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A Study on Hierarchy according to the Spatial Configuration of Nurse Station in Geriatrics Hospital

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Abstract
Due to increase in aging population globally, aging shows rapid increasing, causing various problems. Among those problems, a problem regarding medical facilities for the elderly is becoming more important, but qualitative studies regarding medical facilities for the elderly still remain at an early stage. Therefore, the hierarchical analysis of plane structure at nurse station in hospitals for the elderly was carried out through space syntax based on J-Graph, and the resultsare as follows. 1) The spatial depth of nurse stations in selected hospitals for the elderly is between 3 and 7, showing the average spatial depth at 4.25. This means that the nurse station is located in the middle of spatial hierarchy, and it is located in the space which required high connectivity and control value. 2) As a result of estimating connectivity, the nurse station is located in the middle of moving line system in wards, and the nurse station does not show the highest control value and integration. However, the adjacent corridor and elevator hall tend to show high control value and integration. 3) The control value and integration are indicators which directly affect the control and cognition of wards, and the nurse station does not show the highest control value and integration. However, the adjacent corridor, day room and elevator hall tend to show high control value and integration, and when planning the nurse station, a study to improve control value and cognition in linkage with corridor with high control value and integration is necessary. 4) The tree-type structure is short moving line hierarchy so that it may be suitable for spatial cognition of elderly patients and patient controlling of nurse station, but the ring-type structure may cause inconvenience to elderly patients for using the space and it may be unsuitable for patient controlling of nurse station. 5) The wards in tree type structure in selected hospitals for the elderly shows the average intelligibility of 30.7% which is higher in comparison to the wards in ring type structure, so it is appropriate to design the moving line of patients in wards in geriatric hospitals as the tree structure which has clear spatial hierarchy.

Keywords: Ageing, Geriatric Hospital, Spatial Configuration, Convex Analysis, Nurse Station, J-Graph, Space Syntax

Introduction

The advancement of medicine and science extends the average life span of human being around the globe, and the aging society is proceeding fast due to increase in aging population. The problem according to such increase in aging population is becoming more serious gradually, and the importance of medical facilities for the elderly is increasing. However, studies on medical facilities for the elderly only focus on quantitative increase, and studies on qualitative aspect have been carried out insufficiently [1]. Especially, the wards including the nurse station in geriatric hospitals is a space to control and guide patients, showing plane structure which is similar with the case of normal hospitals, but it may be in question for the elderly who has low recognition capability to use [2].

Therefore, the purpose of this studyis to provide preliminary data for design of geriatric hospitals through thequantitative spatial hierarchy analysis of nurse station in wards of geriatric hospitals.

Method and scope of the study

In this study, J-graph and space syntax were utilized for quantitative spatial hierarchy analysis of geriatric hospitals, and the method used in the study is as follows. First, the plane structure of wards was divided into unit spaces for quantitative spatial hierarchy analysis of nurse station, and the unit space was based on the concept of convex. Second, J-Graph was drawn in order to analyze the spatial depth of divided unit spaces and the connection status of moving line. Third, the preliminary data for quantitative analysis and design was established by drawing connectivity, control value and integration of nurse station through space syntax.

The analysis target was limited to Korea where studies were being carried out activelydue to rapid increasing on aging population [3] and to hospitals with more than 100 sickbeds. Also, this study aimed at hierarchical analysis of plane structure of nurse station, so only one floor of wards where the nurse station was located was analyzed[3].

Elderly characteristic

The various characteristics of the elderly in spatial aspect can be classified into physical characteristic, psychological characteristic and cognitive characteristic. Detailed elements of each characteristic are as shown in Table 2, and especially the cognitive ability and characteristics of elderly patients are

not better than those of normal patients. This may cause a problem for using the space with much complex information, so it should be considered in a study regarding the space of elderly[4].

Table 1: Elements in spatial aspect of elderly

Physical characteristic	Psychological characteristic	Cognitive characteristic
· Deteriorated mobility · Deteriorated physical strength and energy · Deteriorated visualization ability	· Deteriorated memory · Deteriorated learning ability · Deteriorated thinking power and problem-solving ability	· Deteriorated transformative ability · Deteriorated spatial cognition ability

Geriatric hospital and concept of nurse station

A geriatric hospital is defined as medical facility operated for the elderly, and it should be equipped with designated facilities and manpower. According to the spatial characteristics of elderly care facilities, the geriatric hospitals has the intermediate characteristics between the normal hospital mainly for treatment and the elderly care facility mainly for nursing [5].

The nurse station in geriatric hospitals is located on each floor of wards, and nurses reside in this area, carrying out tasks such as the management of hospital rooms, controlling of inpatients and outpatients, and guidance. Therefore, it should be located in an area with high spatial cognition and easy to control the whole wards[6].

