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Original Article

Influence of the coronavirus disease 2019 (COVID-19) pandemic on the incidence of heat stroke and heat exhaustion in Japan: a nationwide observational study based on the Heatstroke STUDY 2019 (without COVID-19) and 2020 (with COVID-19)

Jun Kanda,[1,2] Yasufumi Miyake,[2] Tadashi Umehara,[2] Shoichi Yoshiike,[3] Motoki Fujita,[1,4] Kei Hayashida,[1,5] Toru Hifumi,[1,6] Hitoshi Kaneko,[1,7] Tatsuho Kobayashi,[1,8] Yutaka Kondo,[1,9] Takashi Moriya,[1,10] Yohei Okada,[1,11] Yuichi Okano,[1,12] Junya Shimazaki,[1,13] Shuhei Takauji,[1,14] Junko Yamaguchi,[1,15] Masaharu Yagi,[1,16] Hiroyuki Yokota,[1,17] Keiki Shimizu,[7] Arino Yaguchi,[18] and Shoji Yokobori[1,17]

[1]Japan Association of Acute Medicine Heatstroke and Hypothermia Surveillance Committee, Tokyo, Japan, [2]Department of Emergency Medicine, Teikyo University School of Medicine, Tokyo, Japan, [3]Aizawa Hospital, Nagano, Japan, [4]Advanced Medical Emergency and Critical Care Center, Yamaguchi University Hospital, Yamaguchi, Japan, [5]Department of Emergency Medicine, North Shore University Hospital, Northwell Health System, Manhasset, New York, [6]Department of Emergency and Critical Care Medicine, St. Luke's International Hospital, Tokyo, Japan, [7]Emergency and Critical Care Center, Tokyo Metropolitan Tama Medical Center, Tokyo, Japan, [8]Department of Emergency and Critical Care Medicine, Aizu Chuo Hospital, Fukushima, Japan, [9]Department of Emergency and Critical Care Medicine, Juntendo University Urayasu Hospital, Chiba, Japan, [10]Department of Emergency and Critical Care Medicine, Jichi Medical University Saitama Medical Center, Saitama, Japan, [11]Department of Primary Care and Emergency Medicine, Graduate School of Medicine, Kyoto University, Kyoto, Japan, [12]Department of Emergency Medicine, Japanese Red Cross Kumamoto Hospital, Kumamoto, Japan, [13]Department of Traumatology and Acute Critical Medicine, Osaka University Graduate School, Osaka, Japan, [14]Department of Emergency Medicine, Asahikawa Medical University Hospital, Asahikawa, Japan, [15]Department of Acute Medicine, Nihon University School of Medicine, Tokyo, Japan, [16]Department of Emergency, Disaster and Critical Care Medicine, Showa University School of Medicine, Tokyo, Japan, [17]Department of Emergency and Critical Care Medicine, Nippon Medical School, Tokyo, Japan, and [18]Department of Critical Care and Emergency Medicine, Tokyo Women's Medical University, Tokyo, Japan

Aim: To assess heat stroke and heat exhaustion occurrence and response during the coronavirus disease 2019 pandemic in Japan.

Methods: This retrospective, multicenter, registry-based study describes and compares the characteristics of patients between the months of July and September in 2019 and 2020. Factors affecting heat stroke and heat exhaustion were statistically analyzed. Cramér's V was calculated to determine the effect size for group comparisons. We also investigated the prevalence of mask wearing and details of different cooling methods.

Results: No significant differences were observed between 2019 and 2020. In both years, in-hospital mortality rates just exceeded 8%. Individuals >65 years old comprised 50% of cases and non-exertional onset (office work and everyday life) comprised 60%–70%, respectively. The recommendations from the Working Group on Heat Stroke Medicine given during the coronavirus disease pandemic in 2019 had a significant impact on the choice of cooling methods. The percentage of cases, for which intravascular temperature management was performed and cooling blankets were used increased, whereas the percentage of cases in which evaporative plus convective cooling was performed decreased. A total of 49 cases of heat stroke in mask wearing were reported.

Corresponding: Jun Kanda, MD, PhD, Department of Emergency Medicine, Teikyo University School of Medicine, 2-11-1 Kaga, Itabashi-ku, Tokyo 173-8605, Japan. E-mail: jkanda-cib@umin.ac.jp.
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Conclusion: Epidemiological assessments of heat stroke and heat exhaustion did not reveal significant changes between 2019 and 2020. The findings suggest that awareness campaigns regarding heat stroke prevention among the elderly in daily life should be continued in the coronavirus disease 2019 pandemic. In the future, it is also necessary to validate the recommendations of the Working Group on Heatstroke Medicine.

