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Commentary

Acute myocardial infarction diagnosed in emergency departments: a report from the National Emergency Department Information System (NEDIS) of Korea, 2018–2022

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INTRODUCTION

Over the past decade, Korea has undergone significant transformations in its healthcare system, resulting in improved medical services, advanced technology, and enhanced public health initiatives [1–3]. In light of these developments, it is imperative to conduct a comprehensive analysis of the changing trends in acute myocardial infarction (AMI) presentations at emergency departments (EDs) across the nation. In this study, utilizing data from the National Emergency Department Information System (NEDIS), we aim to provide an overview of the current status of AMI diagnosed in EDs in Korea, including trends in incidence, demographic characteristics, and clinical outcomes categorized by age group and ED category. AMI diagnosis was confirmed using diagnostic codes I210–I219 during the 2018–2022 study period.

Ethics statement

This study was approved by the Institutional Review Board of the National Medical Center, Korea (No. NMC-2023-08-094). The requirement for informed consent was waived due to the retrospective nature of the study.

INCIDENCE AND IN-HOSPITAL MORTALITY RATE OF AMI

Fig. 1 illustrates the temporal trends in AMI incidence in Korea from 2018 to 2022. In the year 2018, the age and sex standardized incidence rate was 61.0 cases per 100,000 population, which steadily declined to 52.4 cases per 100,000 in 2022. Notably, men were three times more likely to be affected than women. As shown in Fig. 2, the in-hospital mortality rate for AMI in 2018 was 10.0% and remained relatively consistent throughout the study period, at 9.7% by 2022. Women consistently displayed a heightened vulnerability, experiencing 1.5 to 1.7 times greater mortality rates in comparison to men across the duration of the study. Fig. 3 illustrates that, of 100,000 ED visits in 2018, there were 35.5 AMI-related in-hospital mortalities. This pattern exhibited minor fluctuations, with 33.0 mortalities in 2022. Of 100,000 ED visits, AMI-related

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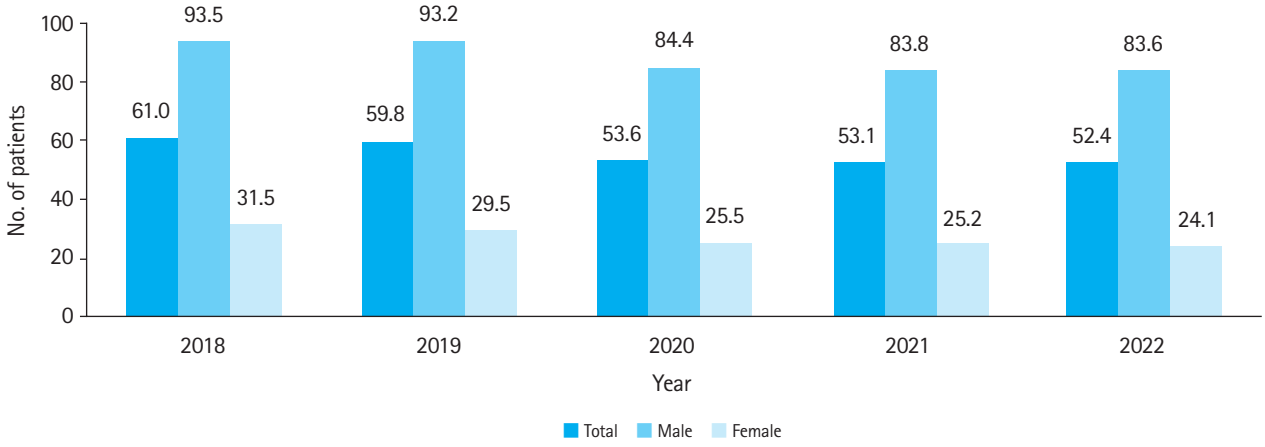

Fig. 1. Age- and sex-standardized emergency department visit of acute myocardial infarction per 100,000 population.

