to allow passage in either direction.

Because inpatient facilities treat patients who receive reimbursement under Medicare, they must meet federal government standards in addition to state and local requirements. If accreditied, they must also meet the standards of, and are subjected to, inspections by the Joint Commission on the Accreditation of Healthcare Organizations (JCAHO). Generally, the federal government, through the Healthcare Finance Administration (HCF), and JCAHO refer to the National Fire Protection Association (NFPA) model codes, including the *Standard for Health Care Facilities (NFPA 99)* and the *Life Safety Code (NFPA 101)*.

Another essential source for understanding the code requirements for inpatient units, and an excellent design reference, is *Guidelines for Design and Construction of Hospital and Health Care Facilities.* Published every two years by the American Institute of Architects Academy of Architecture for Health, with assistance from the U.S. Department of Health and Human Services, the *Guidelines* is referenced directly by many states as a model code. For states that publish a stand-alone code, such as California, the organization of the code sections that apply to inpatient units is similar to that of the *Guidelines*. It is essential, however, to understand the state and local codes that apply to a particular site, to acknowledge from the outset of design that there will be conflicts between the various codes that apply, and to proactively work with code authorities to seek clarification.

In addition to the codes that govern health and life safety, the Americans with Disabilities Act (ADA) also affects the design of inpatient units. The accessibility guidelines included in the ADA acknowledge the special nature of hospitals by not requiring universal access. For general purpose hospitals, psychiatric facilities, and detoxification facilities, the guidelines indicate that 10 percent of patient rooms and adjoining toilets must be accessible. For long-term care facilities, 50 percent of patient rooms and adjoining toilets must be accessible, and for hospitals and rehabilitation facilities that treat conditions affecting mobility, 100 percent of patient rooms and toilets must be accessible. Other than the exceptions indicated for patient rooms and adjoining toilets, an entire inpatient facility must be accessible, in accordance with the ADA guidelines.

Mechanical Systems

Heating, ventilation, and air-conditioning (HVAC) systems must be designed to achieve patient comfort and energy efficiency. They must also accommodate the heat loads produced and environmental conditions required by sophisticated medical equipment.

Because inpatient units are usually within large structures and are often part of a larger campus of healthcare facilities, services are frequently provided from a central plant. Systems that utilize hot water or steam from central boilers and chilled water from central absorption refrigeration units are usually more energy-efficient than those that include boilers and chillers in dedicated spaces for particular buildings. The decision on whether to have a central plant directly affects the amount of space required in either the central plant or a new building and has implications for cost and master planning for routing piping throughout the campus.

Air for heating, cooling, and ventilation is supplied via supply and return ducts from air-handling units. Codes require ducted return in order to control exhaust and filtration. Variable air volume (VAV) boxes are permitted as a means to control air distribution to individual registers, as long as a supply of air is always provided in inpatient areas to meet minimum ventilation standards.

The location of fan rooms is a design issue that relates to building flexibility. Placement of air-handling units in fan rooms on each floor, as was done at Arrowhead Regional Medical Center, allows changes to be made on one floor without affecting the entire building. Air-handling units, potential sources of noise and vibration, should be placed on isolation pads, and the rooms in which they are placed require acoustical treatment.

For most spaces in inpatient facilities, air return is via a common path of connected air ducts returning to the air-handling unit for filtration (using 90 percent efficient HEPA filters for most spaces and 99.97 percent efficient HEPA filters for protective environment rooms) and recirculation. Outside air, to meet minimum requirements, is also introduced into the system at the air-handling unit.

With increased concern for patients with compromised immune systems and patients with contagious diseases, recent code changes have required the creation of protective environment rooms and airborne infection isolation rooms. In a protective environment room, the pressure relationship to surrounding rooms is positive, and air entering the room is protected with 99.97 percent efficient HEPA filters. In an airborne infection isolation room, the pressure relationship to surrounding rooms is negative, and all air is exhausted directly to the outdoors.

