ACCESS AND PARKING CRITERIA FOR HOSPITALS

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Eleven public general hospitals in metropolitan Vancouver, having a total capacity of 2,700 beds and providing direct employment for 5,150 people, were included in this study. The main focus of the study was to describe and understand employee traffic and parking needs with a view to developing overall planning standards for access and parking. The study showed that most employees live within 2 miles of their hospitals and that nurses and technical employees tend to live within 1.6 miles. The employees of larger hospitals live closer to their hospitals than those at smaller hospitals. On the average, 58 percent come to work by car, 20 percent by bus, and 22 percent on foot. Parking is inadequate at most hospitals, and hospital users and employees park on adjacent streets. Trip generation characteristics and travel mode at each hospital were studied in the framework of hospital size, location, and level of transit service. Based on socioeconomic characteristics of employees, parking needs of this group were developed in relation to hospital size and transit service. Access requirements of hospitals are discussed. Finally, visitor and patient requirements deduced from other studies are used to develop parking standards for future planning.

•BY 1980, approximately 20 million Canadians, equal to 80 percent of the total population, are expected to live in urban areas, compared with 73 percent in 1967. The distribution of this urban population is further expected to resemble an east-west demographic ribbon parallel to the U.S. border. Of particular importance is the forecast that most of the predicted urban growth will take place only in a few cities, especially Montreal, Toronto, and Vancouver (1).

Hospital and health care facilities will grow not only because the population is increasing but also because a greater variety of health services is being offered and is available to a greater proportion of the population through a national commitment to universal health care. These facilities and their use are expected to grow faster than population itself.

Recent population forecasts for metropolitan Vancouver indicate a growth pattern of 892,000 people in 1966 (estimated at 915,000 in 1968) increasing to 1,169,000 in 1976 (2). On the other hand, the number of hospital beds is expected to increase by almost 50 percent during 1968 to 1976 even though the number of hospital employees is not expected to increase at a higher rate than the total population in metropolitan Vancouver.

In 1960, Smith examined several hospitals in 8 major U.S. cities and recommended planning standards for parking (3). He examined several traffic and parking studies conducted in major U.S. cities together with related zoning and parking standards. The basic unit of measurement used by Smith was the number of beds in the hospital, and the focus was on parking requirements. Smith's study has provided very useful guidelines for planning of urban and suburban hospitals. There is, however, a critical and urgent need to update these standards in view of the changing nature of hospital services and their changing trip generation characteristics.

In 1969, Keefer and Witheford studied 78 hospitals in 16 metropolitan areas in the United States with particular reference to their trip generation characteristics (4).

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Travel data examined by Keefer and Witheford were derived from a number of traffic and transportation studies done on a metropolitan area-wide basis. The study examined overall employee trip characteristics, trip lengths, trip mode, and peak-hour characteristics related to employees and visitors. These data need to be supplemented by an examination of the trip generation characteristics of hospitals and their linkages to socioeconomic characteristics of employees and their housing location in the Canadian context.

The Vancouver metropolitan area with a population of almost 1 million people has 15 public hospitals fully supported by local, provincial, and federal governments. They have a total capacity of 4,400 beds, employ 9,000 people, and are estimated to provide support for a population of 100,000 including those employed by hospital-related industry. By 1976, these hospitals expect to employ 14,000 people directly with a total estimated bed capacity of 6,200. The research presented here examines the journey-to-work patterns of employees and their relationship to the spatial distribution of housing within the urban structure vis-à-vis socioeconomic characteristics of employees and available transportation linkages (automobile and transit).

STUDY SCOPE AND METHODOLOGY

Study Hospitals

Only 11 general hospitals in metropolitan Vancouver were included in this study. The following 3 hospitals were excluded because of their uniqueness: Children's Hospital, G. F. Strong Rehabilitation Center, and Vancouver General Hospital. Children's Hospital and the G. F. Strong Center are special hospitals catering to an identifiable and unique group of patients and quite unlike other general-purpose hospitals. The Vancouver General Hospital is the biggest hospital in the province of British Columbia and caters to the special and general needs of the entire province. Peace Arch District Hospital was new and not yet in full operation at the time of data collection.

Hospital Characteristics

Characteristics of hospitals included in the study are given in Table 1. Spatial location, interrelationships, and size are shown in Figure 1. These hospitals range in capacity from 52 to 551 beds and in employment from 65 to 1,142 persons. All are public hospitals and derive support from local, provincial, and federal governments.

