Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 8, No. 5, 1551-1559
2024
Publisher: Learning Gate
DOI: 10.55214/25768484.v8i5.1870

Effects of field activities by age of 119 emergency response team on the blood pressure, pulse, respiration, and quality of cardiopulmonary resuscitation

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Abstract: This study analyzed the physical changes according to age and the quality of cardiopulmonary resuscitation through experiments by 119 EMT in transporting equipment at the first aid site and performing post-cardiopulmonary resuscitation. In all ages, cardiopulmonary resuscitation was performed without physical load and CPR was performed after moving the equipment, first, the pulse was significantly increased, and the average pulse was measured higher than in other higher age groups under the age of 30. Second, respiratory changes were significantly increased, and average breathing was measured higher than in other higher age groups when CPR was performed after wearing personal protective equipment and moving the equipment. Third, as for changes in blood pressure, all blood pressure rose, and the average blood pressure in the 40s and older was measured higher than that of the younger age. Fourth, in the quality change of cardiopulmonary resuscitation, the pressure rate was found to have a statistically significant difference in those under 30, 30 to 34, and 35 to 39 years of age, and it was measured that the speed was maintained without change in those over 40. Finally, there was a statistically significant difference in pressure depth between those under 30 and those under 35-39 years old, and the average depth was measured deeper than other higher age groups, so it is necessary to develop differentiated education and training methods at those under 30 years of relatively little experience.

Keywords: *Age, PPE (Personal protective equipment), 119 EMT (Emergency medical technician), CPR (Cardiopulmonary resuscitation), Vital signs.*

1. Introduction

An important task in firefighting is to rescue the people into a safe environment when they are in a dangerous environment. The number of requests for firefighting activities is increasing every year, and 80% of them are emergency cases [1]

When requesting a first aid dispatch, 119 EMTs directly contact patients at the emergency site of acute diseases and various accidents and transfer them to first aid and hospital. However, first aid should be provided immediately regardless of past history or current infectious disease by contacting patients without detailed prior knowledge and testing of what diseases the patient has in a place that has not been confirmed and organized. At this time, protective equipment is required to be worn for the safety of 119 EMTs, and guidelines are strengthened to approach patients with severe injuries or cardiac arrest with COVID-19 based on Level D, a personal protective equipment.[2]

Unlike hospitals where limited space and equipment are maintained, EMTs move equipment from vehicle to site to consume a lot of physical energy. In the case of protecting respiratory and skin, respiratory restrictions and increased body temperature lead to rapid consumption of concentration and physical strength [3].

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In the case of severely injured patients or cardiac arrest patients, medical treatment such as securing airway intubation veins and chest compression is provided within the minimum time of the standard procedure for EMTs.[4] In addition, since these techniques are difficult even in the case of not wearing protective clothing, it is difficult to perform techniques after wearing personal protective equipment with many physical disabilities. [5]

Seo Young-soo (2015) conducted a first-class emergency investigation practical test to measure and confirm changes in vital signs through clinical experiments after wearing personal protective equipment for CBRNE special disasters, showing clinical characteristics such as increased blood pressure, body temperature, pulse, and respiration. [6]

Shin Dong-min et al. (2015) said, "As EMTs wore Level D personal protective equipment and analyzed the movements of CPR, the results of CPR were not significant, but the movement of EMTs was significantly different, which could lead to difficulty in effective first aid and damage to EMTs." [7]

In the above study, it can be seen that personal protective equipment hinders EMTs' performance of skills. Due to the nature of the site that is feared to be infected, the number of people to be treated at the first aid site is limited [8] compared to usual, and the minimum number of people requires more efficient and appropriate treatment and skills to operate equipment and transport patients. The 119 EMTs are each composed of various personnel, such as qualifications, age, and experience, and treatment is conducted in the presence of physical fatigue of EMTs, but few studies have been conducted centered on EMTs considering these sites.

The purpose of this study is to provide basic data for safety and efficient treatment of emergency sites by analyzing changes in the body according to the age of EMTs when EMTs arrive at the site, carry out first aid equipment, and perform CPR.

