Leveraging Clinical Digitized Data to Understand Temporal Characteristics and Outcomes of Acute Myocardial Infarctions at a Tertiary Care Medical Centre in Pakistan from 1988–2018 – Methods and Results

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ABSTRACT

Background and Objective: Few data exist on trends in acute myocardial infarction (AMI) patterns spanning recent epidemiological shifts in low middle-income countries (LMICs). To understand temporal disease patterns of AMI characteristics and outcomes between 1988–2018, we used digitized legacy clinical data at a large tertiary care centre in Pakistan.

Methods: We reviewed digital health information capture systems maintained across the Aga Khan University Hospital and obtained structured elements to create a master dataset. We included index admissions of patients >18 years that were discharged between January 1, 1988, and December 31, 2018, with a primary discharge diagnosis of AMI (using ICD-9 diagnoses). The outcome evaluated was in-hospital mortality. Clinical characteristics derived from the electronic database were validated against chart review in a random sample of cases (k 0.53–1.00).

Results: The final population consisted of 14,601 patients of which 30.6% (n = 4,470) were female, 52.4% (n = 7,651) had ST elevation MI and 47.6% (n = 6,950) had non-ST elevation MI. The median (IQR) age at presentation was 61 (52–70) years. Overall unadjusted in-hospital mortality was 10.3%. Across the time period, increasing trends were noted for the following characteristics: age, proportion of women, prevalence of hypertension, diabetes, proportion with NSTEMI (all p_trend < 0.001). In-hospital mortality rates declined significantly between 1988–1997 and 2008–2018 (13.8% to 9.2%, p < 0.001).

Conclusions: The patterns of AMI have changed over the last three decades with a concomitant decline in in-hospital mortality at a tertiary care centre in Pakistan. Clinical digitized data presents a unique opportunity for gaining insights into disease patterns in LMICs.
INTRODUCTION

The burden of ischemic heart disease is rising disproportionately in low middle income countries (LMICs) such as Pakistan [1]. Acute myocardial infarction (AMI) is the archetype cardiovascular emergency [2]. Outcomes of AMI have improved substantially in developed countries and are often rigorously tracked through national registries and health system databases to serve as guides for continuous improvement efforts [3, 4]. However, while the need is great in LMICs, such registries and tracking efforts are scarce [5, 6]. In addition there are few research studies reporting on outcomes of AMI from LMICs.

Whereas electronic health record (EHR) powered databases have been used extensively to understand disease outcomes trends in developing countries, few examples exist in LMICs due to resource constraints, inadequacy of digitized clinical data and lack of linkages among public-sector maintained resources [7]. The utilization of such digitized clinical data, acquired as a by-product of clinical care across large time periods and across various data capture systems, in LMICs, for research and quality improvement purposes has not been explored at scale previously.

We aimed to leverage longitudinally maintained hospital clinical data at a tertiary care centre in Pakistan to address knowledge gaps around trends in AMI patterns over the last three decades. We hypothesized that digitized data could be leveraged to understand AMI characteristics and outcomes, and that AMI mortality had declined over time [8].

METHODS

Study Setting: Our study was carried out at the Aga Khan University Hospital in Karachi, Pakistan.

Patient Population: We included patients >18 years with a primary discharge diagnosis of acute myocardial infarction between January 1, 1988, to December 31, 2018. Only index admissions with a primary discharge diagnosis of acute myocardial infarction were used for all analyses.

DATA CURATION AND ANALYSIS

Although inpatient admissions and care is mostly documented using paper charts at AKUH, this is supplemented by a robust health information technology support structure that captures structured data elements that AKUH has maintained since its inception. For this study we explored and leveraged the data sources at the Aga Khan University Hospital (AKUH) in Karachi. Our methodological approach can be divided into three overarching strategic phases: 1) Data discovery and extraction, 2) Data transformation 3) Data validation (Figure 1).

(1) Data Discovery and Extraction

The Aga Khan University Hospital Information Management System (HIMS) has been prospectively maintaining data at the Aga Khan University Hospital since 1988. This department populates data on each patient after a rigorous review of the chart by master coders after patient discharge at the conclusion of a hospital admission. As part of its routine practice the HIMS departments re-evaluates 15% of daily discharges (selected randomly) for quality assurance of coding accuracy in the Abstracting System with a benchmark target of 97.5%. Multiple digital systems comprise the hospital information system and after an initial review of ten digital data capture systems we used five systems for the extraction process, based on their clinical relevance, and potential for quality improvement intervention.

