Impact of disease-specific care certification on clinical outcome and healthcare performance of myocardial infarction in Taiwan

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Abstract

Background: The relationship between certification for specific disease care and clinical outcome was not well known. Previous studies regarding the effect of certification for acute stroke centers were limited by their cross-sectional design. This study aimed to investigate the effect of disease-specific care (DSC) certification on healthcare performance and clinical outcome of acute myocardial infarction (AMI).

Methods: This retrospective, longitudinal, controlled study was performed by analyzing the nationwide Taiwan Clinical Performance Indicators dataset from 2011 to 2018. Hospitals undergoing DSC certification for coronary care and reporting AMI indicators 1 year before, during, and 1 year after certification were included in group C, whereas hospitals not seeking DSC certification but reporting AMI indicators during the same period were included in group U. The primary endpoint was in-hospital mortality of AMI.

Results: In total, 20 hospitals (9 in group C and 11 in group U) and up to 16173 AMI cases were included for analysis. In-hospital mortality was similar between both groups at baseline. However, the in-hospital mortality was significantly improved during and after certification periods in comparison with that at baseline in group C (6.8% vs 8.4%, p = 0.04; 6.7% vs 8.4%, p = 0.02), whereas there was no significant change in group U, resulting in a statistically significant difference between both groups during and after certification periods (odds ratio = 0.74 [95% CI = 0.60-0.91] and 0.78 [95% CI = 0.64-0.96]). Compared with group U, the improvement in healthcare performance indicators, such as door-to-electrocardiography time <10 minutes, blood testing for low-density lipoprotein cholesterol level, prescribing a beta-blockade or a $P2Y_{12}$ receptor inhibitor during hospitalization, prescribing a statin on discharge, and consultation for cardiac rehabilitation, was significant in group C.

Conclusion: The current study demonstrated the beneficial effect of DSC certification on clinical outcome of AMI probably mediated through quality improvement during the healthcare process.

Keywords: Coronary artery disease; Indicators; Myocardial infarction; Prognosis

1. INTRODUCTION

Despite some controversies,[1] external accreditation or certification is presumed to promote the improvement of healthcare quality in the hospitals or departments being evaluated, to fulfill relevant requirements. However, the concern of patients is not only the healthcare quality of a hospital but also the clinical outcome of treatment for specific diseases. Theoretically, it might be possible that the prognosis of specific diseases will as well be enhanced by the improvement of healthcare quality due to external accreditation or certification.[2–4] However, up to now, whether accreditation actually improves overall in-hospital prognosis (for example, a reduction in the total mortality rate) remains controversial. Some studies came out with positive results,[5] whereas others reported a neutral effect.[6,7]

The relationship between certification for specific disease care and outcome of care was not well known.[8] Only three studies have evaluated the impact of certification for acute stroke centers on clinical outcome of ischemic or hemorrhagic stroke by the Joint Commission in the United States.[8–11] These studies reported a lower in-hospital[8] or 30-day stroke mortality[9–11] and a similar readmission rate.[10,11] However, these were not longitudinal

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studies specifically assessing the effects of stroke center certification and accounting for the preexisting differences between certified and noncertified hospitals owing to better healthcare quality observed in the primary stroke center-certified hospitals even before the program began.[12] Furthermore, these studies did not compare the healthcare performance and clinical outcomes before and after certification for certified hospitals; neither compared the differences in the healthcare performance and clinical outcomes between certified and noncertified hospitals. To the best of our knowledge, the association between certification of healthcare quality for coronary artery disease (CAD) and clinical outcome of acute myocardial infarction (AMI) has not yet been evaluated using a longitudinal design.

