According to federal statistics, mass shootings have tripled in the United States in the past decade. These mass-casualty events can easily overwhelm the resources of local hospitals. As the number of persons injured increases, even a well-prepared center can be pushed beyond capacity. While trauma systems have been established throughout the United States to prioritize getting the right patient to the right place at the right time, travel distance, traffic, casualty volume, and injury severity often result in transport of patients to a hospital that is not a trauma center (TC). It is hypothesized that the nearest available hospitals to mass shooting events will commonly be non-trauma center (NTC) hospitals, where such patient loads are more likely to overwhelm capacity and advanced care options may be limited. This study evaluates the location of recent mass shooting events relative to nearest hospitals and TCs.

**Methods** Mass shootings, defined as events involving 5 or more injuries or deaths by a firearm, were documented from the Gun Violence Archive for the calendar year 2019. We defined a mass shooting as any having 5 or more individuals injured or killed by a gun, including the shooter; given our focus on system readiness, we selected patient burdens that would challenge the resources of TCs and NTCs alike. Using Google Maps, we calculated driving distance (in miles) from the geocoded address of the event to the nearest NTC (any hospital not verified as a level 1 or 2 adult or pediatric TC), adult level 1 or 2 TC, and pediatric level 1 or 2 TC. The TCs include all centers verified by American College of Surgeons and/or state entities. Hospital addresses were obtained from the American Hospital Directory. As a study involving only publicly available databases, this study was exempt, per the Children's Hospital of Philadelphia institutional review board and 45 CFR 46.104, and did not involve informed consent. Analysis was completed using Stata version 15.1 (StataCorp), and a \( P < .05 \) was considered significant.

**Results** During 2019, there were 187 events occurring in 38 states. There were a total of 1250 individuals injured, with a...
case fatality rate of 23.8% (298 individuals killed; 953 survivors). One or more pediatric patients (<18 years old) were involved in 54 events (28.9%), with 27 such patients killed and 88 injured. Event location and distance to a hospital are presented in the Figure, highlighting that NTCs had a smaller mean (SD) distance from incidents (4.49 [20.78] miles) than adult TCs (13.14 [20.78] miles) or pediatric TCs (43.78 [82.90] miles; non-parametric P < .001 for both comparisons; Table). Non-trauma center hospitals were the nearest hospitals for 133 events (71.1%) involving 845 patients. More than half of all events (95 events [50.80%]) occurred more than 10 miles from a PTC.

Discussion | Mass shootings are unfortunately commonplace, with 187 events during 2019. The mortality of injuries in the mass shooting events reported here (23.8%) exceeds the mortality of combat wounds (10%).3 Different than mass-casualty events from blunt trauma mechanisms, mass shootings involve a large proportion of serious injuries, the need for rapid treatment of exsanguination, and possible scene delays attributable to safety problems. Optimizing the outcomes of these patients requires coordinated, high-level resource allocation.4 Given prior work estimating the potentially preventable death rate for individuals injured in mass shooting incidents at 15%,5 identifying methods to optimize initial care, such as the high-level triage and management skills most commonly found in a TC, is essential. Yet, in more than 70% of events in this study, an NTC was closer and thus was likely often the primary patient-transport destination. When a pediatric patient was involved (as in 28.9% of events in this study), care may have been particularly challenging, because more than 50% of events occurred more than 10 miles from a PTC. Children with injuries place a greater stress on the system because of the limited pediatric-specific resources available at many nonpediatric centers and the limited number of PTCs.6 Data for this analysis were obtained from a publicly accessible database of reported shootings. While not independently verified, this would likely be the source of an underestimate if an error exists.

Table. Notable Statistics for Location and Distance of Hospitals to Mass Shootings

<table>
<thead>
<tr>
<th>Location</th>
<th>Distance, mi</th>
<th>No. (%)</th>
<th>Events &gt;10 mi from hospital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trauma center</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>3.20 (1.80–5.20)</td>
<td>4.49 (4.34)</td>
<td>133 (71.12)</td>
</tr>
<tr>
<td>Adult</td>
<td>4.80 (2.30–12.30)</td>
<td>13.14 (20.78)</td>
<td>39 (20.86)</td>
</tr>
<tr>
<td>Pediatric</td>
<td>10.40 (4.30–38.10)</td>
<td>43.78 (82.90)</td>
<td>15 (8.02)</td>
</tr>
<tr>
<td>Closest hospital</td>
<td>2.60 (1.30–4.20)</td>
<td>3.54 (3.56)</td>
<td>NA</td>
</tr>
</tbody>
</table>

Abbreviations: IQR, interquartile range; NA, not applicable.
* After multiple pairwise comparisons, this value had significance of P < .001 compared with non-trauma center hospitals.

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