Clinical characteristics and in-hospital outcomes of patients receiving contemporary intensive cardiac care: retrospective study from a large centre in China

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ABSTRACT

BACKGROUND Few studies from developed countries have quantitatively characterized the clinical characteristics and outcomes of patients receiving contemporary intensive cardiac care. We sought to investigate these data in patients admitted to a Chinese intensive cardiac care unit (ICCU).

METHODS We conducted a retrospective study using data from 2,337 consecutive admissions to the ICCU at a large centre in China from June 2016 to May 2017. Data were captured after systematic inspection of individual medical records regarding current demographics, primary diagnosis, comorbidities, illnesses severity, and in-hospital outcomes.

RESULTS The mean age was 65.6 ± 14.2 years, and females accounted for 32.0% of patients. The Charlson Comorbidity Index and Oxford Acute Severity of Illness Score were 2.4 ± 1.8 and 22.5 ± 10.4, respectively. The top reason for admission was ST-segment elevation myocardial infarction (32.0%), and nonischaemic heart diseases accounted for 31.2% of all primary diagnoses. Noncardiovascular diseases were prevalent in the ICCU population, including chronic illnesses and acute noncardiovascular critical illnesses (ANCIs); in particular, 21.7% of patients were marked by acute respiratory failure (14.6%), acute kidney injury (13.7%), sepsis (4.2%), or gastrointestinal bleeding (3.3%). The median length of stay in the ICCU and hospital were 1.1 days (interquartile range (IQR): 0.8–2.6 days) and 6.3 days (IQR: 3.8–10.9 days), respectively. The overall incidence of in-hospital death or discharge against medical advice under extremely critical conditions was 7.6% (n = 177). Multivariate logistic regression analysis showed that the complexity of chronic illnesses and incident ANCIs were strong independent determinants for in-hospital outcomes.

CONCLUSIONS Remarkable patient diversity and breadth of critical illnesses were observed in a Chinese ICCU population. Particularly, noncardiovascular diseases were prevalent and associated with adverse outcomes. Reformation of organization and staffing practices may be considered to adapt to the changed landscape.

The coronary care unit (CCU) concept was introduced into clinical practice in the early 1960s, aiming to deliver prompt treatment for peri-infarction complications.[1–3] As the landmark study conducted by Killip, et al.[4] showed a demonstrable reduction in mortality for acute myocardial infarction (AMI) treated in a CCU; afterward, this care model quickly spread worldwide. Nearly sixty years later, however, the CCU has evolved into a complex care environment, now named the intensive cardiac care unit (ICCU), that provides comprehensive critical care to patients with various cardiovascular diseases.[5]

While the landscape has changed vastly, only few studies from developed countries have quantitatively characterized the clinical characteristics and outcomes of patients receiving contemporary intensive cardiac care.[6–10] Meanwhile, the differences in sociodemographic index associated with cardiovascular diseases burden may lead to significant heterogeneity in the data mentioned above among world regions. However, we have noted that no
study to date has investigated current demographics, primary diagnosis, comorbidities, illnesses severity, and in-hospital outcomes in an ICCU population from developing countries such as China, although these may be essential to understand how to optimize organization and staffing practices and improve patient outcomes.

We conducted a retrospective study using data from 2,337 consecutive admissions to the ICCU at a high-volume academic tertiary care centre in China over the course of one year, aiming to investigate the clinical characteristics and in-hospital outcomes of patients admitted to a contemporary Chinese ICCU.

METHODS

Study Population

We studied consecutive admissions to the ICCU at West China Hospital affiliated to Sichuan University, a large academic tertiary care centre with 4,300 beds, from June 2016 to May 2017. In our hospital, patients with cardiovascular diseases who require intensive cardiac care, but without the need for unscheduled surgery or postsurgical management, are admitted to the ICCU. A team consisted of an attending cardiologist, cardiology fellows, medical residents, and nurses staffs this 17-bed unit. There are no dedicated intensivists routinely involved in the daily care of ICCU patients, but critical care consultation is available when necessary. Experienced interventional cardiologists are available 24 h a day, seven days a week. Our ICCU is equipped with advanced monitoring devices that can perform blood gas and electrolyte analysis, activated clotting time analysis, bedside echocardiography, and noninvasive or invasive haemodynamic monitoring. Additionally, the ICCU is equipped with advanced therapeutic devices that can provide mechanical circulatory support [e.g., intra-aortic balloon pump (IABP), extracorporeal membrane oxygenation, mechanical ventilation, and continuous renal replacement therapy (CRRT)].