Key words: Active cooling, COVID-19, heat exhaustion, heat stroke, mask wearing

INTRODUCTION

HEAT STROKE AND heat exhaustion are growing public health concerns worldwide because of the increasing frequency of heat waves. In Japan, 43,060 patients with heat stroke and heat exhaustion were transported by ambulance in August 2020 alone.[1] Moreover, coronavirus disease 2019 (COVID-19) has similar clinical symptoms, including fever and disturbance of consciousness, making it difficult to differentiate from heat stroke.[2] Compounded with the ongoing pandemic, as of September 1, 2021, the COVID-19 pandemic has resulted in more than 1,500,000 cases and 16,000 deaths.[3]

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has been reported to survive for several hours in airborne aerosols and COVID-19 may be transmitted through microparticles and vectors.[4] In an attempt to curtail transmission, mask wearing has become a key preventative behavior during the COVID-19 pandemic. Although there are no known reports of an increase in the number of heat stroke patients after wearing masks, studies have shown that mask wearing increases oral and tympanic membrane temperature and increases the risk of heat illness during summer by increasing the temperature of inhaled air.[5,6]

SARS-CoV-2 is present not only in the upper respiratory tract, but also in the stool, urine, and blood, and viral particles have been detected in these for at least 2 weeks after contamination.[7] Therefore, it should be assumed that SARS-CoV-2 is present on body surfaces and in exhaled air. Moreover, evaporative plus convective cooling is one of the most common active cooling methods for heat stroke and may produce aerosols when water evaporates from the body surface.[8–11] As such, the risk of viruses on the body surface spreading infection via aerosols generated on the body surface cannot be ruled out in evaporative plus convective cooling methods against heat stroke with COVID-19. Therefore, to strengthen and improve infection control against COVID-19, it is necessary to adopt preventive measures and treatments for heat stroke and heat exhaustion.[2]

The Japanese Association for Acute Medicine (JAAM) Heatstroke and Hypothermia Surveillance Committee jointly established the Working Group on Heatstroke Medical Care given the COVID-19 epidemic with the Japanese Society for Emergency Medicine, Japanese Association for Infectious Diseases, and Japanese Respiratory Society. Recommendations for mask wearing include the avoidance of long-term exercise for ≥1 hour and to select an alternative cooling method to the evaporative plus convective cooling method, depending on the experience and conditions at each facility.[2] The JAAM Heatstroke and Hypothermia Surveillance Committee has been conducting a 3-year epidemiological study on heat stroke and heat exhaustion from 2019 to 2021 (Heatstroke STUDY [HsS] 2019–2021) independent of the COVID-19 pandemic. This study aimed to provide an interim report comparing data from 2019 and 2020 to clarify the effects of the COVID-19 pandemic on the incidence of heat stroke and heat exhaustion in Japan. By retrospectively comparing data before (2019) and during (2020) the pandemic, we aimed to understand the characteristics of the incidence of heat stroke in the context of the COVID-19 pandemic.

METHODS

Study design

THIS RETROSPECTIVE, OBSERVATIONAL, multicenter, registry-based study used data from the HsS 2019 and 2020, a nationwide periodical and prospectively collected registry of patients with heat stroke and heat exhaustion. Patient characteristics in HsS 2019 and 2020 were compared. The protocol for this research project was approved by the Teikyo University Ethical Review Board for Medical and Health Research (approval no. 17-021-5) and that of each participating hospital, and conforms to the provisions of the Declaration of Helsinki. Informed consent was provided in a manner specified by the ethics committee of each institution for this study, and data from patients who did not wish to participate were excluded.

The JAAM Heatstroke and Hypothermia Surveillance Committee conducted the HsS 2019 and 2020 between the months of July and September in 2019 and 2020, in which 109 and 142 hospitals participated, respectively. The registered cases were defined as hospitalized patients who were treated as having heat stroke and heat exhaustion in the emergency department, based on symptoms (high body temperature and signs of dehydration, such as dizziness, myalgia, headache, nausea, convulsions, disturbance of consciousness, and convulsions) and a history of exposure to hot environments.

Physicians collected patient data from medical records and registered the data in the HsS 2019 and 2020 study repository using a web-based data collection system. Detailed information on symptom onset (patients' activity and environment of heat illness onset), demographic data (age, sex, height, and weight), clinical data at hospital arrival (bladder or rectal temperature, Glasgow coma scale [GCS] score, and laboratory data on liver, hepatic, and coagulation functions), and information on cooling methods and in-hospital deaths were collected. In HsS 2020, data on mask wearing at the time of onset were also collected.