Taiwan has gradually focused on the quality of AMI care and implemented many related healthcare policies. The Emergency Medical Service System Program (EMSSP) was launched by the Ministry of Health and Welfare in 2009, and it became a mandatory requirement for the accreditation of a medical center or regional hospital. The assessment included acute coronary care quality, equipment, and manpower. Hospitals that pass the assessment are rated as advanced or moderate.[13]

The Disease-Specific Care (DSC) Certification program, developed by the Joint Commission of Taiwan (JCT) in 2009, is a kind of certification system that initially comprised three disease entities, including CAD, acute coronary syndrome, and AMI; nine more have been added since 2017 in Taiwan.[14] Furthermore, the JCT completed the International Accreditation Program for organizations in 2006, standards in 2007, and the surveyor training program in 2013. Based on essential hospital accreditation standards, the DSC certification program provides hospitals with a comprehensive and higher-quality certification program for a specific disease care team. The DSC certification process involves an assessment of the integrated care for a specific disease rather than merely providing certification only. The assessment includes the following: reviewing whether the hospital has a professional core care team and equipment for this specific disease; assessing cooperation mechanisms across interdisciplinary fields; encouraging patients and their families to participate in their disease care, improving patients self-care ability, and implementing "patient-centered" care; and ongoing quality monitoring and improvement of the disease. However, so far, no study has investigated the impact of DSC certification on clinical outcome of care for specific diseases in Taiwan.

The Taiwan Clinical Performance Indicator (TCPI) system, also founded by the JCT in 2011 and derived from the Taiwan Quality Indicator Project, includes an AMI component. Participating hospitals could select TCPIs and report the hospital-level indicators according to their needs. The AMI indicators of the TCPIs were based on clinical guidelines and were designed for assessment, treatment, health education, and prognosis care. Almost all the certified hospitals reported and recorded indicator data via the TCPI system.

This retrospective, observational, longitudinal, controlled study aimed to investigate the impact of DSC certification for CAD/acute coronary syndrome/AMI care on the healthcare quality and clinical outcome of AMI by analyzing nationwide TCPI data. We hypothesized that DSC certification for CAD/acute coronary syndrome/AMI care could provide prognostic benefits in terms of lowering in-hospital mortality, 14-day readmission, and 3-day emergency room revisit rate through improving the quality of health care for AMI patients.

2. METHODS

2.1. Study subject

This retrospective, observational, longitudinal, controlled study included hospitals undergoing DSC certification for CAD/acute coronary syndrome/AMI care and reporting AMI indicators via the TCPI system 1 year before, during, and 1 year after certification in the certified group (group C). In addition, hospitals that did not apply for DSC certification but were similar, in some way, to the certified hospitals, regarding hospital level (either a medical center or regional hospital), location (urban or suburban), and service capacity (defined as the number of AMI cases per year within 20% variation), and had reported AMI indicators via the TCPI system during the same period were included in the uncertified group (group U). Because certified hospitals were either medical centers or regional hospitals, these inclusion criteria were used for enrollment into group U. All of them, hospitals in group C or group U, should be teaching hospitals. Hospitals were excluded if they underwent EMSSP assessment