All admissions to the ICCU during the study period were eligible for inclusion (n = 2,873). We then excluded admissions of patients without any cardiovascular disease (n = 6), patients with an ICCU stay lasting less than four hours after scheduled interventional procedures (n = 150), and patients who were under the age of 16 (n = 139). If a patient was ever admitted to our ICCU more than once during the same hospital stay, his/her admissions during that stay which did not meet the exclusion criteria mentioned above were merged into one (296 into 143). Further, we removed any admission subsequent to the first for patients with multiple ICCU admissions during the study period (n = 88). We systematically inspected individual electronic medical records to obtain demographics, vital signs, laboratory data, cardiovascular and noncardiovascular diagnoses, treatment characteristics, length of stay (LOS), and in-hospital outcomes. The type of admission was categorized as medical if no relevant interventional procedures were performed in the seven days before or after ICCU admission. The Ethics Committee of West China Hospital, Sichuan University (No.2018-464) approved this study protocol and waived the requirement for written informed consent.

Primary Diagnosis

Rather than select the first diagnosis in the discharge summary, we carefully reviewed all available information to determine the primary diagnosis for each admission. The cause of admission and the status (stable or unstable) of the underlying cardiovascular disease were major determinants. For example, a patient admitted for acute coronary syndrome (ACS) complicated by acute heart failure (AHF) received a primary diagnosis of ACS, whereas a patient presenting with AHF and ischaemic cardiomyopathy received a primary diagnosis of AHF. Similarly, the primary diagnosis of a patient with atrial fibrillation (AF) and stable underlying cardiac disease admitted for left atrial appendage closure was ascribed as AF.

Major Acute Noncardiovascular Critical Illnesses

We classified acute respiratory failure, acute kidney injury, gastrointestinal bleeding, or sepsis as major acute noncardiovascular critical illnesses (ANCIs), according to the prevalence and odds ratios for mortality reported by previous studies. [8,9]

Complexity and Severity of Illnesses

We adopted the Charlson Comorbidity Index (CCI), a weighted index that takes into account the number and seriousness of comorbid diseases, [11] to
evaluate the complexity of chronic illnesses. Meanwhile, we calculated the Oxford Acute Severity of Illness Score (OASIS) to assess acute severity of illnesses, which includes ten variables that can be easily captured, such as age, vital signs, ventilation status, etc.; the final OASIS is the sum of the worst score of all the components during the first 24 h after ICCU admission.\[12\]

Clinical Outcomes

The primary endpoint was the composite of in-hospital death or discharge against medical advice (DAMA) under extremely critical conditions, defined as the composite of circulatory shock, electrical instability with the need for emergency medical interventions, or acute respiratory failure requiring invasive mechanical ventilation. The DAMA under extremely critical conditions of critically ill patients is a relatively common phenomenon in China for a variety of reasons, including specific traditional prohibitions, financial concerns, the lack of social support, etc., and those patients often suffer death in the short term. Compared with mortality, this composite endpoint may reflect the in-hospital outcomes more accurately in our study.

Statistical Analysis

Continuous variables were expressed as the mean ± SD or medians [interquartile range (IQR)], while categorical variables were reported as counts and percentages. We compared continuous variables using independent-samples t tests or Kruskal-Wallis tests and compared categorical variables using Pearson’s chi-square tests or Fisher’s exact tests, as appropriate. We developed a multivariate binary logistic regression model to detect the determinants of in-hospital outcomes for the study population. Candidate determinants were selected based on previously published studies. The final model included the following variables: age, gender, complexity of chronic illnesses (assessed by CCI), acute severity of illnesses (assessed by OASIS), cardiogenic shock, ventricular arrhythmia, acute respiratory failure, acute kidney injury, sepsis, and gastrointestinal bleeding. Odds ratios (ORs) were presented with 95% confidence intervals (CIs). We calculated the C-statistic based on receiver operating characteristic (ROC) curve analysis to quantify the discrimination of the final model, and the Hosmer-Lemeshow test was utilized to evaluate the goodness of fit. A two-sided P-value less than 0.05 was considered statistically significant. We performed all the statistical analyses with the use of IBM SPSS Statistics 25.0 (SPSS Inc., IBM, Armonk, NY, USA).