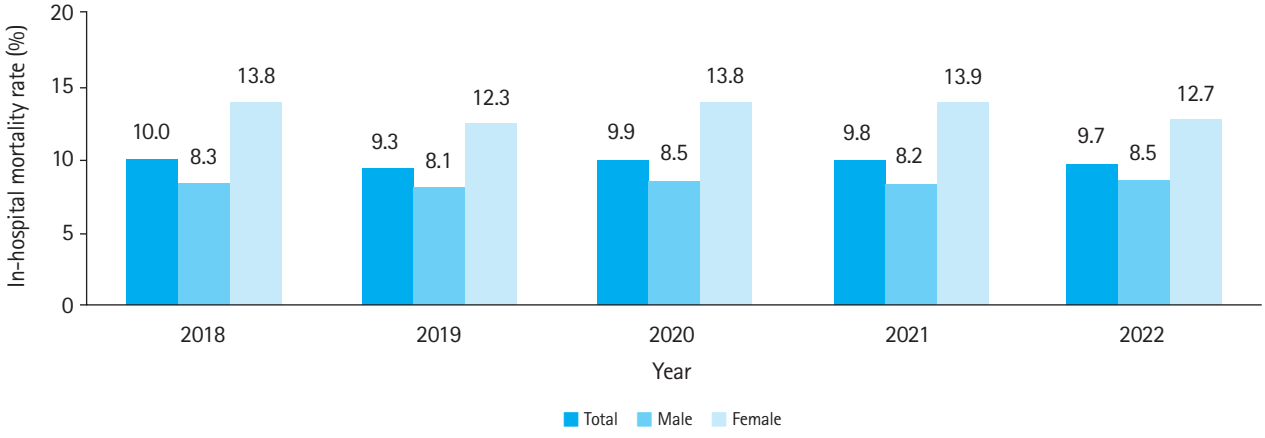

Fig. 2. In-hospital mortality rate of acute myocardial infarction.

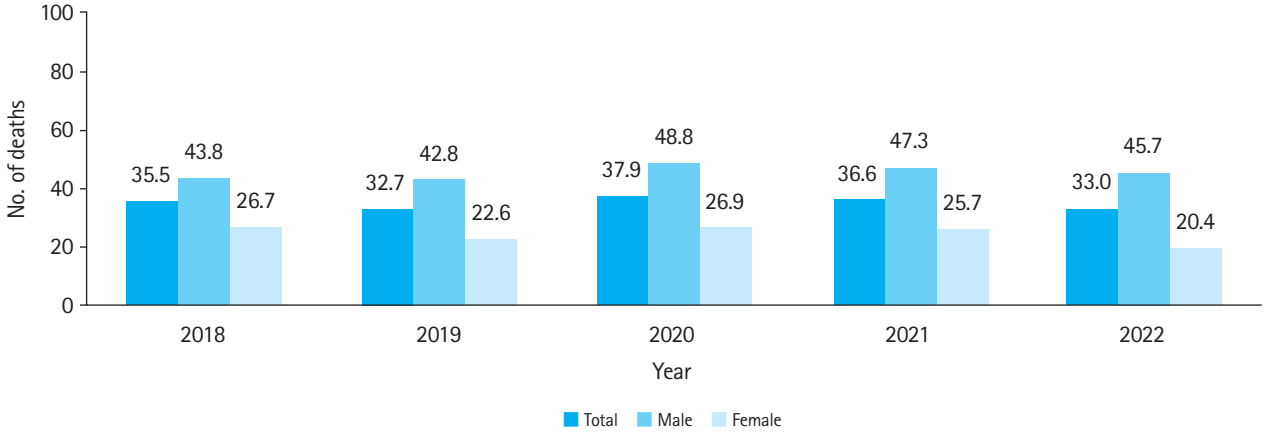

Fig. 3. Age- and sex-standardized mortality of acute myocardial infarction per 100,000 emergency department visits.

in-hospital mortalities were more pronounced among men, with a prevalence of 1.6 to 2.2 times higher than their female counterparts.

