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RESEARCH ARTICLE

Analysis of Body Temperature in Patients with Trauma Visiting a Local Emergency Medical Center during the SARS-CoV-2 Outbreak

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Abstract

Background: The study aimed to evaluate the usefulness of body temperature monitoring as a screening tool for Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2).

Methods: This retrospective study was conducted in an emergency department from January 1, 2019, to December 31, 2020. A total of 5,502 out of 9,205 patients with trauma during the pre-pandemic period and 3703 out of 9205 during the pandemic period (age ≧ 18 years old) were enrolled in the study. Data collected included sex, age, time of visit, initial and follow-up BT, Korean Triage and Acuity Scale (KTAS) score, disposition results, time of disposition, time of the first imaging study, and SARS-CoV-2 test results. Patients were divided into two groups based on their body temperature.

Results: During the pandemic period, three out of 832 patients with a body temperature below 37.5°C tested positive for SARS-CoV-2 *via* polymerase chain reaction, while none of the 342 patients with a body temperature above 37.5°C tested positive negative. However, this was statistically insignificant. Patients with a body temperature over 37.5°C had to wait significantly longer to see a doctor, undergo imaging studies, and receive disposition, especially in non-major trauma cases. Follow-up body temperatures were significantly lower except in KTAS 1- and ICU-admitted patients.

Conclusion: The usefulness of body temperature as a screening tool for trauma patients in the emergency department during the pandemic period is limited and could have detrimental effects on emergency department crowding.

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Abbreviations

KTAS: Korean Triage and Acuity Scale; PCR: Polymerase Chain Reaction; SARS-CoV-2: Severe Acute Respiratory Syndrome Coronavirus 2

Introduction

At the end of 2019, the sudden global outbreak of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) significantly affected

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the health and daily lives of people worldwide. Various regulations have been implemented in each country to address this socially, with the medical sector requiring the strongest response [1]. Emergency medical centers had to rigorously address the treatment of patients vulnerable to infection, such as children, older adults, those with chronic diseases, and immunocompromised patients.

To cope with this, most local emergency medical centers implemented strategies, such as rearranging existing spaces to segregate infection zones and setting up new areas outside the centers for treating infectious patients. While it was necessary to prioritize infection management during a novel infectious disease pandemic, these methods exacerbated existing chronic overcrowding in emergency medical centers and caused secondary delays in non-infectious trauma patients [2].

Fever is a common symptom of SARS-CoV-2 infection [3], with reports indicating that 45%-64% of confirmed cases experience fever [4-6]. Screening for SARS-CoV-2 in hospitals, public buildings, airports, and other locations was conducted through fever checks. Although some studies have suggested that screening for fever has a low sensitivity for detecting SARS-CoV-2 [7], these studies did not provide clear alternative screening methods.

At our hospital's emergency medical center, patients are screened for SARS-CoV-2 infection based on initial temperature measurements. According to the Korea Disease Control and Prevention Agency guidelines, a body temperature of 37.5˚C or higher was used as the criterion [8]. Patients with temperatures above 37.5˚C were isolated and treated until results from rapid Polymerase Chain Reaction (PCR) or standard PCR tests were confirmed. This resulted in delays in treatment and testing, further worsening overcrowding in the emergency medical center.

Therefore, this study aimed to assess the presence of SARS-CoV-2 in patients with temperatures of 37.5˚C or higher. Additionally, temperatures, temperature variations, and treatment times of patients with trauma were compared before and after the global spread of SARS-CoV-2 to evaluate its impact on emergency medical center overcrowding and enhance readiness for future outbreaks of new infectious diseases.

Materials and Methods

This study retrospectively analyzed the data of patients aged ≥18 years who visited the hospital's emergency department between January 1, 2019 and December 31, 2020. This study was approved by the Institutional Review Board of the Ilsan Hospital (IRB approval number: 2022-06-027) and the requirement for informed consent was waived owing to the retrospective nature of the study. This study focused on patients with trauma codes starting with S or T who underwent SARS-CoV-2 PCR testing during their visits.