The design of rooms for these patients involves the use of an anteroom, which functions as an airlock between the patient room and the surrounding spaces. The proposed plan for patient rooms at the City of Hope National Medical Center, where patients undergo bone marrow replacement therapy, illustrates the use of one anteroom shared by every two patient rooms. The pressure relationship of the patient rooms to the anteroom shared is positive, and all air is exhausted from the anteroom directly to the outdoors. The large doors leading directly into the patient rooms are used only when the patients are first admitted. Nurses and doctors enter and exit the patient rooms via the anteroom.

In designing the inpatient building, the location of outdoor air intakes must be carefully considered to avoid local sources of pollution (for example, heavy automobile traffic) and to separate intake and exhaust fans. Indoor air quality should be a major determinant in the architectural design, as well as in the design of the HVAC systems. Materials should be selected to avoid products that give off unacceptable levels of volatile organic compounds (VOCs).

In addition to special HVAC requirements, mechanical design includes special plumbing requirements, which involves the provision of piped medical gases. These normally include oxygen, vacuum, and medical air. In surgery nitrogen (for running equipment) and nitrous oxide (for anesthesia) are normally used as well. Because the anesthesia gases used today are not explosive, there is no longer a requirement for nonconductive flooring in the operating room. Medical gas systems will have to be zoned, with zone alarms near nurses' stations or other normally staffed locations. Zoning allows the isolation of portions of the system if there is a fault, without taking down the whole system. Medical gas systems are subject to testing and certification during construction by an independent testing agency, as a cross-check to make sure that outlets are installed correctly. With the use of gases in surgery comes the requirement for separate exhaust of waste gases, to protect operating room personnel. This is accomplished through the use of a scavenger system—a vacuum system that exhausts waste anesthesia gas when the patient exhales. It keeps the breath of the patient from infecting medical staff and/or keeps anesthesia gases out of the general atmosphere of the operating room.

Vertical transportation is also a key mechanical design element for inpatient facilities. Elevators should be grouped for efficiency and located in cores that work together with the overall circulation scheme to allow separation of visitor, patient, and staff/service circulation. The location of the elevator core should also take into account future expansion, wayfinding, and other master plan issues.

Special elevators outside the main elevator cores are frequently necessary. Examples include oversized cars that connect surgery directly to emergency room trauma units or to intensive care units. Patients can be moved in these elevators while on stretchers, surrounded by medical staff, and connected to monitors, IVs, and medical gases. Special elevators or hoists (dumbwaiters) are also frequently used to connect central processing, where surgical equipment is sterilized, directly to the surgery suite. In this case there will usually be a "clean" elevator for sterile supplies and carts and a "dirty" elevator for soiled instruments and carts.

Pneumatic tube systems are frequently included in inpatient units. Pneumatic tubes, which were formerly used primarily for movement of forms and records, are now mostly used for pharmaceuticals and for blood samples. The recent development of "soft landing" pneumatic tube systems has made this practical, and increasing use of electronic media has made the movement of paper less critical.

Electrical/Communications Systems

Electrical systems for inpatient units are required to provide power to maintain critical operations even if the local power source is disrupted. Emergency power generation with an adequate supply of on-site fuel is required by code. In addition, in planning for hospital construction and expansion, redundant supply from the power company on two separate feeders, ideally from two separate main transformer locations, is a good idea. In the event of a power failure, automatic transfer switches shift loads from the local power to generators in a manner of seconds. However, for some critical functions, such as physiological monitoring, an uninterruptible power system (UPS) may also be required.

The electrical code specifies which inpatient care services (the most critical) must be restored first, and which functions can be restored with some time lapse. Today's code does not require all functions to be on emergency power; however, the facility may elect to increase generator capacity to keep more services up and running. For example, it may be wise to put elevators on emergency power even if this is not required by the particular jurisdiction.

Communications systems in inpatient units include conventional voice (telephone, intercom), nurse call, data network, and many specialty applications such as picture archiving and communications systems (PACS) for the transmission of radiographic images. In addition to internal staff and patient communications, an inpatient facility also includes electronic systems that actuate controls for the HVAC and lighting systems and provide fire alarm, fire protection, and building security functions.