Variables

Deep body temperature was classified into five levels: ≥42.0°C, 41.0–41.9°C, 40.0–40.9°C, 39.0–39.9°C, and ≤38.9°C. The measurement sites were classified as follows: rectum, bladder, esophagus, tympanic membrane, intravascular, brain, and other than the above. Cooling methods were classified as active cooling therapy or rehydration-only therapy used in hospitals. Active cooling included internal, external, and combined cooling; all patients who were treated with active cooling were also treated with rehydration therapy. Active cooling methods used in the participating facilities were categorized as external cooling (cooling of body surfaces via evaporative plus convective cooling, the Arctic Sun temperature management system, cooling blanket, and cold-water immersion), internal cooling (cold-water gastric lavage, intravascular temperature management, cold-water bladder irrigation, renal replacement therapy, and extracorporeal membranous oxygenation), or combined cooling (combinations of internal and external cooling methods). The classification of the cooling methods did not overlap, although multiple answers were permitted. Rehydration-only therapy comprised intravenous fluid replacement without active cooling, in which extracellular fluid (such as lactate or acetate Ringer's solution) was typically used.

Onset environment was classified as exertional (manual labor and sports) and non-exertional (office work and everyday life). Liver damage was defined as aspartate transaminase levels ≥30 U/L or alanine aminotransferase levels ≥42 U/L in men and ≥23 U/L in women. Renal dysfunction was defined as creatinine ≥1.07 mg/dL in men and ≥0.80 mg/dL in women. The JAAM disseminated intravascular coagulation (DIC) score was calculated, and DIC was defined as a score of ≥4. The DIC score assesses DIC severity ranging from 0 (mild) to 6 (severe), depending on systemic inflammatory response syndrome, thrombocytopenia, prothrombin time international normalized ratio prolongation, and increases in D-dimer levels.[12]

To quantify the severity of the patients' condition, we used the JAAM Heatstroke Criteria (JAAM-HS criteria) and early risk assessment tool for detecting clinical outcomes in patients using a heat-related illness (J-ERATO) score. Based on JAAM-HS criteria, degree III (severe) was defined as any of the following: unconscious (Glasgow coma scale ≤14), liver damage, renal dysfunction, and DIC, whereas degree I–II (mild to moderate) was defined as the absence of these symptoms.[13] The J-ERATO score comprises six items (respiratory rate, GCS, systolic blood pressure, heart rate, body temperature, and age), each scoring 0 or 1, with a total score of 0-6 (mild, 0–1; moderate, 2–4; severe, 5–6).[14] The JAAM-HS criterion is a hospital assessment, and the J-ERATO score is a pre-hospital assessment. Although both include awareness level in the assessment items, they are independent severity assessment criteria.

Data analysis

To understand the impact of the COVID-19 pandemic, we described and compared the characteristics of patients in the HsS 2019 and HsS 2020. Statistical analysis was performed on factors of heat stroke and heat exhaustion, which include in-hospital deaths, cooling methods, sex, age, onset situation, mask wearing, deep temperature, GCS, liver damage, renal dysfunction, DIC, JAAM-HS criteria, and J-ERATO score. Missing values for each item were unknown cases and, therefore, excluded, and the ratio of each item between HsS 2019 and HsS 2020 was calculated and compared. In addition, we compared the in-hospital mortality rate and deep body temperature between mask wearers and non-mask wearers.

Cramér's V was calculated to determine the effect size for group comparisons; $P < 0.05$ and $V \geq 0.2$ were defined as indicating statistical and practical significance, respectively.[15] We only considered the ratio of mask wearing and details of cooling methods. SPSS Statistics version 28 (IBM Corporation) was used for the data analysis.

RESULTS

Study participants

A TOTAL OF 1,766 cases were included in the study. In HsS 2019, 734 patients were enrolled, of whom 247 received active cooling, 414 were treated with rehydration-

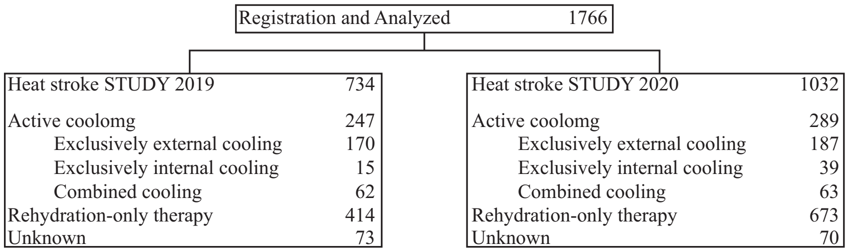

Fig. 1. Participants of the Heatstroke STUDY 2019 and 2020 categorized by cooling method.

only therapy, and 73 were treated with unknown cooling methods. In HsS 2020, 1,032 patients were enrolled, of whom 289 received active cooling, 673 were treated with rehydration-only therapy, and 70 were treated with unknown cooling methods (Fig. 1).

