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EDITORIAL COMMENT

# Multiple Layers of Care and Risk

## Comparing Cross-Specialty Outcomes Using Regional, Hospital, and Patient-Level Data*

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In tertiary and quaternary care hospitals, coronary care units have evolved from their original purpose as post-myocardial infarction arrhythmia monitoring and response units in to the modern cardiac intensive care unit (CICU) capable of caring for patients with complex cardiovascular and multisystem diseases. This temporal growth in patient acuity, complexity,[1] and the provision of critical care-restricted therapies[2] has prompted international organizations to call for expanded training in critical care medicine for CICU attendings.[3,4] While nonrandomized studies supported this position,[5] very few institutions have dual-trained cardiologist-intensivists,[6] and little is known about the contemporary outcomes of CICU- or ICU-based care in the complex patient population.

In this issue of the *JACC: Advances*, Brusca et al[7] conducted a retrospective cohort analysis that leverages the electronic health records (EHRs) from 16,163 patients admitted with a primary cardiovascular diagnosis between January 1, 2009, and December 31, 2014, to 14 hospitals with a CICU and at least 1 noncardiac ICU (medical, general, or surgical). The authors compared in-hospital mortality between patients admitted to CICUs and those admitted to noncardiac ICUs. In the univariable analysis, the association favored CICU care in 7 of 14 hospitals and noncardiac ICU care in 2 of 14, although sequential organ failure assessment scores, mechanical ventilation, and vasopressor use were significantly higher in the noncardiac ICUs. In the first multivariable model, which accounted for demographics, available patient clinical data, and a selected number of hospital variables (rural vs urban, teaching status, number of beds), the relationship was no longer significant (odds ratio: 1.04, 95% CI: 0.91-1.18; $P = 0.56$). In a second model that incorporated diagnoses that typically warranted noncardiac ICU admissions (eg, respiratory, infectious, and/or neurologic diagnosis), a lower odds of mortality was observed in the noncardiac units (odds ratio: 0.86, 95% CI: 0.76-0.98; $P = 0.03$). Moreover, they conducted a number of sensitivity analyses limited to patients with mechanical ventilation (n = 817) or vasopressors (n = 3,751) and reported a lower observed mortality among patients admitted to noncardiac ICUs in these subgroups. Among patients without ventilation or vasopressors, outcomes were better in CICUs, leading the authors to propose a potential beneficial association with critical care training in patients with primary or concurrent noncardiac illnesses.

The study's strengths include the selection of hospitals with both dedicated CICUs and noncardiac ICUs which may mitigate potential admission practice biases in centers without both specialty services. The multicenter EHR-based cohort is also a potentially novel platform for CICU-focused studies and ensures minimal discrepancies in data between centers. The authors were fastidious in acknowledging a number of limitations and were careful not to overstate causality in the reported associations. Notwithstanding, the authors propose the results could be interpreted as either a traditional ICU environment may be best equipped to manage multiorgan failure or it may also support ongoing efforts to increase CICU staffing with

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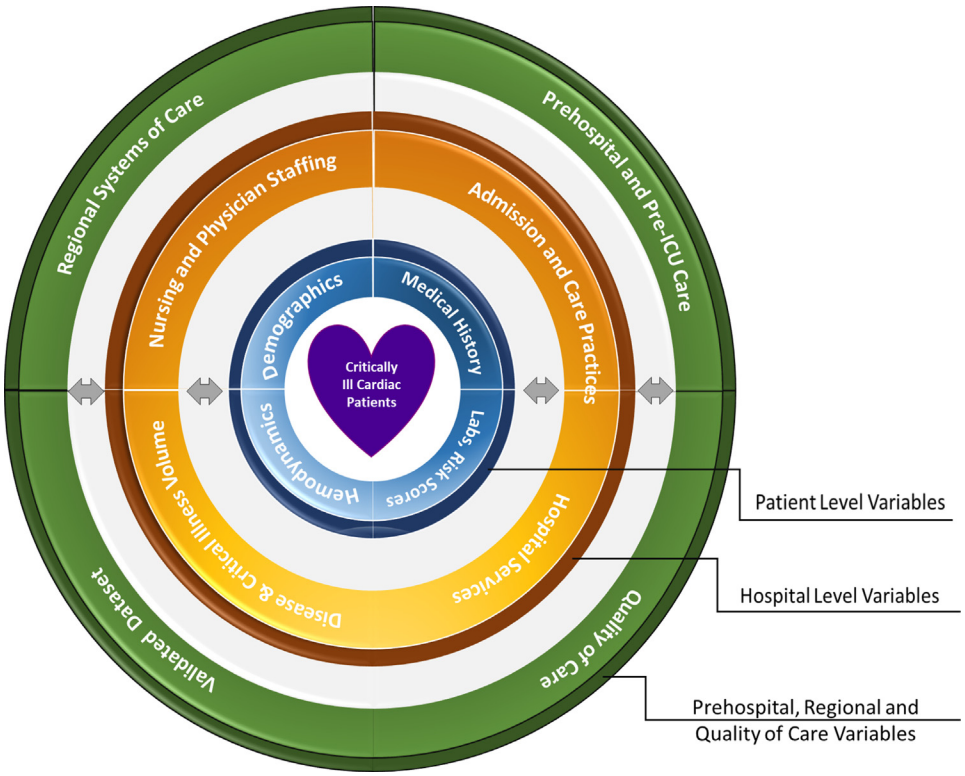
**FIGURE 1** **Proposed Multitiered Electronic Health, Registry, and/or Quality of Care Data Linkages Required to Better Assess Interspecialty Outcomes**