A recent trend in the design of inpatient facilities is the specification of the many electronic systems components with a standards-based interface so that they can electronically communicate with each other, electronically report to a building management system computer, and, most important, share a common networking infrastructure, or cable network backbone. This creates an integrated building system (IBS), which has the benefit of reducing the number of different types of cabling as well as the overall amount of cable. For the shared backbone to be successful, bandwidth must be adequate.

Currently, Category 5 copper wire can be used for most applications; however, fiber optics are required for high-volume uses, such as imaging. Anticipating the continued future growth in required bandwidth, one possibility is to install hollow tubes to future outlets. At any time in the future, fiber can be blown to the outlet locations (using liquid nitrogen). This has a first-cost premium but might be worthwhile for flexibility.

Another factor influencing flexibility is the sizing and location of communications rooms. These should not be combined with electrical rooms, and they should be large enough to allow for future expansion or should be located adjacent to soft space into which they can be expanded. Ideally, communications rooms should be stacked, one floor above the other, to minimize bends in fiber-optic trunks. The maximum distance from each communications room to a data outlet is today 300 ft. For large floor plates, this may dictate more than one communications room on each floor.

A growing amount of inpatient information is being assembled electronically. Currently, inpatient facilities are installing systems for the electronic retrieval of medical records and X-ray images. There is also a trend toward fully electronic charting, although currently a combination of paper and computer records is not unusual. Nurse call systems are also becoming more sophisticated, including the use of remote paging devices that allow the nurse to receive calls and communicate away from the nurses' station. In addition, telemetry for physiological monitoring is also becoming routine. This allows an expectant mother, for example, to walk the corridors of the nursing unit while still in communication with a fetal monitor, instead of being confined to her room.

With the pace of technological change at its current rapid rate, and with the long development time (five to seven years) for a major inpatient building, it makes sense to defer some of the systems selection decisions until well into the development process. This requires the design of a system infrastructure that is flexible enough to adapt to the last-minute selection of systems, which in turn allows the inpatient unit to take advantage of advances in technology.

Special Equipment

Planning for the required medical equipment is a key part of the design of any inpatient unit. Equipment can range from major imaging and treatment devices, costing millions of dollars, to small rolling stock such as instrument carts in an operating room. Equipment planning usually groups individual items into categories: Group I, major fixed equipment; Group II, major movable equipment with electrical, mechanical, and electrical service requirements; and Group III, minor movable equipment such as carts, stands, and so forth, with no service requirements. Coordinating the budgeting, selection, and purchasing of equipment is a major task. Of particular concern to the architect is the assembly

MEDICAL CENTER: ENGINEERING ALTERNATIVES AND COSTS

Item No.	Description	In Current Plans	Area (sq ft)	Cost/sq ft	Current scope in base estimate	Current scope, new (not in base estimate)	Current scope, remodel (not in base estimate)	Potential additions or alternatives (not in base estimate)	Comments
	Building Scope:								
1.1	Reduction in shell space with increase in clinics/support	Yes	3,882	$80		$310,560			
1.2	Cardiac cath lab at former residents' sleep rooms, level 3	No	2,131	$90				$191,790	Without equipment
1.3	Physical therapy space at Extended Care	Yes	800	$169	$135,200				Did not increase building area
1.4	Resident's lounge/workroom at remodel area	Yes	1,300	$52					
1.5	Connector corridor to south of existing dietary	Yes	2,000	$110			$220,000		
1.6	New lobby and exterior stairs at conference entry	Yes	300	$90			$27,000	$67,600	
	Building Construction/Finish:								
2.1	Precast architectural concrete exterior @ Family Center	No	9,800	$16				$156,800	
2.2	Upgrade of architectural finishes:								
2.2.1	Sheet vinyl flooring in lieu of VCT @ Extended Care	No	8.68	$2				$17,360	
2.2.2	50% Vinyl wall covering in lieu of paint @ Extended Care	No	25,872	$3				$77,616	
2.3	Skylights at 2nd floor waiting areas	Yes	8	$1,000		$8,000			Per 4' x 8' unit
2.4	Higher precast walls at Central Plant	Yes	2,212	$25		$54,194			

of equipment information needed for engineering coordination.