RESULTS

A total of 2,337 ICCU admissions were included in this analysis. Baseline characteristics of the patients are presented in Table 1. The mean age was 65.6 ± 14.2 years, and the female accounted for 32.0% of patients. Most ICCU admissions originated from the emergency department (68.6%) and underwent interventional procedures (77.8%). The CCI and OASIS, used to quantify the complexity of chronic illnesses and the acute severity of illnesses, were 2.4 ± 1.8 and 22.5 ± 10.4, respectively. There were significant differences in the baseline characteristics between patients who were free from primary endpoint and those who were not. Patients who were not free from primary endpoint tended to be older, admitted only for medical treatment, originate from the emergency department, present with greater complexity of chronic illnesses and acute severity of illnesses, and have a higher incidence of major ANCI.

The distribution of primary diagnoses for ICCU admissions is depicted in Figure 1. The most prevalent primary diagnosis was ST-segment elevation myocardial infarction (STEMI), accounting for nearly one-third of all admissions. Other types of ischaemic heart disease (IHD), including non-ST-segment elevation myocardial infarction (NSTEMI), unstable angina (UA), and stable IHD with the need for special attention after complicated interventional procedures, were common causes for ICCU admission. Meanwhile, the proportion of patients with non-IHD primary diagnoses was approximately one-third. AHF and arrhythmia were relatively prevalent primary causes. Additionally, patients principally admitted for noncardiovascular diseases comprised 1.4% of the entire study population.

Figure 2 shows the prevalence of various cardiovascular diagnoses in the ICCU, which include nearly all of the most common diseases in cardiology. The first three most prevalent cardiovascular
diagnoses were as follows: IHD (72.5%), heart failure (59.5%), and hypertension (51.8%). Frequently, ICCU admissions were complicated by cardiogenic shock (7.5%) or cardiac arrest (7.0%). For instance, more than 10% of the patients admitted for myocardial infarction or AHF were complicated by cardiogenic shock.

The prevalence of noncardiovascular diagnoses is illustrated in Figure 3. Dyskalemia (30.2%) and pneumonia or low respiratory tract infection (28.3%) were the most common noncardiovascular diseases. Chronic noncardiovascular diseases, such as diabetes mellitus (28.2%), chronic kidney disease (18.6%), and chronic lung disease (13.8%), were also prevalent in the ICCU. Notably, more than 20% of the patients (21.7%) were marked by major ANCI, defined as the composite of acute respiratory failure, acute kidney injury, sepsis, or gastrointestinal