Medical record reviews were conducted to collect data on sex, age, time of visit, initial and subsequent temperature measurements, Korean Triage and Acuity System (KTAS) ratings, time of nursing reception, time of initial visit to measure emergency department stay duration, time for imaging examinations, discharge outcomes after treatment, and PCR results.

This study compared the time from emergency department admission to medical treatment and completion of imaging examinations before and after the SARS-CoV-2 pandemic. Statistical analyses were performed using SPSS (version 23.0; SPSS Inc., Chicago, IL, USA). Categorical variables are presented as numbers (%) and continuous variables as mean ± standard deviation. Chi-square tests were used for categorical variables and t-tests were used for continuous variables, with statistical significance set at $p < 0.05$.

Result

General characteristics of the enrolled patients

The total number of patients during the study period was 10,618. Excluding 962 patients under 18 years of age during the pre-pandemic period, 5,502 patients were included. In the pandemic period, 445 patients under 18 years of age and six patients who did not undergo PCR tests were excluded, resulting in 3,703 included patients (Figure 1). Among the patients included in the pre-pandemic study group, there were 2,589 men (47.1%) and 2,913 women (42.9%). During the pandemic period, 1,714 males (46.3%) and 1,989 females (43.7%) were included in the study. There was no statistically significant difference between the two groups in terms of temperature being below or above 37.5˚C.

Comparing age groups between the two periods, statistically significant decreases were observed in cases with temperatures below 37.5˚C during the pandemic period, while there was no statistical difference in cases with temperatures above 37.5˚C.

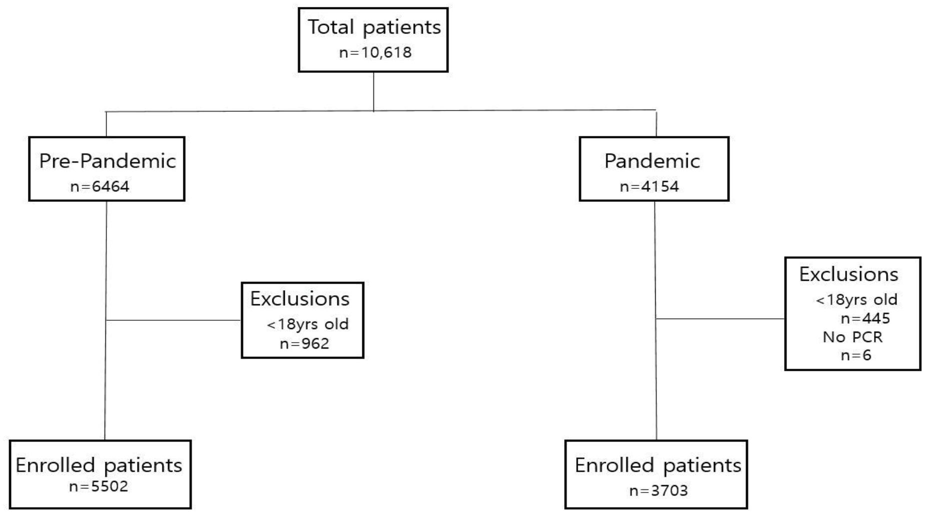

Figure 1 Flow chart of enrolled patients.

The KTAS score exhibited statistically significant decreases at all stages for temperatures below and above 37.5°C during both the pre-pandemic and pandemic periods.

In terms of emergency room discharge outcomes, statistically significant decreases were observed between temperatures below and above 37.5°C during both the pre-pandemic and pandemic periods (Table 1).

SARS-CoV-2 positivity rate according to body temperature during the pandemic period

During the pandemic, 1,174 PCR tests were conducted on patients who visited the hospital. Among them, 832 tests (70.9%) were conducted when the BT was below 37.5°C, and 342 tests (29.1%) were conducted when the BT was above 37.5°C. Among the below 37.5°C group, 3 patients were positive and 829 were negative, while among those with BT above 37.5°C, all 342 patients tested negative. No statistically significant differences were observed between the two groups (Table 2).