The Abstracting System contains primary, secondary, and associated diagnoses using International Classification of Diseases, 9th revision (ICD-9) codes and ICD-9 procedure codes and has been maintained since 1988. This system was used to identify the AMI cases. We used the ICD-9 diagnoses codes of 410.0 – 410.9, 410.00 – 410.02, 410.10 – 410.12, 410.20 – 410.22, 410.30 – 410.32, 410.40 – 410.42, 410.50 – 410.52, 410.60 – 410.62, 410.70 – 410.72, 410.80 – 410.82 and 410.90 – 410.92 to identify cases of AMI. NSTEMI was defined as diagnosis codes 410.0 – 410.6, 410.8 – 410.9, 410.00 – 410.02, 410.10 – 410.12, 410.20 – 410.22, 410.30 – 410.32, 410.40 – 410.42, 410.50 – 410.52, 410.60 – 410.62, 410.80 – 410.82 and 410.90 – 410.92. In
addition, associated clinical diagnoses reporting on diseases such as diabetes, hypertension, dyslipidaemia, and AMI complications were also curated on the patients with AMI. PCI was defined as ICD-9 procedure codes 00.66, 36.06 and 36.07, CABG was defined as procedure codes 36.10–36.16, and angiography was defined as procedure codes 37.21–37.23 and if PCI was done.

The presence of a diagnosis code reporting the condition on discharge was considered presence of the condition and absence of the diagnosis code as absence of a history of the condition. From the extracted data set we included index admissions where the primary discharge diagnosis was an AMI as defined by the above codes. Repeat admissions and records identifying AMI as a secondary diagnosis and \( n = 15,089 \) were excluded (Figure 1).

(2) Data transformation

The transformation process was designed such that raw data from the source files were imported. Mappings were first done for a pilot dataset of one year. Analysis of this data resulted in finding rectifiable errors in the mapping process and subsequent iterative changes in the transformation rules that were then applied to the entire data set spanning 1988–2018.

(3) Data validation

A paper chart review of discharge summaries and inpatient notes was conducted by three independent reviewers. These reviewers were blinded to the digital dataset at the time of the chart review. For the purposes of this validation process, a random sample of 1.0% electronic records from the 30-year dataset was identified for the chart review process but paper chart review was possible on 0.34% of the cohort as some paper files, purged based on hospital policies, were not available for review. The age field was extracted from the abstracting system which maintains the most up to date information on demography of any given patient. The age in the system is calculated using date of admission subtracted from the date of birth rounded to year.
PATIENT AND PUBLIC INVOLVEMENT

Patient and public were not directly involved in the design or execution of this project.

STATISTICAL ANALYSIS

For data validation, Cohen’s kappa coefficient was calculated for categorical variables (chart review vs digital dataset) and ICC was used to describe agreement in continuous variables between chart review and the digital dataset.

Continuous variables such as age and length of hospital stay were described using median with interquartile ranges. Categorical variables were described as proportions with percentages. The cohort was described as a whole, by STEMI and NSTEMI, and by time periods (1988–1997, 1998–2007 and 2008–2018). Differences in continuous variables were examined using Generalized Linear Models and reported the p value of likelihood ratio chi-square test. Likewise, differences in categorical variables were evaluated using the linear-by-linear chi-square statistic. Statistical analyses were carried out using Statistical Package for Social Sciences (SPSS, version 19.0).

This study was approved by the Ethical Review Committee at the Aga Khan University (2018-0149-219).

RESULTS

COHORT IDENTIFICATION AND VALIDATION

A total of 29,690 discharges with AMI were identified during the period 1988–2018. Of these 14,601 comprised index admissions on unique patients discharged/deceased with a primary discharge diagnosis of AMI (Figure 1). The Cohen’s kappa coefficient for categorical variables such as patient’s demographics, diagnoses (primary and associated) and procedures ranged from 0.53 to 1.00. ICC for length of hospital stay and age was 0.95 and 0.99 respectively (Table 1).