Factors of heat stroke and exhaustion

No significant differences were observed between HsS 2019 and HsS 2020 in terms of in-hospital deaths, cooling methods, sex, age, onset situation, mask wearing, deep temperature, measurement sites, GCS, liver damage, renal dysfunction, DIC, JAAM-HS criteria, and J-ERATO score. In both groups, in-hospital mortality rates just exceeded 8%. In HsS 2020, 49 cases (18.6%) were reported while mask wearing. In both HsS 2019 and HsS 2020, men comprised ~70% of cases, and individuals older than 65 years comprised 50% of cases. Non-exertional onset (office work and everyday life) and exertional onset (manual labor and sports) comprised 60%–70% and 30%–40% of cases, respectively. Regarding factors at the time of hospital visits, the deep body temperature was >40°C in <40% of patients. Deep body temperature was measured primarily in the rectum and bladder (Table 1). Of the cases, 25%–30% presented with severely impaired consciousness with GCS 3–8. Liver damage, renal dysfunction, and DIC were observed in 70%, 80%, and 20% of cases, respectively. Based on JAAM-HS criteria, degree III constituted the majority of cases (>97%). Mild (0–2), moderate (2–4), and severe (5–6) J-ERATO scores were observed in over 10%, ~50%, and just under 40% of cases, respectively (Table 1).

The proportion of individuals with a deep body temperature of <40.0°C was greater among mask wearers than among non-mask wearers, whereas the in-hospital mortality rate was lower for the former than for the latter (Table 2).

Cooling methods

Evaporative plus convective cooling, cold-water gastric lavage, intravascular temperature management, and cooling blankets were used in >10% of cases. In all cases, in which active cooling was performed, cooling methods that increased the ratio by >3.0% were intravascular temperature management and cooling blankets, whereas those that decreased the ratio by >3.0% were evaporative plus convective cooling and the Arctic Sun temperature management system. No changes >3.0% were observed for cold-water gastric lavage, cold-water bladder irrigation, cold-water immersion, renal replacement therapy, or extracorporeal membranous oxygenation. In this study, we only observed the changes in 2019 and 2020, and did not perform any statistical study (Table 3).

DISCUSSION

THIS NATIONWIDE OBSERVATIONAL study examined the effects of the COVID-19 pandemic on the incidence of heat stroke and heat exhaustion in Japan using data from HsS 2019 and 2020. Epidemiological assessments of heat stroke and heat exhaustion did not reveal any significant changes between 2019 and 2020. Indeed, the observation that ~ 60% of cases were non-exertional, ~ 70% were men, and the majority of cases occurred in individuals age ≥65 years has not changed from HsS 2017 to HsS 2018.[16] The current findings suggest that the incidence of heat stroke and heat exhaustion in Japan has not changed significantly as a result of the ongoing COVID-19 pandemic. Nevertheless, it is advisable to continue conventional activities to raise awareness to prevent heat stroke and heat exhaustion given the high incidence of these conditions in the elderly population.[17]

Based on the JAAM recommendations, we assumed that many facilities changed their cooling methods from evaporative plus convective cooling to intravascular temperature management or cooling blankets.[2] Aerosol generation in evaporative plus convective cooling warrants verification, although if its risk is indeed confirmed, JAAM recommendations may have been effective in preventing the occurrence of COVID-19 clusters in medical institutions.

Further, we identified an increase in the proportion of patients receiving rehydration-only therapy. This may be

Table 1. Patient characteristics in 2019 and 2020

	2019 (n = 734)		2020 (n = 1032)		V	P
	n	(%)	n	(%)		
In-hospital deaths, number (%)						
In-hospital deaths	54	(8.5)	76	(8.2)	0.004	0.879
Unknown	95		109			
Cooling methods, number (%)						
Exclusively external cooling	170	(25.7)	187	(19.4)	0.105	<0.001
Exclusively internal cooling	15	(2.3)	39	(4.1)		
Combined cooling	62	(9.4)	63	(6.5)		
Rehydration-only therapy	414	(62.6)	673	(70.0)		
Unknown	73		70			
Sex, no. (%)						
Male	498	(67.9)	717	(70.1)	0.023	0.336
Unknown	1		9			
Age, y, no. (%)						
0–14	13	(1.8)	22	(2.1)	0.041	0.556
15–44	107	(14.6)	132	(12.8)		
45–64	151	(20.7)	197	(19.1)		
65–74	132	(18.1)	180	(17.5)		
75+	328	(44.9)	498	(48.4)		
Unknown	3		3			
Onset situation, no. (%)						
Non-exertional	456	(63.7)	669	(66.2)	0.026	0.286
Exertional	260	(36.3)	342	(33.8)		
Unknown	18		21			
Mask wearing, no. (%)						
Mask wearing	–		49	(18.6)	–	–
No mask wearing	–		215	(81.4)		
Unknown	734		768			
Deep body temperature, °C, no. (%)						
≥42.0	26	(7.3)	15	(3.9)	0.103	0.099
41.0–41.9	53	(15.0)	43	(11.1)		
40.0–40.9	68	(19.2)	74	(19.2)		
39.0–39.9	74	(20.9)	95	(24.6)		
≤38.9	133	(37.6)	159	(41.2)		
Unknown	380		646			
Glasgow coma scale score, no. (%)						
3–5	126	(18.3)	148	(14.8)	0.061	0.103
6–8	62	(9.0)	93	(9.3)		
9–14	272	(39.4)	376	(37.6)		
15	230	(33.3)	383	(38.3)		
Unknown	44		32			
Measurement site, no. (%)						
Rectum	114	(32.7)	115	(30.4)	0.093	0.283
Bladder	219	(62.8)	240	(63.5)		
Esophagus	4	(1.1)	3	(0.8)		
Tympanic membrane	10	(2.9)	18	(4.8)		
Intravascular	2	(0.6)	0	(0.0)		
Brain	0	(0.0)	0	(0.0)		
Other than above	0	(0.0)	2	(0.5)		
Unknown	385		654			