Concept and type of J-Graph

J-Graph is a diagram which systematizes complicated spatial hierarchy visually. Convex is used as basic unit for space division to draw J-Graph. The nurse station was considered as one independent convex for space division and the space with same character except for corridor was considered as one convex.

J-Graph is classified into the tree type and the ring type, the tree type has higher visibility than the permeability of space and it has a connected property and hierarchical structure. The ring type is the structure where the permeability is more important than the visibility, and it shows high autonomy and social characteristics [3].

Concept of space syntax

The space syntax is a method to consider convex as a unit space and analyze the arrangement and connection between unit spaces quantitatively, and it is based on J-Graph [7]. The followings are main indicators of space syntax related to this study. First, the connectivity means the number of axial line that the target space is connected to the surrounding unit space, and a space with high connectivity means high use frequency [8]. Second, the control value is an indicator to evaluate the effect on the unit space adjacent to a specific space and it can estimate the control level of specific space on the adjacent space [9]. Third, the integration is an indicator which shows the relevant depth to access from a specific space to the adjacent unit space. Higher integration means easier access [10]. Therefore, the space syntax method is a proper method to analyze geriatric hospitals targeting elderly patients with deteriorated physical and cognitive abilities[3].

Selection of geriatrics hospital

As mentioned earlier, the analysis target was limited to Korea where studies were being carried out actively due to rapid increasing on aging populations and to hospitals with more than 100 sickbeds located in Korea[3]. GyeongbukAndongGeriatric Hospitals, Incheon EunhyeHospital, Seoul BukbuHospital, GyeongnamGimhaeSenior Specialized Hospital, BobathMemorial Hospital, Good Busan Geriatric Hospitals were selected for the analysis.

Table 2: Overview of research subject

Hospital Name		Year opened	Number of sickbed	Number of floors (ground/underground)	Image of Geriatric Hospital
Andongyuri Hospital	AH	1993	150	7/1	
Eunhye Hospital	EH	1997	325	6/1	 
Seoul Bukbu Hospital	SR	2000	200	4/1	 

Gimhae Hospital	GH	2005	225	5/0	
Bobath Memorial Hospital	BB	2006	150	5/1	
Good Busan Geriatric Hospital	BS	2014	661	6/1	

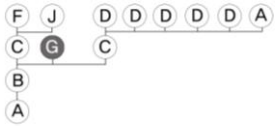
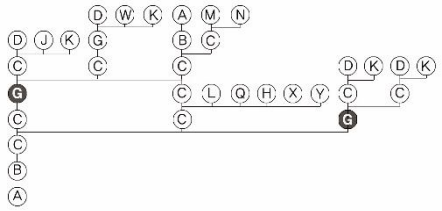
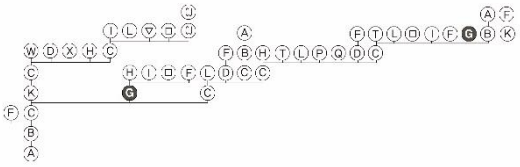
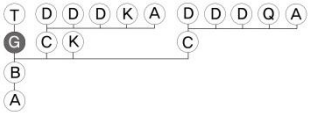
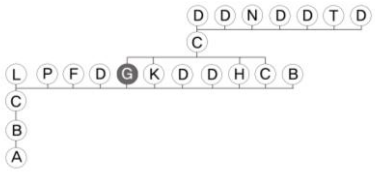
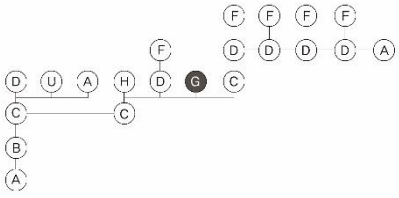
Results of deducting and analyzing J-Graph of the subjects

J-Graph of GyeongbukAndongGeriatric Hospitals, Incheon Eunhye hospital, Seoul BukbuHospital, GyeongnamGimhaeSenior Specialized Hospital, BobathMemorial Hospital, Good Busan Geriatric Hospitals is as shown in Table 3, and the drawn characteristics are as follows.

1) The whole spatial depth of wards in selected geriatric hospitals was 4, 4, 8, 6, 8 and 6 respectively, and the spatial depth of nurse station was 3, 3, 4/5, 4, 4/7 and 4 respectively so that the average spatial depth of nurse station was 4.25. This means that the nurse station is located in the middle of spatial hierarchy, and especially in case there are two nurse stations according to the hospital size, these nurse stations are located near hospital rooms to enable easy access to each hospital room.

2) The nurse station may be located in a deep space, but usually it is located in the spatial depth of 3 and 4. This is to enable easy controlling and cognition of outpatients and inpatients when designing the nurse station in the hospital.