CHARACTERISTICS OF AMI ACCORDING TO AGE GROUP

Table 1 shows that most AMI patients presenting to the ED were elderly (54.0%), followed by adults (45.9%), with an overall mean age of 66.2 years. Among these patients, men were 2.6 times more prevalent than women. The primary mode of transportation to the ED was ambulance (43.1%), followed by ambulatory (36.3%). This trend was consistent in both adult and elderly patient groups. However, for pediatric patients, the most common mode of transportation was ambulatory (69.9%). Most patients (69.8%) spent less than 6 hours in the ED, with a median duration of 196 minutes (interquartile range [IQR], 82–432 minutes). Elderly patients had the longest median length of ED stay at 229

Table 1. Characteristics of acute myocardial infarction according to age group

Characteristic	Total	Age group		
		Pediatric (0–17 yr)	Adult (18–64 yr)	Elderly (65–130 yr)
No. of patients	144,295 (100)	83 (0.1)	66,288 (45.9)	77,924 (54.0)
Age (yr)	66.2 ± 13.8	12.3 ± 4.5	53.8 ± 7.8	76.8 ± 7.6
Sex				
Male	104,072 (72.1)	60 (72.3)	57,815 (87.2)	46,197 (59.3)
Female	40,223 (27.9)	23 (27.7)	8,473 (12.8)	31,727 (40.7)
Time between attack and presentation[a] (median [IQR]) (min)	133 (60–361)	138 (57–429)	112 (51–295)	164 (60–426)
Route of arrival				
Direct visit	97,921 (67.9)	72 (86.7)	46,785 (70.6)	51,064 (65.5)
Transferred from other hospital	42,640 (29.6)	10 (12.0)	17,889 (27.0)	24,741 (31.8)
Referred from outpatient clinic	3,703 (2.6)	1 (1.2)	1,603 (2.4)	2,099 (2.7)
Other	28 (0.0)	0 (0)	9 (0.0)	19 (0.0)
Unknown	3 (0.0)	0 (0)	2 (0.0)	1 (0.0)
Transport				
119 Ambulance	62,180 (43.1)	17 (20.5)	27,342 (41.2)	34,821 (44.7)
Other medical institution ambulance	6,862 (4.8)	5 (6.0)	2,572 (3.9)	4,285 (5.5)
Other ambulance	21,711 (15.0)	3 (3.6)	8,464 (12.8)	13,244 (17.0)
Police or official transport	112 (0.1)	0 (0)	78 (0.1)	34 (0.0)
Air transport	784 (0.5)	0 (0)	370 (0.6)	414 (0.5)
Ambulatory	52,358 (36.3)	58 (69.9)	27,341 (41.2)	24,959 (32.0)
Other or unknown	288 (0.2)	0 (0)	121 (0.2)	167 (0.2)
Length of stay				
Mean ± SD (min)	380.6 ± 531.9	283.7 ± 324.1	330.5 ± 479.9	423.4 ± 569.1
Median (IQR) (min)	196 (82–432)	193 (134–291)	159 (65–369)	229 (103–483)
0–6 hr	100,703 (69.8)	71 (85.5)	49,291 (74.4)	51,341 (65.9)
6–12 hr	22,706 (15.7)	7 (8.4)	8,909 (13.4)	13,790 (17.7)
12–24 hr	14,130 (9.8)	2 (2.4)	5,593 (8.4)	8,535 (11.0)
≥ 24 hr	6,751 (4.7)	3 (3.6)	2,492 (3.8)	4,256 (5.5)
Unknown	5 (0.0)	0 (0)	3 (0.0)	2 (0.0)
ED disposition				
Discharge	5,782 (4.0)	33 (39.8)	2,687 (4.1)	3,062 (3.9)
Admission[b]	129,019 (89.4)	40 (48.2)	60,032 (90.6)	68,947 (88.5)
General ward[c]	38,466 (29.8)	25 (62.5)	16,456 (27.4)	21,985 (31.9)
Intensive care unit[c]	90,506 (70.1)	15 (37.5)	43,560 (72.6)	46,931 (68.1)
Transfer	6,650 (4.6)	9 (10.8)	2,869 (4.3)	3,772 (4.8)
Hopeless discharge	19 (0.0)	0 (0)	0 (0)	19 (0.0)
Death	2,779 (1.9)	1 (1.2)	668 (1.0)	2,110 (2.7)
Other or unknown	46 (0.0)	0 (0)	32 (0.0)	14 (0.0)
Hospital disposition				
Discharge	114,996 (79.7)	73 (88.0)	58,088 (87.6)	56,835 (72.9)
Transfer	14,413 (10.0)	9 (10.8)	4,767 (7.2)	9,637 (12.4)
Hopeless discharge or transfer	127 (0.1)	0 (0)	28 (0.0)	99 (0.1)
Death	13,886 (9.6)	1 (1.2)	3,022 (4.6)	10,863 (13.9)
Other or unknown	873 (0.6)	0 (0)	383 (0.6)	490 (0.6)

