Number of ambulance transportation due to indoor heatstroke classified by perception time and effect of air conditioner on reducing the risk of severe indoor heatstroke

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Abstract. Deterioration of thermal environment due to the global warming and urban heat island causes the increase of the number of ambulance transport due to heatstroke. For the efficient ambulance operation, it is preferable to know when heatstroke is likely to occur during the day. However, the onset of heatstroke, particularly indoor heatstroke, depends on not only outside temperature and other meteorological condition, but also on health status and the use of air conditioner. It is therefore difficult to grasp the actual situation of indoor heatstroke and predict when indoor heatstroke is likely to occur. In order to contribute to above problem, as a first step, the number of indoor heatstroke at each perception time (time when the fire department receives an emergency call) was investigated using ambulance transport data provided by the Toyohashi Fire Department, Japan. The data period is June to October from 2013 to 2019. In addition, the effect of air conditioner status on reducing the severity of indoor heatstroke was evaluated using a logistic regression model. Obtained results showed that 1) the number of ambulances transport due to indoor heatstroke in case of air conditioner OFF increased sharply from 7 am, peaking at 9 am and 1 pm 2) more patients were diagnosed with moderate or severe heatstroke in the morning than in the afternoon. These results suggested that high number of indoor heatstroke in the morning was attributed to the possibility of heatstroke occurred while sleeping, as well as to the delay in calling for ambulance. Furthermore, 3) the use of air conditioner may reduce the probability of moderate or severe heatstroke by an average of 26 points compared to not using air conditioner.

1 Introduction

Indoor heatstroke has been one of the serious health problems caused by high temperature environment. According to the most recent statistics from the Fire and Disaster Management Agency, Japan, 40% of heat stroke cases transported to hospital occurred in residences and 55% of indoor heatstroke patients were aged 65 years or older [1]. This suggests the need to the further countermeasures of indoor heatstroke especially for the elderly. However, the onset of indoor heatstroke depends not only on environmental factors such as high temperature and humidity but also on personal lifestyle, use of air conditioner and health status. Of these, using air conditioner significantly reduce the mortality risk of heatstroke [2-5], and therefore, appropriate use of air conditioner may not only reduce the risk of mortality but also contribute to the prevention of severe indoor heatstroke.

In addition, for efficient ambulance operation, it is also important to clarify at which times of the day indoor heatstroke is more likely to occur in residences to prevent severe heatstroke. However, for the same reasons as above, it is difficult to know when indoor heatstorke is likely to occure. To contribute to the problems, as a first step, this study aims to 1) investigate the number of ambulance transport due to indoor heatstroke classified by air conditioner status (air conditioner ON/OFF) at each perception time (time when the fire department receives a emergency call), and 2) clarify to what extent the use of air conditioning can reduce the severity of indoor heatstroke using ambulance transport data.

2 Methods

2.1 Summary of Ambulance transport data

Ambulance transport data was provided by the Toyohashi Fire Department, Japan. Toyohashi is a medium-sized city (N34.75°, E137.3° at the city center) with a population of appoximately 370,000 in 2023 and an area of 261.9km^2.

The period coverd by the data is June to October from 2013 to 2019 and the items of the data is presented in Table 1. It is noteworth that this transport data includes records of air conditioner use and the ventilation status at the time of arrival of the emergency

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services. Note that perception time is not necessarily the time heatstroke occurred.

Table 1. Ambulance transport data provided.

Date of emergency call
Perception time
Name of place
Place that heatstroke occurred (residence, workplace, public area, road, other)
Age
Sex
Severity of heatstroke (mild, moderate, severe)
Air conditioner status (ON or OFF)
Ventilation status (window open, close, unknown)
Others

2.2 Survey subjects

This study focused on indoor heatstoke patients whose age was over 60 years old since the number of indoor heatstroke rapidly increases after 60 years old and the proportion of those with moderate or severe heatstroke also increases significantly compared to people aged under 60 years. There were 209 cases of indoor heatstroke observed during the data period (June to October from 2013 to 2019), of which 178 cases were the eldely (Fig. 1). The severity of heatstroke in this study was classified as 'mild' and 'moderate or severe' because the number of severe cases was very low (N=3 in Table 2). Here, the severity of heatstroke defined by the Japanese Association of Emergency Medicine [6] was classified as 'mild' (Stage 1) with symptoms such as dizziness, fainting and profuse sweating, but no impairment of consciousness, 'moderate' (Stage 2) with symptoms of headache, vomiting, a sinking feeling and loss of concentration, 'severe' (Stage 3) with symptoms of central nervous system manifestation and blood coagulation disorders.