Table 3: J-Graph of ward department

AH(depth: 4 / NS: 3 / J-Graph: Tree)

SR(depth: 8 /NS: 4, 5 / J-Graph: Ring)

BB(depth: 8 /NS: 4, 7 / J-Graph: Tree)

EH(depth: 4 / NS: 3 / J-Graph: Tree)

GH(depth: 6 /NS: 4 / J-Graph: Ring)

BS(depth: 6 /NS: 4 / J-Graph: Tree)


A: core section, B: ELEV.hall, C: corridor, D: ward, F: toilet, G: nurse Station, H: foyer, I: linen room, J: treatment room K: dayroom, L: dirty utility room, M: pantry, N: cafeteria, P: a shower room, Q: washroom, R: visiting room, T: night-duty room W: observation room, X: doctor room, Y: meeting room, ▽: supply, □: administration

Hierarchical analysis and results of the plane structure in geriatric hospitals

The connectivity, control value and integration were drawn for the evaluation on the hierarchy of plane structure in

geriatric hospitals, and the result corresponding to the values shown above was presented. The analysis results of spatial hierarchy of nurse station in geriatric hospitalsare as follows.

1) As shown in Table 4, the corridors on the left and right sides of the nurse station and the elevator hall had high connectivity, showing that these areas are located in the middle of moving line in wards.
2) As shown in Tables 5 and 6, the control value and integration are indicators which directly affect the control and cognition of wards and the nurse station requires high control value and integration, but the analysis result shows that the control value and integration of nurse station are lower in comparison to the corridor of wards. However, the nurse station is connected to the elevator hall and corridor where the control value and integration are high, so there will be no problem for spatial cognition. This means that a plan to link with space such as corridor with high cognition and control value is necessary when planning the nurse station.
3) The tree-type structure is short moving line hierarchy so that it may be suitable for spatial cognition of elderly patients and patient controlling of nurse station, but the ring-type structure may cause inconvenience to elderly patients for using the space and it may be unsuitable for patient controlling of nurse station.
4) The wards in tree type structure in selected hospitals for the elderly shows the average intelligibility of 30.7% which is higher in comparison to the wards in ring type structure, so it is appropriate to design the moving line of patients in wards in geriatric hospitals as the tree structure which has clear spatial hierarchy. However, as mentioned earlier, the ring type structure is social and circulation structure, and it is applied intentionally when designing the hospital to improve the sociality and spatial cognition ability of elderly patients.

Table 4: Average and deviation of connectivity in convex by component

Name	Ranking of the average of connectivity by component				
AH	Right corridor of ELEV.hall	ELEV.hall	Left corridor of ELEV.hall	Nurse Station	Treatment room
	12.000	5.000	4.000	2.000	2.000
EH	Left corridor of ELEV.hall	Under the corridor of ELEV.hall	ELEV.hall	Nurse Station, Day Room	Toilet, Core Section
	9.000	7.000	6.000	3.000	2.000
SR	Left corridor-Ⅰ of Nurse Station-Ⅰ	Left corridor-Ⅰ of Nurse Station-Ⅱ	Right corridor-Ⅱ of Nurse Station-Ⅱ, Doctor room corridor	Right corridor of Nurse Station-Ⅰ	ELEV.hall corridor
	17.000	11.000	8.000	7.000	4.000
GH	Right corridor of Nurse Station	Left corridor of Nurse Station	Nurse Station	Day Room, Left corridor of the courtyard	Foyer
	16.000	14.000	5.000	3.000	2.000
BB	Left corridor of Nurse Station-Ⅰ	Right corridor of Nurse Station-2	Nurse Station-1 Nurse Station-2	ELEV.hall	ICU
	22.000	19.000	5.000	4.000	3.000
BS	Left corridor-Ⅱ of Nurse Station, ELEV.hall corridor	Left corridor of Nurse Station	Dayroom	Terrace	Right corridor of dayroom
	10.000	9.000	6.000	4.000	3.000

