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Handling of Household Flammables by Elderly Dwelling in the Community: Executive Function and Judgment Involved in Handling Errors; *The Kurihara Project*

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Abstract

Background: Handling errors with household flammables, such as pan burning, may result in serious accidents. In the previous study, we surveyed an actual status of handling errors with household flammables in the 590 older residents in Kurihara, northern Japan. The accidents were caused by a decrease in attention/executive function and the ability to predict risks.

Methods: According to results of a questionnaire regarding the "frequency of small fire accidents at home" and "the presence or absence of pan burning", 592 elderly people were divided into 2 groups, the "low-risk group" (no small fire accident, or <1 small fire accident but the absence of pan burning in a year and the "high-risk group" (<1 small fire accident but the presence of pan burning in a year, or frequent small fire accidents). For the neurobehavioral assessments, their memory, executive function, depressive state, and judgment were evaluated using WMSR Logical Memory-I/II, Trail Making Test A/B and Digit Symbol (DS), Geriatric Depression Scale (GDS), and the question regarding "fire" in Cognitive Abilities Screening Instrument (CASI)-7, respectively.

Results: The number of subjects with higher Clinical Dementia Rating (CDR) score was greater in the high-risk group compared with the low-risk group. Two-way ANCOVA using the CDR scale and risk classification as the main effect, and using age, educational level, and MMSE scores as covariant, showed that the CDR effect and risk classification were observed in Logical Memory-I/II and DS, respectively. The subjects in the high-risk group were more likely not to answer the question about "fire" in CASI -7.

Conclusion: Executive function and judgment may be more likely to be involved in handling errors with household flammables, compared with memory. The finding indicated that a scale specific to the handling of household flammables should be established.

Keywords: Household flammables; Risk management; Mild cognitive impairment; Executive function

Introduction

The "Orange Plan", a 5 year plan for promotion of measures against dementia in Japan, suggests that people with dementia want to live in their own home as long as possible [1,2]. However, ordinary domestic life requires appropriate management of "fire" and "water," which are both likely to lead to death when accidents occur.

In the previous study [3], we surveyed an actual status of handling errors with household flammables in the 590 residents aged 75 years or older in Kurihara, northern Japan, and found that 93.1% of the subjects operated heating appliances by themselves. The use rate of IH (Induction Heating) appliance was quite low. According to the descriptions in the survey on the actual status, the accidents were caused by a decrease in attention/executive function and the ability to predict risks in all Clinical Dementia Rating (CDR) [4,5] groups.

Dementia is a brain disease that affects activities of daily life. In order to elucidate the pathology, the neurobehavioral aspects should be elucidated based on the neurological background of social behaviors. Handling errors with household flammables, represented by pan burning, can lead to serious accidents that will destroy the social daily living. In terms of neurobehavioral aspects, the cause may be related not only to "memory" problems (forgetfulness in turning a gas cooking stove off) but also decreased "attention (executive function)" (distraction by something) and lack of "social judgment" (predictability of risk that rubbish burning in the garden may cause a fire accident). However, there have been no studies on the cause of fire accidents in terms of neurobehavioral aspects.

There were no epidemiologic surveys on dementia related behavioral problems and the health-related issues of inappropriate handle of the appliance/inflammable in Japan. The purpose of this study was to evaluate the problems of handling errors with household flammables in residents with cognitive impairment. Our operational hypothesis for this study was as follows: when the overall CDR score was higher or cognitive functions, in particular, impairment of memory, judgment, and attention (executive function) were more severe, handling errors with household flammables become more serious.

Materials and Methods

Subjects and region

We described in the previous study [3]. Briefly, we had conducted a population-based prevalence study of dementia over 3 years, from 2008 to 2010, in cooperation with Kurihara city of Miyagi Prefecture in northern Japan. Due to the severe winter with heavy snowing, the residents cannot live without the use of a heating appliance. They underwent MRI, CDR scale, neuropsychological tests, and a questionnaire which was administered to their family members.

Analysis

As Table 1 shows, the subjects were divided into two groups based on the "frequency of small fire accidents at home" and "the presence or absence of pan burning" as follows:

"Low-risk group": No small fire accident, or <1 small fire accident but the absence of pan burning in a year

"High-risk group": The presence of <1 small fire accident(s) within a year and the incidence of pan burning, or frequent small fire accidents (Table 1).