Time intervals according to body temperature in treatment stages

During the pre-pandemic period, there were no statistically significant differences in triage time, time to first physician encounter, or time to first imaging examination based on BT. However, the time to discharge decision was statistically significantly delayed in the group with temperatures above 37.5°C. During the pandemic period, there was no statistically significant difference in triage time; however, the time to first physician encounter, time to first imaging examination, and time to discharge decision were all significantly delayed (Table 3).

Time intervals according to KTAS stages

During the pre-pandemic period, there were no statistically significant differences in triage time, time to first physician encounter, time to first imaging examination, or time to discharge across all KTAS 1 and 2 stages. For KTAS 3, 4, and 5, a statistically significant delay in the time to discharge was observed only in the group with temperatures above 37.5°C. During the pandemic period, there were no statistically significant differences in triage time, time to first physician encounter, or time to first imaging examination between KTAS 1 and KTAS 2. However, for KTAS 3, 4, and 5, except for triage time, all time intervals showed a statistically significant delay in the group with temperatures above 37.5°C (Table 4).

Time intervals according to collaboration with other clinical departments

During the pre-pandemic period, there were no statistically significant differences in triage time, time to first physician encounter, time to first imaging examination, or time to discharge based on collaboration with other clinical departments. During the pandemic period, except for time to triage in cases where temperatures were above 37.5°C, there was a statistically significant delay in all time intervals (Table 5).

Table 1: General characteristics of enrolled patients.

		Pre-pandemic		Pandemic		*p*-value	
		<37.5°C	≧37.5°C	<37.5°C	≧37.5°C	<37.5°C	≧37.5°C
Sex							
	Male	2445	144	1569	145	0.418	0.344
	Female	2668	245	1775	214		
Age							
	18-20	1017	86	462	52	<0.001	0.1063
	21-40	909	90	631	96		
	41-60	1297	65	849	69		
	61-80	1235	85	902	82		
	>=81	655	63	500	60		
KTAS							
	1	25	2	18	5	<0.001	<0.001
	2	278	26	232	22		
	3	831	66	766	79		
	4	2257	159	1341	181		
	5	1722	136	987	72		
Disposition							
	ICU	93	11	86	12	<0.001	0.0325
	GW	557	47	472	51		
	Transfer	162	13	185	28		
	Discharge	4300	318	2598	268		
	Death	1	0	3	0		

KTAS: Korean Triage and Acuity System; ICU: Intensive care unit; GW: General Ward

Table 2: SARS-CoV-2 results according to body temperature during pandemic.

	<37.5°C	≧37.5°C	*p*-value
Positive	3	0	0.266
Negative	829	342	

Table 3: Comparison of time interval according to body temperature.

		Pre-pandemic			Pandemic		
		<37.5°C	≧37.5°C		<37.5°C	≧37.5°C	
		Mean ± SD	Mean ± SD	p-value	Mean ± SD	Mean ± SD	*p*-value
Time (min) to	Triage	3.1 ± 2.2	3.1 ± 1.9	0.598	3.9 ± 2.6	4.2 ± 3.0	0.070
	Doctor	26.7 ± 24.3	26.1 ± 27.0	0.690	33.4 ± 39.1	61.5 ± 70.6	<0.0001
	Imaging	39.1 ± 65.1	45.5 ± 68.8	0.061	46.8 ± 65.0	76.8 ± 81.5	<0.0001
	Disposition	185.6 ± 153.7	208.7 ± 180.3	0.014	223.8 ± 180.0	293.9 ± 198.0	<0.0001

SD: Standard Deviation

Table 4: Comparison of time interval according to KTAS and body temperature.