Values are presented as number (%), unless otherwise indicated. Percentages may not total 100 due to rounding.
IQR, interquartile range; SD, standard deviation; ED, emergency department.
[a]Data provided by emergency centers. [b]Data for the "other" category are not presented. [c]Proportion among total admissions.

minutes (IQR, 103–483 minutes). Of the total patients, approximately 90% were admitted, with 70% placed in intensive care units and the remaining 30% in general wards. In total, 1.9% of patients experienced death during their stay in the ED. Among these patients, the elderly population exhibited the highest mortality rate of 2.7%, which was higher than the rates of 1.2% for pediatric patients and 1.0% for adult patients with AMI. Considering the final disposition of these patients, elderly patients faced a markedly elevated death rate of 13.9%, in contrast to the 4.6% of the adult population and the 1.2% of the pediatric group. This disparity underscores the vulnerability of the elderly demographic when confronted with AMI and the subsequent challenges in managing their outcomes.

CHARACTERISTICS OF AMI ACCORDING TO ED CATEGORY

Table 2 presents the characteristics of AMI patients based on ED category. EDs in Korea are classified into three categories according to hospital function and size: level I, regional emergency medical centers; level II, local emergency medical centers; and level III, local emergency medical institutes. Study data reveal that most AMI patients visited level II EDs (55.9%), followed by level I (44.0%). Only a minority of patients chose to visit level III EDs (0.1%) for their initial place of care. The median time between the onset of symptoms and the presentation of patients to the ED was 133 minutes (IQR, 60–361 minutes) for the entire patient cohort. When examining specific types of EDs, patients visiting level II EDs had a median time of 120 minutes (IQR, 53–345 minutes), while those seeking care at level I EDs exhibited a median time of 152 minutes (IQR, 60–389 minutes). Direct presentation, without being transferred from other hospitals, was the most prevalent route of access to EDs (67.9%); level II (74.9%) and level III EDs (75.5%) had higher rates of direct visits compared to level I EDs (58.9%). Conversely, considering patients who were transferred from other hospitals, level I EDs had the largest proportion (38.8%). Admission rates for patients with AMI varied, with level I EDs having the highest admission rate (93.4%), followed by level II (86.3%) and level III EDs (78.3%). In contrast, the transfer rates to other hospitals were highest for patients initially presenting at level III EDs (20.8%), followed by level II (7.3%) and level I EDs (1.1%). A comparable pattern was evident in the final disposition of patients within each ED category. Specifically, 30.2% of patients visiting level III EDs were transferred to other medical institutions, as opposed to 12.3% in level II and 7.0% in level I EDs.