| Characteristic                          | All (n=2,337) | Survivors (n=2,160) | Non-survivors (n=177) |
|----------------------------------------|--------------|---------------------|-----------------------|
| Age, yrs                               | 65.6 ± 14.2  | 65.3 ± 14.2         | 69.1 ± 13.5           |
| Age ≥ 65 yrs                           | 1,353 (57.9%)| 1,230 (56.9%)       | 123 (69.5%)           |
| Female                                 | 748 (32.0%)  | 687 (31.8%)         | 61 (34.5%)            |
| Source of admission                    |              |                     |                       |
| Department of Emergency                | 1,604 (68.6%)| 1,459 (67.5%)       | 145 (81.9%)           |
| General ward of Cardiology             | 620 (26.5%)  | 593 (27.5%)         | 27 (15.3%)            |
| Other Departments                      | 113 (4.8%)   | 108 (5.0%)          | 5 (2.8%)              |
| Type of admission                      |              |                     |                       |
| Medical                                | 518 (22.2%)  | 409 (18.9%)         | 109 (61.6%)           |
| Scheduled procedure                    | 1,083 (46.2%)| 1,065 (49.3%)       | 18 (10.2%)            |
| Unscheduled procedure                  | 736 (31.5%)  | 686 (31.8%)         | 50 (28.2%)            |
| Vital signs on admission               |              |                     |                       |
| Temperature, °C                        | 36.3 ± 1.7   | 36.4 ± 0.7          | 35.6 ± 5.5            |
| Respiratory rate, per min              | 20.3 ± 3.8   | 20.2 ± 3.4          | 21.2 ± 6.8            |
| Heart rates, beats/min                 | 79.9 ± 21.5  | 78.6 ± 19.9         | 95.6 ± 31.8           |
| Systolic blood pressure, mm Hg         | 125.1 ± 44.5 | 126.7 ± 44.6        | 104.9 ± 37.7          |
| Diastolic blood pressure, mm Hg        | 72.6 ± 16.3  | 73.5 ± 15.0         | 61.8 ± 25.3           |
| Charlson Comorbidity Index             | 2.4 ± 1.8    | 2.2 ± 1.7           | 4.6 ± 2.3             |
| Oxford Acute Severity of Illness Score | 22.5 ± 10.4  | 20.9 ± 8.2          | 42.0 ± 14.7           |
| NYHA functional classification         |              |                     |                       |
| I                                      | 776 (33.2%)  | 773 (35.8%)         | 3 (1.7%)              |
| II                                     | 398 (17.0%)  | 392 (18.1%)         | 6 (3.4%)              |
| III                                    | 423 (18.1%)  | 415 (19.2%)         | 8 (4.5%)              |
| IV                                     | 526 (22.5%)  | 367 (17.0%)         | 159 (89.8%)           |
| Cardiogenic shock                      | 176 (7.5%)   | 63 (2.9%)           | 113 (63.8%)           |
| Ventricular tachycardia/Fibrillation   | 159 (6.8%)   | 114 (5.3%)          | 45 (25.4%)            |
| Major acute noncardiovascular critical illnesses |        |                     |                       |
| Acute respiratory failure              | 342 (14.6%)  | 192 (8.9%)          | 150 (84.7%)           |
| Acute kidney injury                    | 321 (13.7%)  | 208 (9.6%)          | 113 (63.8%)           |
| Sepsis                                 | 98 (4.2%)    | 48 (2.2%)           | 50 (28.2%)            |
| Gastrointestinal bleeding              | 78 (3.3%)    | 43 (2.0%)           | 35 (19.8%)            |

Data are presented as means ± SD or n (%). All the P-value for statistical tests to detect differences was less than 0.005 except that for gender and temperature on admission. NYHA: New York Heart Association.
bleeding; in particular, 9.6% of the patients were complicated by two kinds of major ANCIs.

Invasive coronary angiography and percutaneous coronary intervention (PCI) were the most frequently used procedures in the ICCU setting, although the application of other interventional procedures was also relatively prevalent (Table 2). Compared with those free from primary endpoint, patients with primary endpoint were more likely to have received the invasive haemodynamic monitoring (e.g., arterial line and central venous catheter), treatment with advanced devices (e.g., mechanical ventilation, IABP, and CRRT), and therapy with inotropes or vasopressors during hospitalization.

The median LOS in the ICCU and hospital were 1.1 days (IQR: 0.8–2.6 days) and 6.3 days (IQR:
3.8–10.9 days), respectively. The overall incidence of the primary endpoint was 7.6% (n = 177) during hospitalization of the study population, with 6.5% (n = 151) occurring in the ICCU. Compared with patients admitted only for medical treatment, those admitted for unscheduled or scheduled procedures

Figure 3  Noncardiovascular diseases of patients admitted to the intensive cardiac care unit. *Refers to the random blood glucose level was greater than the optimal cut-off value (19.05 mmol/L) to predict diabetic ketoacidosis.