Only one hospital—Surrey Memorial—is not served by transit. For the remaining ten, the transit service varies from 1 bus line to 16 bus lines within 1,000 ft of walking distance. St. Paul's Hospital, one of the largest, is located in the central business district of Vancouver. As can be expected, it has excellent transit service. Mount St. Joseph's Hospital, outside the CBD but in the heart of an old business district, also has excellent transit service. All other hospitals are served by transit and have available 1 to 6 bus lines within 1,000 ft of walking distance.

Parking provided at these hospitals varies from 35 to 445 spaces. Only one hospital provides parking as required by the zoning bylaw, three provide more than that required, and seven provide less than that required.

Scope of Study

The study deals with employee travel and related facilities only; it does not, therefore, present a total picture of hospital transportation characteristics and needs. A complete picture must include consideration of the needs and characteristics of patient, visitor, and delivery transport in addition to those of employees.

The study is descriptive and does not pretend to be deterministic for cause and effect relationships. The findings should prove useful, however, to hospital administrators and planning agencies concerned with the planning of new or expanded hospital facilities or with the upgrading of present transportation facilities.

TABLE 1

HOSPITAL CHARACTERISTICS

Hospital Capacity and Employment							Cost of Parking Development		Parking Spaces Provided			Parking Required by Local Zoning Bylaw	
Name	Type[a]	Number of Beds 1968	Number of Beds 1976	Gross Floor Area (ft^2)	Number of Employees	Transit Service Index[b]	Land	Improvements	Staff	Public	Total	Space Ratio	Number of Spaces
Grace	CG	93	170	67,807	235	L	64,000	–	15	36	51	1/1,000 gross ft^2	68
Holy Family	Reh	52	52	24,500	65	M	2,500	2,500	10	25	35	1/1,000 gross ft^2	25
Lions Gate	CG	484	658	263,000	707	M	–	–	73	0	73	1/4 beds	121
St. Joseph	CG	141	400	72,000	166	H	82,000	5,000	–	–	71	1/1,000 gross ft^2	72
Richmond General	CG	154	229	101,420	199	M	12,400	–	26	114	140	1/1 bed	154
St. Mary	CG	256	256	157,848	321	M	26,018+	11,296+	67	30	97	1/1,000 gross ft^2	158
St. Vincent	CG	180	332	95,000	297	M	50,000	10,000	35	60	95	1/1,000 gross ft^2	95
Surrey Memorial	CG	103	253	47,600	164	L	–	–	107	28	135	1/4 beds 1/1 staff doctor 1/3 employees	81
Royal Columbian	Ref	434	403	325,637	869	L	200,000	15,000	279	166	145	1/1,000 gross ft^2	326
St. Paul	Ref	551	651	247,500	1,142	H	–	–	161	4	165	1/1,000 gross ft^2 1/5 beds	247
Burnaby General	CG	242	350	168,778	379	L	46,000	18,000	70	155	225	1/2 staff doctors 1/4 employees	147

Note: 1968 data unless otherwise stated.

[a]CG = community general, active care; Reh = rehabilitation; and Ref = referral, approximately 30 percent of cases from outside city and approximately 20 percent of cases from outside metropolitan area.

[b]L = 0, 1, or 2 bus lines within $^1/_5$ mile; M = 3, 4, 5, or 6 bus lines within $^1/_5$ mile; and H = 7 or more bus lines within $^1/_5$ mile.