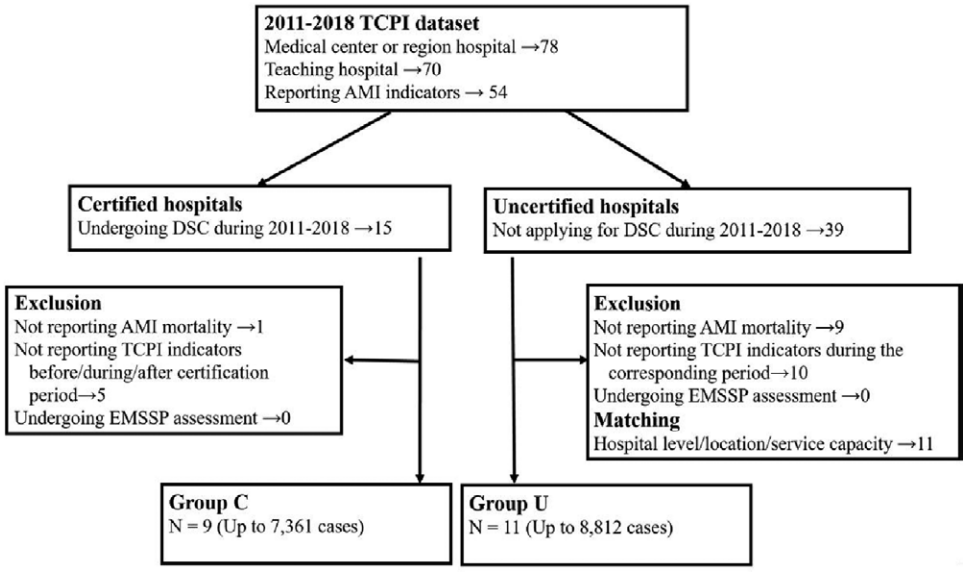

Fig. 1 Flow diagram of hospital selection. AMI = acute myocardial infarction; DSC = disease-specific care certification; EMSSP = the Emergency Medical Service System Program; TCPI = Taiwan Clinical Performance Indicators.

or did not report in-hospital mortality rate to TCPI during the year of certification in group C and during the corresponding year in group U (Fig. 1). The inclusion and exclusion criteria of enrolled hospitals were examined by a committee, and the final decision was made by the consensus of the committee members who were not privy to the indicator data. This study was reviewed with exemption and approved by the Institutional Review Board of National Cheng Kung University (protocol number: A-EX-108-011).

2.2. Data collection

The baseline characteristics of the certified and uncertified hospitals, including hospital level, number of beds, total number of admissions, the percentage of beds occupied, and the number of AMI cases in 1 year, were collected from the official public information website: Institutional Public Information inquiry platform,[15] and the Quality Indicators disclosure platform of the National Health Insurance Administration, Ministry of Health and Welfare, Executive Yuan.[16] Other characteristics in group C were collected from the query system.[17]

The majority of the healthcare performance and clinical outcome data were collected from the TCPI database. Due to the voluntary reporting by the TCPI participating hospitals, some indicators were not enough to report (<5 hospitals). Therefore, the data of these indicators would come from the data of these hospitals on the Quality Indicators disclosure platform of the National Health Insurance Administration[16] in the same year.

2.3. Outcome measurements

Primary clinical outcome endpoint was in-hospital mortality of AMI; secondary endpoint was 14-day unplanned readmission of AMI patients, and other outcome endpoint was 3-day unplanned emergency room revisit.

2.4. Statistical analysis

Distributions of continuous variables and skewed data in both groups were expressed as median (interquartile range). The baseline characteristics were compared by a χ^2 test or Fisher's exact test, or Mann-Whitney *U* test as appropriate. Categorical variables before, during, and after certification periods were compared by χ^2 test or Fisher's exact test in both groups. Odds ratio (OR) or risk ratio, wherever appropriate, for comparison of each indicator was obtained while performing χ^2 test. A p value of <0.05 was regarded as statistically significant. All statistical analyses were performed by an online calculator (http://vassarstats.net/odds2x2.html) and SPSS for Windows (version 22.0; IBM Corp, Armonk, NY).

3. RESULTS

3.1. Hospital characteristics

In total, 20 hospitals were included and were classified into two groups (9 in group C and 11 in group U). The hospital characteristics were well matched despite a slightly higher bed occupation in group C, though without statistical significance (Table 1). The majority of the enrolled hospitals were accredited as medical centers and located in urban areas. All enrolled hospitals passed the EMSSP. The majority of them passed the advanced accreditation. The capacity of the enrolled hospitals for clinical service was adequate with respect to the median number of beds and total admissions per year in both groups. All hospitals in group C passed DSC certification, among whom the majority had underwent certification for CAD care.

3.2. Healthcare performance

In total, up to 16173 cases (2469 cases in group C and 2617 cases in group U at baseline, 2399 in group C and 2791 in group U during certification period, and 2493 cases in group C and 3404 in group U after certification period, respectively) were included in the analysis of healthcare performance and clinical outcomes.