Table 2  Major treatment characteristics of intensive cardiac care unit admissions.

| Characteristics                                              | All (n = 2,337) | Survivors (n = 2,160) | Non-survivors (n = 177) |
|--------------------------------------------------------------|-----------------|-----------------------|-------------------------|
| Invasive coronary angiography†                                | 1,640 (70.2%)   | 1,572 (72.8%)         | 68 (38.4%)              |
| Percutaneous coronary intervention†                          | 1,341 (57.4%)   | 1,294 (59.9%)         | 47 (26.6%)              |
| Temporary pacemaker                                          | 210 (9.0%)      | 188 (8.7%)            | 22 (12.4%)              |
| Conventional pacemaker                                       | 111 (4.7%)      | 108 (5.0%)            | 3 (1.7%)                |
| Implantable cardioverter defibrillator                       | 15 (0.6%)       | 15 (0.7%)             | 0                       |
| Cardiac resynchronization therapy and pacemaker or defibrillator | 11 (0.5%)     | 10 (0.5%)             | 1 (0.6%)                |
| Ablation for tachycardia                                     | 88 (3.8%)       | 88 (3.8%)             | 0                       |
| Left atrial appendage closure                                | 31 (1.3%)       | 31 (1.4%)             | 0                       |
| Transcatheter aortic implantation or balloon aortic valvuloplasty | 51 (2.2%)   | 48 (2.2%)             | 3 (1.7%)                |
| Interventional therapy for congenital heart disease          | 21 (0.9%)       | 20 (0.9%)             | 1 (0.6%)                |
| Extracorporeal membrane oxygenation                          | 4 (0.2%)        | 2 (0.1%)              | 2 (1.1%)                |
| Intra-aortic balloon pump†                                    | 87 (3.7%)       | 56 (2.6%)             | 31 (17.5%)              |
| Inotropes or vasopressors†                                    | 312 (13.4%)     | 175 (8.1%)            | 137 (77.4%)             |
| Arterial line†                                               | 407 (17.4%)     | 284 (13.1%)           | 123 (69.5%)             |
| Central venous catheter†                                     | 227 (9.7%)      | 130 (6.0%)            | 97 (54.8%)              |
| Continuous renal replacement treatment†                      | 59 (2.5%)       | 32 (1.5%)             | 27 (15.3%)              |
| Mechanical ventilation†                                      | 316 (13.5%)     | 175 (8.1%)            | 141 (79.7%)             |

Data are presented as n (%). *Refers to the P-value for statistical test to detect difference was less than 0.001.
had a shorter LOS and a lower incidence of primary endpoint (Table 3). Particularly, patients admitted for AHF (rate: 45/228, 19.7%) or myocarditis (rate: 8/51, 15.7%) had a higher incidence of primary endpoint, though primary endpoint occurring in patients admitted for myocardial infarction were the most common (STEMI, rate: 66/748, 8.8%; NSTEMI, rate: 32/352, 9.1%). In addition, the incidence of primary endpoint in those admitted for UA or stable IHD was only 0.6%.

Multivariate binary logistic regression analysis revealed the determinants of in-hospital outcomes in ICCU patients (Figure 4). The complexity of chronic illnesses (assessed by CCI) (OR = 1.16, 95% CI: 1.04–1.31), acute respiratory failure (OR = 4.37, 95% CI: 2.33–8.21), gastrointestinal bleeding (OR = 3.04, 95% CI: 1.41–6.56), and acute kidney injury (OR = 2.04, 95% CI: 1.18–3.54) were independently associated with in-hospital outcomes after controlling for the impact of demographics, acute severity of illnesses (assessed by OASIS) (OR = 1.87, 95% CI: 1.48–2.36), ventricular arrhythmia (OR = 4.81, 95% CI: 2.49–9.27), and cardiogenic shock (OR = 8.21, 95% CI: 4.72–14.27). However, the incidence of sepsis was not statistically associated with outcomes (OR = 1.1, 95% CI: 0.5–2.1). The model had a C-statistic of 0.96 (95% CI: 0.94–0.97, P < 0.001) which indicated excellent discrimination. Moreover, the Hosmer-Lemeshow test statistic was 4.49 (P = 0.811) which confirmed the goodness of fit of the model.