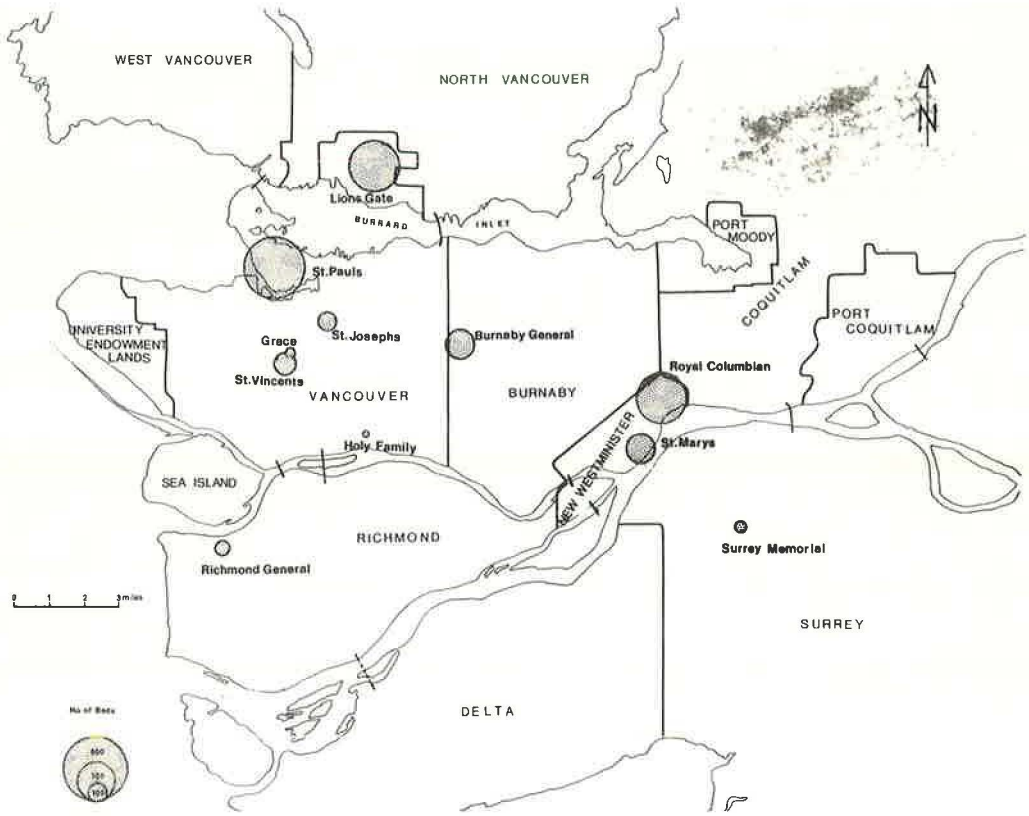

Figure 1. Location and size of hospitals in study.

Study Methodology

Information on employee travel and other characteristics was obtained in August-September 1968. Questionnaires were distributed to 5,150 employees through the payroll offices in the 11 hospitals. Forty-eight percent or 5,200 employees returned the completed questionnaires; 3 hospitals returned 100 percent samples; and 1 hospital returned only a 20 percent sample.

Information on basic hospital characteristics was obtained in November-December 1968. This information was compiled from the files of the respective hospitals, the Greater Vancouver Regional Hospital District, and the local municipal planning departments. Only simple statistical and graphical analysis techniques have been used to discover apparent correlations between the variables considered.

TRAVEL CHARACTERISTICS

Parking has become a major issue facing the administrator of an urban hospital; with both land and capital in short supply, he is often unable to provide the amount of parking that seems to be required. Municipal bylaw requirements for hospital parking are often inadequate and add to the administrator's problems because more parking than that legally required is not likely to be constructed until severe problems develop.

Parking demand determinants at urban hospitals are directly related to the type and magnitude of health care provided. Whether it be a general, referral, or special care hospital, the number of beds determines the number and type of employees as well as visitor potential and emergency needs. To some degree, aggregate parking demand is a direct function of the number of beds or the number of employees or both.

Trip Generation

Each employee generates at least 2 trips per day, 1 trip to and 1 trip from the hospital. Exceptions to this are the doctors who may travel to and from a hospital several times a day for consultation and emergencies. Employee trip-making, other than to and from work, was not considered in this study, but the assumption of 2 trips per employee, with some additional allowance for doctors, was considered adequate for planning purposes. Visitor trips, which account for most of hospital travel, must also be considered.

Shift Work

Shift work reduces the proportion of employees present at any one time; the total number of hospital employees, therefore, may not be the best indicator of the demand for parking. The study data indicate that, on the average, 50 percent of employees do not work shifts at all and that 79 percent of employees work during the daytime. The proportion of employees working each shift is as follows:

Shift	Percentage of Employees
None	50
Day	29
Evening	14
Night	7

The most critical time of day for employee parking is the period immediately before the start of the evening shift. During this period parking space must be available not only for those working the evening shift but also for those working the day shift and straight days. An average of 14 percent more parking space than would normally be required by employees must be available to handle the critical period unless an effective system of staggered shift changes is in operation.

Parking Cost

Only 1 of the 11 hospitals included in this study charges for the use of its parking space. These charges are very moderate, in the order of 10 to 15 cents per hour or

$6 per month, and certainly insufficient to reduce the demand for parking to a degree that can be observed in parking-lot usage. The capital cost of providing off-street parking varies with the location of the hospital, from a low of $150 to a high of $1,250 per space. The average cost per space is $500. This is between 2 percent and 2.5 percent of the capital cost of hospital construction with a "1-bed, 1-space" policy.

Residence Location

Approximately 50 percent of all hospital employees live within 1.8 miles of their places of work. This distance is different for each hospital. Employees of large hospitals tend to live closer to work than those at small hospitals. This is shown in Figure 2. (All distances are measured in straight air-line miles.)