Comparisons of healthcare performance indicators in patients with AMI between both groups are demonstrated in Table 2. The certified hospitals had a higher goal attainment rate for door-to-enzyme reporting time <60 minutes and a higher percentage of blood test for low-density lipoprotein cholesterol and prescribing aspirin during hospitalization than uncertified hospitals during the baseline period (98.3% vs 95.7%, 83.4% vs 76%, and 95.8% vs 92.2%, respectively; all $p < 0.0001$). However, more AMI patients in group U received beta-blockade

Table 1.

Comparisons of baseline characteristics between certified and uncertified hospitals

	Group C (n = 9)	Group U (n = 11)	*p*
Hospital level, n (%)			1.0
Medical center	7 (77.7)	8 (72.7)	
Regional hospital	2 (22.2)	3 (27.2)	
Location, n (%)			1.0
Urban	8 (88.9)	9 (81.8)	
Suburban	1 (11.1)	2 (18.2)	
Number of beds, median (interquartile range)	1377 (881.5, 1741.5)	1221 (1105, 2844)	0.71
Total admissions per year, median (interquartile range)	48855 (28397.5, 55576.5)	39020 (28128, 77372)	0.65
Percentage of beds occupied, median (interquartile range)	86.1 (73.5, 87.8)	74 (66.7, 84.6)	0.11
Number of AMI cases per year, median (interquartile range)	160 (91.5, 212.5)	105 (95, 246)	0.88
Emergency Medical Service System Program Accreditation, n (%)			1.0
Advanced	8 (88.9)	9 (81.8)	
Moderate	1 (11.1)	2 (18.2)	
DSC certification, n (%)			…
CAD	6 (66.7)	…	
ACS	2 (22.2)	…	
AMI	1 (11.1)	…	
Passing DSC certification, n (%)	9 (100)	…	…

p values compared between both groups were obtained using a Mann-Whitney *U* test, χ^2 test, or Fisher's exact test.
ACS = acute coronary syndrome; AMI = acute myocardial infarction; CAD = coronary artery disease; DSC = disease-specific care.

Table 2.

Comparisons of healthcare performance indicators in patients with AMI between certified and uncertified hospitals