POPULATION CHARACTERISTICS

Among 14,601 patients with AMI, the median (interquartile range) was 61 (52–70) years, and 10,131 (69.4%) patients were men. A total of 1,315 (9.0%) patients were <45 years of age; n = 7298 (50.0%) were between 45–64 years of age; and 5,988 (41.0%) patients were 65 years of age. Women were older compared with men (64.5 years vs. 59.3 years respectively, p < 0.001). A total of 7,651 (52.4%) patients had STEMI and 6,950 (47.6%) patients had NSTEMI (Table 2).
Between 1988–2018, a rise in yearly AMI admissions was noted (Figure 2). In addition, a rising trend was observed among all risk factors such as smoking, diabetes, hypertension, dyslipidaemia ($p < 0.001$). Over the three decades (1st vs 2nd vs 3rd), a significant increase was observed in the proportion of women presenting with AMI (26.9% vs 29.4% vs 32.9%, $p < 0.001$). The proportion of STEMI declined over the years from 81.6% during first decade to 41.1% during last decade and a rise in the proportion of NSTEMI admissions was concomitantly observed (Table 3 and Figure 3). The median age at presentation of STEMI increased from 57 years to 59 years. Patients with NSTEMI were older and their median age at presentation increased from 61 years to 65 years (Table 3).

**TEMPORAL TRENDS**

|                                      | 1988–2018 TOTAL n = 14,601 | 1988–1997 TOTAL n = 2544 | 1998–2007 TOTAL n = 5102 | 2008–2018 TOTAL n = 6955 | $P_{\text{trend}}$ |
|--------------------------------------|----------------------------|--------------------------|--------------------------|--------------------------|------------------|
| Age; Median (IQR)                    | 61 (52–70)                 | 58 (50–66)               | 60 (52–70)               | 63 (54–71)               | <0.001*          |
| Range                                | 19–101                     | 22–94                    | 19–96                    | 19–101                   |                  |
| Sex                                  |                            |                          |                          |                          |                  |
| Male                                 | 10131 (69.4)               | 1859 (73.1)              | 3603 (70.6)              | 4669 (67.1)              | <0.001           |
| Female                               | 4470 (30.6)                | 685 (26.9)               | 1499 (29.4)              | 2286 (32.9)              |                  |
| STEMI                                | 7651 (52.4)                | 2076 (81.6)              | 2714 (53.2)              | 2861 (41.1)              | <0.001           |
| NSTEMI                               | 6950 (47.6)                | 468 (18.4)               | 2388 (46.8)              | 4094 (58.9)              |                  |
| **RISK FACTORS**                     |                            |                          |                          |                          |                  |
| Current Smoker                       | 4388 (30.1)                | 336 (13.2)               | 1842 (36.1)              | 2210 (31.8)              | <0.001           |
| Diabetes Mellitus                    | 6985 (47.8)                | 962 (37.8)               | 2342 (45.9)              | 3681 (52.9)              | <0.001           |
| Hypertension                         | 9070 (62.1)                | 1108 (43.6)              | 3006 (58.9)              | 4956 (71.3)              | <0.001           |
| Dyslipidaemia                        | 3594 (24.6)                | 284 (11.2)               | 2264 (44.4)              | 1046 (15.0)              | <0.001           |
| **PROCEDURES**                       |                            |                          |                          |                          |                  |
| Coronary Angiography                 | 7382 (50.6)                | 110 (4.3)                | 2699 (52.9)              | 4573 (65.8)              | <0.001           |
| Percutaneous Coronary Intervention   | 4626 (31.7)                | 17 (0.7)                 | 1366 (26.8)              | 3243 (46.6)              | <0.001           |
| Coronary Artery Bypass Graft         | 1149 (7.9)                 | 16 (0.6)                 | 546 (10.7)               | 587 (8.4)                | <0.001           |
| **COMPLICATIONS AND OUTCOMES**       |                            |                          |                          |                          |                  |
| Acute Kidney Injury                  | 2295 (15.7)                | 78 (3.1)                 | 347 (6.8)                | 1870 (26.9)              | <0.001           |
| Cardiogenic Shock                    | 1206 (8.3)                 | 142 (5.6)                | 373 (7.3)                | 691 (9.9)                | 0.001            |
| Heart Failure                        | 4129 (28.3)                | 684 (26.9)               | 1422 (27.9)              | 2023 (29.1)              | 0.072            |
| In-hospital Mortality                | 1507 (10.3)                | 351 (13.8)               | 513 (10.1)               | 643 (9.2)                | <0.001           |
| Length of hospital stay (days); median (IQR) | 4 (3–7)                   | 6 (4–8)                  | 5 (3–8)                  | 3 (2–6)                  | <0.001*          |

Table 2 Total and decade-wise chronological trends of patient characteristics (n = 14,601).