The median home-work distance for hospital employees driving cars to work was found to be 2.8 miles. This compares favorably with the patterns of journey to work in metropolitan Vancouver, although hospital employees seem to live closer to work than others. Wolforth's study of journey to work in Vancouver indicated a median home-to-work distance of 3.4 miles for work centers outside the CBD, while Pendakur and Hickman pointed out that mean journey-to-work distance for peripheral work centers is 3.6 miles. Wolforth and Pendakur measured over-the-road distances, and these are generally higher than air-line distance used in this study (5, 6).

Hospital employee work-trip lengths for automobile drivers, as revealed in this study, are slightly less in Vancouver than in the United States. Keefer and Witheford, in a study of 78 hospitals that included hospitals of 150 to 600 bed capacity, showed that average work-trip length was 3.5 air-line miles (4). Work-trip lengths are generally lower in Vancouver than in other large U.S. cities because it is a smaller urban area. This has been studied and pointed out by Wolforth and Pendakur and by Hickman.

The median home-to-work distance for transit riders is 2.2 miles in Vancouver. No comparative data for other work centers in Vancouver for transit riders are available.

Employee category and distance to work are related as shown by data given in Table 2. Because only 4 hospitals returned information concerning doctors, the median distance shown for this group may be biased. If doctors are excluded, there seems to be a correlation between socioeconomic status, as defined by employee category, and the home-to-work distance.

Employees in the nontechnical category appear to have a significantly longer trip to work than do those in other categories. Two arguments may be advanced in explanation: (a) Employees in the lower socioeconomic class cannot afford to obtain housing close to their places of work and must substitute travel in place of convenient locations; or (b) nontechnical work is not unique or peculiar to hospitals, and employees in this category can work in many places and will therefore tend to optimize their locations in terms of all work opportunities. The latter argument is supported by the fact that employees tend to live closer to large hospitals near which there are many other work opportunities.

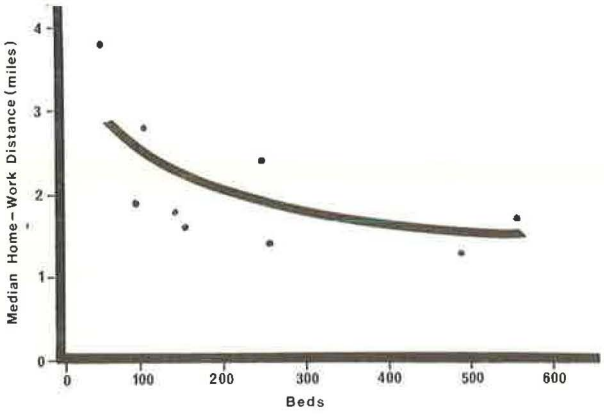

Figure 2. Distance from home to work versus size of hospital based on number of beds.

Modal Split

Modal split varies not only among hospitals but also among employment categories (Table 2). The proportion of employees driving to work varies with socioeconomic status as defined by employment category. All the doctors are automobile drivers. This is

TABLE 2

EMPLOYEE HOME-TO-WORK TRAVEL DISTANCE AND MODE

Employment Category	Distance (miles)	Mode (percentage of employees)			
		Automobile Driver	Automobile Passenger	Bus	Walk and Other
Doctors	2.25	100	0	0	0
Technical	1.61	61	7	15	17
Nurses	1.85	50	10	15	25
Administrative and clerical	1.85	46	11	21	22
Nontechnical	2.11	36	10	31	23
Average		48	10	20	22
Range of average					
High		85	12	33	34
Low		24	5	0	3
Urban hospitals only		46	11	19	24
Suburban hospitals only		68	10	10	12

understandable because of the nature of their work and is consistent with experience in the United States. A very high proportion of technical employees (61 percent) and nurses (50 percent) drive their cars to work compared with administrative (46 percent) and nontechnical employees (36 percent). Those of higher status and in higher income groups drive to work. Keefer and Witheford have shown that 42 to 62 percent of employees drive to work at U.S. hospitals (4). In comparison, 48 percent of all employees drive to work in Vancouver.

Twenty-two percent of all employees live close enough to be able to walk to work. Again lower socioeconomic groups (administrative and nontechnical) tend to live closer to work. Only 17 percent of technical employees live within walking distance to work compared with 23 percent for nontechnical and 22 percent for administrative employees.

On the other hand, 25 percent of the nurses live within walking distance. This may be due to several reasons: Some hospitals have nurses' residences located very close by; most nurses are single and tend to aggregate and live close by; many nurses are required to work shifts; and either apartment or multifamily rental accommodations are available near most hospitals.

The number of employees coming as automobile passengers is fairly constant at an average of 10 percent of all employees. Car occupancy is 1.21 for hospital employees, and this is slightly lower than overall car occupancy computed by Lea (7) of 1.34 for work trips for Vancouver.