		Pan burning		
		Yes	**No**	**ND**
Accident	Never	16*#	332#	8#
	Less than once	42^	42#	1**
	Several times per year	81^	32#	0
	Usually	9^	4^	1^
#High risk group; ^Low risk group; *Families described that no "accident" but pan burning; **Excluded from analyses; ND=No data				

Table 1: Classification of risk groups.

Demographics of the both groups are shown in Table 2. CDR and neurobehavioral assessments were used as explanatory variables, to evaluate the association between the risk classification and CDR by chi-square test, and two-way ANCOVA or chi-square test were performed to evaluate the association between the risk classification and neurobehavioral assessments, using age, educational level, and MMSE scores as covariant (Table 2).

CDR		**0**		**0.5**		**1+**	
Risk group		**Low**	**High**	**Low**	**High**	**Low**	**High**
n		176	39	209	74	45	24
Age	m	79.0	79.2	80.2	80.6	82.2	82.4
	SD	3.6	3.7	4.3	4.3	4.9	3.5
Education	m	9.5	8.7	8.6	8.1	8.0	7.8
	SD	2.1	1.5	1.7	1.8	1.7	1.4
CDR: Clinical Dementia Rating							

Table 2: Demogrpahics of four groups.

Endpoints: Diagnosis and severity of dementia and neurobehavioral assessments

Diagnosis and severity of dementia: DSM-IV and CDR

Neurobehavioral assessments

- **Memory:** WMSR Logical Memory-I/II
- This tests were commonly used for assess the logical memory function.
- **Judgment:** Cognitive Abilities Screening Instrument (CASI)-7 [6]

Domain of "Abstraction and judgment" (CASI-7) was used to assess the ability on judgment. The CASI can be used to assess a wide range of cognitive abilities within about 20 min, and it is considered to be useful for community-based studies. Because the CASI is a short, practical test designed to serve multiple functions, it can be used as a screening instrument for dementia, to monitor disease progression and to provide a profile of impairment in various cognitive domains. 1) Remote memory: personal semantic memory and general semantic memory; 2) Recent memory: immediate and delayed (10 min) recall of three words from different categories and immediate recall of five objects presented visually; 3) Attention: repeating three words and two sentences; 4) Mental manipulation and concentration: repeating digit span backwards and serial subtraction of 3 from 100; 5) Orientation: age, temporal and spatial orientation; 6) Figure copying: copying two intersecting pentagons; 7) Abstraction and judgment: abstracting similarities between pairs of items, judgment; 8) List-generating fluency: generating names of four-legged animals; 9) Language:

executing a simple written command, writing a simple dictated sentence, following a three-step oral command, naming five body parts and five common objects.

Among the CASI domain-7, the subquestion on fire "what actions would you take if you saw your neighbor's home catching fire?" was used for "judgment of fire."

- **Executive function:** Digit Symbol (DS) and Trail Making Test A/B

This tests were commonly used for assess the executive function

Results

1) As Table 1 shows, the number of subjects with higher CDR scores was greater in the high-risk group (chi-square test).

2) Table 3 shows the neurobehavioral assessments for 6 groups (3 CDR groups *2 Risk groups). Risk group effect: Compared with the low-risk group, DS scores were lower in the high-risk group. For association with "judgment of fire" CASI-7: there was Presence of a significant difference. Regarding association with completion of Trail Making Test B (TMTB): no significant difference was noted.