Table 1. (Continued)

	2019 (n = 734)		2020 (n = 1032)		V	P
	n	(%)	n	(%)		
Liver damage, no. (%)						
Having liver damage	433	(61.9)	682	(67.9)	0.063	0.010
Unknown	34		28			
Renal dysfunction, no. (%)						
Having renal dysfunction	528	(75.5)	851	(84.4)	0.111	<0.001
Unknown	35		24			
DIC, no. (%)						
Having DIC	110	(24.0)	137	(19.2)	0.057	0.049
Unknown	276		319			
JAAM-HS criteria, no. (%)					0.004	0.854
I–II (mild to moderate)	18	(2.6)	28	(2.8)		
III (severe)	663	(97.4)	975	(97.2)		
Unknown	53		29			
J-ERATO score, no. (%)						
0	18	(3.2)	23	(3.0)	0.071	0.354
1	50	(8.9)	83	(10.7)		
2	69	(12.3)	105	(13.6)		
3	81	(14.5)	129	(16.7)		
4	128	(22.9)	160	(20.7)		
5	174	(31.1)	206	(26.6)		
6	39	(7.0)	67	(8.7)		
Unknown	175		289			

We calculated the ratio (%) and Cramér's V after excluding patients with unknown data in each category.
DIC, disseminated intravascular coagulation; J-ERATO score, the early risk assessment tool for detecting clinical outcomes in patients with heat-related illness score; SOFA score, the sequential organ failure assessment score.

Table 2. Characteristics and prognoses of patients who wore masks and those who did not

	Mask wearers (n = 49)		Non-mask wearers (n = 215)		V	P
	n	(%)	n	(%)		
In-hospital deaths, no (%)						
In-hospital deaths	1	(2.1)	23	(11.8)	0.130	0.043
Unknown	1		20			
Deep body temperature, °C, no. (%)						
≥42.0	0	(0.0)	2	(2.0)	0.187	0.382
41.0–41.9	2	(10.0)	8	(8.0)		
40.0–40.9	2	(10.0)	28	(28.0)		
39.0–39.9	5	(25.0)	26	(26.0)		
≤38.9	11	(55.0)	36	(36.0)		
Unknown	29		115			

We calculated the ratio (%) and Cramér's V after excluding all unknown patients in every category.

because of the recommendation to avoid the evaporative plus convective cooling method. Nevertheless, evidence supporting cooling rehydration-only therapy for active cooling is lacking, and many facilities may find it difficult to measure the actual liquid temperature of the infusion stored in a refrigerator.[2] Therefore, we caution against the easy use

Table 3. Details of active cooling in 2019 and 2020

Cooling methods†	2019 (n = 247)		2020 (n = 289)	
	n	(%)	n	(%)
Cold-water gastric lavage				
Internal cooling	34	(13.4)	38	(13.1)
Intravascular temperature management				
Internal cooling	27	(10.7)	44	(15.2)
Cold-water bladder irrigation				
Internal cooling	13	(5.1)	10	(3.5)
Renal replacement therapy				
Internal cooling	3	(1.2)	1	(0.3)
Extracorporeal membranous oxygenation				
Internal cooling	2	(0.8)	0	(0.0)
Evaporative plus convective cooling				
External cooling	197	(77.9)	178	(61.6)
The Arctic Sun temperature management system				
External cooling	17	(6.7)	8	(2.8)
Cooling blanket				
External cooling	16	(6.3)	39	(13.5)
Cold-water immersion				
External cooling	13	(5.1)	8	(2.8)
Unknown	12	(4.7)	23	(8.0)

†External cooling included the cooling of body surfaces via evaporative plus convective cooling, the Arctic Sun temperature management system, cooling blanket, and cold-water immersion; internal cooling included cold-water gastric lavage, intravascular temperature management, cold-water bladder irrigation, renal replacement therapy, and extracorporeal membranous oxygenation; and combined cooling included combinations of internal and external cooling methods.

of rehydration-only therapy, regardless of the liquid temperature of the infusion.