Hospital employee travel mode and trip length characteristics presented here seem to be typical and comparable to those in large cities of western Canada. For example, hospital employees in Edmonton, Alberta, have similar trip lengths and use similar modes if allowance is made for the colder climate that discourages walking. In Edmonton 52 percent of employees drove cars compared with 48 percent in Vancouver, and 16 percent came by bus compared with 20 percent in Vancouver (8).

There are variations in the modal split among hospitals, but 2 distinct patterns can be identified. One pattern is best described as urban; 4 hospitals fit this pattern. The other pattern is best described as suburban; 3 hospitals fit this pattern. Modal-split variation between urban and suburban hospitals is given in Table 2. Hospitals described as urban are typically located in fairly intensely developed areas (6,000 persons/sq mi or more) and have average or better than average transit service. Hospitals fitting into the suburban pattern are typically located in less intensely developed areas (less than 6,000 persons/sq mi) and have less than average transit service.

Parking

The amount of parking required by employees varies with staff composition and shift-work practices and is related to alternative transportation quality available. On the

average, all doctors, 61 percent of technical employees, 50 percent of nurses, 46 percent of administrative and clerical employees, and 36 percent of nontechnical employees drive to work and require parking. Overall, it was found that 48 percent of employees require parking, but this proportion varies between 24 and 85 percent (Table 2). Not unexpectedly, the low proportion of drivers applies to a downtown hospital with very good transit service and the high proportion to a suburban hospital with almost no transit service.

Approximately 75 percent of employee cars are parked on hospital property, 21 percent on the streets in the neighborhood, and 4 percent on private parking lots. The number of employee cars parked on the neighborhood streets can be reduced considerably by a moderate increase in the amount of off-street parking provided. Forty percent of the hospitals appear to have recognized this and are providing an average of 45 percent more parking than required under the zoning regulations. At the same time another 40 percent of the hospitals are supplying an average of 30 percent less parking than is required. The effect of these variations on on-street parking is as follows:

Amount of Parking Provided as Percentage of Zoning Requirement	Employee Cars Parked in Hospital-Provided Lots (percent)
145, 4 hospitals	95
100, 2 hospitals	82
70, 4 hospitals	64
30, 1 hospital	34

Municipal zoning regulations for off-street parking to be provided by hospitals vary between "one parking space per bed" and "no parking required." Between these extremes another 5 varieties of regulations establish minimum requirements. The regulations for the 14 municipalities in metropolitan Vancouver are given in Table 3.

The wide variety of minimum standards for parking suggests little agreement on the magnitude of the parking problem facing hospitals. For the urban hospitals, an average of 0.57 parking space per bed was required by zoning bylaw; and for the suburban hospitals, an average of 0.78 parking space per bed was required.

The level of transit service to a hospital can be used as an indicator of employee demand for parking. Grouping the same hospitals by the number of bus lines serving them revealed the following:

Transit Service		
Level	Number of Bus Lines Within 1,000 Ft	Employees Driving to Work (percent)
High	7 or more	27
Medium	3, 4, 5, and 6	54
Low	2 or fewer	67

Transit service is generally better in high-density areas, and the effect of transit service suggested by the preceding data also includes the effects of density and income on car ownership and consequently on modal split. Figure 3 shows the relationship among density, income, and car ownership in greater Vancouver. Data shown in Figure 3 are consistent with the trends in other Canadian metropolitan areas. Generally speaking, high-income groups living in low-density areas have the greatest number of cars per household. Almost 100 percent of the hospital employees have annual incomes of more than $3,000. All doctors and some technical employees have incomes of more than $8,000 per year. More than two-thirds of the total employees (technical, nontechnical, administrative, clerical, and nurses) have annual incomes of $5,000 to $8,000. Median car ownership is approximately 1.0 car per household and slightly higher in low-density suburban areas.

Figure 4 shows the relationship between the proportion of employees driving to work and resident population density in the neighborhood where the sample hospital is located. On the average 50 percent of employees live within 1.8 miles of

their hospitals, 67 percent live within 2.7 miles, and 85 percent live within 4.8 miles. Even though these commuting distances vary, it is significant to note that 50 percent of employees live in the hospital neighborhood itself, and consequently their socioeconomic-travel characteristics are typical of those in neighborhoods having similar density, income, and other neighborhood characteristics.