For the largest equipment items, coordination usually occurs directly with the equipment vendor, who prepares the installation drawings. Linear accelerators, which are used for cancer treatment, require thick walls and ceilings for radiation shielding. These devices must also be located at the lowest occupied building level (ground floor or basement) to eliminate the need for (expensive) radiation shielding below the equipment. Magnetic resonance imaging (MRI) units require extensive radiofrequency shielding and a ground floor location. MRI units need controlled access to ensure that metal objects are not brought within the magnetic field.

Radiology departments require coordination of complex imaging equipment. Areas of technology that are currently undergoing great expansion include cardiac catheterization, electrophysiology, and interventional radiology. The line between diagnostic and interventional procedures is becoming less strict, with the prospect that traditional imaging rooms will take on some of the characteristics of surgery and surgical operating rooms will increasingly include imaging capabilities.

Acoustics

Acoustic control in the inpatient unit is important to the well-being of both patients and staff. Walls between patient rooms, as well as offices and examination rooms, should provide acoustic privacy. Partitions between these spaces should have a sound transmission class (STC) of 45. In addition, isolation of vibration from mechanical equipment and the prevention of noise from pipes, elevators, and other building services is essential.

For some areas within the inpatient facility, special acoustic standards apply. One of these areas is the neonatal intensive care unit, or special care nursery. Recent research in the developmental pattern of preterm infants indicates the importance of maintaining a quiet environment in the nursery. The noise level within these areas should never exceed 50 decibels.

Acoustic control will at times conflict with other requirements, including the cleanability of interior surfaces. Some areas will be required to have ceilings that are washable and, hence, not acoustically treated. Floors may have to be of sheet vinyl rather than carpet. The design and selection of components such as acoustic wall panels and furniture may in some cases be used to compensate for hard surfaces in the room.

Key Cost Factors

As in the design of any building, key decisions early in the project will have a great influence on the cost of the inpatient facility. Among these are selection of the site, including the extent to which existing buildings impede construction activity, the extent of demolition required, utilities that may have to be relocated, and soils and geologic conditions. Other key decisions include selection of the basic structural system, mechanical and electrical system types, and exterior envelope criteria.

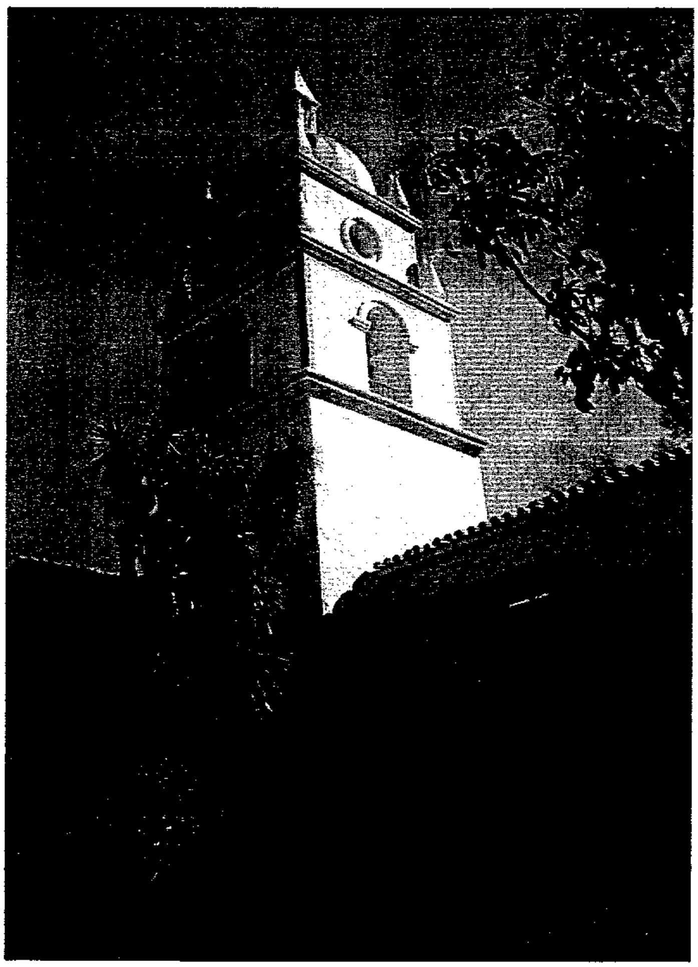
Initially, the most important step is setting an appropriate quality level for the project. This will require discussions with the client concerning the budget target as well as the client's own preconceptions about what the building should be. Healthcare construction costs vary by

