

The Nature and Necessity of Operational Flexibility in the Emergency Department

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Hospital-based emergency departments (EDs), given their high cost and major role in allocating care resources, are at the center of the debate about how to maximize value in delivering health care in the United States. To operate effectively and create value, EDs must be flexible, having the ability to rapidly adapt to the highly variable needs of patients. The concept of flexibility has not been well described in the ED literature. We introduce the concept, outline its potential benefits, and provide some illustrative examples to facilitate incorporating flexibility into ED management. We draw on operations research and organizational theory to identify and describe 5 forms of flexibility: physical, human resource, volume, behavioral, and conceptual. Each form of flexibility may be useful individually or in combination with other forms in improving ED performance and enhancing value. We also offer suggestions for measuring operational flexibility in the ED. A better understanding of operational flexibility and its application to the ED may help us move away from reactive approaches of managing variable demand to a more systematic approach. We also address the tension between cost and flexibility and outline how “partial flexibility” may help resolve some challenges. Applying concepts of flexibility from other disciplines may help clinicians and administrators think differently about their workflow and provide new insights into managing issues of cost, flow, and quality in the ED. [Ann Emerg Med. 2015;65:156-161.]

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INTRODUCTION

There is increasing concern that the US health care system is not achieving optimal value (outcomes that matter to patients relative to cost) or operational efficiency (the amount and quality of care provided relative to the resources consumed).¹ One of the primary goals for the Patient Protection and Affordable Care Act is to optimize value through payment and delivery system changes. Improving population health outcomes will require, among many things, accommodating great variation in the demand for health care services while minimizing waste and improving responsiveness to patients' individual needs.²

The emergency department (ED) is a key delivery setting in which cost of care and its timeliness are major issues. EDs deliver care in episodic patient encounters; however, decisions made in the ED have substantial health and financial consequences. Nearly half of all hospital admissions originate in EDs. EDs are also the staging area for the critically ill and injured and deliver time-sensitive interventions in response to medical and surgical emergencies.^{3,4} Furthermore, EDs are the primary site for a large proportion of the acute unscheduled care in the United States⁵ and are the safety-net providers for critical-access populations.⁶ ED care, as the pivot point between inpatient and outpatient care, can greatly influence patient outcomes, as well as the resources consumed and costs associated with an episode of care (within and outside the ED).

We propose that EDs may be able to improve the value of the care delivered by better understanding and using the concept of operational flexibility in managing variable demands for care. Flexibility is a complex, multidimensional concept that refers to an organization's ability to respond to uncertainty in its environment.⁷ It has been defined as “the ability to change or react with little penalty in time, effort, cost or performance.”⁸ Flexibility is central to ED care because it enables adapting to significant hour-to-hour changes in demand while preserving quality of care.^{3,9,10}

Flexibility is informally ingrained in the ED operations mantra of “anyone, anywhere, anytime.” EDs are designed to deliver effective responses to events whose timing cannot be anticipated: disaster management of multicasualty incidents, critically ill patients arriving when there are no more beds, or multiple undifferentiated patients of various acuities. Yet, as described in one editorial, this flexibility is sometimes insufficiently deployed in ED operations because the underlying concepts may not be explicitly applied.¹¹ Furthermore, flexible schedules and physical resources may enhance responsiveness of EDs for their patients by better matching the variable demand for care with required supplies of physical resources (eg, beds), people, and space.^{7,12,13} Flexibility addresses both the numerator (patient outcomes) and denominator (costs) of value delivered by EDs. Incorporating flexibility into the ED may help maintain or

even improve timeliness of care, and potentially patient outcomes, during periods of high demand and uncertainty.¹⁴ Costs may be addressed through a more efficient use of resources.

In this article, we draw on research in operations management and organizational theory to explore flexibility and its dimensions most relevant to ED operations. We provide examples of how to apply ED flexibility in practice. Finally, we outline the cost and performance limitations of flexibility while illustrating how EDs can cope with these concerns through a more targeted application of flexibility called *partial flexibility*.