* $p$ value of likelihood ratio chi-square test.

Figure 2 Trends in total number of AMI index admissions.
### Table 3: Temporal trends of characteristics of STEMI (n = 7,651) and NSTEMI (n = 6,950).

* p value of likelihood ratio chi-square test.

#### STEMI (N = 7,651)

|                     | 1988–1997 TOTAL n = 2076 | 1998–2007 TOTAL n = 2714 | 2008–2018 TOTAL n = 2861 | \( P_{\text{trend}} \) |
|---------------------|---------------------------|---------------------------|---------------------------|--------------------------|
| **Age, in years, median (IQR)** | 57 (49–65) | 58 (50–66) | 59 (50–68) | <0.001* |
| Range               | 22–94         | 25–96         | 19–100        |             |
| **Sex**             |               |               |               |             |
| Male                | 1567 (75.5)  | 2092 (77.1)  | 2134 (74.6)  |             |
| Female              | 509 (24.5)   | 622 (22.9)   | 727 (25.4)   |             |
| **RISK FACTORS**    |               |               |               |             |
| Current Smoker      | 241 (11.6)   | 1086 (40.0)  | 1031 (36.0)  | <0.001      |
| Diabetes Mellitus   | 759 (36.6)   | 1090 (40.2)  | 1250 (43.7)  | <0.001      |
| Hypertension        | 851 (41.0)   | 1386 (51.1)  | 1735 (60.6)  | <0.001      |
| Dyslipidaemia       | 201 (9.7)    | 1192 (43.9)  | 412 (14.4)   | 0.383       |
| **PROCEDURES**      |               |               |               |             |
| Coronary Angiography| 77 (3.7)     | 1626 (59.9)  | 2477 (86.6)  | <0.001      |
| Percutaneous Coronary Intervention | 12 (0.6) | 961 (35.4) | 2088 (73.0) | <0.001 |
| Coronary Artery Bypass Graft | 12 (0.6) | 267 (9.8) | 223 (7.8) | <0.001 |
| **COMPLICATIONS AND OUTCOMES** |           |               |               |             |
| Acute Kidney Injury | 65 (3.1)     | 148 (5.5)    | 508 (17.8)   | <0.001      |
| Cardiogenic Shock   | 130 (6.3)    | 287 (10.6)   | 462 (16.1)   | <0.001      |
| Heart Failure       | 530 (25.5)   | 523 (19.3)   | 495 (17.3)   | <0.001      |
| In-hospital Mortality| 314 (15.1) | 334 (12.3) | 331 (11.6) | <0.001 |
| Length of hospital stay (days); median (IQR) | 6 (4–8) | 4 (3–7) | 3 (2–5) | <0.001* |