		Pre-pandemic			Pandemic		
		<37.5°C	≧37.5°C		<37.5°C	≧37.5°C	
		Mean ± SD	Mean ± SD	*p*-value	Mean ± SD	Mean ± SD	*p*-value
KTAS 1,2							
Time (min) to	triage	4.6 ± 3.7	3.5 ± 3.1	0.144	4.7 ± 3.6	6.0 ± 4.8	0.207
	doctor	26.5 ± 51.3	22.8 ± 18.6	0.424	38.1 ± 98.5	85.2 ± 235.2	0.312
	imaging	32.5 ± 59.0	47.9 ± 86.2	0.364	45.8 ± 87.6	55.7 ± 56.8	0.425
	disposition	277.4 ± 203.5	223 ± 183.3	0.174	324.5 ± 234.8	385 ± 289.2	0.216
KATAS 3,4,5							
Time (min) to	triage	3.0 ± 2.1	3.0 ± 1.6	0.945	3.9 ± 2.5	4.1 ± 2.7	0.160
	doctor	26.7 ± 21.6	26.3 ± 27.6	0.830	33.1 ± 29.5	59.6 ± 31.6	<0.001
	imaging	39.5 ± 65.5	45.3 ± 67.4	0.102	46.9 ± 62.9	78.6 ± 83.1	<0.001
	Disposition	17 9.8 ± 148.2	207.6 ± 180.3	0.005	215.6 ± 172.3	286.5 ± 187.3	<0.001

SD: Standard Deviation; KTAS: Korean Triage and Acuity System

Correlation between Tracked Temperature and Initial Temperature above 37.5˚C

During the pre-pandemic period, statistically significant decreases in body temperature were observed across sex, age groups, and KTAS scores. There were no statistically significant differences in discharge outcomes, except for patients admitted to intensive care units and general wards. During the pandemic, statistically significant differences were noted, except for KTAS 1 and intensive care unit admissions (Table 6).

Discussion

Overcrowding in emergency medical centers is a persistent challenge both domestically and globally, largely driven by the influx of non-emergency patients. Strategies to mitigate this problem include measures such as limiting the duration of patient stays [9,10].

However, the sudden global onset of the COVID-19 pandemic in 2020 introduced initial screening measures, including the assessment of relevant clinical symptoms, epidemiological investigations

Table 5: Comparison to time interval according to consultation and body temperature.

		Pre-pandemic			Pandemic		
		<37.5˚C	≧37.5˚C		<37.5˚C	≧37.5˚C	
		Mean ± SD	Mean ± SD	*p*-value	Mean ± SD	Mean ± SD	*p*-value
w/o consultation							
Time (min) to	Triage	3.1 ± 2.4	3.0 ± 1.5	0.574	3.8 ± 2.3	4.0 ± 2.2	0.308
	Doctor	26.3 ± 25.4	25.9 ± 19.9	0.830	33.5 ± 38.8	57.2 ± 29.0	<0.001
	Imaging	20.1 ± 31.7	20.5 ± 31.0	0.878	25.8 ± 39.5	52.4 ± 62.5	<0.001
	Disposition	113.1 ± 82.1	11.7 ± 73.3	0.839	129.2 ± 92.7	178.3 ± 96.8	<0.001
w/ consultation							
Time (min) to	Triage	3.1 ± .1	3.1 ± 2.0	0.714	4.0 ± 285	4.4 ± 2.8	0.136
	Doctor	27.1 ± 23.3	26.3 ± 30.9	0.701	33.4 ± 39.3	64.4 ± 88.1	<0.001
	Imaging	56.4 ± 81.1	62.3 ± 81.0	0.291	60.4 ± 74.1	93.2 ± 88.6	<0.001
	Disposition	251.9 ± 172.8	273.6 ± 200.5	0.110	284.9 ± 195.7	371.3 ± 210.5	<0.001

SD: Standard Deviation; KTAS: Korean Triage and Acuity System

Table 6: Comparison of initial ≧37.5 ˚C and follow-up body temperature.