DISCUSSION

We conducted a retrospective study using data from 2,337 consecutive admissions to the ICCU at a large institution in China over the course of one year. The results showed the following: (1) the primary diagnoses for ICCU admission were highly diverse and not limited to AMI, although the latter (especially STEMI) was still the most common; (2) non-cardiovascular diseases, including chronic illnesses and ANCIs, were prevalent in patients receiving in-

| Outcomes                        | All (n = 2,337) | Medical (n = 518) | Unscheduled procedure (n = 736) | Scheduled procedure (n = 1,083) |
|---------------------------------|-----------------|-------------------|---------------------------------|---------------------------------|
| Primary endpoint                | 177 (7.6%)      | 109 (21.0%)       | 50 (6.8%)                       | 18 (1.7%)                       |
| DAMA from hospital in ECC       | 83 (3.6%)       | 58 (11.2%)        | 21 (2.9%)                       | 4 (0.4%)                        |
| DAMA from ICCU in ECC           | 67 (2.9%)       | 47 (9.1%)         | 17 (2.3%)                       | 3 (0.3%)                        |
| All-cause death in hospital     | 94 (4.0%)       | 51 (9.8%)         | 29 (3.9%)                       | 14 (1.3%)                       |
| All-cause death in ICCU         | 84 (3.6%)       | 46 (8.9%)         | 26 (3.5%)                       | 12 (1.1%)                       |

Data are presented n (%). All the P-value for statistical tests to detect differences in outcomes among admission-type groups was less than 0.001. Primary endpoint was defined as the composite of death from any cause or DAMA in ECC (defined as the composite of circulatory shock, electrical instability requiring emergency medical interventions, or acute respiratory failure with the need for invasive mechanical ventilation). DAMA: discharge against medical advice; ECC: extremely critical condition; ICCU: intensive cardiac care unit.
tensive cardiac care; and (3) the complexity of chronic illnesses and major ANCIs were independently associated with in-hospital outcomes. To our knowledge, this is the first study from developing countries such as China that investigates the current status of patients admitted to the ICCU.

The advantages of an intensive care unit in providing comprehensive critical care to patients with acute cardiovascular diseases prompted the evolution from CCU to ICCU. With the accumulation of evidence supporting the use of intensive care, physicians began to admit patients with other cardiac critical illnesses to CCUs, the once post-AMI care unit. Consequently, the principal causes for ICCU admission became highly diverse, although ACS was still the most common. Our findings were consistent with the results from observational studies conducted in developed countries in terms of the diversity of primary diagnoses, although there were remarkable differences in the proportions of some specific diagnoses. In contrast to the trend for a significant decline in STEMI and a significant increase in non-ST-segment elevation ACS, our data showed that STEMI admissions were more common than admissions for non-ST-segment elevation ACS. A possible explanation for this inconsistency is that the creation of regional networks, designed to deliver reperfusion therapy in a timely manner, may lead to more transfer of STEMI patients to the large primary PCI-capable centre in a geographic area of developing countries with unbalanced distribution of medical resources. Additionally, inconsistent criteria for admitting non-ST-segment elevation ACS may also be a contributing factor.

The overall rate of the primary endpoint was 7.6% in our study, and patient outcomes seemed to be better than those reported by several previous studies in which in-hospital mortality ranged from 9.0% to 14.0%. However, the direct comparison of outcomes may be questionable when considering of the non-standardized admission criteria adopted by each ICCU. We noted that there was pronounced heterogeneity regarding the incidence of primary endpoint among patients stratified by primary diagnoses (e.g., AHF: 19.7%; myocardial infarction: 8.9%; UA or stable IHD: 0.6%). Currently, studies addressing standardized ICCU admission criteria are lacking. The recommendations from expert consensus regarding this issue are mainly based on empirical evidence, and the determination of which patients should be routinely admitted to the ICCU needs further investigation. Our findings suggested that admitting low-risk patients, such as UA patients and stable IHD patients following complicated procedures, to the ICCU may be considered only after careful assessment, as the overall risk of adverse outcomes is low in these patients and inappropriate admissions may increase staff workload and worsen the outcomes of more critically ill patients. Conversely, high-risk patients, such as those principally presenting with AHF, should receive more priority when deciding on ICCU admission.