2. Subjects, Equipment, And Locations of Experiments

2.1. Subjects

The subjects of this study were 35 119 EMTs working at the G Fire Station in Seoul who voluntarily agreed to the experiment, and before participating in the study, precautions such as safety matters according to the measurement procedure were explained.

Table 1.
Features of subjects.

			N=35
Classification		**Frequency**	**Percent**
Sex	Male	30	85.7
	Female	5	14.3
Age	Under 30	8	22.9
	30~34	11	31.4
	35~39	7	20.0
	over 40	9	25.7
Career experience	Less than 1 year	7	20.0
	1~5	12	34.3
	5~10	6	17.1
	10~20	8	22.9
	Over 20 years	2	5.7
Qualification	Nurse	7	20.0
	Paramedic	15	42.9
	Advanced EMT	9	25.7

Edelweiss Applied Science and Technology
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	First aid educated	4	11.4
Class	Firefight	14	40.0
	Senior firefight	10	28.6
	Fire sergeant	8	22.9
	Fire lieutenant	3	8.6

As shown in Table 2, the characteristics of the subjects were 30 men (85.7%) and 5 women (14.3%), the average age was 34.94 years old, and 11 people (31.4%) aged 30 to 34, followed by 9 people (25.7%) aged 40 or older, 8 people (22.9%) under 30 and 7 people (20%). Career was the most common with 12 (34.3%) under 1 to 5 years, followed by 8 (22.9%) under 10 to 20 years, 7 (20%) under 1 year, 6 (17.1%) under 5 to 10 years, and 2 (5.7%) over 20 years. The class was the most common with 14 firefights (40%), followed by 10 senior firefights (28.6%), 8 fire sergeants (22.9%), 3 fire lieutenants (42.9%), 15 paramedics (42.9%), 9 advanced EMTs (25.7%), 7 nurses (20%), and 4 first-aid educated (11.4%).

Physical factors must be passed in accordance with the Fire Officer's Appointment Ordinance [9], and are managed through physical examinations and once a year according to the Fire Officer's Physical Fitness Rules and Fire Officer's Health and Safety Management Regulations, and [10] EMTs are conducted twice a year (Including one regular medical checkup for fire officials) under the 119 Rescue and Emergency Act. [11]

2.2. Experimental Equipment

2.2.1. Body Load Equipment

The basic set of personal protective equipment (Level D) consists of an N94 mask, goggles, gloves, full-body protective clothing, and overshoes. First aid equipment is the most basic equipment to carry during cardiac arrest, and in this experiment, CU Medical Defibrillator LIFEGAIN CU-HD1 was set as a portable device. Quality evaluation was conducted by measuring the pressure speed position depth as a digital value using Innosonion's cardiopulmonary resuscitation training mannequin IM13.

2.2.2. Body Physiological Response Measuring Instrument

Blood pressure gauges are usually measured in the upper arm close to the heart, and in this experiment, each experiment was compared using an oscillometric blood pressure meter, a digital expression method, to maintain objectivity to body changes after cardiopulmonary resuscitation. Among oxygen saturation measuring devices that can measure oxygen saturation and pulse in the blood within a short period of time, a portable oxygen saturation measuring device generally used by 119 EMTs was used. Since the eardrum of the ear eardrum thermometer (BRAUNR IRT6530 for eardrum) shares the same blood as the hypothalamus of the brain that controls body temperature, it accurately reflects the core body temperature, so it is possible to measure temperature change using infrared rays.

2.3. Locations of Experiments

In 2018, 77% of 119 emergencies occurred inside the building.[12] According to Cho Kyu-jong et al. (2016), it is difficult [13] to perform cardiopulmonary resuscitation if the EMTs are on the second or higher floor. In the case of upper-floor training, the place of occurrence was set on the third floor, and the ambulance arrived at the entrance and the EMTs approached the site.

Starting from the garage of the ○○119 Safety Center, carry a Defibrillator (CU Medical LIFEGAIN CU-HD1 weight of 5Kg), pass the 10m corridor, and contact the mannequin, a virtual patient, in the auditorium on the third floor, to perform CPR.