#### NSTEMI (N = 6,950)

|                     | 1988–1997 TOTAL n = 468 | 1998–2007 TOTAL n = 2388 | 2008–2018 TOTAL n = 4094 | \( P_{\text{trend}} \) |
|---------------------|--------------------------|---------------------------|---------------------------|--------------------------|
| **Age, in years, median (IQR)** | 61 (53–69) | 64 (55–72) | 65 (57–74) | <0.001* |
| Range               | 25–90         | 20–96         | 19–101        |             |
| **Sex**             |               |               |               |             |
| Male                | 292 (62.4)   | 1511 (63.3)  | 2535 (61.9)  | 0.418       |
| Female              | 176 (37.6)   | 877 (36.7)   | 1559 (38.1)  |             |
| **RISK FACTORS**    |               |               |               |             |
| Current Smoker      | 95 (20.3)    | 756 (31.7)   | 1179 (28.8)  | 0.289       |
| Diabetes Mellitus   | 203 (43.4)   | 1252 (52.4)  | 2431 (59.4)  | <0.001      |
| Hypertension        | 257 (54.9)   | 1620 (67.8)  | 3221 (78.7)  | <0.001      |
| Dyslipidaemia       | 83 (17.7)    | 1072 (44.9)  | 634 (15.5)   | <0.001      |
| **PROCEDURES**      |               |               |               |             |
| Coronary Angiography| 33 (7.1)     | 1073 (44.9)  | 2096 (51.2)  | <0.001      |
| Percutaneous Coronary Intervention | 5 (1.1) | 405 (17.0) | 1155 (28.2) | <0.001 |
| Coronary Artery Bypass Graft | 4 (0.9) | 279 (11.7) | 364 (8.9) | 0.130 |
| **COMPLICATIONS AND OUTCOMES** |           |               |               |             |
| Acute Kidney Injury | 13 (2.8)     | 199 (8.3)    | 1362 (33.3)  | <0.001      |
| Cardiogenic Shock   | 12 (2.6)     | 86 (3.6)     | 229 (5.6)    | <0.001      |
| Heart Failure       | 154 (32.9)   | 899 (37.6)   | 1528 (37.3)  | <0.001      |
| In-hospital Mortality| 37 (7.9)  | 179 (7.5)   | 312 (7.6)   | 0.973       |
| Length of hospital stay (days); median (IQR) | 6 (4–8) | 5 (3–8) | 3 (2–6) | <0.001* |
Overall, the proportion of patients receiving PCI, angiography and CABG rose over the years. Concomitantly from 1988 to 2018, a downward trend in length of stay (median six days in first decade to three days in the last decade) and in-hospital mortality (Figure 4) from 13.8% during first decade to 9.2% in the last decade (p\text{trend} < 0.001). A significant decline in in-hospital mortality was observed over the three decades (1\text{st} vs 2\text{nd} vs 3\text{rd}) for STEMI (15.1% vs 12.3% vs 11.6%, p < 0.001) but not for patients with NSTEMI (7.9% vs 7.5% vs 7.6%, p = 0.97) (Table 3).

**DISCUSSION**

This study is the first description of the use of digitized legacy clinical data to understand temporal disease patterns at a large tertiary centre in Pakistan. Digitized data were transformed and successfully validated against chart review, and the main findings include the following: 1) AMI admissions have steadily increased over the last three decades, 2) the age at presentation has steadily increased, 3) the distribution of MIs has changed with increasing NSTEMIs and decreasing STEMIs over time, and 4) In-hospital mortality has decreased with time.
1) AMI ADMISSIONS HAVE STEADILY INCREASED OVER THE LAST THREE DECADES

According to the 2017 Census by the Pakistan Bureau of Statistics, Pakistan has <1300 hospitals serving a population of 207.78 million individuals [9]. AKUH is one of the foremost tertiary care hospitals in the region accredited by the Joint Commission International and has a catchment population reach of 11 million within a 15km radius [10].

AKUH caters to patients with diverse ethnic and socioeconomic backgrounds and so trends noted in our study may be generalizable to the catchment population. The present study examining trends across three decades demonstrates an increased number of AMI admissions. Similar temporal trends have been highlighted in New Zealand where the hospitalizations for AMI have increased by 8% from 1993 to 2005 [11]. However, most developed countries are experiencing a decline in AMI incidence rates [12]. The increasing trends in admissions in our study possibly reflect on improved diagnostic capabilities with more diagnoses of AMI but also more likely the growing cardiovascular disease burden in Pakistan and other low middle-income countries [13, 14]. The increase in CVD burden in LMICs has been attributed to increased burden of smoking and increasing prevalence of risk factors such as hypertension and diabetes that were also observed in our cohort [15].

2) INCREASING AGE AT PRESENTATION, BUT YOUNGER THAN DEVELOPED COUNTRIES

The median age at presentation in our study was 58 (50–66) in the first decade and increased to 63 (54–71) in the last decade. Similar trends were seen across 2,157 US hospitals in the National Registry of Myocardial Infarction (NRMI), where mean age at presentation increased from 64.1 in 1990 to 66.4 in 2006 [16]. In the SWEDHEART registry reporting on STEMIs from 1995 to 2014, the mean age at presentation was 70 years [17]. Similarly in a study from UK across 243 hospitals in England and Wales the median age at presentation of AMI was 70.0 years [18]. Our STEMI cohort was more than a decade younger than in the US and Europe and even though age increased with time, the median age at presentation for STEMI remained in the 50s over the last decade. This age difference could be attributed to a more aggressive and more premature phenotype of coronary artery disease in South Asia, complex gene-environment interplays and a higher burden of metabolic risk factors and comorbid diagnoses such as prior diabetes, hypertension at younger ages in South Asian patients [19–21].

