Association Between In-Hospital Critical Illness Events and Outcomes in Patients on the Same Ward

Major critical illness events, such as cardiopulmonary arrest and intensive care unit (ICU) transfer, disrupt workflow in a hospital ward. Other patients on the same ward may receive inadequate attention, especially if their care team is distracted by the emergency. Most studies have concentrated on patient-level variables associated with outcomes. To our knowledge, no study has quantified the risk to ward occupants associated with patients on the same ward experiencing critical illness.

Methods | This observational cohort study of consecutive adult admissions (2009-2013) at the University of Chicago Medicine where rapid-response teams were used included 13 medical-surgical wards that were geographically distinct areas, had patient-nurse ratios of 4:1 on average and 1 charge nurse, and had approximately 20 beds per ward. Physician teams consisted of 1 attending and 2 to 3 resident trainees or a hospitalist. The university’s institutional review board granted a waiver of informed consent.

The primary outcome was a composite of cardiac arrest and ICU transfer. The primary exposure was the number of patients on the same ward experiencing a critical illness event (cardiac arrest, ICU transfer, or death) anytime during the prior 6 hours. Discrete time survival analysis modeling (using fixed 6-hour blocks of time beginning at ward admission) was used to adjust for severity of illness (electronic Cardiac Arrest Risk Triage score), time of day (day: 7 AM-5 PM; evening: 5 PM-10 PM; night: 10 PM-7 AM), weekday vs weekend, total number of ward patients, proportion of occupied ICU beds, and specific ward.

Analyses were performed using R (R Project for Statistical Computing), version 3.1, with a 2-sided P < .05 denoting statistical significance.

Results | Of 83,723 admissions, 4,286 experienced the primary outcome (179 cardiac arrests and 4,107 ICU transfers). Compared with patients without an event, those with an event were older (60 years vs 57 years), less likely to be female (50% vs 53%), and had a longer median length of stay (12.8 days vs 3.0 days) (all P < .001).

The likelihood of cardiac arrest or ICU transfer within the next 6 hours was greater when 1 event (5.0 [95% CI, 4.6-5.6] per 1000-patient 6-hour blocks) or more than 1 event (7.1 [95% CI, 5.0-10.3] per 1000-patient 6-hour blocks) occurred during the prior 6 hours compared with no event (3.6 [95% CI, 3.5-3.8] per 1000-patient 6-hour blocks). In the fully adjusted model (Table 1), when 1 or more patients developed critical illness, other ward patients’ risks for cardiac arrest or ICU transfer increased over the next 6 hours (1 event: odds ratio [OR], 1.18 [95% CI, 1.07-1.31], adjusted absolute risk increase of 0.6 per 1000-patient 6-hour blocks); >1 event: OR, 1.53 [95% CI, 1.03-2.18], adjusted absolute risk increase of 1.9 per 1000-patient 6-hour blocks). Results remained statistically significant when changing the time window to 3 and 12 hours (Table 2).

The association was not statistically different during nighttime hours (1 event: OR, 1.42 [95% CI, 1.17 to 1.71], P = .06 for interaction; >1 event: OR, 2.23 [95% CI, 1.07 to 4.08], P = .20 for interaction), although this analysis is likely underpowered. Severity scores for ICU transfer patients exposed and not exposed to a critical illness event during the prior 6 hours were not statistically different (mean, 39 vs 37, respectively; mean difference of 2 [95% CI, −11 to 7]).

Mortality was not significantly different between the exposed and not exposed groups (14% vs 14%, P = .90). Critical illness events were associated with a decrease in other patients being discharged from the hospital within the next 6 hours (1 event: OR, 0.94 [95% CI, 0.92-0.96]; >1 event: OR, 0.95 [95% CI, 0.87-1.04]).

Discussion | Development of a critical illness event in a patient was associated with a higher risk of cardiac arrest or ICU transfer in other patients on the same ward. Although the absolute increased risk was small, these events were associated with high morbidity and mortality.

The association may be explained by the diversion of resources to critically ill patients, which may result in caregivers being less attentive to other ward patients. Study limitations include the retrospective design, single center,
unavailability of patient-specific clinician information or reason for admission, and possible residual confounding.

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Administrative, technical, or material support: Volchenboum, Edelson, Howell, Churpek.

Conflict of Interest Disclosures: The authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Drs Edelson and Churpek reported having a patent pending for risk stratification algorithms for hospitalized patients. Dr Edelson also reported ownership interest in Quant HC, which is developing products for risk stratification of hospitalized patients; receiving research support and honoraria from Philips Healthcare; and receiving honoraria from Early Sense. Dr Churpek also reported receiving honoraria from Chest. No other disclosures were reported.

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COMMENT & RESPONSE

Prenatal Carrier Screening

To the Editor Dr Grody’s Editorial commented on our article on population risk of severe mendelian diseases. We have concerns about several of his statements.

Grody claimed that some aspects of our “approach are not reported in the article or otherwise ascertainable by the general public” and suggested our motives may be “driven by marketing” as much as by science. He stated: “only the most frequently identified mutations are presented” and “no information is provided ... to indicate which and how many mutations are actually being tested.” This is incorrect. The complete list of all diseases and alleles considered pathogenic is available, with counts, in the Supplement of the article. Criteria for variant classification are available on ClinVar, as stated in the Supplement.

Grody also stated that all “tests were performed among individuals rather than on defined reproductive couples.” However, as noted in the Supplement, our data set included 37 719 total couples (17 275 screened in tandem) with no statistically significant differences between modeled and observed counts. Although follow-up information is difficult to obtain, preliminary data indicate that carrier couples of severe disorders included in screening guidelines or non-guideline conditions make similar reproductive decisions after expanded carrier screening.

Grody claimed that cystic fibrosis is the only disease currently recommended for universal carrier screening. However, the American College of Medical Genetics and Genomics (ACMG) also recommends spinal muscular atrophy for universal screening. He also claimed that conditions screened should be such that “most couples would be interested in prenatal diagnosis and potential pregnancy termination.” However, a joint statement from the ACMG and other organizations lists “prenatal intervention,” “delivery management,” and “prenatal education” as valid reasons for carrier screening and does not list termination.

He argued that because phenylketonuria is part of newborn screening “there is no justification for doing the [carrier] screening.” Grody’s opinion differs from professional consensus. The American College of Obstetricians and Gynecologists (ACOG) cautions against replacing carrier screening with newborn screening.

In addition, Grody stated that we demonstrated a “9% to 55%” increase in detection over standard screening.

Table 2. Association Between a Patient’s Risk of a Cardiac Arrest or Intensive Care Unit (ICU) Transfer and Critical Illness Events Using Different Time Intervals

<table>
<thead>
<tr>
<th>Time, h</th>
<th>Cardiac Arrest or ICU Transfer, Odds Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Event</td>
<td>1.18 (1.02-1.35)</td>
</tr>
<tr>
<td>&gt;1 Event</td>
<td>1.18 (1.02-1.35)</td>
</tr>
<tr>
<td>6*</td>
<td>1.18 (1.07-1.31)</td>
</tr>
<tr>
<td>12</td>
<td>1.09 (1.01-1.19)</td>
</tr>
</tbody>
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*Indicates time point for the main analysis.