DISCUSSION

Interpreting the data presented in our study requires a comprehensive and nuanced understanding, and the characteristics inherent to each dataset must be considered. The included patients were those who presented to the ED within 24 hours of symptom onset and received a diagnosis of AMI either at the ED or upon inpatient discharge. However, recording of the time from symptom onset to hospital presentation is not mandatory in level III EDs, and the data may not have been consistently documented in these settings. Nevertheless, most cases of AMI diagnosed in EDs nationwide are likely to be included in the statistics, given that a significant number of patients diagnosed in level III EDs is subsequently transferred to specialized centers. The impact of the COVID-19 pandemic on AMI should be carefully considered. Reports indicate that the pandemic had both direct and indirect effects on AMI incidence and care. At the outset of the pandemic, many individuals exhibiting symptoms of a heart attack hesitated to seek medical attention due to concerns about contracting COVID-19 in healthcare settings. This reluctance led to delayed treatment-seeking, which may have resulted in more severe cases of AMI and poorer outcomes [4]. These observed trends could help explain the decreased incidence of AMI during the study period. Notably, the claims data obtained from the NEDIS, which is managed by the Ministry of Health and Welfare of Korea, is highly reliable. Several factors contribute to the reliability of this data. First, it benefits from the participation of a vast majority of EDs in the system, with more than 98% of them contributing data. Additionally, the dataset undergoes an annual review process conducted by the government, which further enhances its accuracy and quality [5–7]. When comparing the mortalities in the study dataset with those of others, it is important to take into account the differences in patient inclusion criteria. For instance, when examining data from the Korea Acute Myocardial Infarction Registry (KAMIR), the in-hospital mortality rate was 3.8% in 2018 and 5.7% in 2019 [8]. These results are derived from individuals admitted as inpatients within a select group of participating hospitals. However, the NEDIS dataset includes both fatalities from AMI that occurred in the ED and fatalities among individuals who were subsequently hospitalized following ED presentation. As a result, our dataset exhibits elevated in-hospital mortality rates. While these national data offer valuable insights into the characteristics of AMI patients visiting EDs in Korea, it also underscores some concerning trends. That more than one-third of patients arrive at EDs via non–ambulance vehicles suggests a potential lack of public awareness regarding the severity of AMI