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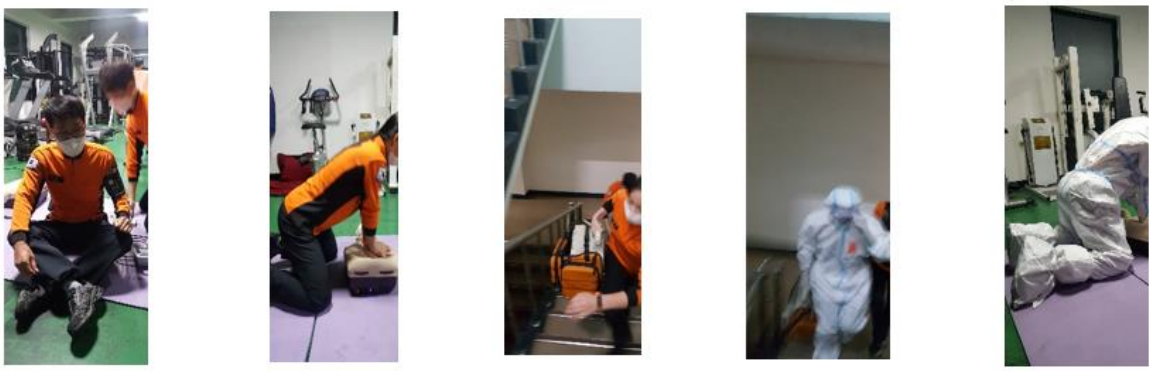
3. Experimental and Analytical Methods

3.1. Experimental Method

For this study, repeated measurements were conducted on 35 EMTs, and blood pressure, pulse, and respiratory rate were measured before the experiment as shown in Figure 1(a).

As shown in Figure 1(b), chest pressure is performed on the cardiopulmonary resuscitation mannequin at the experimental site without wearing personal protective equipment (Level D). Measure blood pressure, pulse and respiratory rate. As shown in Figure 1(c), start from the ambulance garage on the first floor without wearing personal protective equipment (Level D) and arrive at the auditorium on the third floor with first aid equipment. After performing two cycles of chest pressure on the cardiopulmonary resuscitation mannequin, measure blood pressure, pulse, and respiratory rate, and wear personal protective equipment (Level D) as shown in Figure 1(d), and start from the ambulance garage on the first floor. EMT arrives at the auditorium on the third floor with a defibrillator and measures blood pressure, pulse, and respiratory rate after performing two cycles of chest pressure on the cardiopulmonary resuscitation mannequin.



(a)Measurement of Body Signs (b) CPR without PPE (c)move to stairs without PPE (d) Move to stairs with PPE (e)Perform CPR after wearing PPE

Figure 1.
experimental scene.

3.2. Analysis Method

For the data of this study, the following statistical analysis was conducted using the SPSS 25.0 program.

First, frequency analysis was conducted to understand the general characteristics of the research subject.

Second, EMTs conducted technical statistics and Friedman tests to verify physical changes and the degree of cardiopulmonary resuscitation through physical loads such as protective clothing, equipment transport, and stairs at the site, and post-test was conducted with Wilcoxon's signed-ranks test.

The statistical analysis determined whether there was statistical significance based on the significance level of 5%.

4. Experimental Results

4.1. Pulse Changes

The pulse was found to have a statistically significant difference in all four measurement conditions under the age of 30, 30 to 34, 35 to 39, and 40 years of age or older. Under 30 years of age (χ^2 = 23.538, p<.001), aged 30 to 34 (χ^2=28.101p<.001), 40 years of age or older (χ^2=25.933, p<.001) was higher in the order of CPR after wearing PPE, CPR after moving stairs, CPR before performance, and 35 to 39 years of age were higher in the order of CPR after wearing PPE, CPR after moving stairs, CPR and

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before performance (χ^2=18.257, p<.001).

Changes in the average were shown in CPR before implementation, CPR after stair movement, and CPR after PPE wear, as shown in Figure 2(a). Those under 30 years of age were 79.50 (±10.76), 98.25 (±12.98), 121.13 (±13.51), 131.13 (±15.34), which was higher than 40 years of age that are 78.11 (±8.10), 95.33 (±10.69), 109.00 (±13.20), and 121.33 (±8.79).

