MEDICAL SCHOOL
UNIVERSITY OF MICHIGAN

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Project Title: Approach to Right-Sizing Vertical Treatment Zones at the Michigan Medicine Emergency Department

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Summary (~250-500 words):

The Medical Educational Consulting Group (MedECG) is a University of Michigan Medical School student group with the stated mission of instersecting "curious, innovative, and analytical-minded medical students with community focused non-profit health care organizations to provide valuable, impactful, and sustainable solutions." In late 2019, MedECG worked with senior members of the Michigan Medicine Adult Emergency Department (MMED) to develop a project regarding the recent implementation of vertical treatment zones (VTZs) in the MMED. In this approach to addressing issues of ED crowding, providers identify patients that are able to remain "vertical" (i.e. do not require a traditional private room with a gurney) and "room" several of them in a space that would normally accommodate fewer patients. For sensitive exams or treatment, patients can be quickly transported to a dedicated treatment space within the vertical treatment zone or simply treated in their chair. In our case, the MMED was interested in determining the optimal resource allocation for VTZs given the inherent opportunity costs of dedicating rooms, staff, and resources to treating lower acuity patients.

A team of five students including this author self-selected from within the ranks of MedECG to work on this project. We began by conducting a literature review of the emergency department operational literature, focusing on VTZs and their implementation at peer institutions across the country. While there are many such case studies to be found in the literature, few if any described a rigorous or methodological approach to proactively determining the appropriate size of their VTZ. Instead, most articles homed in on the changes made and the resulting impact such as decreases in wait times and staff or patient satisfaction. As a result, we decided we needed a more analytical and reproducible way of determining the right-size of the VTZ. Based on the frequent references in the emergency department operational improvement literature to computer simulation, we decided to pursue an approach based on utilizing modeling software. To this end, we added an additional team member with experience in computer programming, and we analyzed multiple patient flow modeling options. We presented our findings and recommendations to the MMED leadership, and we collectively agreed to pursue a discrete event simulation (DES) approach in which the flow of the ED is mimicked using modeling software.

Through further consultation with MMED leadership and guided tours of the patient flow in the ED, we created a basic schematic to be used in our simulation. Utilizing the library SimPy and the programming language Python, our team expert created a simulated MMED that could model patient flows with and without a VTZ. Although only an initial proof of concept, these initial results indicate that this low-cost approach to modeling patient flow can be a useful and informative way to predict changes in key operational metrics. With further data collection and iterative improvements in the algorithm, we can produce a more accurate simulated patient journey that helps predict the right-sized VTZ.

Methodology:

We conducted a review of the literature discussing VTZs in similarly sized emergency departments at academic centers throughout the United States to gain a baseline understanding. We then highlighted several key case studies such as Stanford University Hospital's implementation of VTZs to use as a guide. However, due to a lack of clarity and details in the planning process with regards to right-sizing VTZs, we needed to create our own approach. Fortunately, in our study of the emergency department operational improvement literature, we discovered multiple references to various forms of computer simulation as a means for analyzing and modeling proposed procedural changes. This led to the addition of a sixth team member from the medical school who had experience in computer modeling and programming. Upon further review of these methodologies and in consultation with MMED leadership, we decided to pursue a discrete event simulation approach (DES). In DES, processes are simulated using placeholders and variables with different attributes. These attributes can be adjusted to mimic their real-life counterparts depending on the degree of precision and accuracy required, i.e. a triage placeholder can be created and the amount of time it takes a patient to clear this stage is a based on the patient's attributes (severity of illness) and the triage attributes (number and type of staff allocated to this role). By utilizing the Python programming language and the software SimPy, we created a schematic of a VTZ patient's journey from arrival to discharge or admission. A basic proof of concept scenario was conducted and presented by our team in the fall. The next step is to enrich the model with more variables and more accurate attributes to more closely simulated the real MMED environment. We then propose iterating off this baseline simulation by adding and subtracting VTZ resources to find the optimum balance of bed utilization rates and waiting times so as not to waste resources on one hand or cause excessive wait times on the other.

Results:

Our preliminary findings from simulating the MMED with and without a VTZ demonstrated an impact consistent with the literature and the initial results reported by MMED leadership. In particular, adding a VTZ decreases the utilization rate of the main ED pool of beds by almost 20 percent, though the triage bottleneck remained. While the magnitude of this change is not to be relied upon at this nascent stage of model development, it does serve as an initial proof of concept for our approach to utilizing simulation software for a customized analysis of patient flow through the MMED VTZ. Further refinement is still necessary to more accurately and precisely predict the optimal size of the VTZ based on bed utilization rates and wait times.

Conclusion (~250-500 words):

Instituting operational and procedural adjustments in the emergency department is often a risky endeavor, though the rewards for patients, staff, and the hospital can be significant. VTZs have shown promise over the past decade as a method of streamlining throughput and decreasing wait times, most notably for low acuity patients. However, due to the risks and costs involved in creating new spaces and reassigning staff and resources, it is helpful to have prognostic tools to guide decision making. Unfortunately, there are few mentions in the literature discussing how to best approach this step for VTZs. By adopting a discrete event simulation approach that has demonstrated positive results in other procedural improvement initiatives, we created a simulated MMED environment that can be used to model marginal changes to the patient flow schematic. The initial proof of concept created by our team member demonstrated simplified but expected results consistent with our findings in the literature. Namely, our model illustrated a nearly 20 percent decrease in main ED bed utilization rates by instituting a VTZ. These results are preliminary and offered only to highlight the feasibility and flexibility of our approach, and further refinement is obviously needed to increase accuracy. Moreover, by enriching the model with more details and through further iterating off this baseline, we believe we can provide a tool for conducting ex-ante analysis of the impact of marginal changes to the size, staff, and resource allocations to the VTZ. These results can in turn help MMED's leadership determine the right-sized VTZ where utilization remains high while wait times are kept to a minimum.

Reflection/Impact Statement:

Executing this project was a growth experience in many ways. First of all, the pandemic posed a major and persistent obstacle. In our case specifically, it limited our ability to meet and collaborate in person, delayed our data gathering, and even called into question the utility of the project given operational adaptations caused by the pandemic. Overcoming these challenges was a lesson in the value of adaptability, both in terms of how to lead a team in changing circumstances and how to be flexible with your goals. Secondly, this project highlighted my own substantive knowledge limitations in terms of emergency department operations. As a future EM physician, filling this knowledge gap was invaluable not just for the sake of the project but also for my future career.

This project could potentially be of benefit to several groups. First, the original concept could be continued by our team to help answer the initial question of what the optimal resource allocation for vertical treatment zones in Michigan Medicine's Emergency Department is. Secondly, the academic medical community at large could benefit from learning about our process and findings. As mentioned above, there is a rich literature regarding operational enhancement initiatives in Emergency Medicine. However, the implementation of vertical treatment zones is less commonly discussed. We identified early on that this was a challenge for our project, especially in terms of academic papers discussing modeling and predictions rather than simply documenting outcomes. In that light, this project could benefit other institutions attempting to answer the same question.

In terms of project continuation, this was fortunately a group consulting project in which all but one member will continue to be enrolled at the University of Michigan. Given that the initial methodological work has been completed, the next step is to populate the model with real patient flow data. To that end, all of our deliverables and data will remain available to the current team members as well as to MedECG. The key faculty advisor, Dr. Somand, is also available, and can help facilitate the gathering and input of data.

For future students, your CFI is an opportunity to pursue a project that excites you. Start by finding something you are truly interested in, and don't be afraid if it feels ambitious. I would also recommend finding mentors and collaborators early on, and be sure to seek help if you need it.