An Investigation into Midnight Lighting for the Elderly
-Focusing on Residence Type-

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Abstract
As people age, they develop more health problems and suffer a decline in body function that can lead to physiological concerns that younger people do not face. One of those concerns is the issue of nighttime toilet usage – some elderly people go as often as three times in one night. These people must wake up during the night, walk to the bathroom, use the facilities, then return to bed and sleep again. They repeat this pattern 2 or 3 times in one night, reducing the time and quality of their sleep, and it also increases the risk of injury due to falls or slips. The purpose of this research was to check a variety of retirement homes and care facilities in and around the Tokyo area to see how they dealt with the issue, and how they used lighting to provide a solution. For this particular study, care was given to the differences of the living environment at each care facility, as well as an analysis of the needs and concerns of the people using those facilities.

Keywords: elderly; midnight lighting; midnight waking; return to sleep; bathroom lighting; residence type

1. Introduction
1.1 Background
Especially as the spread of the nuclear family continues, the number of elderly living alone is increasing. As this change progresses, respect must be given to the health and independence of the elderly, and special attention should be paid to their living space. That is to say, for those elderly whose families cannot look after them research needs to be done on making living spaces safe yet comfortable.

As people age, they develop more health problems and suffer a decline in body function that can lead to physiological concerns that younger people do not face.

One of those concerns is the issue of nighttime toilet usage – some elderly people go as often as three times in one night. These people must wake up during the night, walk to the bathroom, use the facilities, then return to bed and sleep again. They repeat this pattern 2 or 3 times in one night, reducing the time and quality of their sleep, and also making it harder to fall asleep again. Also, if it is too bright during that movement their level of arousal rises in proportion to the brightness, causing discomfort and further increasing the difficulty of returning to sleep.

However, complicating this issue is that under certain lighting conditions, going to the bathroom can greatly increase the risk of falling and injury. Unlike younger individuals, the elderly can suffer life-threatening injuries from a fall, the consequences of which mean this is something that cannot be ignored. Thusly, the ideal lighting would provide for ease and safety of movement without hindering the ability to return to sleep. Recently there has been an increase in the awareness of this situation, and the amount of research has increased accordingly.

In Akizuki et al. (1996)4, an examination of light levels of hallways was performed. Illuminance during night hours varied between 1 and 10 lux, with the average being 5, and it was recommended that the JIS (Japanese Industrial Standards) expand their rules regarding lighting during nighttime hours.

However, for that research subjects were not in a state of recent arousal at nighttime, but were fully awake and thus one must assume that that research is insufficient.

1.2 Purpose of this Research
The goal of this research was to get a real understanding of the nighttime light environments from elderly residents in and around the Tokyo area by providing them with questionnaires. These questionnaires inquired about the respondents’ state
of arousal, lighting at bedtime and during nighttime periods, feelings on the physical design of bathroom access (including hallways), their needs for nighttime lighting, differences in habitat, and the affect the lighting has on their ability to return to sleep.

2. Questionnaire Inquiry
2.1 Breakdown of Inquiry

From September, 2006 until April, 2007 questionnaires were given to a variety of elderly living in the Tokyo area at various kinds of residence (single-family housing, complex housing, retirement communities, and senior housing), of which 309 replied. (Age 60: 34 respondents, age 70: 135, age 80: 127, age 90: 9, no response: 3)

For those living in regular or complex housing, assistance was obtained from a neighborhood elderly group in passing out and collecting the questionnaires. For those living in retirement communities, assistance was gotten from the facility director.

It is assumed that the elderly people who answered were able-bodied and could carry out their daily lives without assistance. Table 1. shows 6 categories of the questionnaire.

Table 1. Category on the Questionnaire

| I  | Lighting Environment at Bedtime |
|----|---------------------------------|
|    | Light at Time of Sleep          |
| II | Emotional State when Waking     |
| III| Movement Pattern                 |
|    | Lighting Situation               |
| IV | Lighting Needs/Concerns         |
| V  | Time Until Fall Asleep Again    |
| VI | Lighting Situation, Lighting Needs/Concerns |
|    | Sleep-inducing Lighting (Free Response) |

2.2 Results
(1) Lighting Environment at Bedtime

Fig.1. shows the responses to question 1. At the time of sleep, 53.4% of respondents turn off all lights, with the remaining 46.6% leaving some kind of light on. Looking at the reasons why those respondents turned off everything (Fig.2.), most common were "can't sleep with lights on" and "there is enough ambient light" were the most common, but responses such as "old habit" and "worried about cost" were also present.

![Fig.1. Lighting at Time of Sleep](image)

(2) Lighting at Time of Late Night Arousal

The respondents indicated they mostly had no strong feelings when waking during the night.

However, there were more responses indicating negativity more than there were positive responses. Uncertainty, annoyance, loneliness, and fear were the most common negative responses, as shown in Fig.4.

The most commonly stated reason for this was that "waking to go to the bathroom was frustrating," indicating a general sense of dissatisfaction with their current situation.