Table 2. Characteristics of acute myocardial infarction according to ED category

Characteristic	Total	Type of ED		
		Level I	Level II	Level III
No. of patients	144,295 (100)	63,463 (44.0)	80,726 (55.9)	106 (0.1)
Age (yr)	66.2 ± 13.8	66.3 ± 13.5	66.1 ± 14.1	64.7 ± 13.5
Sex				
Male	104,072 (72.1)	45,837 (72.2)	58,160 (72.0)	75 (70.8)
Female	40,223 (27.9)	17,626 (27.8)	22,566 (28.0)	31 (29.2)
Time between attack and presentation[a] (median [IQR]) (min)	133 (60–361)	152 (60–389)	120 (53–345)	122 (47–302)
Route of arrival				
Direct visit	97,921 (67.9)	37,374 (58.9)	60,467 (74.9)	80 (75.5)
Transferred from other hospital	42,640 (29.6)	24,631 (38.8)	17,991 (22.3)	18 (17.0)
Referred from outpatient clinic	3,703 (2.6)	1,449 (2.3)	2,246 (2.8)	8 (7.5)
Other	28 (0.0)	8 (0.0)	20 (0.0)	0 (0)
Unknown	3 (0.0)	1 (0.0)	2 (0.0)	0 (0)
Transport				
119 Ambulance	62,180 (43.1)	25,238 (39.8)	36,895 (45.7)	47 (44.3)
Other medical institution ambulance	6,862 (4.8)	5,050 (8.0)	1,811 (2.2)	1 (0.9)
Other ambulance	21,711 (15.0)	12,140 (19.1)	9,556 (11.8)	15 (14.2)
Police or official transport	112 (0.1)	57 (0.1)	55 (0.1)	0 (0)
Air transport	784 (0.5)	706 (1.1)	78 (0.1)	0 (0)
Ambulatory	52,358 (36.3)	20,139 (31.7)	32,146 (39.8)	43 (40.6)
Other or unknown	288 (0.2)	103 (0.2)	185 (0.2)	0 (0)
Length of stay				
Mean ± SD (min)	380.6 ± 531.9	452.2 ± 586.7	324.6 ± 477.3	185.8 ± 259.8
Median (IQR) (min)	196 (82–432)	250 (105–533)	163 (71–360)	96 (49–206)
0–6 hr	100,703 (69.8)	40,078 (63.2)	60,536 (75.0)	89 (84.0)
6–12 hr	22,706 (15.7)	11,690 (18.4)	11,002 (13.6)	14 (13.2)
12–24 hr	14,130 (9.8)	7,717 (12.2)	6,411 (7.9)	2 (1.9)
≥ 24 hr	6,751 (4.7)	3,974 (6.3)	2,776 (3.4)	1 (0.9)
Unknown	5 (0.0)	4 (0.0)	1 (0.0)	0 (0)
ED disposition				
Discharge	5,782 (4.0)	2,219 (3.5)	3,562 (4.4)	1 (0.9)
Admission[b]	129,019 (89.4)	59,297 (93.4)	69,639 (86.3)	83 (78.3)
General ward[c]	38,466 (29.8)	17,636 (29.7)	20,805 (29.9)	25 (30.1)
Intensive care unit[c]	90,506 (70.1)	41,641 (70.2)	48,807 (70.1)	58 (69.9)
Transfer	6,650 (4.6)	716 (1.1)	5,912 (7.3)	22 (20.8)
Hopeless discharge	19 (0.0)	11 (0.0)	8 (0.0)	0 (0)
Death	2,779 (1.9)	1,203 (1.9)	1,576 (2.0)	0 (0)
Other or unknown	46 (0.0)	17 (0.0)	29 (0.0)	0 (0)
Hospital disposition				
Discharge	114,996 (79.7)	52,654 (83.0)	62,276 (77.1)	66 (62.3)
Transfer	14,413 (10.0)	4,428 (7.0)	9,953 (12.3)	32 (30.2)
Hopeless discharge or transfer	127 (0.1)	95 (0.1)	32 (0.0)	0 (0)
Death	13,886 (9.6)	5,978 (9.4)	7,901 (9.8)	7 (6.6)
Other or unknown	873 (0.6)	308 (0.5)	564 (0.7)	1 (0.9)

Values are presented as number (%), unless otherwise indicated. Percentages may not total 100 due to rounding.
ED, emergency department; IQR, interquartile range; SD, standard deviation.
[a]Data provided by emergency centers. [b]Data for the "other" category are not presented. [c]Proportion among total admissions.

and the need for immediate medical attention. According to a report from the Korea Disease Control and Prevention Agency (KDCA) [9], the nationwide recognition rate of early symptoms of AMI in 2022 was 47.1%. This indicates that one of every two adults is unaware of early AMI symptoms. However, after initially being recorded at 46.5% in 2017, the recognition rate increased to 56.9% in 2019 but has been on a decline since 2020. Additionally, delayed hospital presentation among elderly patients, with a longer median time interval between symptom onset and ED arrival compared to adults shown in our data, is concerning, especially considering the higher mortality in this group compared to others. Early detection and prompt treatment of AMI are

crucial in reducing mortality rates [10,11]. Therefore, it is vital to strengthen public health campaigns that raise awareness about the seriousness of AMI and the urgency of seeking medical assistance. Such efforts should also aim to reduce the time between symptom onset and ED arrival.

ARTICLE INFORMATION

Author contributions

Conceptualization: all authors; Data curation: EK, YSR; Methodology: all authors; Project administration: YSR; Visualization: SA, EK; Writing–original draft: SA; Writing–review & editing: all authors. All authors read and approved the final manuscript.

Conflicts of interest

The authors have no conflicts of interest to declare.

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Data availability

Data of this study are from the National Emergency Medical Center (NEMC; Seoul, Korea) under the Ministry of Health and Welfare of Korea, which were used under license for the current study. Although the data are not publicly accessible, they are available from the corresponding author upon reasonable request with permission from the NEMC.

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