Our study showed that chronic noncardiovascular diseases were prevalent in Chinese ICCU patients, although the prevalence rates were slightly lower than those reported in studies from developed countries. However, the score used to quantify the complexity of chronic illnesses was similar (CCI: 2.4 ± 1.8 vs. 2.3 ± 1.8 or 2.4 ± 2.6). Advances in the medical field have resulted in the prolonging of life expectancy and the increased prevalence of age-related comorbidities; thus, patients admitted to the ICCUs are increasingly older, with a substantial increase in the complexity of chronic illnesses. Accordingly, current ICCU patients tend to be vulnerable, with poor physiological reserve, and are less likely to survive critical illnesses. Our data echoed this standpoint, with CCI being independently associated with adverse in-hospital outcomes. Additionally, chronic comorbidities may influence decisions regarding treatment options and increase ICCU-related complications. Hence, we should pay more attention to the baseline health status of patients in the contemporary ICCU.

We also found that more than 20% of our study population were marked by major ANCIs. Compared with data from previous studies, this proportion was relatively low. The difference may be partly attributable to the fact that we admitted more patients who needed special attention following complicated procedures to our ICCU, and they rarely suffered major ANCIs. Meanwhile, our study showed that acute respiratory failure, gastrointestinal bleeding, and acute kidney injury were strong
determinants for adverse outcomes, next to cardio-
genic shock and ventricular arrhythmia. These re-
sults supported the findings from a previous study. [8] With advances in cardiovascular medicine and im-
proved treatment outcomes from acute cardiac ill-
nesses, the impact of ANCIs on the survival of ICCU patients is becoming more predominant. This change is challenging the traditional ICCU staffing model, in which cardiologists with relatively lim-
ited experience in treating noncardiovascular critical conditions direct patient management. Thus, based on evidence from studies conducted in general inten-
sive care units, the American Heart Association proposed that cardiac intensivists or multidisciplin-
ary teams including medical intensivists should be introduced into contemporary ICCUs.[26] Recent studies regarding the role of the intensivist in the ICCU further confirmed the benefit of the new staffing models. Theoretically, we believe that revolutionizing staffing practices should also be considered in Chinese ICCU.

LIMITATIONS

There were several potential limitations that should be addressed. Firstly, the observational data were retrospectively abstracted, introducing inher-
ent biases which we could not entirely account for, although we utilized trained cardiology fellows to systematically inspect individual medical records. Secondly, this is a single-centre retrospective study conducted at a large institution in China. The rep-
resentativeness and generalizability of the results may be affected by the non-standardized ICCU ad-
mission criteria and the differences in the distribution of medical resources among Chinese hospitals. Thirdly, contrary to what is widely known, age was not significantly associated with outcomes in our study. This discrepancy may be explained by the fact that our study was underpowered to detect a difference after controlling for other strong deter-
minants of adverse outcomes and age distribution was highly heterogeneous among those admitted with high-risk conditions such as cardiogenic shock. Last but not least, we failed to find a statistically significant association between sepsis and adverse outcomes, differing from some published studies.[8,27] A possible explanation for this is that the missed diagnoses caused by the controversial diagnostic criteria for sepsis may influence the calculation of odds ratio in our regression analysis.[28,29] Further high-quality multicentre studies are needed to provide more information regarding this issue.

CONCLUSIONS

Remarkable patient diversity and breadth of crit-
ical illnesses were observed in Chinese patients re-
ceiving intensive cardiac care. The primary dia-
gnoses for ICCU admissions were highly diverse, although AMI (especially STEMI) was still the most common. Noncardiovascular diseases, including chronic illnesses and ANCIs, were prevalent in this population. Moreover, the complexity of chronic ill-
nesses and major ANCIs were independently asso-
ciated with adverse in-hospital outcomes. The char-
acteristics of contemporary Chinese ICCUs were significantly different from simple CCUs. Reformation of organization and staffing practice may be considered to adapt to the changed landscape.

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