Healthcare performance indicators	Group C numerator/denominator (%)	Group U numerator/denominator (%)	Odds ratio (95% CI)	*p*
Assessment				
Door-to-EKG time <10 min				
Before certification period	1413/1733 (81.5)	1155/1445 (79.9)	1.11 (0.93-1.32)	0.25
During certification period	1275/1549 (82.3)	874/1135 (77)	1.39 (1.15-1.68)	<0.001
After certification period	1268/1525 (83.1)	1304/1525 (85.5)	0.84 (0.69-1.02)	0.07
p (before vs during certification period)	0.57	0.07		
p (during vs after certification period)	0.54	<0.0001		
p (before vs after certification period)	0.23	<0.0001		
Door-to-enzyme reporting time <60 min				
Before certification period	1398/1422 (98.3)	1177/1230 (95.7)	2.62 (1.61-4.27)	<0.0001
During certification period	1198/1223 (98)	1087/1109 (98)	0.97 (0.54-1.73)	0.92
After certification period	1185/1253 (94.6)	980/994 (98.6)	0.25 (0.14-0.45)	<0.0001
p (before vs during certification period)	0.50	<0.0001		
p (during vs after certification period)	<0.0001	0.31		
p (before vs after certification period)	<0.0001	<0.0001		
Blood testing for LDL-C level[a]				
Before certification period	1242/1489 (83.4)	1300/1710 (76)	1.59 (1.33-1.89)	<0.0001
During certification period	1301/1473 (88.3)	1336/1643 (81.3)	1.74 (1.42-2.13)	<0.0001
After certification period	1151/1294 (88.9)	1242/1472 (84.4)	1.49 (1.19-1.86)	<0.0001
p (before vs during certification period)	<0.0001	<0.0001		
p (during vs after certification period)	0.60	0.02		
p (before vs after certification period)	<0.0001	<0.0001		
Treatment				
Door-to-balloon time <90 min in STEMI cases				
Before certification period	629/702 (89.6)	514/575 (89.4)	1.02 (0.71-1.46)	0.92
During certification period	617/708 (87.1)	552/648 (85.2)	1.18 (0.87-1.61)	0.29
After certification period	649/732 (88.7)	794/866 (91.7)	0.71 (0.51-0.99)	0.04
p (before vs during certification period)	0.15	0.03		
p (during vs after certification period)	0.38	<0.0001		
p (before vs after certification period)	0.57	0.14		
Receiving lysis or pPCI in STEMI cases				
Before certification period	667/691 (96.5)	463/463 (100)	0.97 (0.95-0.98)[b]	<0.0001
During certification period	718/745 (96.4)	353/358 (98.6)	0.38 (0.14-0.99)	0.04
After certification period	639/648 (98.6)	304/304 (100)	0.99 (0.98-1.00)[b]	0.06
p (before vs during certification period)	0.89	0.02		
p (during vs after certification period)	0.01	0.07		
p (before vs after certification period)	0.01	1.00		
Prescribing beta-blockade during hospitalization[a]				
Before certification period	972/1418 (68.5)	1227/1617 (75.9)	0.69 (0.59-0.81)	<0.0001
During certification period	1004/1397 (71.9)	1147/1539 (74.5)	0.87 (0.74-1.03)	0.10
After certification period	897/1222 (73.4)	1057/1381 (76.5)	0.85 (0.71-1.01)	0.07
p (before vs during certification period)	0.05	0.38		
p (during vs after certification period)	0.38	0.21		
p (before vs after certification period)	0.01	0.67		
Prescribing ACEi or ARB during hospitalization[a]				
Before certification period	1040/1479 (70.3)	1230/1698 (72.4)	0.90 (0.77-1.05)	0.19
During certification period	1027/1457 (70.5)	1165/1632 (71.4)	0.96 (0.82-1.12)	0.58
After certification period	858/1308 (65.6)	948/1485 (63.8)	1.08 (0.92-1.26)	0.33
p (before vs during certification period)	0.92	0.50		
p (during vs after certification period)	0.01	<0.0001		
p (before vs after certification period)	0.01	<0.0001		
Prescribing aspirin during hospitalization[a]				
Before certification period	1332/1390 (95.8)	1449/1571 (92.2)	1.93 (1.40-2.67)	<0.0001
During certification period	1285/1343 (95.7)	1386/1495 (92.7)	1.74 (1.26-2.42)	<0.001
After certification period	1162/1218 (95.4)	1257/1342 (93.7)	1.40 (0.99-1.98)	0.05
p (before vs during certification period)	0.84	0.62		
p (during vs after certification period)	0.73	0.31		
p (before vs after certification period)	0.60	0.13		

(*Continued*)

Table 2 (Continued)

Comparisons of healthcare performance indicators in patients with AMI between certified and uncertified hospitals

Healthcare performance indicators	Group C numerator/denominator (%)	Group U numerator/denominator (%)	Odds ratio (95% CI)	*p*
Prescribing a $P2Y_{12}$ receptor inhibitor during hospitalization[a]				
Before certification period	1408/1489 (94.6)	1595/1710 (93.3)	1.25 (0.93-1.68)	0.13
During certification period	1411/1473 (95.8)	1535/1643 (93.4)	1.60 (1.16-2.21)	0.004
After certification period	1226/1294 (94.7)	1387/1473 (94.2)	1.12 (0.81-1.55)	0.50
p (before vs during certification period)	0.12	0.62		
p (during vs after certification period)	0.19	0.40		
p (before vs after certification period)	0.82	0.31		
Prescribing a statin on discharge				
Before certification period	1604/1849 (86.7)	1021/1194 (85.5)	1.11 (0.90-1.37)	0.33
During certification period	1710/1865 (91.7)	503/600 (83.8)	2.12 (1.62-2.79)	<0.0001
After certification period	1627/1724 (94.4)	439/476 (92.2)	1.41 (0.95-2.09)	0.08
p (before vs during certification period)	<0.0001	0.35		
p (during vs after certification period)	<0.0001	<0.0001		
p (before vs after certification period)	<0.0001	<0.0001		
Health education				
Consultation for tobacco smoking cessation in smokers				
Before certification period	686/786 (87.3)	324/366 (88.5)	0.89 (0.61-1.31)	0.55
During certification period	730/825 (88.5)	140/162 (86.4)	1.21 (0.73-1.99)	0.46
After certification period	700/742 (94.3)	105/119 (88.2)	2.22 (1.17-4.21)	0.01
p (before vs during certification period)	0.46	0.49		
p (during vs after certification period)	<0.0001	0.65		
p (before vs after certification period)	<0.0001	0.92		
Consultation for cardiac rehabilitation				
Before certification period	1594/1999 (79.7)	879/995 (88.3)	0.52 (0.42-0.65)	<0.0001
During certification period	1729/2033 (85)	334/391 (85.4)	0.97 (0.71-1.32)	0.84
After certification period	1689/1926 (87.7)	289/334 (86.5)	1.11 (0.79-1.56)	0.55
p (before vs during certification period)	<0.0001	0.14		
p (during vs after certification period)	0.02	0.67		
p (before vs after certification period)	<0.0001	0.38		