4.2. Changes in Respiratory Rate

Respiratory was found to have statistically significant differences under the age of 30, 30 to 34, 35 to 39, and 40 years of age or older. Under 30 years of age (χ^2= 23.423, p<.001) and over 40 (χ^2=22.588, p<.001) was higher in the order of CPR after wearing PPE, CPR after moving stairs, CPR, and pre-implementation, and 30 to 34 years old (χ^2=27.291, p<.001) and 35 to 39 years of age (χ^2=17.250, p<.001) was higher in the order of cardiopulmonary resuscitation after wearing PPE, cardiopulmonary resuscitation after moving stairs, cardiopulmonary resuscitation, and pre-implementation.

Changes in the average were shown in cardiopulmonary resuscitation, post-step CPR, and post-PPE CPR as shown in Figure 2(b). Those under 30 years of age were 23.25 (±5.65), 27.75 (±7.05), and 31.50 (±6.39), which were measured higher than 21.78 (±3.49), 27.22 (±6.28), and 30.44 (±7.65) years of age 40 or older.

4.3. Changes in Blood Pressure

Blood pressure was found to have statistically significant differences in all four measurement conditions under the age of 30, 30 to 34, 35 to 39, and 40 years of age or older. Under 30 years of age (χ^2 = 15.900, p<.01), 30–34 years old (χ^2=22.486, p<.001), 35 to 39 years of age (χ^2=13.800, p<.01), 40 years of age or older (χ^2=21.400, p<.001) All were higher in the order of CPR after wearing PPE, CPR after moving stairs, CPR and pre-implementation.

Changes in the average were shown in CPR before implementation, CPR after stair movement, and CPR after PPE wear, as shown in Figure 2(c). Age 40 or older 139.00 (±14.82), 143.44 (±10.28), 161.00 (±17.76) and 166.56 (±18.45) were measured to be 130.57 (±6.19), 135.00 (±14.54), 155.71 (±18.65), and 164.29 (±18.07) as higher than 35-39 years of age.

4.4. Change in Compression Speed

The speed was found to be statistically significant in the case of performing cardiopulmonary resuscitation for those under the age of 30, 30 to 34, and 35 to 39 years of age performing CPR after wearing PPE. Those under the age of 30 had higher CPR after wearing PPE and CPR after moving stairs (χ^2=11.467, p<.01), after wearing PPE, CPR was higher than CPR (χ^2=9.333, p<.01) Cardiopulmonary resuscitation after wearing PPE was higher than CPR and CPR after moving stairs (χ^2=8.538, p<.05).

As shown in Figure 2(d), the change in the average was measured to be 114.36 (±4.37), 116.45 (±7.59), and 118.91 (±8.46) for 30 to 34 years of age in CPR after step movement, and PPE wear which had small shifts.

4.5. Change in Pressure Depth

The depth was found to be statistically significant under the three measurement conditions for those under 30 years of age and 35 to 39 years to 39. For those under 30 years of age, CPR after wearing PPE was higher than CPR after moving stairs (χ^2=8.538, p<.05), 35 to 39 years of age had higher CPR after wearing PPE and CPR after moving stairs than CPR (χ^2=11.467, p<.01).

Changes in the average were shown in cardiopulmonary resuscitation, post-step CPR, and post-PPE CPR as shown in Figure 2(e). Only those under 30 years of age were measured deeply at 6.14 (±0.35), 6.04 (±0.34), 6.18 (±0.32), and those over 40 years of age were measured shallowly at 5.33 (±0.51), 5.34 (±0.48), and 5.33 (±0.40).

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Table 2.
Differences between physical changes and cardiopulmonary resuscitation quality according to age.