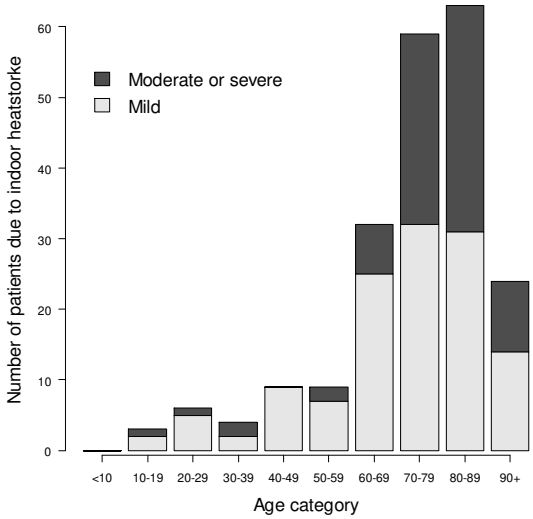

Fig. 1 Number of indoor heatstroke patients classified by age category and severity of indoor heatstroke in Toyohashi City (June to October 2013 – 2019, N = 209).

2.3 Analysis

The data recorded as 'residence' in the category of 'Place that heatstroke occurred' (Table 1) were extracted as a case of indoor heatstroke and the number of indoor heatstroke per perceived time was organized by each air conditioner ON or OFF.

For the analysis of the effect of air conditioner on reducing severity of indoor heatstroke, logistic regression was adopted to estimate how much the use of air conditioner can reduce the severity of indoor heatstroke. The objective variable in the logistic analysis was the severity of indoor heatstroke, which was a binary variable with 0 for mild case and 1 for moderate or severe cases. A total of seven explanatory variables were used: age, gender, air conditioner use (ON/OFF), ventilation status (window open/non-open), time of day (0-23 h), temperature and WBGT. Note that although the number of ambulance transports due to heatstroke has a positive correlation with the daily maximum temperature or daily maximum WBGT, these daily

Table 2. Summary of ambulance transport data for indoor heatstroke (N=178).

Variable	Group	Severity of indoor heatstroke		
		Mild	Moderate	Severe
N		102	73	3
Mean age (years old) (S.D.)		78.6 (9.2)	81.0 (7.8)	86.3 (8.3)
Gender (person) (%)	Male	53 (52.0)	42 (57.5)	1 (33.3)
	Female	49 (48.0)	31 (42.5)	2 (66.7)
Air conditioner (cases) (%)	ON	27 (26.5)	7 (9.6)	0 (0.0)
	OFF	75 (73.5)	66 (90.4)	3 (100.0)
Ventilation (window) (cases) (%)	Open	33 (32.4)	24 (32.9)	1 (33.3)
	Close	55 (53.9)	41 (56.2)	2 (66.7)
	Unknown	14 (13.7)	8 (11.0)	0 (0.0)
Mean daily maximum temp.(℃) (S.D.)		32.3 (1.7)	32.0 (1.7)	32.8 (3.0)
Mean daily maximum WBGT (℃) (S.D.)		30.2 (1.5)	29.8 (1.5)	30.9 (2.3)

maximum data were not used for this analysis but used the temperature and WBGT observed at the perception time. Also note that, 22 cases in which the 'Ventilation status' was 'unknown' were excluded.

The probability of being moderate or severe indoor heatstroke was calculated based on the logistic analysis for each age group (60-69, 70-79, 80-89 and 90 or older) by air conditioner ON and OFF.

3 Results and Discussions

3.1 Descriptive statistics

Table 2 shows the descriptive statistics of indoor heatstroke by the severity: 102 cases (57%) were mild, 73 (41%) moderate and 3 (2%) severe out of the total number of cases (178 cases). The proportion of moderate and severe cases for age of 60 years and over is larger than that of cases for under 60 years old. The average age of transport due to indoor heatstroke was 78.6 (mild case), 81.0 (moderate case) and 86.3 (severe case).

3.2 Number of indoor heatstroke transported by perception time

Figures 2 and 3 show the number of ambulance transport due to indoor heatstroke when air conditioner was ON (Fig. 2) and OFF (Fig. 3). The horizontal axis represents the perception time. Note that the number of transports at each perception time does not necessarily correspond to the onset time heatstroke occurred.

The number of ambulance transport due to indoor heatstroke with air conditioner ON is less than 5 and no transport occurred during nighttime (9 to 11 pm). On the other hand, the number of transports rapidly increases from 7 am in case of air conditioner OFF (Fig. 3) and two peaks were found at 9 am and 1pm. The former peak suggests that heatstroke may have occurred while sleeping with no use of air conditioner. Furthermore, the ratio diagnosed with moderate and severe cases tend to be higher than that in the afternoon. This is due to a delay in finding the person with heatstroke in the midnight.