dual-trained cardiologist-intensivists who are capable of quarterbacking both cardiac and noncardiac care. This latter assertion is supported by a propensity-matched before-and-after study from Korea showing a transition to closed-unit staffing with dual-trained cardiologist-intensivists resulted in decreased CICU mortality (7.5%-3.7%) which included reductions in both cardiovascular and noncardiovascular mortality.[5]

The study's associations should be cautiously interpreted in light of the limitations of the EHR data. Importantly, there was no information on patient hemodynamic data or laboratory variables which may have further enlightened risk differences at the time of admission. Second, although administrative coding for hospital diagnoses is quite specific,[8] ascribing a primary cardiac diagnosis is often challenging in critically ill patients, especially at the time of triage. In patients with multiorgan failure, there may be a number of concurrent serious problems, and the admission/discharge diagnosis may be a sequalae of another later diagnosed condition, eg, rapid atrial fibrillation after noncardiac surgery or due to an underlying pulmonary embolism. This issue simply reflects the need for independent validation of coding using observational or EHR research. Third, interspecialty comparison based on the provision of critical illness therapies (such a mechanical ventilation, vasoactive agents, or renal replacement therapy) are fraught with pitfalls. The mortality risk with vasoactive therapies for sepsis or hypovolemia (more frequent in noncardiac ICUs) is lower than that for cardiogenic shock,[9,10] whereas the attributable risk for mechanical ventilation for acute decompensated heart failure (more common in CICUs)[11] or routine post-coronary artery bypass grafting (more common in surgical ICUs)[12] is lower than that for acute respiratory distress syndrome.[13,14] This underscores the needs for more robust risk stratification within each subgroup. Fourth, hospital-level variables were very limited in the data set. Physician training,[5] nurse-to-patient ratios,[15] and staffing models (closed/unit-based attending vs open models)[5,16] have been previously associated with improved CICU outcomes. Recognizing that this information was not available and given that an American Heart Association and

American College of Cardiology survey[6] has reported that 74% of all CICUs (and 63% of all academic CICUs) had open physician staffing model highlight the potential for incomplete adjustment and the need for multitiered data collection. Finally, on a regional level, systems of cardiovascular care including participating in quality-assurance programs have been shown to improve patient outcomes.[17,18] Thus, understanding the prehospital response and precritical care treatment together with individual unit volumes of critical care therapies are important risk elements.[19]

The complexities of risk adjustment beg the following question: What are the priorities for data collection to better address interspecialty outcomes between patients treated in the CICU vs those in noncardiac ICU environment? Recognizing the study question is unlikely to be answered by a randomized controlled trial, it will likely require a comprehensive prospective registry or linking of multiple retrospective data sets (including EHRs, registries, and/or population health data) that capture relevant patient, prehospital, hospital, regional, and quality-of-care metrics (**Figure 1**). In addition to the datapoints discussed above, future studies ought to ensure that the time and quality-of-care metrics are valid for the primary diagnosis,[20] should seek to incorporate usual local referral and admission practices (eg, who is admitted to CICUs vs noncardiac ICUs[21,22] and which is the primary unit for mechanical circulatory support care[23]), incorporate contemporary patient populations given population health studies have shown improvement in CICU cardiac and noncardiac mortality over time,[1,2] and attempt to capture differences in goals of care[24] or destination therapy candidacy.

The authors should be congratulated for contributing a novel analysis to the growing body of cardiac critical care research. The conclusions are thought-provoking, plausible, and they may be viewed as complimentary to prior studies showing transition to dual training in cardiology and critical care has the potential to improve patient outcomes.[5] In the context of the data set's limitations, we propose that the results should not be used to change current admission practices or to infer superiority/inferiority of individual specialty care. It should, however, stimulate debate and academic interest how to better prospectively collect and create observational data sets that better account for the multitiered layers of risk and care. Although clinical trials are the gold standard of evidence, many complex process-of-care questions may be ill-suited for randomization and may be of low priority for funding agencies. Thus, linking existing data sets to provide a more comprehensive assessment of the patient and their care journey may be the most feasible platform to address these quality-assurance questions that may foster future changes in the cardiac critical care delivery.

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