[a]Data Sources: National Health Insurance Quality Indicators disclosure platform of National Health Insurance Administration.

[b]Presented as risk ratio and its confidence interval.

ACEi = angiotensin-converting enzyme inhibitor; AMI = acute myocardial infarction; ARB = angiotensin receptor blockade; EKG = electrocardiography; LDL-C = low-density lipoprotein cholesterol; pPCI = primary percutaneous coronary intervention; STEMI = ST-segment-elevation myocardial infarction.

therapy and underwent consultation for cardiac rehabilitation during this period.

Compared with group U, an improvement in assessment, treatment, and health education was significant in group C with respect to clinical indicators such as door-to-electrocardiography time <10 minutes (an increase in OR from 1.11 to 1.39), blood test for low-density lipoprotein cholesterol (OR from 1.59 to 1.74), prescribing beta-blockade during hospitalization (OR from 0.69 to 0.87), prescribing a $P2Y_{12}$ receptor inhibitor during hospitalization (OR from 1.25 to 1.60), prescribing a statin on discharge (OR from 1.11 to 2.12), and consultation for cardiac rehabilitation (OR from 0.52 to 0.97); however, a significant improvement in door-to-enzyme reporting time <60 minutes was observed in group U. Nevertheless, the achievement rate was very high in both groups. The goal attainment rate for door-to-balloon time <90 minutes and receiving lysis or primary percutaneous coronary intervention in ST-elevation myocardial infarction patients was not significantly changed in group C during the baseline and certification periods, whereas it decreased in group U. Regardless of baseline or certification period, there was a significantly higher percentage of cases involving patients receiving aspirin therapy during hospitalization in group C compared with group U. There was no significant difference in prescribing renin-angiotensin system blockade during hospitalization or consultation for tobacco smoking cessation between both groups either at baseline or during the certification period.

In group C, some indicators, such as receiving lysis or primary percutaneous coronary intervention in ST-elevation myocardial infarction cases, prescribing a statin on discharge, consultation for tobacco smoking cessation in smokers, and consultation for cardiac rehabilitation, were significantly improved after certification when compared with those during certification, suggestive of continuing quality improvement. Some indicators, including blood testing for low-density lipoprotein cholesterol level and prescribing aspirin during hospitalization, were consistently better than those in group U.

3.3. Clinical outcomes

In-hospital mortality was similar between both groups at baseline (Table 3). However, the in-hospital mortality rate was significantly improved during the certification period in comparison with that at baseline in group C (6.8% vs 8.4%, $p = 0.04$), whereas there was no significant change in group U (9.0% vs 9.6%, $p = 0.51$), resulting in a statistically significant difference between both groups during the certification period (6.8% vs 9.0%; OR = 0.74 [95% CI = 0.60-0.91]; $p = 0.004$). The in-hospital mortality rate was still lower in group C than that in group U 1 year after certification (6.7% vs 8.4%; OR = 0.78 [95% CI = 0.64-0.96]; $p = 0.02$).