The onset of heat stroke and heat exhaustion during mask wearing had not been reported before 2019, but was confirmed in HsS 2020.[2] In this survey, although the mask wearing group tended to have more minor cases than did the non-mask wearing group, there were many unknown cases and only a few cases were actually reported. Accordingly, it is necessary to examine the details of the onset pattern to control COVID-19 and to prevent heat stroke and heat exhaustion.

This study has three main limitations. First, we did not perform a survey of the entire population. Therefore, the study may not directly reflect the actual situation, but may afford an inference of the general situation in the country or in a particular region. Second, this study did not examine the cooling methods according to disease severity. A comprehensive assessment of the type of treatment may be considered acceptable, although the severity and background of the patients must be matched to investigate the effects of cooling methods. Finally, hospitalized patients with heat stroke and heat exhaustion were included in this study, although the criteria for admission often depended on each institution and patient background; as such, the admission criteria may not have been uniform. Nevertheless, this is acceptable in this study because the purpose of this report was to provide a summary of a larger epidemiological study, although future studies using data from this registry should ensure that admission criteria are standardized.

CONCLUSION

THIS REPORT EXAMINED the impact of the COVID-19 pandemic on the incidence of heat stroke and heat exhaustion in Japan by comparing data from HsS 2019 and HsS 2020. Epidemiological assessments of heat stroke and heat exhaustion did not reveal significant changes between 2019 and 2020. Many facilities altered their cooling methods based on recommendations by the Working Group on Heatstroke Medical Care, which recommended the selection of alternative cooling methods to the evaporative plus convective cooling given the COVID-19 pandemic. This study shows that awareness of heat stroke prevention among the elderly in daily life should be continued in the COVID-19 pandemic as in the past. It is also necessary to validate the recommendations of the Working Group on Heatstroke Medical Care.

DISCLOSURE

APPROVAL OF THE Research Protocol: The protocol for this research project was approved by the Teikyo University Ethical Review Board for Medical and Health Research (approval no. 17-021-5) and that of each participating hospital.

Informed Consent: Informed consent was provided in a manner specified by the ethics committee of each institution for this study, and data from patients who did not wish to participate were excluded.

Registry and the Registration Number of the Study: N/A.

Animal Studies: N/A.

Conflict of Interest: None declared.

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Heatstroke STUDY 2019 (109 Facilities)

1. Aichi Medical University Hospital
2. Aidu Chuo Hospital
3. Aizawa Hospital
4. Asahikawa Medical University Hospital
5. Chiba University Hospital
6. Daiyukai General Hospital
7. Dokkyo Medical University Saitama Medical Center
8. Eastern Chiba Medical Center
9. Ehime Prefectural Central Hospital
10. Fujieda Municipal General Hospital
11. Fujisawa City Hospital
12. Fukui Prefectural Hospital
13. Funabashi Municipal Medical Center
14. Gifu Prefectural General Medical Center
15. Gifu University Hospital
16. Hamamatsu Medical Center
17. Handa City Hospital
18. Hiroshima City Hiroshima Citizens Hospital
19. Hyogo Prefectural Awaji Medical Center
20. Hyogo Prefectural Kakogawa Medical Center
21. Hyogo Prefectural Nishinomiya Hospital
22. Ichinomiya Municipal Hospital
23. Iizuka Hospital
24. Ina Central Hospital
25. Ishikawa Prefectural Central Hospital
26. Iwata City Hospital
27. Japanese Red Cross Ise Hospital
28. Japanese Red Cross Ishinomaki Hospital
29. Japanese Red Cross Kyoto Daini Hospital
30. Japanese Red Cross Maebashi Hospital
31. Japanese Red Cross Medical Center
32. Japanese Red Cross Narita Hospital
33. Japanese Red Cross Shizuoka Hospital
34. Japanese Red Cross Tokushima Hospital
35. Jichi Medical University Saitama Medical Center
36. Juntendo University Nerima hospital
37. Juntendo University Urayasu Hospital
38. Kagawa Prefectural Central Hospital
39. Kasugai Municipal Hospital
40. Kawasaki Municipal Hospital
41. Kitakyushu General Hospital
42. Kochi Health Sciences Center
43. Kurume University Hospital
44. Kushiro City General Hospital
45. Kyorin University Hospital
46. Kyoto University Hospital
47. Kyushu University Hospital
48. Mie University Hospital
49. Mito Saiseikai General Hospital
50. Nagoya Ekisaikai Hospital
51. Nagoya University Hospital
52. National Center for Global Health and Medicine
53. National Hospital Organization Hokkaido Medical Center
54. National Hospital Organization Kumamoto Medical Center
55. National Hospital Organization Osaka National Hospital
56. National Hospital Organization Takasaki General Medical Center
57. National Hospital Organization Yokohama Medical Center
58. Nihon University Hospital
59. Nihon University Itabashi Hospital
60. Nihonkai General Hospital
61. Niigata Prefectural Shibata Hospital
62. Nippon Medical School Tama Nagayama Hospital
63. Odawara Municipal Hospital
64. Oita University Hospital
65. Okazaki City Hospital
66. Okinawa Prefectural Chubu Hospital
67. Ome Municipal General Hospital
68. Omihachiman Community Medical Center
69. Osaka City General Hospital
70. Osaka Mishima Emergency Critical Care Center
71. Osaka Police Hospital
72. Osaka Prefectural Nakakawachi Emergency and Critical Care Center
73. Ota Medical Hospital
74. Saiseikai Utsunomiya Hospital
75. Saiseikai Yokohamashi Tobu Hospital
76. Saitama Medical University International Medical Center
77. Saku Central Hospital
78. Sapporo City General Hospital
79. Sapporo Medical University Hospital
80. Shinshu University Hospital
81. Shonan Kamakura General Hospital
82. Showa University Fujigaoka Hospital
83. St. Luke's International Hospital
84. St. Mary's Hospital
85. Sugita Genpaku Memorial Obama Municipal Hospital
86. Sunagawa City Medical Center