TABLE 3

ZONING REQUIREMENTS FOR HOSPITAL PARKING

Zoning Requirement	Number of Municipalities
1 space/1,000 sq ft of floor area	2
1 space/4 beds	1
1 space/2 beds	1
1 space/1 bed	1
1 space/4 beds, 1 space/1 staff doctor, and 1 space/3 employees	2
1 space/5 beds, 1 space/2 staff doctors, and 1 space/4 employees	1
No requirement	6

Data given in the preceding tabulation and shown in Figures 3 and 4 are interrelated and should be considered together. For example, hospitals with low transit service are characteristically in the suburbs where there are low densities and slightly higher incomes and where the highest proportion of employees drive to work. In contrast, hospitals with the highest level of transit service are characteristically located either in the central business district or en route to the CBD but not necessarily in low-income neighborhoods. These have the fewest employees who drive and the most employees who ride transit. All the hospitals studied provide similar services, but their locations influence transportation service levels and employee travel habits. The number of employees driving to work is obviously a function of income, car availability, and transit service and directly determines the employee parking needs.

Based on the amount of parking actually supplied by the various hospitals, in terms of parking spaces per bed or parking spaces per 1,000 sq ft of floor area, approximately 95 percent of employee cars will be parked in hospital parking lots if these lots have 0.75 parking space per bed or 1.3 parking spaces per 1,000 sq ft of floor area. Provision of parking simply to prevent employee cars from being parked on the street is, of course, no guarantee that the employee demand for parking is being met. It seems reasonable to assume, however, that had a large unsatisfied demand for employee parking existed, the street spaces freed through provision of more off-street parking would automatically be used to satisfy this demand. This has not occurred, and it may be assumed that the employee demand for parking is reasonably satisfied if 0.75 space per bed is supplied. To what extent this amount of parking will satisfy the visitor de-

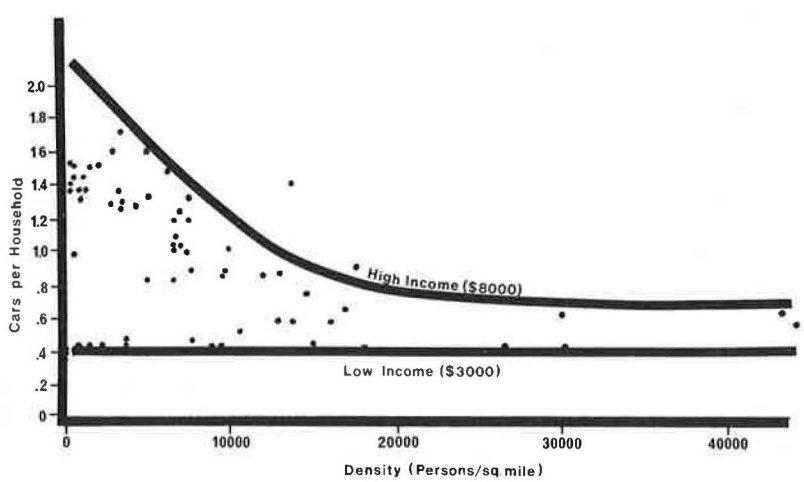

Figure 3. Relationship of population density, income, and automobile ownership.

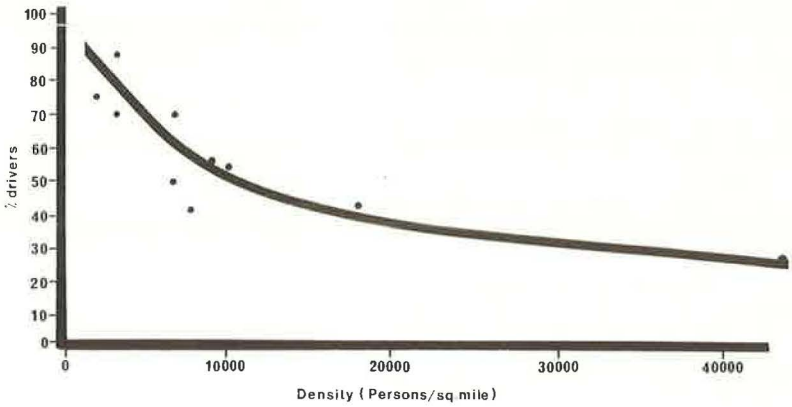

Figure 4. Relation of resident population density in hospital area and proportion of employees driving to work.

mand is uncertain; employees are usually in a position to preempt parking spaces, and the relative satisfaction of their needs is not necessarily a measure of the satisfaction of other users' needs.

PLANNING CRITERIA FOR ACCESS AND PARKING

In 1960, Smith studied 8 large hospitals in the United States and concluded that the hospitals had serious access problems and did not provide adequate parking facilities (3). He recommended interim parking standards and suggested further research. The American Hospital Association subsequently made an effort to incorporate access and planning criteria into hospital development procedures. These standards were minimal and somewhat inadequate even in 1962 (9, 10). Biciunas studied the trip generation potential of hospitals in 1965 in the context of increasing availability and use of health care services and pointed out the need to coordinate transport planning with site planning (11).