		Pre-pandemic			Pandemic		
		Initial	F/U		Initial	F/U	
		Mean ± SD	Mean ± SD	*p*-value	Mean ± SD	Mean ± SD	*p*-value
Sex							
	Male	37.8 ± 0.4	37.4±0.6	<0.001	37.8±0.4	37.4±0.6	<0.001
	Female	37.8 ± 0.3	37.4±0.6	<0.001	37.7±0.3	37.3±0.5	<0.001
Age							
	18-20	37.8 ± 0.4	37.5 ± 0.8	<0.001	37.8 ± 0.2	37.6 ± 0.6	0.0006
	21-40	37.7 ± 0.2	37.4 ± 0.5	<0.001	37.7 ± 0.2	37.2 ± 0.5	<0.001
	41-60	37.7 ± 0.3	37.3 ± 0.5	<0.001	37.7 ± 0.2	37.3 ± 0.5	<0.001
	61-80	37.8 ± 0.3	37.4 ± 0.5	<0.001	37.9 ± 0.5	37.4 ± 0.6	<0.001
	>81	37.9 ± 0.5	37.7 ± 0.6	<0.001	37.8 ± 0.3	37.4 ± 0.5	<0.001
KTAS							
	1	37.7 ± 0.3	37.7 ± 0.3	<0.001	38.8 ± 1.0	38.0 ± 1.0	0.0906
	2	37.8 ± 0.3	37.5 ± 0.5	0.0031	37.8 ± 0.5	37.4 ± 0.8	0.0022
	3	37.9 ± 0.4	37.5 ± 0.7	<0.001	37.8 ± 0.3	37.5 ± 0.5	<0.001
	4	37.8 ± 0.4	37.4 ± 0.6	<0.001	37.8 ± 0.3	37.3 ± 0.5	<0.001
	5	37.7 ± 0.2	37.4 ± 0.6	<0.001	37.7 ± 0.2	37.2 ± 0.4	<0.001
Disposition							
	ICU	38.1 ± 0.7	38.0 ± 0.7	0.3409	38.3 ± 1.0	38.0 ± 1.0	0.0999
	GW	37.8 ± 0.3	37.8 ± 0.3	0.3225	37.7 ± 0.2	37.7 ± 0.3	0.0269
	Transfer	37.8 ± 0.3	37.5 ± 0.3	0.0012	37.8 ± 0.3	37.4 ± 0.4	<0.001
	Discharge	37.8 ±0.3	37.4 ± 0.6	<0.001	37.8 ± 0.3	37.3 ± 0.5	<0.001
	Death						

SD: Standard Deviation; KTAS: Korean Triage and Acuity System; ICU: Intensive care unit; GW: General ward; F/U: Follow-Up for contact history, checks on overseas travel, and body temperature measurement. These processes inevitably led to treatment delays and further exacerbated overcrowding in emergency medical centers.

The golden time is crucial for patients with severe trauma, as commonly acknowledged [11]. However, due to the nature of patients with severe trauma, obtaining an immediate medical history is challenging, particularly with changes in consciousness. Therefore, in practice, treatment is often conducted in isolated spaces, such as negative-pressure rooms, based solely on initial body temperature assessment. This study included all types of trauma, with patients classified as KTAS 1 and 2 representing those with severe injuries.

Definitions of fever vary in the literature, but normal body temperature ranges approximately from 35.3°C to 37.7°C, with an average of 36.7°C when measured orally. However, strictly adhering to these definitions during a pandemic is difficult. Thus, the Korea Centers for Disease Control and Prevention established 37.5°C as the initial temperature measurement criterion for screening.

Therefore, this study compared pre-pandemic and pandemic periods to assess the actual SARS-CoV-2 positivity rate using 37.5°C or higher as the screening criterion for patients with trauma. We aimed to explore the significance of body temperature as an initial screening tool, particularly for patients with severe trauma and low probability of infection, to identify solutions for alleviating emergency room overcrowding during future pandemics.