FLEXIBILITY IN OTHER INDUSTRIES

Manufacturing Flexibility

In operations research, the concept of flexibility in manufacturing systems was first widely discussed in the 1970s. It gained added attention in the 1990s as a result of intensifying global competition, rapid development of new technologies, and shorter product life cycles in manufacturing.¹⁵ Gerwin¹⁶ provided an extensive discussion and review of flexibility in manufacturing. Although patients involved in health care services differ substantially from material inputs or outputs,¹⁷ much can be learned from research on manufacturing.

There are 3 forms of flexibility from manufacturing that are relevant to the ED, including physical resource, human resource, and volume flexibility (Table). Physical resource flexibility is flexibility obtained through the actual care environment. For

example, it could apply to how a treatment space is used in patient care. Reclining chair space may be an appropriate treatment space for patients with lower-acuity illness but is less flexible because fewer patients can be cared for in this setting. By comparison, a more flexible treatment space that contains a stretcher, cardiac monitoring, oxygen wall mounts, and isolation can accommodate any type of patient.

Human resource flexibility relates to the providers' range of available skills, specifically, the types of patients a provider can treat (eg, severity of a patient) or the number of jobs a staff member can perform. For example, a nurse practitioner may be credentialed to treat only low-acuity patients (Emergency Severity Index score 4 or 5), whereas a physician is permitted to care for patients of all acuity levels. Because of physicians' ability to see a broader range of patients, they exhibit greater human resource flexibility.

Volume flexibility refers to the ability of the ED as an organization to maintain smooth operations by quickly accommodating fluctuations in the quantity and type of patients arriving. For example, surge protocols may be activated that open temporary treatment spaces, rapidly discharge low-acuity patients, and prevent wait times from significantly increasing during periods of crowding.

As described above, each of the forms of flexibility, or all of them in tandem, presents potential benefits such as decreasing wait times, reducing length of stay, and smoothing care coverage. However, there are also costs associated with flexibility. Costs can take the form of unused capacity that acts as overhead. The extra cost of a physician who provides human resource flexibility may not be justified in an ED setting with predominantly low-acuity

Table. Forms of flexibility and their application to emergency care.

Manufacturing Dimension	Original Definition	Application to Emergency Care
Physical resource	The number and heterogeneity (variety) of operations a machine can execute without incurring high transition penalties or large changes in performance outcomes ²⁷	Physical resources (eg, patient rooms) that allow a wider range of patients to be cared for
Human resource	The number and heterogeneity (variety) of tasks/operations a worker can execute without incurring high transition penalties or large changes in performance outcomes ²⁷	Clinicians who can treat any type of patient (eg, ESI 1–5) versus providers credentialed to treat only low acuity (ESI 4–5).
Volume	The extent of change and the degree of fluctuation in aggregate output level that the system can accommodate without incurring high transition penalties or large changes in performance outcomes ²⁷	How effectively and quickly an ED accommodates surge in volume or specific types of patients
Behavioral	Dynamics that create or retain resources (cognitive, emotional, relational, or structural) in a form sufficiently flexible, storable, convertible, and malleable, give rise to resilience, and allow organizations, their units, and their members to avert maladaptive tendencies and positively cope with the unexpected ²⁸	Adapting to a changing clinical scenario in which a patient appears to have one condition (eg, STEMI), but realizing and appropriately treating when identified that they have another (eg, aortic dissection)
Conceptual	A divergence in analytical perspectives among members of an organization over theories, models, or causal assumptions pertaining to its technology or production processes. This divergence is not about what an organization is doing but about how it is doing it. ²¹	Providers actively questioning and deviating from a standardized protocol (eg, rule out for acute coronary syndrome) as a result of discussing different interpretations of the causes of a patient's symptoms, realizing, for instance, that the patient's chest pain is indicative of an entirely different disease process not covered by the protocol (eg, acute pancreatitis)

ESI, Emergency Severity Index; STEMI, ST-segment elevation myocardial infarction.

patients. In addition, a flexible resource is by definition not tailored to any particular patient or situation and therefore might not be preferred by patients seeking a highly customized care experience. However, costs of flexibility can be reduced by conceiving of flexibility in more creative ways (eg, cross training that has staff trained in multiple tasks versus adding staff).¹⁸ Although cross training may itself be cost-prohibitive where advanced training is required—eg, additional degrees or schooling—it may be especially useful for tasks such as performing ECGs, reevaluating patients, performing discharges, or taking vital signs.