87. Teikyo University Hospital
88. Teine Keijinkai Hospital
89. The University of Tokyo Hospital
90. Toho University Omori Medical Center
91. Tohoku University Hospital
92. Tokai University Hachioji Hospital
93. Tokai University Hospital
94. Tokushima Prefectural Miyoshi Hospital
95. Tokyo Metropolitan Tama Medical Center
96. Tokyo Women's Medical University Hospital
97. Tokyo Women's Medical University Medical Center East
98. Tokyo Women's Medical University Yachiyo Medical Center
99. Tosei General Hospital
100. Toyama Prefectural Central Hospital
101. Toyama University Hospital
102. University of Yamanashi Hospital
103. Yamagata Prefectural Central Hospital
104. Yamagata University Hospital
105. Yamaguchi University Hospital
106. Yamanashi Prefectural Central Hospital
107. Yokkaichi Municipal Hospital
108. Yokohama Minami Kyosai Hospital
109. Yokohama Rosai Hospital

Heatstroke STUDY 2020 (142 Facilities)

1. Advanced Critical Care and Emergency Center, Yokohama City University Medical Center
2. Advanced Emergency and Critical Care Center, Kurume University Hospital
3. Aidu Center Hospital
4. Akita University Graduate School of Medicine, Department of Emergency and Critical Care Medicine
5. Asahikawa Medical University
6. Center Hospital of the National Center for Global Health and Medicine
7. Daiyukai General Hospital
8. Department of Emergency and Critical Care Medicine Hyogo Emergency Medical Center
9. Department of Emergency and Critical Care Medicine Faculty of Medicine, Saga University
10. Department of Emergency and Critical Care Medicine, Nara Medical University
11. Department of Emergency and Critical Care Medicine, Tohoku University Hospital
12. Department of Emergency, Disaster and Critical Care Medicine, Showa University School of Medicine
13. Dept of Emergency and Critical Care Center, Fukuoka University Hospital
14. Dokkyo Medical University Saitama Medical Center
15. Eastern Chiba Medical Center
16. Ehime Prefectural Central Hospital
17. Emergency Medical Center, Kagawa University Hospital
18. Fujieda Municipal General hospital
19. Fujisawa City Hospital
20. Fukaya Redcross Hospital
21. Fukui Prefectural Hospital
22. Funabashi Municipal Medical Center
23. Gifu Prefectural Central Medical Center
24. Hachinohe City Hospital
25. Hamamatsu Medical Center
26. Handa City Hospital
27. Hyogo Prefectural Kakogawa Medical Center
28. Hyogo Pref Awaji Medical Center
29. Hyogo Prefectural Nishinomiya Hospital
30. Ichinomiya Medical Hospital
31. Iizuka Hospital
32. Ina Central Hospital
33. Ishikawa Prefectural Central Hospital
34. Iwata City Hospital
35. Japanese Red Cross Akita Hospital
36. Japanese Red Cross Ashikaga Hospital
37. Japanese Red Cross Ise Hospital
38. Japanese Red Cross Ishinomaki Hospital
39. Japanese Red Cross Kumamoto Hospital
40. Japanese Red Cross Maebashi Hospital
41. Japanese Red Cross Medical Center
42. Japanese Red Cross Shizuoka Hospital
43. Japanese Red Cross Society Kyoto Daini Hospital
44. Japanese Red Cross Society Wakayama Medical Center
45. Juntendo University Nerima Hospital
46. Juntendo University Urayasu Hospital
47. Kagawa Prefectural Central Hospital
48. Kagoshima Prefectural Ohshima Hospital
49. Kansai Medical University Medical Center
50. Kansai Medical University Hospital
51. Kasugai Municipal hospital
52. Kawaguchi Municipal Medical Center
53. Kawasaki Medical School General Medical Center
54. Kawasaki Municipal Kawasaki Hospital
55. Kimitsu Chuo Hospital Department of Emergency and Critical Care Medicine
56. Kochi Medical School Hospital
57. Kochi Health Science Center
58. Kochi Red Cross Hospital
59. Kouseiren Takaoka Hospital
60. Kumamoto University Hospital Emergency and General Medicine
61. Kushiro City General Hospital