3) TEMPORAL CHANGES IN STEMI AND NSTEMI PROPORTIONS AND RISK FACTOR BURDENS

Concomitant to increasing age at presentation, the proportion of STEMIs declined and NSTEMIs increased over time. The lower proportion of NSTEMIs during the first decade is likely due to non-availability of more specific and highly sensitive biomarkers such as high sensitivity troponin. Similar trends have been noted in other countries such as the NRMI in the United States (n = 1,950,561) where the proportion of NSTEMI showed a significant jump from 14.2% in 1990 to 59.1% in 2006 and the French registry (FAST-MI, n = 14,223) projecting a similar jump from 29% in 1995 to 51% in 2015 [16, 22]. The Korea Acute Myocardial Infarction study also showed a decrease in incidence of STEMI from 60.5% in 2006 to 48.1% in 2013, along with an increase in incidence of NSTEMI from 39.5% in 2006 to 59.1% in 2013 [23]. This MI phenotypic shift may be related to risk factor prevalence and background risk factor treatment.

The complexity of patients increased over time with higher risk factor burden and higher prevalence of AMI complications including acute kidney injury and cardiogenic shock [24]. It is possible that the decrease in STEMI over time could be attributable to distribution of such patients across other hospitals in the city with the gradual initiation of primary PCI programs in nine institutions across the city, including free PCI management at public sector hospitals. Despite that, the in-hospital mortality of STEMI is lower during the last decade primarily due to availability of primary PCI for all eligible patients.

The unusually low prevalence of dyslipidemia during the first and the last decade is likely due to changes in clinical practice. During the first decade, lipid panels were not routinely checked. During the second decade, it was standard practice for all patients to have their lipids checked...
following admission to the hospital. However, during recent years, lipid panels are not routinely checked during hospitalization, but rather checked 12 weeks after initiation of high intensity statin therapy.

Contrastingly, with diabetes, we noted both a high prevalence and an increasing trend across the decades. Data from the International Diabetes Federation’s Atlas (10th Edition) shows that Pakistan ranks third in the number of adults (20–79 years) with diabetes, and first in age-adjusted comparative diabetes prevalence in adults [25]. Further on, data from the National Diabetes Survey of Pakistan (NDSP), 2016–2017, indicates a high overall weighted prevalence of diabetes (26.3%) in the Pakistani population [26]. Given that South Asian countries, particularly Pakistan, have a drastically high prevalence of diabetes compared to other countries, and that our source population is patients with acute myocardial infarction rather than the overall community, the reported diabetes prevalence within this cohort is notably high.

4) IN-HOSPITAL MORTALITY DECREASED OVER TIME, AND THIS WAS LIKELY ATTRIBUTED TO A DROP IN STEMI RELATED MORTALITY

Across the study period, in-hospital mortality decreased from 15.2% in 1988–1990 to 8.2% in 2016–2018 (p < 0.001). Moreover, there was a significant decline in the in-hospital mortality rates between 1988–1997 and 2008–2018 (13.8% to 9.2%, p < 0.001). Large datasets from Japan (n = 27,220), Italy (1,110,822) and the United States (46,086) have shown a similar decline in AMI mortality over the decades [27–29]. A recent cross-sectional study in Pakistan has shown comparable mortality statistics. This two-year study, spanning 11 territory care hospitals in the Punjab province of our country, found the AMI mortality to be 8.6% [30]. Together, these data suggest that although variability exists, there has been an overall decrease in AMI mortality, but there is still room for improvement. In addition to institutional guideline directed therapy, factors such as improving competencies of healthcare workers’ training, awareness of cardiovascular diseases and their risk factors, and growth of the cardiology workforce may have contributed to these reductions.