Variable	Group	Average ranking				χ^2	p	Wilcoxon
		a	b	c	d			
Pulse	under 30	1.00	2.00	3.13	3.88	23.538***	<.001	a<b<c<d
	30~34	1.09	2.09	2.95	3.86	28.101***	<.001	a<b<c<d
	35~39	1.14	1.86	3.29	3.71	18.257***	<.001	a,b<c,d
	over 40	1.00	2.11	2.89	4.00	25.933***	<.001	a<b<c<d
Breathing	under 30	1.00	2.06	3.00	3.94	23.423***	<.001	a<b<c<d
	30~34	1.00	2.32	3.05	3.64	27.291***	<.001	a<b<c,d
	35~39	1.00	2.21	3.21	3.57	17.250***	<.001	a<b<c,d
	over 40	1.17	2.06	2.94	3.83	22.588***	<.001	a<b<c<d
Blood pressure	under 30	1.38	1.88	3.13	3.63	15.900**	.001	a,b<c,d
	30~34	1.27	1.95	3.41	3.36	22.486***	<.001	a,b<c,d
	35~39	1.43	1.86	3.00	3.71	13.800**	.003	a,b<c,d
	over 40	1.11	2.00	3.44	3.44	21.400***	<.001	a,b<c,d
Speed	under 30	-	1.13	2.13	2.75	11.467**	.003	b<c,d
	30~34	-	1.36	2.00	2.64	9.333**	.009	b<d
	35~39	-	1.29	1.93	2.79	8.538*	.014	b,c<d
	over 40	-	1.56	1.94	2.50	4.171	.124	
Depth	under 30	-	2.00	1.44	2.56	6.480*	.039	c<d
	30~34	-	2.23	1.91	1.86	1.267	.531	
	35~39	-	2.79	1.79	1.43	8.083*	.018	b<c,d
	over 40	-	2.00	1.94	2.06	0.061	.970	

Note: * p<.05 ** p<.01 *** p<.001
a = Before implementation
b = CPR
c = CPR after moving stairs
d = CPR with PPE

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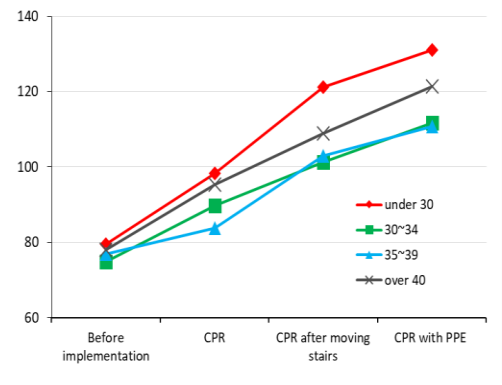
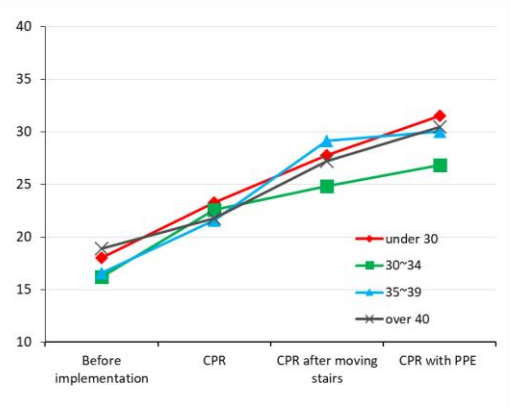
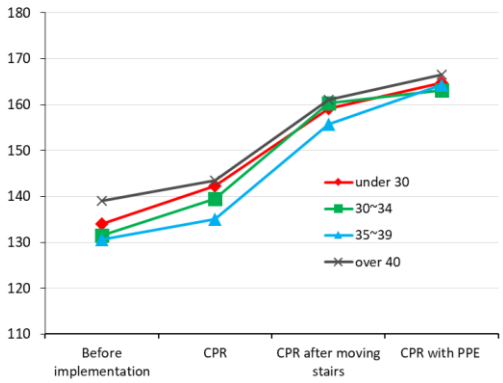