CDR		0		0.5		1+		Main effect			Covariance	
Risk group		Low	High	Low	High	Low	High	CDR	Risk group	Interaction	age	education
n		176	39	209	74	45	24					
MMSE	m	25.5	25.2	22.8	22.7	16.3	16.9	115.47	0.84	0.25	4.47*	40.11**
	SD	2.6	2.1	3.5	3.1	5.5	5.4					
LM I	m	12.9	12.2	8.9	7.7	2.8	3.5	35.78**	0.04	0.53	7.77*	39.59**
	SD	6.5	6.8	6.5	5.9	4.1	3.4					
LM II	m	8.4	7.3	4.7	3.6	0.8	0.6	33.07**	0.78	0.16	4.21*	27.85**
	SD	5.7	5.8	5.3	4.4	2.0	1.2					
CASI7	m	8.9	7.8	7.5	7.3	6.0	6.3	15.48**	0.47	2.08	1.14	68.06**
	SD	2.2	2.1	2.2	2.1	2.2	2.6					
CASI7-Fire	m	1.9	1.7	1.8	1.7	1.7	1.6	2.4	6.48*	0.03	0.11	6.59*
	SD	0.3	0.5	0.4	0.5	0.5	0.6					
TMT-A	m	69.1	76.2	80.2	85.6	102.0	113.4	13.71**	1.26	0.26	4.73*	44.76**
	SD	25.4	32.0	31.7	32.5	32.9	29.8					
DS	m	26.4	23.2	21.5	19.3	15.2	10.6	25.21**	4.78*	0.34	12.76**	127.32**
	SD	9.0	7.0	8.5	6.7	9.2	6.3					

CDR: Clinical Dementia Rating; MMSE: Mini-Mental State Exam; LM: Logical Memory; CASI: Cognitive Abilities Screening Instrument; TMT: Trail Making Test; DS: Digit Symbol; *p<0.05, **p<0.01

Table 3: Neurobehavioral asssessments for six groups.

Discussion

The results of Study 2 suggested that the association of the handling errors with household flammables with "judgment" and "executive function" (DS) might be greater than with "memory". However, a future study should clarify whether "memory" is related to the handling errors with household flammables. The WMS-R logical memory, which was not significantly different in this study, assesses story learning and recall, but does not evaluate episodic memory. The stories that a police collected donation for a victim from whom money was stolen on the street and that a person crashed against another car while driving a 4-ton truck are definitely not related to episodic memory of the elderly.

Furthermore, there are many debates as to whether judgment is involved in an individual cognitive domain. There has been one psychological report that the current situation is judged by comparison with past memory [7], which suggests that current behavior is selected by finding a difference between the current and past incidents. This is the reason why the judgment items of CDR and CASI7 contain semantic memory of similarity and difference.

"Executive function" is the overall control ability, including attention, and may be specific to risk control. As mentioned above, the descriptions of a fire accident in Study 1 showed that the accidents were caused by a decrease in attention/executive function and the ability to predict risks in all CDR groups. If they recall that they are cooking without burning a pan, even if they are distracted by something, it may be said that the behavior is based on their past memory.

This survey result showed that induction-heating (IH) appliances were very less likely to be introduced into the subjects' houses. An electric IH appliance is recommended for people who are at risk of handling errors with household cooking appliances, but IH appliances cannot be used during a power failure, require special pans and pots;

and it is difficult to handle for the elderly due to the complicated button operation. In fact, safety and convenience are often mutually contradictory. Even children can use matches, and playing with matches may sometimes cause fire accidents. While an IH appliance is difficult to handle due to its complicated operation, it does reduce the risk of fire accidents. It should be considered that the residents would likely come to not to cook much at home due to the difficulty in handling the IH appliance and soon forget about the existence of the appliance. In brief, an IH appliance that is easy and simple to handle for elderly should be developed.

The local governments set up the individual emergency reporting system, to deal with an increase in the number of elderly living alone and elderly with dementia. However, the content varies depending on the local governments and do not always take the possibility of fire accidents into consideration. The disparity should be appropriately corrected.

The 2011 Tohoku earthquake triggered the establishment of the capacity for crisis management. After completion of the Kurihara project, we conducted a similar survey in Tome city of Miyagi prefecture for 2 years from 2011 to 2012 [8]. The survey in Tome city focused on the ability to understand scene images and descriptions of various facts including risk, to evaluate the “ability to understand risk” in elderly who were survivors of the big earthquake. The result showed that elderly with lower “ability to understand risk” tended not to be aware of the aftershock. Similar to the topics in this study, “fire” and “water”, “earthquake” is also an important concept of safety at home and in the community. Appropriate collaboration between the departments of the local government is essential in “developing a comfortable community for dementia”, in other words, “to develop a community to protect residents from disasters”.

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