Among the other answers, there was little dissatisfaction with their physical environment, with most focus on normal things, like health or family issues. When comparing emotional states among the various residence types, those living at retirement community had less worries than other residence types (Fig.5.). Fig.5. is collected from Fig.3. It has been changed to make it easier to understand.

Negative responses ([Fear][Loneliness], [Frustration], [Uncertainty]) and positive responses ([Comfortable], [Relaxed]) is black tone. And [Other] and [No Special Feeling] is gray tone.

It is assumed that this is because more thought has gone into the physical design of the facility over other types of residence. Senior housing also possess a physical environment designed for the elderly, but since rooms are separated there are typically more cases of negative feelings.

However, in this particular study Senior housing had the least amount of negative responses, so there may be some bias involved.

Most respondents woke 2.3 times in one night, on average. (Fig.6.)

The number 2.3 was created by averaging all 293 respondents answers. Looking at the age breakdown, it is easy to see that as age increases, so does the number of times needed to wake, and the amount of sleep time decreases accordingly. (Fig.7.)

(3) Moving Around at Night

Fig.8. shows the lighting choices the respondents made when they need to move around at night. Whole room lighting, such as ceiling lights, was the
least common response. The most common response was to leave lights off, relying on night vision and a minimum of light to move around. (Fig.9.) However, this increases the risk of accidents and a safer lighting environment should be used.

Fig.10. shows the concerns the respondents had about the turning on of lights. While largest number of respondents don’t like bright lights because it increases the amount of time it takes to fall asleep after using the bathroom, there were also a large number who worry about the lights bothering other people or family members, and responses were received that some elderly had financial concerns regarding the use of lights.
Fig. 11. Desires Concerning Night Movement

Fig. 11. shows that the biggest concern the respondents have about moving around at night is that there is often not enough light to move around safely. Combined with the number 2 concern (ability to control brightness), it seems logical that having a simple and easy to reach light control/dimmer would be able to address both concerns with one solution.

Regarding the physical environment, the more physical barriers, the brighter the lighting required. Also, there was a distinct need to increase the brightness to maintain proper safety. (Fig. 12.)

(4) Bathroom Lighting

Concerns regarding on nighttime lighting in the bathroom is shown in Fig. 13. While the majority of responses were indicated nothing particular, a large number of respondents stated that "it should be darkened," indicating that there should be a difference between daytime and nighttime lighting. Ability to return to sleep after using the bathroom is shown in Fig. 14.

For this study, the number of respondents who answered "easily fall asleep" was comparatively large. Figs. 14. and 15. show the ability to fall asleep based on age and brightness, respectively. Fig. 14. most clearly indicates that as age increases it becomes more difficult for a person to fall asleep again. Also, the responses indicate that the more lights a person uses the harder it becomes to fall asleep again.
5) Sleep-inducing Lighting

The results from the free responses regarding sleep-inducing lighting are shown in Figs. 16. through 19., and are broken down by brightness, light color, image, and lighting method. The most common response for brightness was in support of dim lighting. This was divided among several related responses such as "not too bright", "low wattage", "similar to miniature bulbs", "minimal brightness", and "about the same as the moon." Responses in this vein were indeed greater than those preferring darkness. The most common preference for light color were orange/warm colors for causing a feeling of peacefulness, however there were also many respondents suggesting blues, greens, fluorescent, and deep purple. Due to this result, further investigation into light color is recommended. Ambient lighting was the most suggested lighting type, followed by natural (timed) lighting, adjustable brightness lighting, and remote control lighting. There is a need to avoid unnecessary frustration in turning the lights on and off.

3. Conclusions

The results of this questionnaire, as based on movement, residence, and physical environment are as follows:

- When going to sleep, dimly light is better than darkness.
- Most elderly people do indeed wake up during the night.
- Elderly people wake up 2.3 times in one night for the bathroom, causing a significant loss of sleep.
- There is a need to provide controllably bright lighting for safe conduct to the bathroom during nighttime hours.
- Turning on the lights is unsatisfactory and causes increased problems in returning to sleep.
- There are not many concerns with the actual lighting of the bathroom, but perhaps dimming the lights would be of benefit.
- The ability to return to sleep and the required brightness of lighting is affected by age.
- Those who live in a normal house had the most freedom, but also had the most fears regarding waking during the night.
- Those living in a facility had less freedom, but since the facilities are designed specifically for the elderly, the satisfaction rate was high.
- There were not many direct needs indicating a change to the nighttime environments, but some areas where safety could be improved were found.
- Regarding the physical environment, the more physical barriers, the brighter the lighting required. Also, there was a distinct need to increase the brightness to maintain proper safety.
- This study did not see a link between the ability to return to sleep and the physical environment.

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- Care House「GRACE VILLAGE」
- Care House「KIKUKAORUEN」
- Keihi* Nursing Home「ROKUGATU」
- Keihi Nursing Home B-type「SIMURAHOME」
- Bunkyo Ward Elderly Club

*A Care House is a Japanese equivalent to Nursing Care Center
*Keihi indicates a free or low-cost facility, usually public.

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