Regarding secondary endpoint and other endpoint, there was no statistically significant difference between both groups at baseline, during certification, or after the certification period (Table 3).

4. DISCUSSION

The current study, for the first time, demonstrated that DSC certification for CAD/acute coronary syndrome/AMI care was associated with a significant reduction in the in-hospital mortality of AMI

Table 3.

Comparisons of clinical outcome indicators in patients with AMI between certified and uncertified hospitals

Clinical outcome indicators	Group C numerator/denominator (%)	Group U numerator/denominator (%)	Odds ratio (95% CI)	*p*
Prognosis care				
Primary endpoint: in-hospital mortality				
Before certification period	208/2469 (8.4)	250/2617 (9.6)	0.87 (0.72-1.06)	0.16
During certification period	164/2399 (6.8)	252/2791 (9.0)	0.74 (0.60-0.91)	0.004
After certification period	168/2493 (6.7)	287/3404 (8.4)	0.78 (0.64-0.96)	0.02
p (before vs during certification period)	0.04	0.51		
p (during vs after certification period)	0.89	0.41		
p (before vs after certification period)	0.02	0.13		
Secondary endpoint: 14-day unplanned readmission[a]				
Before certification period	18/1476 (1.2)	13/1114 (1.2)	1.05 (0.51-2.14)	0.92
During certification period	20/1494 (1.3)	17/1076 (1.6)	0.85 (0.44-1.62)	0.61
After certification period	18/1317 (1.4)	16/1249 (1.3)	1.07 (0.54-2.10)	0.84
p (before vs during certification period)	0.78	0.41		
p (during vs after certification period)	1.00	0.54		
p (before vs after certification period)	0.73	0.81		
Other endpoint: 3-day ER revisit[a]				
Before certification period	17/1483 (1.1)	29/1717 (1.7)	0.68 (0.37-1.23)	0.20
During certification period	20/1494 (1.3)	23/1672 (1.4)	0.97 (0.53-1.78)	0.92
After certification period	19/1317 (1.4)	21/1496 (1.4)	1.03 (0.55-1.92)	0.92
p (before vs during certification period)	0.64	0.46		
p (during vs after certification period)	0.81	1.00		
p (before vs after certification period)	0.49	0.52		

[a]Data Sources: National Health Insurance Quality Indicators disclosure platform of National Health Insurance Administration.
AMI = acute myocardial infarction; ER = emergency room.

patients, along with an improvement in most healthcare performance of AMI cases. High quality of care, represented as an excellent clinical outcome after AMI, was sustainable after certification in the certified hospitals. To the best our knowledge, this is the first report demonstrating the prognostic benefits of DSC certification for CAD/acute coronary syndrome/AMI care in the literature.

Previous studies[9–11] regarding the association between certification for specific disease and clinical outcomes were all performed for acute stroke and were limited by their cross-sectional design,[8,18] without knowing the specific certification period.[18] Cross-sectional studies could probably demonstrate higher quality of care in certified hospitals than in uncertified facilities, but they cannot specifically determine whether or show how certification per se helped them improve healthcare quality or whether outcomes are due to preexisting high quality of care.[12,18] Furthermore, it was more difficult to interpret the results of the previous studies without knowing the specific period of certification because quality performance at baseline, during precertification period, during certification, and after certification would be different.[18] Therefore, more research studies reporting longitudinal data and with a clearly identified certification period would be helpful to overcome these drawbacks.[8,18] In particular, because healthcare quality is improving as time goes by,[19,20] it is also important to include control hospitals that are not certified to identify the specific effects of certification. As such, by using a longitudinal design and with a clearly identified certification period and the inclusion of a control group, our current study clearly demonstrated the effect of DSC certification on quality improvement (as in the case of Type 3 stated by Baker and Williams[18]).