Table 5: Average and deviation of controlvalue in convex by component

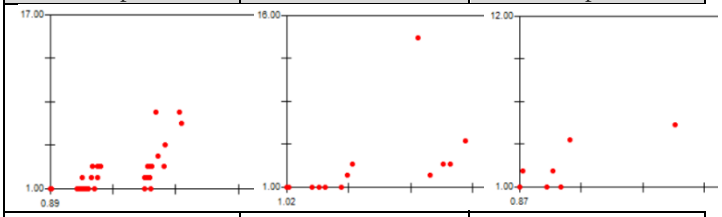
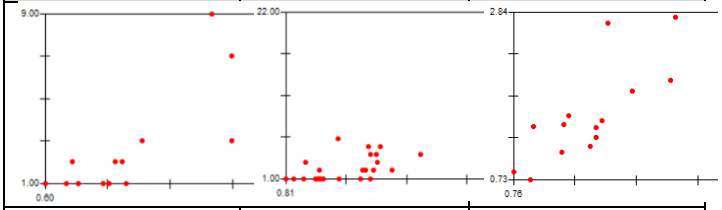
Name	Ranking of the average of control by component				
AH	Right corridor of ELEV. hall	ELEV. hall	Left corridor of ELEV. hall	Patient Room	Treatment room
	11.200	2.833	2.700	0.083	0.750
EH	Left corridor of ELEV. hall	Under the corridor of ELEV. hall	ELEV. hall	Nurse Station	Core Section
	7.500	4.500	2.921	2.167	1.500
SR	Left corridor of Nurse Station -Ⅰ	Left corridor Of doctor room	Left corridor of Nurse Station -Ⅱ	Right corridor of Nurse Station-Ⅱ	Right corridor of Nurse Station-Ⅰ
	10.560	5.591	3.367	3.124	2.225
GH	Right corridor of Nurse Station	Left corridor of Nurse Station	Nurse Station	ELEV. hall	Left corridor of the courtyard
	11.533	11.367	2.467	2.063	1.134

BB	Left corridor of Nurse Station -I	Right corridor of Nurse Station -II	Nurse Station -I	Nurse Station-II	ELEV. hall
	17.086	14.245	3.379	3.553	2.545
BS	ELEV. Hall corridor	Left corridor of Nurse Station	Right corridor of Nurse Station	Dayroom	Terrace
	9.333	5.833	5.000	3.944	1.833

Table 6: Average and deviation of integration in convex by component

Name	Ranking of the average of integration by component				
AH	Right corridor of ELEV. hall	ELEV. hall	Left corridor of ELEV. hall	Patient Room	Nurse Station
	3.849	2.749	1.480	1.375	1.283
EH	ELEV. hall	Day Room	Left corridor of ELEV. hall	Nurse Station	elevator
	2.465	1.991	1.849	1.328	1.204
SR	ELEV. Hall corridor	Left corridor of Nurse Station-I	Right corridor of Nurse Station -I	Right corridor of Nurse Station-II	Nurse Station -II
	2.253	2.150	1.605	1.589	1.516
GH	Right corridor of Nurse Station	Nurse Station	Day Room	Left corridor of the courtyard	Foyer
	3.340	2.691	2.549	2.484	2.363
BB	Left corridor of Nurse Station -I	Right corridor of Nurse Station-II	ELEV. hall	Observation room	Nurse Station -I
	3.726	3.294	2.444	2.104	1.959
BS	Left corridor of Nurse Station	Dayroom	Nurse Station	Right corridor of dayroom	Right corridor of Nurse Station
	1.710	1.628	1.364	1.346	1.173

Table 7: Index of Space Syntax(Intelligibility)

Type of J-Graph: Ring Type		Type of J-Graph: Tree Type
Seoul Bukbu Hospital	Gimhae Hospital	Andongyuri Hospital
		
0.425	0.447	0.842
Type of J-Graph: Tree Type		
Eunhye Hospital	Bobath Memorial Hospital	Good Busan Geriatric Hospital
		
0.651	0.630	0.650

4. Conclusion

This study was carried out for the purpose of establishing preliminary design data through the quantitative spatial hierarchy analysis of nurse station in geriatric hospitals, and the results of this study are as follows.

1) The spatial depth of nurse stations in selected hospitals for the elderly is between 3 and 7, showing the average spatial depth at 4.25. This means that the nurse station is located in the middle of spatial hierarchy, and it is located in a space which requires high connectivity and control value.

2) As a result of estimating connectivity, the nurse station is located in the middle of moving line system in wards, and the nurse station does not show the highest control value and integration. However, the adjacent corridor and elevator hall tend to show high control value and integration.

3) The control value and integration are indicators which directly affect the control and cognition of wards, and the nurse station does not show the highest control value and integration. However, the adjacent corridor, day room and elevator hall tend to show high control value and integration, and when planning the nurse station, a study to improve control value and cognition in linkage with corridor with high control value and integration is necessary.

4) The tree-type structure is short moving line hierarchy so that it may be suitable for spatial cognition of elderly patients and patient controlling of nurse station, but the ring-type structure may cause inconvenience to elderly patients for using the space and it may be unsuitable for patient controlling of

nurse station.

5) The wards in tree type structure in selected hospitals for the elderly shows the average intelligibility of 30.7% which is higher in comparison to the wards in ring type structure, so it is appropriate to design the moving line of patients in wards in geriatric hospitals as the tree structure which has clear spatial hierarchy. However, as mentioned earlier, the ring type structure is social and circulation structure, and it is applied intentionally when designing the hospital to improve the sociality and spatial cognition ability of elderly patients.

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