High-Reliability Organizations

Organization theory provides insight into high-reliability organizations, such as nuclear power control rooms, air traffic control towers, and naval aircraft carriers, which operate complex technologies in dynamic, interdependent, and time-pressured environments.^{15,19} As is the case with EDs, their risks can never be completely eliminated. Consequently, high-reliability organizations develop an “infrastructure to enable simultaneous adaptive learning and reliable performance.”¹⁹ From organization theory, we identify 2 additional forms of flexibility, behavioral and conceptual, that are relevant to the ED.

High-reliability organizations develop behavioral flexibility by building a broad set of behavioral repertoires and developing networks of professionals which allow members of a unit to rapidly draw on recognized experts in a particular domain in response to emergent problems.¹⁹ Building behavioral flexibility in ED care means individuals delivering care need to have an up-to-date understanding of where expertise resides and how to locate it. It also means that when encountering unexpected events, individuals need to defer to those who have expertise with the problem at hand rather than deferring to authority when making decisions.²⁰ In the ED, behavioral flexibility is essential because individuals need to be able to adapt to a changing situation (ie, changing interventions in response to an unfolding diagnosis) or bring in individuals with the necessary expertise to swiftly and seamlessly respond to unexpected events (eg, a resident asking a more experienced attending emergency physician’s opinion on a specific case).²⁰

Conceptual flexibility relies on organizational members recognizing that they cannot plan for every possible situation and therefore must elicit diverse perspectives and thinking about problems in different ways.²¹ In other words, it consists of being actively engaged in the environment, speaking up when needed, and deviating from standard procedure when necessary.²¹ Conceptual flexibility is essential in the ED because patients may present with similar chief complaints (eg, chest pain) and be assigned a protocol to standardize care yet have different eventual diagnoses and outcomes from the original intent of the pathway. Although these protocols may be designed to rule out a specific disease process (eg, acute coronary syndrome), they may not account for the full range of conditions or match how a condition unfolds with a specific patient during the acute phase of his or her illness. Such a change requires the recognition and

willingness of staff to speak up and deviate from the predetermined protocol. Behavioral and conceptual flexibility in EDs is meant to be seen as complementary to checklists and protocols. In fact, protocols may help free attention for engaging in behavioral and conceptual flexibility and also help staff to focus on potentially dangerous deviations from expected care trajectories.²²

MEASURING FLEXIBILITY IN EMERGENCY CARE

By illustrating the relevant dimensions of flexibility to emergency care, our goal is to increase the visibility and use of flexibility to manage ED operations. We view the absence of easy-to-use operational measures as one of the key barriers to careful application of flexibility in the ED. To aid in this pursuit, we provide some initial examples of potential measures of 3 forms of operational flexibility: physical resource, human resource, and volume flexibility. Examples of behavioral and conceptual flexibility were already developed in rigorous case studies of high-reliability organizations in health care contexts and quantitative work linking them to safety outcomes (eg, medication errors, patient falls) and are therefore not presented here.^{15,23,24}

Physical Resource Flexibility

Physical resources (eg, beds, equipment) are both scarce and expensive in the ED. How these resources are allocated affects the timeliness of patient care and may represent a potential source of flexibility. Because treatment spaces are designated for specific patient types (eg, fast track for low-acuity patients), the flexibility of the ED treatment spaces could be quantified as the quotient of the total number of potential patients who can be cared for in a particular space in a specified period and the total number of patients treated in the ED during that time with the following sample measure:

Flexibility of an ED Treatment Space = Potential Patients / Total ED Patients.

A value of 1 for this ratio represents a fully flexible resource; every patient type can be seen in a particular treatment space. Values below 1 indicate less flexibility. For example, if a hallway ED bed can accommodate only 70 of a total of 100 patients in a single day, the bed has a flexibility score of 0.7.

Human Resource Flexibility

Managing the dynamic demands of the ED requires having human resources capable of doing so. Changing demands (eg, increasing the number of tasks, tasks requiring different skills) can result from evolving needs of patients, family members, and other care teams. Flexible staffing is a potential source of human resource flexibility.¹³ For example, if a Monday is a particularly busy day because of an unusually high number of patient arrivals, extra staff who were scheduled ahead of time could be called on as needed to assist with clinical care. The flexibility of such staffing could be measured as the quotient of potential

hours (ie, the amount present plus “on call” or otherwise available) and scheduled hours (ie, physically present and caring for patients in the clinical setting) with the following sample measure:

Staffing Flexibility=(Potential Staff Hours/Scheduled Staff Hours)–1.