MEDICAL CENTER: BUDGET RECAPITULATION

Budgeted Line Item	April 30, 1999 Master Plan	Adjusted Total Budget Aug. 27, 1999 BTA	Preliminary Schematic Estimate Sep. 17, 1999	Schematic Estimate Oct. 5, 1999 BTA	DRAFT Design Dev. Estimate Jan. 27, 2000 BTA
1 Construction cost	$38,642,169	$45,149,000	$44,629,567	$45,584,023	$48,961,027
2 Site development	$2,773,000	$2,773,000	$4,500,000	$4,644,442	$4,859,450
3 Design contingency	$6,212,275	$2,575,000	$1,785,183	$2,009,139	$1,942,441
4 Subtotal (1+2+3)	$47,627,444	$50,497,000	$50,914,750	$52,237,604	$55,762,918
5 Escalation (June 2000)	$4,411,444	$1,800,000	1,740,806	1,828,316	1,123,626
6 Site construction cost (4+5)	$52,038,888	$52,297,000	$52,655,556	$54,065,920	$56,886,544
7 Furniture, fixtures & equipment (F.F.& E)	$7,961,545	$7,960,000	$7,419,944	$7,960,000	$7,960,000
8 Construction contingency (3%)	$0	$2,345,000	$2,345,000	$2,345,000	0
9 Owner Contingency (2% of line 1)	$0	$2,265,000	$2,265,000	$2,265,000	$2,448,051
10 Subtotal (7+8+9)	$7,961,545	$12,570,000	$12,029,944	$12,570,000	$10,408,051
11 Subtotal construction + F.F. & E. (6+10)	$60,000,433	$64,867,000	$64,685,000	$66,635,920	$67,291,497
12 Permits/Testing/OSHPD/I.O.R.	$1,088,000	$1,088,000	$1,088,000	$1,088,000	$1,088,000
13 Fees (A&E, A&E Reimb., CM, CM Reimb.)	$6,717,833	$5,630,000	$5,630,000	$4,920,688	$5,100,000
14 Subtotal (12+13)	$7,805,833	$6,718,000	$6,718,000	$6,008,688	$6,188,000
15 Subtotal grand total (11+14)	$67,806,266	$71,585,000	$71,403,500	$72,644,608	$73,479,497
16 Site development bldg. relocation	$6,225,000	$3,745,000	$3,745,000	$2,045,000	$2,045,000
17 Total cost (15+16)	$74,031,266	$75,330,000	$75,148,500	$74,689,608	$75,524,497
18 Family Center	$1,275,000	$1,050,000	$1,231,500	$1,690,392	$1,673,439
19 Financing	$7,093,733	$6,020,000	$6,020,000	$6,020,000	$6,020,000
20 Total project cost (17+18+19)	$82,400,000	$82,400,000	$82,400,000	$82,400,000	$83,217,936
20A - Total project cost overage - to be reduced:					$817,936
Addendum - medical office building:					Concept 12/9/99
21 Construction cost with contingency & escalation					$5,117,171
22 Site development					$200,000
23 Fees (A&E, A&E Reimb.)					$270,000
24 Contingency (10% of Line 51)					$511,717
25 Total cost, MOB (21+22+23+24)					$6,098,888
26 Grand total project cost (20+25)					$89,316,824
Medical center areas (Building gross sq ft)					
New hospital building (OSHPD) T1	173,635	179,048	186,844	184,435	186,468
Existing hospital renovation (OSHPD)	23,400	20,855	23,136	23,136	23,136
Outpatient - serv. (non-OSHPD)T2	40,000	57,902	68,109	69,000	69,000
Administration/support (non-OSHPD) T2	31,161	35,853	30,000	31,200	29,952
Extended Care/rehab (OSHPD) T2	25,413	23,540	22,933	23,847	24,545
Generator building					3,437
Subtotal area	293,609	317,198	331,022	331,618	336,538
Family Center	7,000	7,319	9,852	13,365	13,802
Total Area	300,609	324,517	340,874	344,983	350,340

region, with a premium for inpatient unit construction in seismically active areas. Currently, construction costs range between $200 and $300 per square foot, depending on the complexity of space provided and the quality level selected.