Concomitant relevant accreditation would be another confounder, an issue that had not been included in the context of study design and discussion of the previous studies. The scope, spectrum, and depth of assessment for coronary care in DSC certification were very different from those in EMSSP in Taiwan. Nevertheless, the confounding effect of EMSSP was eliminated from the current study.

To study the effect of certification on quality of care, a comparison should be made between hospitals seeking certification and control hospitals with similar baseline characteristics and service capacity that did not seek certification.[18] Many characteristics of hospitals, such as location,[21] passing teaching hospital accreditation,[22] and service capacity,[23] have been reported to be associated with healthcare quality and clinical outcomes. However, these factors were not identified, and thus comparisons were not performed in the previous studies.[9–11] The baseline characteristics of certified and uncertified hospitals were compatible in our study. In addition, some baseline healthcare performance data were better in the certified hospitals, but not so for some indicators, suggestive of very similar baseline characteristics between both groups. Furthermore, almost all the assessment indicators showed 80% or more attainment in both groups, conveying the notion that enrolled hospitals were already high-quality centers. As such, our study could provide a better opportunity to evaluate the actual effect of certification.

The baseline goal attainment rate of door-to-balloon time <90 minutes before certification was over 88% in either certified or uncertified hospitals in our study, which was very similar to that in the 2016 to 2017 annual report of the Australian Council on Healthcare Standards.[24] The quality of health care for AMI patients in Taiwan could be on par with the performance of international hospitals.

In our study, some healthcare performance indicators in certified hospitals were inferior or not superior to those in uncertified hospitals. Nevertheless, a lower in-hospital mortality was observed in the certified hospitals. We could only speculate because the true mechanisms responsible for the discrepancy were not well known. Firstly, better healthcare quality and safety culture were not always well correlated with better clinical outcome of AMI care.[25,26] Secondly, although keeping coronary arteries open has long been a cornerstone of acute coronary care, an improvement in door-to-balloon time was not always associated with better in-hospital outcome in recent studies.[26,27] Total ischemic/reperfusion time might

be more important than door-to-balloon time.[27] Thirdly, an increase in noncardiovascular causes of death, such as sepsis, have been observed in recent years after controlling the rate of cardiovascular death through excellent compliance with guideline-recommended evidence-based management.[26] An interprofessional team-based integrated healthcare system, just like the mainstay of DSC certification, might be helpful for minimizing noncardiovascular causes of death. Despite the fact that some factors accounting for the effect of an interprofessional team-based integrated healthcare system were difficult to measure and not present in the current study, an improvement in consultation for cardiac rehabilitation in certified hospitals could be representative. Finally, the enrolled hospitals provided exceptionally high-quality care at baseline as seen in the current study. Therefore, a small but significant change in healthcare performance might not alter clinical outcome dramatically.[18]

Whether better healthcare quality and safety culture can translate into better clinical outcome of AMI remains a subject of debate.[2,3,25] Better performance measures[2] and safety survey instruments[25] that are tightly linked to patient outcomes are needed. Nevertheless, evidence-based treatment and management are strongly recommended in major international clinical guidelines and implementation of clinical performance, and quality measures are also widely adopted.[28] Our data showed in-hospital mortality of AMI was improved during certification and evident after certification, although certified hospitals did not perform well in some well-known quality measures, such as door-to-balloon time and prescription of beta-blockade, implying development of newer quality measures needed in the current era.

The current study was limited in some ways. Some bias could not be excluded owing to the retrospective design adopted. The number of hospitals participating in DSC certification was relatively small at present, and the data of TCPIs were incomplete due to the voluntary nature of the reporting. Therefore, the interpretation and extrapolation of the research results should be carefully done. Furthermore, because the current study was conducted at hospital level rather than at patient level, adjusting the analysis for differences in patient characteristics over time could not be performed and the association of effect of certification and quality improvement could not be concluded definitely. In conclusion, our study highlighted the beneficial effect of DSC certification on clinical outcome of AMI, probably mediated through quality improvement during the healthcare process. A large-scale, prospective, controlled trial is warranted.

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