In comparing the general characteristics of the study participants, specifically the age groups, the total number of study subjects decreased significantly during the pandemic owing to factors such as lockdowns and reduced outdoor activities. However, a statistically significant decrease was observed in the group with temperatures below 37.5°C, while no significant difference was found in the group with temperatures above 37.5°C. Therefore, analyzing trauma patients with temperatures above 37.5°C before and after the pandemic may yield meaningful insights (Table 1).

Secondly, an examination of the results of PCR testing based on initial body temperature revealed three positive cases when the temperature was below 37.5°C, while no positive cases occurred when the temperature was above 37.5°C, showing statistically insignificant results. Thus, using the initial body temperature as a screening tool for trauma patients appears less meaningful (Table 2).

Third, when analyzing time intervals in the treatment process based on the initial body temperature, there was no statistically significant difference in the time to initial triage. However, the time to first physician encounter, time to first imaging examination, and time to discharge decision were all significantly delayed, potentially impacting overcrowding in emergency medical centers (Table 3).

Fourth, an examination of the time intervals in the treatment process based on KTAS stages revealed that, for severe cases categorized as KTAS 1 and 2, there was no statistically significant delay in the measured values before and after the pandemic. This could be attributed to the healthcare professionals wearing protective gear and actively engaging in treatment. However, for moderate to mild cases (KTAS 3, 4, 5), excluding initial triage, the time to first physician encounter, the time to first imaging examination, and the time to discharge decision were all statistically significantly delayed when initial body temperature was measured above 37.5°C. This might have resulted from prioritizing PCR testing or initial treatment for patients with severe or no trauma. Therefore, improving the domestic conditions in Korea to encourage outpatient visits is desirable (Table 4).

Fifth, when analyzing patient groups undergoing collaboration with other clinical departments outside of emergency medicine, neither group showed statistically significant delays in the time to initial triage. However, all other measured values were delayed regardless of collaboration. Therefore, using body temperature as a screening criterion for patients with trauma may cause delays in emergency medical treatment, worsening overcrowding in emergency medical centers (Table 5).

Lastly, an examination of the tracked temperatures of patients initially measured above 37.5°C revealed statistically significant decreases in all measured values except for patients admitted to KTAS 1 and intensive care units during the pandemic period. Therefore, it is necessary to avoid compromising the overall treatment capacity of the emergency medical center for patients with trauma when using body temperature as a screening tool, except for those admitted to KTAS 1 and intensive care units during the pandemic (Table 6).

The importance of checking temperature in the screening of COVID-19 in patients with suspicious symptoms has been reported differently in different studies and there is a lot of controversy [7,12]. In trauma patients, fever was often not be the chief complain, and these patients might have an elevated temperature, not due to fever, but because many people sustained trauma during physical activities. However, during the pandemic period trauma patients with a high temperature had to wait to see a doctor, undergo imaging studies and receive disposition due to concerns about COVID-19, even if they had no other symptoms or risk factors. This delay could worsen the prognosis for patients with severe trauma and contribute to overcrowding in emergency medical centers. Therefore, we demonstrated that temperature screening was not useful in trauma patients, and those with other treatment priorities should receive immediate care before being evaluated for COVID-19 infection.

The limitations of this study include the lack of uniformity in the measurement intervals between the initial and tracked temperatures of the patients. Although this is a retrospective study based on medical records, there are currently no established guidelines for measurement intervals. It may be possible to confirm appropriate intervals in future studies based on the results of this study. Second, there may be selection errors due to variations in the adherence to the KTAS and emergency medical center discharge outcomes across different institutions. Lastly, as a single-institution study conducted in one region, the findings may not be generalizable.

Although elevated temperature is not specific to having a COVID-19 infection, it has been considered a key clinical finding, along with other symptoms, during the initial presentation. However, many studies, including this one, have demonstrated that checking a fever as a screening tool had negligible value. Therefore, it is important to explore new screening tools for controlling future pandemics through more comprehensive studies, if feasible [3,7,12-14].

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