In managing an inpatient facility project, the architect must keep in mind that construction cost is one component of the overall project cost. It is useful to establish with the client and/or construction manager a cost budget for all categories. Once the cost budget is established, it can be monitored, with updated estimates at each design phase, and adjustments made to keep the overall project cost in line. An example of the cost budget by categories for a recent inpatient facility project is shown in the table on page 189. As of the most recent phase, a budget shortfall has been identified. To bring the project in on target, value engineering ideas were offered to the client, as shown in the table on page 187. Only by closely monitoring costs at each stage of design can budget control be maintained.



▼ *California State University, Channel Islands (BTA; formerly the Camarillo State Developmental Hospital).*

TRENDS, INCLUDING REUSE AND RETROFIT

Health System Trends and Indicators for Inpatient Design

With the rapid changes in healthcare delivery, the impact on inpatient care is significant and constantly evolving. The following are some of the trends and indicators affecting nursing unit design today:

- Increasing levels of care for patients
- Increasing utilization of home health/subacute care/skilled nursing units
- Increasingly elderly population with multiple diagnoses/illnesses
- Increasing utilization of computerized/bedside charting
- Increasing provision of treatments at bedside
- Increasing integration of family members as caregivers
- Increasing focus on patient education/information
- Increasing focus on patient ambulation
- Increasing utilization of ICUs for surgical recovery, bypassing postanesthesia recovery

Increasing potential for infectious disease and/or immune-compromised patients
Questionable success of cross-training
Questionable success of patient-centered care approach to increasing ancillary services on the patient unit
Changing types of nursing care/support (decreasing licensed vocational nurse/registered nurse levels)
Increasing utilization of electronic information and delivery (e.g., tube systems and digital radiography)
Increasing emphasis on patient-focused care and treating the person vs. the disease

Adaptive Reuse of Hospitals

The reuse of hospitals for purposes other than healthcare is the subject of increasing discussion, given the overbedding of hospitals and unnecessary duplication of hospital facilities. This becomes increasingly important as inpatient utilization declines and more procedures are done on an outpatient basis in clinics and doctors' offices.

There have been a multitude of suggestions for the reuse of hospitals. Actual transformations to other uses have included an art college on the East Coast, the reuse of a psychiatric long-term hospital as a state university in California, and a number of hospitals converted to single-room-occupancy housing.

SUMMARY

Because change is a constant force in design, today's designs must acknowledge that what is built for today is not permanent and will at some point become a candidate for reuse, retrofit, or removal. Therefore, the need for a comprehensive master plan that provides an "arrow" into the future is necessary. Hospital planning at its highest level recognizes this open-ended indeterminacy and creates a conceptual structure for this change.

It is to be expected that inpatient care will change and in many cases disappear. There is a need to create nursing units today that are adaptable to major change through the use of flexible long-span structures, with vertical service systems pulled out of the core to leave the floor plate as free as possible for change.

Trends indicate that virtually all patients in the future who are housed in acute care hospitals will require a level of care close to intensive care, with sophisticated monitoring. The rooms must be designed today as "universal rooms" to allow for this evolution.

Although construction of replacement nursing units is often questioned because of initial costs and the difficulty of financing, the solution to that dilemma is in the design of an efficiently staffed unit. The cost of construction is but a small part of the cost of the daily operation of a hospital. Over the lifetime of a building, construction costs have averaged only 6 percent of operating expenditures. It can be demonstrated (in todays dollars) that the savings of one nursing staff member or equivalently salaried employee can save one million dollars in construction costs. The reductions in staff possible with new construction of efficient units can often pay for the unit.

Thus, the challenge to architects and hospitals is to create nursing units that are most efficient for today's operation, are flexible enough to adapt to the unknown needs of tomorrow, and provide a humanizing architecture that can be a positive contributor to the healing process.