62. Kyorin University School of Medicine
63. Kyoto City Hospital
64. Kyoto University Hospital
65. Mie Prefectural General Medical Center
66. Mie University School of Medicine
67. Mito Saiseikai General Hospital
68. Nagahama Red Cross Hospital
69. Nagano Red Cross Hospital
70. Nagoya University Hospital
71. Nanbu Medical Center Nanbu Child Medical Center
72. Nara Prefecture General Medical Center
73. National Hospital Organization Disaster Medical Center
74. National Hospital Organization Kumamoto Medical Center
75. National Hospital Organization Kyoto Medical Center
76. National Hospital Organization Mito Medical Center
77. National Hospital Organization Takasaki General Medical Center
78. National Hospital Organization Yokohama Medical Center
79. Nayoro City General Hospital
80. Nigata Prefectural Shibata Hospital
81. Nihon University Itabashi Hospital
82. Nihonkai General Hospital
83. Niigata University Medical & Dental Hospital
84. Nippon Medical School Hospital
85. Nippon Medical School Tamanagayama Hospital
86. Noto General Hospital
87. Odawara Municipal hospital
88. Oita University Hospital Advanced Trauma, Emergency and Critical Care Center
89. Okazaki City Hospital
90. Okinawa Chubu Hospital
91. Okitama Public Hospital
92. Ome Municipal General Hospital
93. Osaka City General Hospital Emergency and Critical Care Medical Center
94. Osaka Mishima Emergency Medical Center
95. Osaka Prefectural Nakakawachi Emergency and Critical Care Medicine
96. Osaka Red Cross Hospital Department of Emergency Medicine
97. Osaka University Hospital
98. Osaki Citizen Hospital Emergency Center
99. Our Lady of the Snow Social Medical Corporation St. May's Hospital
100. Rinku General Medical Center
101. Saiseikai Kumamoto Hospital
102. Saiseikai Siga Hospital
103. Saiseikai Yokohamashi Tobu Hospital
104. Saitama Medical University International Medical Center
105. Saku Central Hospital Advanced Care Center
106. Sapporo Medical University Hospital
107. Sapporo City General Hospital
108. Seirei Mikatahara General Hospital
109. Shakaiiryouhoujinnzaidann Jisennkai Aizawabyouinn
110. Shimane University
111. Shimane Prefectural Central Hospital
112. Shinshu University Hospital
113. Shonan Kamakura General Hospital
114. South Miyagi Medical Center.
115. Sugita Genpaku Memorial Municipal Hospital
116. Sunagawa City Medical Center
117. Teikyo University Hospital
118. The University of Tokyo Hospital
119. Tokai University Hospital
120. Tokushima Prefectural Miyoshi Hospital
121. Tokushima Red Cross Hospital
122. Tokyo bay Urayasu Ichikawa Medical Center
123. Tokyo Medical University
124. Tokyo Medical and Dental University Medical Hospital
125. Tokyo Medical University Hachioji Medical Center
126. Tokyo Medical University Hachioji Medical Center
127. Tokyo Metropolitan Tama Medical Center
128. Tokyo Women's Medical University Medical Center East
129. Tosei Central Hospital
130. Toyama Prefectural Central Hospital
131. Toyama University Hospital
132. Toyohashi Medical Hospital
133. Tsukuba Medical Center Hospital
134. University Hospital, Kyoto Prefectural University of Medicine
135. University of the Ryukyus Hospital
136. Urasoe Central Hospital
137. Yamagata University Faculty of Medicine
138. Yamaguchi University Hospital
139. Yamanashi Prefectural Central Hospital
140. Yodogawa Christian Hospital
141. Yokohama Minami Kyousai Hospital
142. Yokosuka General Hospital Uwamachi

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