Overall, AMI in-hospital mortality decline was likely attributable to a drop in STEMI related in-hospital mortality. There was no significant change in NSTEMI mortality. The decline in STEMI mortality is likely related to increased use of revascularization and guideline directed medical therapy over time. During the first decade, patients were primarily treated medically, including patients with STEMI who received lytic therapy. Although the first cardiac catheterization laboratory at AKUH was constructed in 1995, PCI was first performed in 1996, and it was not until 1999 that primary PCIs were performed, and a 24/7 primary PCI program (first in country) was established in 2006. This is the probable reason why only 0.7% patients underwent PCI during the first decade. Even though PCI rates increased over time, they remained <80% in the last decade.

IMPACT

This study provides important evidence on the changing patterns of AMI in a low middle-income country. It also highlights the need for tracking AMI outcomes and care through a registry/quality-network approach in other tertiary care hospitals in Pakistan and other LMICs. Through this dataset, clinicians can put into perspective outcome gains over three decades at a tertiary medical centre in Pakistan. These data need to be put in context with other data gathering efforts at larger network of hospitals across Pakistan to contribute to quality improvement through novel interventions in therapy, coordination of systems and health literacy. Any subsequent quality improvement interventions in lifestyle, emergency management and systems’ development must have greater availability, accessibility, awareness, and affordability as core foundations.

Our use of lean digitized clinical data longitudinally maintained represents a novel approach in an LMIC. This study demonstrates the value of clinical data capture that can be accomplished in most medical centres in LMICs. Employing electronic data capture in health facilities in Pakistan and other LMICs has substantial potential implications for benchmarking, strategy development, quality improvement and policy reform in LMICs [31–33]. Indeed, it is often the lack of timely reliable data that acts as a serious impediment to health care delivery [34, 35] but improved health information systems providing robust research capacity can address this issue
Flexible strategies that promote interoperability of systems may help establish national databases that, if integrated with a vital registration system, may provide insights into long-term outcomes and an effective platform for disease and hospital quality surveillance [37].

STRENGTHS AND LIMITATIONS

The strengths of our study include: a novel approach in the creation of a large database with information on three decades, in a resource-limited, low-middle income country, completeness of the dataset and rigorous multiple quality control processes implemented during the data discovery, extraction and preparation phase which allowed for a higher validity and accuracy.

Conversely, there are several important limitations of our study. First, a very detailed variable list could not be created as data systems did not capture characteristics such as symptoms, duration of symptoms, or reasons for not undergoing PCI or other cardiac procedures. However, even with a lean variable list we uncovered several important observations that can then be evaluated comprehensively in a prospective manner. Second, although these data encompass a diverse population cohort, this study is still restricted to a single centre, and may not be generalizable to the entire country. However, it reports on one of the few large-scale electronic health care systems in the country. In-hospital AMI mortality at AKUH may be lower than other health facilities in Pakistan related to variability of capacity in rural and urban set ups. Third, we are unable to make causal associations with the observed temporal trends in mortality. While we can speculate that an increase in revascularization, coupled with adoption of guideline directed medical therapy, has likely played an important role, we cannot comment on adequacy of either therapy. Fourth, we are unable to account for miscoding (if any) of type 2 MI as a primary diagnosis; however, it is likely that this is a small number in the overall cohort.

CONCLUSIONS

AMI presentations and patterns have changed over the last three decades, with a decline in in-hospital mortality in Pakistan. But there are still several care areas such as the use of PCI that need to be further investigated and improved upon. The use of large electronic data to gain insights about disease patterns is feasible in low-middle income countries.

ETHICS AND CONSENT

This study complies with the Declaration of Helsinki and has been approved by the Ethics Review Committee at the Aga Khan University (2018-0149-219).

COMPETING INTERESTS

The following authors declare that there is no conflict of interest:

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AUTHOR CONTRIBUTIONS
ZS conceived the idea, led the study planning and execution at every stage. AAN, AF, SA, NQQ, MM, MA, LM, GA have actively participated in designing the study, data curation, data review and validation, analysis and reporting, manuscript preparation and final revisions. LKS, FHJ, SSV, EJV, ZB, GSB and JT acted as expert advisors and provided critical feedback and input during the manuscript writing and finalization stages. ZS serves as the principal investigator of this study. All authors have read the final draft and approved it before submission.

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