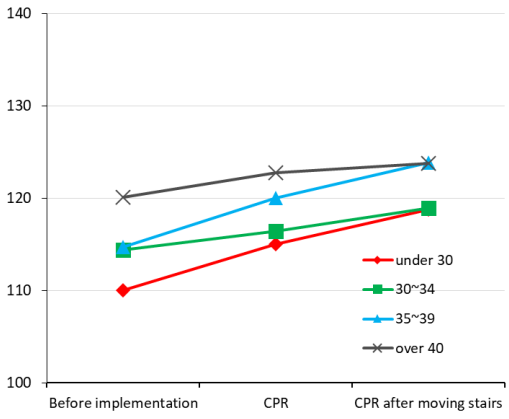
(a) Change in pulse



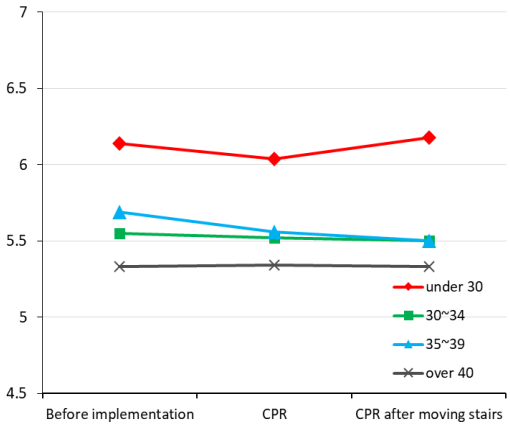
(b) Change in breathing



(c) Change in blood pressure



(d) Change in speed



(e) Change in depth

Figure 2.
Change comparison according to step.

5. Consideration of the Experiment

5.1. Variation of pulse

When 119 EMTs wore protective clothing after getting off the ambulance at the emergency site and performed CPR after moving the equipment, the pulse rate showed a sharp rise. This can be seen as a factor in raising the pulse rate in a short time by 119 EMTs arriving at the accident site in a short

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time with the equipment necessary for CPR to the emergency site. In the comparison by age, the pulse rate of members under the age of 30 was higher under four measurement conditions than those in their 40s or older. In the study of Ji Dae-geun (2016), it is the result [14] of a lack of field experience in members under the age of 30 and feeling a lot of tension and stress accordingly.

5.2. Changes in Respiratory Rate

When 119 EMTs wear personal protective equipment after getting off the ambulance at the emergency site and perform CPR after moving the equipment, the number of breaths is measured more than 30 times, excluding the age group of 30-34. This is likely to lead to difficulty breathing, and it was measured higher than the age of 40 or older at the age of 30 or younger, indicating that it affects body changes along with an increase in pulse.

5.3. Changes in Blood Pressure

Cardiopulmonary resuscitation after moving the stairs showed a rapid increase in blood pressure, especially in some over 40 years of age, with systolic blood pressure exceeding 170 mmHg and measuring up to 202 mmHg, which can be a dangerous factor for cardiovascular diseases such as stroke and myocardial infarction.

5.4. Changes in Cardiopulmonary Resuscitation Compression Speed

Cardiopulmonary resuscitation performed after wearing personal protective equipment exceeded 120 times in the 35-40 and 40+ age groups, indicating that the speed was maintained in the 30-34 age group, indicating relatively high physical consumption

5.5. Changes in Cardiopulmonary Resuscitation Compression

By age, it remains stable at 5.5cm at the age of 30-34 and 35-39, but 5.3cm is applied at the age of 40 or older, and more than 6cm is applied at the age of under 30 with little experience. Since physical differences are present, experienced senior EMTs should act as Preceptors [15] to help the new EMTs transfer to practice for a short period of time.

6. Conclusion

In this study, the following results were derived by analyzing physical changes through experiments in transporting equipment from the first aid site and performing post-cardiopulmonary resuscitation.

For 119 EMTs, CPR after wearing PPE, CPR after moving stairs, CPR, and blood pressure, pulse, respiration, and CPR quality were measured before implementation. As a result, there were statistically significant differences in pulse, respiration, and blood pressure in all age groups, pressure rates under the age of 30, 30 to 34, and 35 to 39, and pressure depth under the age of 30 and 35 to 39. In addition, on average, those under the age of 30 showed higher average pulse, breathing, and pressure rates than those over the age of 40, and the pressure depth was deep.

As a result of this study, it was confirmed that the treatment after transporting equipment and the treatment after wearing protective clothing increased the physical burden, and the quality of cardiopulmonary resuscitation differed according to age.

The physical and physical burden of experienced members in the EMTs was relatively greater. Since field activities are recommended mainly for experienced members after COVID-19, if the status of COVID-19 infectious diseases continues in the future, there should be continuous research on physically vulnerable elderly members and young members with little experience.

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