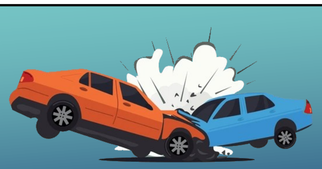
Crash Course



Optimizing Trauma Center Locations to Shorten Drives and Save Lives in Massachusetts (2022-2024)

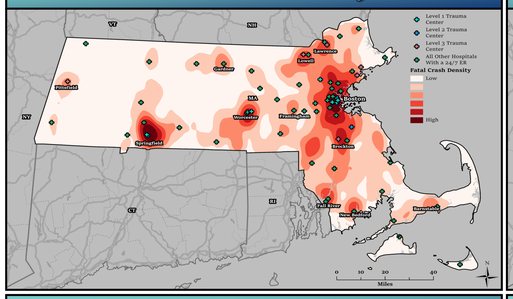
Background

Despite advancements in safety, **motor vehicle accidents** have remained a **leading cause of death** in the United States.[1] **Level 1 and level 2 trauma centers** provide specialized care that significantly improves patient survival following a motor vehicle crash.[2] The distribution of these facilities varies across the United States such that many rural areas are a **greater than 60-minute drive** from the nearest level 1 or 2 trauma center.[3] Prior studies have established that **motor vehicle accident mortality** is associated with **access to trauma care centers** across the **U.S. as a whole**.[4-6] However, it is unclear if this nationwide association exists at the state level, specifically in **Massachusetts**. As such, this project aims to address the following questions:

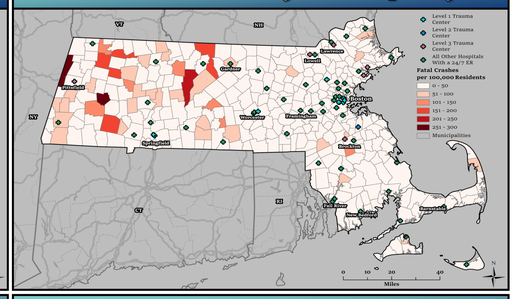
What is the spatial relationship between fatal car crashes and drive time to trauma centers in Massachusetts?

To reduce drive time, which hospitals should be upgraded level 1 or level 2 trauma centers?

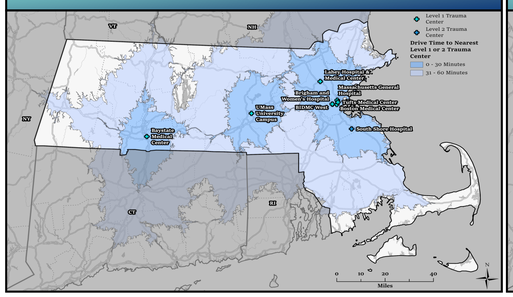
Fatal Crash Density



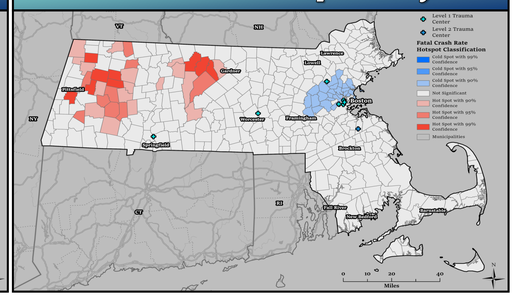
Fatal Crash Rate By Municipality



Current Service Area



Fatal Crash Rate Hotspot Analysis



Methods

To determine the spatial relationship between fatal motor vehicle crashes and drive time to trauma centers in Massachusetts, the points of fatal crashes from **2022 to 2024** was accessed through **MassDOT** and the locations of hospitals were retrieved from **MassGIS**.

The **Kernel Density tool** was used to identify areas with a high density of fatal crashes. A map was made to show the types of hospitals alongside this fatal crash density. To control for population, the points were **aggregated** to their municipalities, provided by **MassGIS**, to create a **choropleth** map. **Hotspot analysis** was used to identify any statistically significant hotspots and coldspots among the municipalities.

30-minute and 60-minute drive time **service area** buffers surrounding level 1 and 2 trauma centers were mapped. These drive times were chosen due to a previous study which found that mortality increased with increasing 30-minute increments of prehospital time.[7]

To identify hospitals to upgrade, **location-allocation analysis** was used. These analyses were done among **level 3 trauma centers** and **all other hospitals with a 24/7 ER** separately due to the former needing less resources to reach level 1 or 2 status. All hospitals that fell under these categories were used as candidates with existing level 1 or 2 trauma centers being required locations and demand points being fatal crashes between 2022 and 2024. Each analysis chose **3 hospitals** from their respective category. A 60-minute driving time cutoff was used and the analysis was done to maximize coverage.

Results

- From **2022 to 2024**, major **cities**, such as Boston, Worcester, and Springfield, had the highest **fatal crash density**.
- After controlling for population, **rural** municipalities had the highest **fatal crash rate** even though they had a low fatal crash density.
- Many of these rural municipalities were **hotspots** while the greater **Boston** area was a **coldspot**, despite its high fatal crash density.
- The **greater Boston area** is within a **30-minute drive** to a level 1 or 2 trauma center.
- When comparing the **current service area** and the **fatal crash rate hotspot analysis** qualitatively, it is clear that municipalities that fall outside of a **60-minute drive** to a level 1 or 2 trauma center have a significantly greater **fatal crash rate**.
- Future analysis could determine the **direction** of this relationship as well as **quantify** its effect size.
- Among the **level 3 trauma centers**, Berkshire Medical Center, Lawrence General Hospital, and Good Samaritan Medical Center were selected.
- Among the **other hospitals with a 24/7 ER**, Fairview Hospital, Baystate Franklin Medical Center, and Tobey Hospital were selected.
- Despite a difference in options between the two types of hospitals, both analyses chose one candidate to cover **Pittsfield** and another to cover **Cape Cod**.

