HCA Healthcare Challenge: Emergency Response Leadership Network Documentation

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Problem Statement

During natural disasters, hospitals struggle to efficiently locate and deploy experienced crisis leaders, as unpredictable events overwhelm healthcare systems and complicate coordination. A study from Geisinger Medical Center's Emergency Medicine Department identified infrastructure damage, loss of staff, and resource limitations as major barriers to effective disaster response, all of which severely impact patient care (Melnychuk, Sallade, & Kraus, 2022).

Despite HCA's Enterprise Emergency Operations Center (HCA Healthcare, n.d.), there is no centralized system to specifically assess leadership resources before a disaster or quickly replace lost leadership during a crisis. Hospitals must act fast—but without a structured network, identifying the right personnel for support becomes challenging.

Proposed Solution

To solve the highlighted problem, we propose the Emergency Response Leadership Network, a platform that allows hospitals to identify, request, and deploy experienced HCA Healthcare supervisors both proactively and reactively.

- Before disasters, hospitals can preemptively assess leadership availability across facilities, ensuring key personnel are strategically positioned in high-risk areas.
- During disasters, if hospitals experience leadership loss due to evacuations, injuries, or staff shortages, the system enables rapid identification and deployment of experienced supervisors from other facilities.

Our system reduces delays in leadership deployment during crises, improves coordination between facilities by providing a shared resource pool, and can potentially enhance strategic pre-disaster planning by ensuring leadership is distributed optimally before an event occurs. By offering visibility into leadership availability, key experience details, and immediate request functionality, Emergency Response Leadership Network ensures that patients receive timely and well-coordinated care, whether hospitals are preparing ahead of a disaster or reacting in real time.

Tech Stack

Emergency Response Leadership Network was developed using the following tech stack:

- Data Cleaning: Jupyter Notebook was used for data preprocessing and visualization, leveraging Python libraries such as Pandas, NumPy, Matplotlib, and Plotly.
- Database Storage: The cleaned dataset is stored in an SQLite database, providing efficient querying and filtering capabilities.

- Backend Development: A FastAPI-based backend was implemented to facilitate dynamic data processing and retrieval.
- Frontend Interface: React.js was used, creating an interactive platform for hospital administrators to search for, filter, and request leadership personnel.

Analysis

We first filtered the dataset to include only employees in supervisory positions (EmpPositionIsSuper == True), ensuring that the leadership database focused on individuals capable of managing emergency situations. Additionally, data types were adjusted to align with the filtering logic used in the frontend, improving consistency in querying.

Next, we checked for missing and inconsistent values, standardizing them to align with the majority of existing data. To simulate real-world availability, we introduced an Availability variable, randomly assigning supervisors to one of four statuses: Available (Ready for immediate deployment), On Call (Available but not immediately on-site), Deployed (Currently assisting at another location), and Unavailable (On leave or unable to assist).

We also integrated GeoApify's Geocoding API to generate coordinates for each facility using its name, city, and state. This allowed us to create an interactive map displaying all facilities with supervisory personnel, enabling the user to visually assess the proximity of available supervisors to affected hospitals for faster decision-making.

Additionally, we analyzed departments (ER, Surgery, Respiratory Therapy, etc.) to identify which ones had the highest concentration of supervisors, ensuring that hospitals can prioritize leaders from the most relevant departments in the UI. We then integrated FEMA disaster data (linked below) to identify high-risk areas for high-risk states, serving as a reference when assessing pre-disaster planning through the platform.

Finally, the cleaned and structured leadership dataset was converted into an SQLite table, ensuring seamless integration with the backend. This database allows for efficient filtering, querying, and deployment request functionalities.

Future Considerations

If given more time, we would focus on improving the frontend design to further enhance usability and efficiency. This includes refining the UI layout for better user experience, and improving filter functionalities, allowing for a more seamless and scalable solution beyond this prototype.

If additional HCA Healthcare data sources were provided, the Emergency Response Leadership Network could be further improved in the following ways:

- Automated Availability Updates: Instead of manually assigning availability statuses, integrating real-time scheduling data would allow the system to automatically update a supervisor's status based on their actual work schedule, providing more accurate deployment information.
- Requesting a Manager: If more data was provided for the supervisor's manager, like their location, department(s), and employment tenure, the user could also request their deployment.
- AI-Powered Leadership Recommendations: By collecting additional data on employees' participation in the Enterprise Emergency Operations Program (HCA Healthcare, n.d.), their department expertise, and geographic proximity, machine learning algorithms can more accurately recommend the most suitable leaders.
- Specified Requests: Currently, request submissions are simulated by displaying a "Request Sent" message. However, with more data, these requests could be integrated into real-time communication channels, triggering urgent emails, messages, or calls directly to the requested employee for immediate response.

These enhancements would refine the system's ability to find the ideal available leaders so that hospitals are best prepared for disaster events.

References

HCA Healthcare. (n.d.). Preparing for response. HCA Healthcare Magazine. Retrieved February 20, 2025, from https://magazine.hcahealthcare.com/communities/community-impact/preparing-for-response/

Kanter, R. K., & Moran, J. R. (2022). *Disaster response and hospital infrastructure: Challenges in coordination and resource allocation*. *National Library of Medicine*. Retrieved from https://pmc.ncbi.nlm.nih.gov/articles/PMC8749465/

https://www.fema.gov/openfema-data-page/disaster-declarations-summaries-v2