In 1969, Keefer and Witheford analyzed travel patterns at 78 large hospitals in the United States as a part of their study of urban travel patterns to major trip generators. They found that on the average parking facilities at hospitals were inadequate and that some hospitals had serious access problems (4).

Changing Trends

Access and parking problems at many Canadian hospitals partly result from tremendous post-war growth and partly reflect the general increase in congestion on urban arterials in Canada during the past 25 years. Because of a national commitment to universal medicare in Canada, there is likely to be unprecedented expansion of health care facilities in the future.

Hospital use has approximately doubled in Canada since 1945. However, the number of new hospitals constructed has only been small. Even though the hospitals have grown larger in bed-care capacity, the average length of stay per patient has decreased. Therefore, even where beds and other new facilities have not been added, patient and visitor trips to hospitals have increased. There are more people working in hospitals now than in the past. Even with mechanization and automation, every medicare advance brings with it the need for more doctors, nurses, and technicians. This has increased the work trips to hospitals.

There has been a continuing shift from transit to the automobile consistent with general urban travel characteristics of an increasingly affluent population. Even when

adequate public transit facilities are available, it is likely that patients and visitors will continue to travel by car. It is likely that public transit may not meet hospital travel requirements, particularly those of the aging population that has increased frequency of trips for medical purposes (12).

Roth, in a study of hospital locations and future needs, concluded that future hospitals will be fewer, but larger, long-term care institutions will be integrated with community hospitals, and the hospital will be the focal point of all health activities in the community (13). With increasing national commitment to health care and increasing public use by a more affluent society, the urban hospitals will become more important as major trip generators and focal points of urban travel.

Criteria for Access

Planning for access to major hospitals, or for that matter to any other major trip generator, cannot be undertaken outside the context of urban transportation planning within the entire metropolitan area. Where the major traffic generators such as hospitals are public facilities, there should at least be fewer problems of communication between hospital management and urban transportation planning agencies. Yet even this study of only 11 hospitals suggests lack of coordination and understanding of access and travel problems and zoning standards on the one hand and implementation of these standards on the other.

There is no question about the basic objective that all hospitals should have adequate access for patients, visitors, and employees. Access includes roads as well as transit. Nevertheless the findings of this study show that one fairly large suburban hospital built recently has no bus lines within reasonable walking distance (½ mile), and no attempt has been made either by the hospital or by the transit agency (B.C. Hydro and Power Authority) to improve the service. This may indicate that both agencies do not consider that transit service is necessary. It must be clearly understood that this implicit level of service gives very little consideration to those who do not have cars.

The principal application of the findings of this study regarding access to hospitals is informational. The objective of the study was to explore the relationship between travel to hospitals and various factors that influence such travel. Furthermore the study was limited to employee travel only. The data presented in this study suggest that transportation planners should concentrate more on major trip generators. Hospital travel can have critical impact on local travel facilities. In the context of increasing use and size of urban hospitals, locational criteria and zoning standards could be seriously reviewed.

Parking Standards

The data presented here depict the current conditions with regard to access and parking at 11 hospitals included in this research. At most of these hospitals, the current supply of parking falls critically short of meeting the current employee parking demand. Often employees park on the hospital lot, preempting visitors and patients. Consequently, employee and visitor cars are often parked on surrounding streets.

The shortage of parking space at urban hospitals appears to be a chronic problem that the hospitals alone cannot solve. At hospitals located in high-density commercial (CBD) or residential areas, convenient parking would help relieve the natural anxieties of hospital trip-making. However, at hospitals located in low-density off-center areas, whether all the required parking should be on the hospital lot and not on the surrounding streets is an issue that each community must resolve. Additional costs relative to the provision of all the required parking by the hospital must be balanced against community values related to street parking and congestion, especially when hospitals are publicly funded.

This study has included an analysis of the employee travel characteristics. To develop proper standards for planning purposes requires further analysis of visitor and patient parking demands. Even though this research has been neither extensive nor conclusive, it is possible to develop parking standards based on current travel patterns of employees and on assumptions of proportional demands for visitors based on experience elsewhere.