Discussion

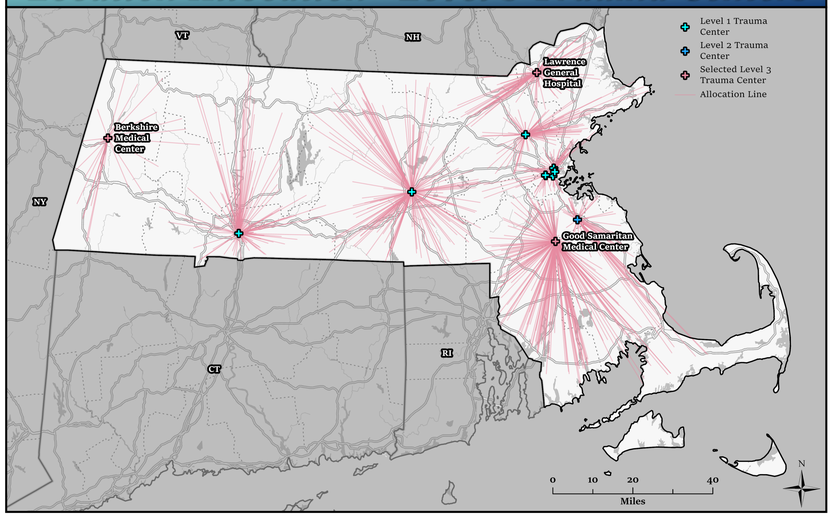
In **Massachusetts**, the density of **fatal crashes** is driven primarily by **population** density since after accounting for population, less populous areas have a **disproportionately high** rate of fatal crashes. These rural regions tend to be a greater than **60-minute drive** to the nearest level 1 or 2 trauma center. These findings align with the **established spatial relationship** between motor vehicle accident mortality and access to trauma care centers across the **entire U.S.**

When it comes to determining where new level 1 and 2 trauma centers should be placed, hospitals in **Western** and **Southeastern** Massachusetts were most common candidates. The coverage of these chosen facilities **optimally** include the points of fatal car crashes from **2022 to 2024**.

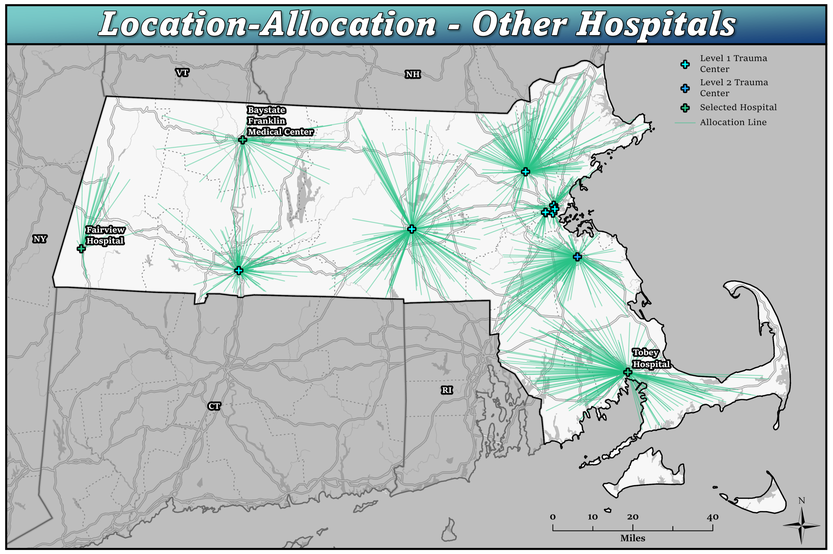
A **limitation** of this project is that hospitals **outside of Massachusetts** were not accounted for. It is possible that fatal crashes near the state border would be benefitted by new trauma centers in **other states**. That being said, these results provide **vital information** for state-level decision making.

These recommended locations can inform **public health officials** where to **allocate resources**. Additionally, a **level 3 trauma center** or another **hospital with a 24/7 ER** can be chosen depending on the resources available.

Location-Allocation - Level 3 Trauma Centers



Location-Allocation - Other Hospitals



References

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7. Gauss T, Ageron FX, Devaud ML, et al. Association of Prehospital Time to In-Hospital Trauma Mortality in a Physician-Staffed Emergency Medicine System. *JAMA Surg*. Dec 1 2019;154(12):1117-1124. doi:10.1001/jamasurg.2019.3475

Data Sources

MassGIS Massachusetts Hospitals (Feature Service)

MassGIS Municipalities

MassDOT IMPACT

USDOT North American Roads

ArcGIS Hub World Cities

Census State Boundaries

Tufts University | School of Medicine
Department of Public Health and Community Medicine

Dan Himsworth

PH 262: GIS for Public Health | Thomas Stopka | May 7th, 2025

All maps projected using NAD 1983 StatePlane Massachusetts FIPS 2001