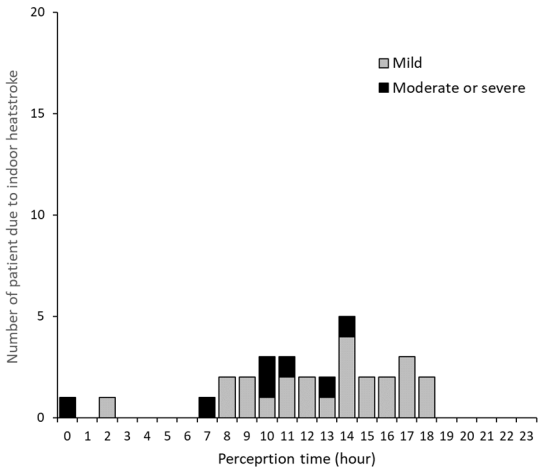

Fig. 2 Number of indoor heatstroke at each perception time. Air conditioner was used.

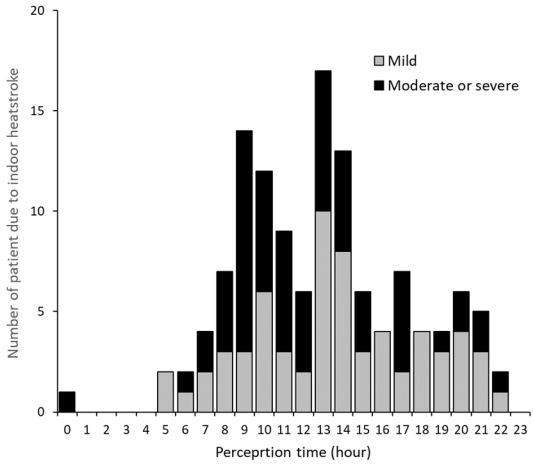

Fig. 3 Number of indoor heatstroke at each perception time. Air conditioner was NOT used.

3.3 Probability of moderate or severe heatstroke by air conditioner ON/OFF

Figure. 4 shows the probability of being moderate or severe indoor heatstroke for each age group by air conditioner ON and OFF. Here, the error bars denote the 95% confidence interval.

The probability of being moderate or severe cases when air conditioner OFF was 37% for aged 60-69, while it increased to 59% for aged 90 and over. On the other hand, there was no significant difference between the two age groups when the air conditioner was ON, that is, a range of 15-30%. The difference in the probability in case of the air conditioner ON and OFF was 16 points for aged 60-69 (but not a significant difference due to overlapping error bars), 27 points for aged 70-79 and aged 80-89, 33 points for aged 90 and over (average was 26 points). These results show that the use of air conditioner can reduce the probability of being moderate or severe indoor heatstroke by 26 points.

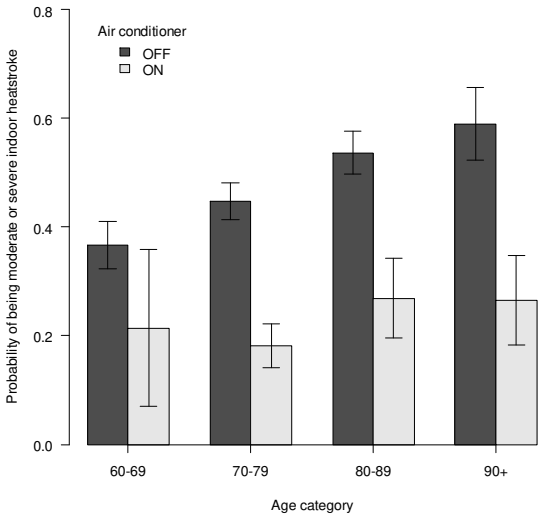

Fig. 4 Averaged probability of moderate or severe indoor heatstroke classified by age categories. Black bars represent probabilities that air conditioner was NOT used; gray bars represent probabilities that air conditioner was used. Error bars represent the 95% CIs.

4 Conclusions

The aim of this study is to clarify the number of indoor heatstroke for the elderly by the perception time (time of emergency call) and how much air conditioning reduce the risk of moderate and severe indoor heatstroke. Obtained results showed that 1) the number of ambulances transport due to indoor heatstroke in case of air conditioner OFF increased sharply from 7 am, peaking at 9 am and 1 pm 2) more patients were diagnosed with moderate or severe heatstroke in the morning than in the afternoon. These results suggested that high number of indoor heatstroke in the morning was attributed to the possibility of heatstroke occurred while sleeping, as well as to the delay in calling for ambulance. Furthermore, 3) the use of air conditioner may reduce the probability of moderate or severe heatstroke by an average of 26 points compared to not using air conditioner. These results suggest that to prevent indoor heatstroke, particularly while sleeping, appropriate use of air conditioner is significant even if they do not feel hot.

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