TABLE 4

EMPLOYEE PARKING DEMAND AT HOSPITALS

Hospital	Transit Service Level[a]	Number of Employees	Maximum Daytime Total[b]			Employee Cars During Day Shift per 100 Employees	
			Employees	Automobile Drivers (percent)	Automobiles	Number	Average
St. Joseph	H	166	131	40	52	32	25
St. Paul	H	1,142	904	24	216	19	
Holy Family	M	65	54	39	21	33	42
Lions Gate	M	707	523	58	303	43	
Richmond General	M	199	144	72	104	52	
St. Mary	M	321	254	47	119	37	
St. Vincent	M	297	255	53	135	45	
Grace	L	235	162	51	83	35	51
Royal Columbian	L	869	756	67	506	58	
Surrey Memorial	L	114	144	85	97	59	

[a]H = 7 or more bus lines within 1/5 mile; M = 3 to 6 bus lines within 1/5 mile; and L = 0 to 2 bus lines within 1/5 mile.
[b]Includes all employees working day shift and those working no shifts but regularly during days.

Visitor parking space requirements are directly related to the number of patients served by the hospital. Keefer and Witheford, in analyzing the parking provided at 29 general hospitals of up to 500 bed capacity, found that on the average 22 parking spaces per 100 beds were provided for visitors (4). Based on the experience by Smith and Biciunas, this seems adequate but may be low in view of predictions by Ballard and Roth (3, 11, 12, 13). The 11 hospitals included in this study were all general hospitals and on the average had 1.5 to 2.0 employees per bed. Based on this, the U. S. experience shows that the patient and visitor parking needs are approximately 10 to 15 parking spaces per 100 employees. Because of current shortages of parking spaces, the changing trends, and the possibly increasing use of automobiles for patient and visitor travel discussed earlier, it is assumed for the purpose of developing parking standards that the patient and visitor parking needs are 10 to 20 spaces per 100 employees depending on the quality of alternative transportation service available.

In the assessment of the employee parking demand, it is assumed that the objective is to provide parking for all employees who are likely to drive their cars as determined by current socioeconomic conditions. The study has not included any consideration of increased parking fees that may restrain parking demand. Maximum employee accumulation is assumed to be during daytime after the arrival of clerical and administrative employees who generally do not work shifts and the employees who work the day shift. No allowance has been made for shift overlaps as it is presumed that there is sufficient staggering of arrivals and departures to take care of overlap.

The availability, quality, and quantity of transit service within walking distance clearly affect employee parking demand. Data given in Table 4 show that employee parking demand varies between 25 and 51 spaces per 100 employees depending on transit service quality.

Recommended parking standards are given in Table 5. Although these general standards may be applicable to general hospitals of 50 to 500 bed capacity, they must be used only as guidelines in planning. The requirements for each hospital must be developed within the context of urban area transport service levels, community values, and unique characteristics of each hospital. The standards given in Table 5 are a result of analysis of employee travel

TABLE 5

PARKING STANDARDS FOR GENERAL HOSPITALS OF 50 TO 500 BEDS

Transit Service Level[a]	Parking Spaces Required per 100 Employees		
	For Employees	For Visitors	Total
High[b]	25 to 30	10	35 to 40
Medium	40 to 45	10 to 15	50 to 60
Low[c]	50 to 60	15 to 20	65 to 80

Note: Full-time employee equivalent: 1 bed = 1.5 to 2.0 employees.
[a]High = 7 or more bus lines within 1/5 mile; Medium = 3 to 6 bus lines within 1/5 mile; and Low = 0 to 2 bus lines within 1/5 mile.
[b]Applicable to hospitals within or near either the CBD or very high density areas.
[c]Applicable to suburban hospitals with little or no transit service in very low density areas.

characteristics to 11 general hospitals in the Vancouver metropolitan area with a total population of approximately 1 million people. Included in the study were 5,200 employees, and the analysis involved simple statistical correlations. Finally, when parking requirements of hospitals are developed, public policy determinants and price-demand functions must also be considered before investment decisions are made regarding planning for parking. Although this study included 11 hospitals and the related access and parking criteria, it has by no means been exhaustive. However, the parking standards given in Table 5 are applicable to general hospitals in Canadian metropolitan areas; modifications can be made for each unique case.

FUTURE RESEARCH

Future research should include components of parking policy formulation, visitor and patient parking requirements, attitudes to public transport, and transport systems interpretations. Access and parking policies of the hospital must be developed in the context of urban transportation planning. Long-range national land use plans in the hospital neighborhood may reduce vehicular travel of employees.

Because major hospitals occasion as many trips as some central business districts and create circulation problems, the planning of related traffic facilities must be done on a cooperative basis between hospitals and planning agencies. This appears, however, not always to be the case. To resolve some of the resulting problems will require guidelines for planning not only locally but also regionally and nationally. Research aimed at disclosing variations in existing planning policies should make an interesting and effective beginning.

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