A value of 0 indicates that there is no flexible staffing, whereas a ratio above 0 indicates the degree of flexibility for that particular staff role.

Volume Flexibility

In contrast to measures of specific resources (eg, physical, human), volume flexibility encompasses the ED’s overall capacity or the maximum number of patients who can be cared for in treatment spaces simultaneously. Volume flexibility could be measured as the number of spaces in which clinical care can potentially be provided to patients (ie, able to be activated and used in a period even if not staffed or in use during the period) as a proportion of the number of active treatment spaces that are open and staffed. The following sample measure demonstrates this relationship:

Total ED Volume Flexibility=(Potential Treatment Spaces/Active Treatment Spaces)–1.

For example, if there is an ED of 30 active care spaces and a surge unit is opened when specific operational criteria are met, 15 extra beds will open and be staffed by clinical providers. This configuration yields a value of 0.5 (45/30–1) and flexibility, whereas a value of 0 indicates no flexibility (ie, an ED performing at capacity). Volume flexibility depends on other forms of flexibility. Thus, in the absence of human resource flexibility to staff the potentially available surge unit, it is only theoretical flexibility. Consequently, each of the potential measures needs to be considered in light of the others because considering all 3 simultaneously might help identify why and when ostensible flexibility (eg, a surge unit) does not alleviate crowding and other demands.

Challenges and Use of Flexibility in the ED

We have identified some potential measures that could help capture multiple forms of flexibility in the ED; we now turn to ways ED managers might use the measures in practice.

First, the proposed measures of flexibility can help provide a more specific understanding of the actual baseline level of flexibility in an ED. That is, what are the “normal” levels of flexibility and where does flexibility reside; is it balanced across the different forms or does the ED have great human resource flexibility but lack physical resource or volume flexibility?

Second, the measures can be evaluated to dynamically assess levels of flexibility against variations in demand (number of patients and acuities) and relationships with other outcomes. This analysis can be used to guide interventions and investments in flexibility that correct for specific vulnerabilities (eg, insufficient physical resources as patient arrivals increase).

Third, the measures could serve as inputs into discrete-event simulation, a tool from operations research, which can examine

the relationship between flexibility and operational performance.²⁵

Fourth, administrators and researchers could examine the extent to which these forms of flexibility alone or in combination are associated with resolving surge situations, improving disaster response, and recognizing time-sensitive illnesses such as stroke, acute myocardial infarction, or sepsis.

An important area for future research is testing the linkage between the flexibility measures with meaningful outcomes. Although flexibility may enhance operational flow, does it also influence the clinical outcomes of the patients seeking care in the ED?

However, implementing flexibility will require experiential learning because flexibility inherently depends on its context and relies on people to implement it. Thus, computer simulations may be useful, but not definitive, because the results may not perfectly translate to practice. Furthermore, computer simulation results will likely not be generalizable beyond the site studied. Implementing flexible policies may be hampered by staff and patient preferences. For instance, one ED attempted to build human resource flexibility by allowing emergency physicians to be called into work early and stay late as needed for high patient volume. Limited staff buy-in resulted in physician dissatisfaction and the ultimate abandonment of the policy. Furthermore, patients may not prefer a more flexible resource, precluding its widespread use. For example, although the use of curtains may enhance the flexibility of rooms in the ED, the ability to overhear conversations of the patient next door and the lack of privacy may make patients dissatisfied with their use.

Hospitals and EDs are moving toward increased specialization (eg, freestanding urgent care centers) that limits the number and type of patients treated and can also limit the flexibility of their resources. Thus, in some cases, too much flexibility can be just as problematic as too little and can negatively affect cost and other indicators of performance. This tension between cost and benefits (eg, quality, timeliness) of flexibility is highlighted in recent work on partial flexibility, which provides important insights into this relationship.^{12,26}

PARTIAL FLEXIBILITY

The common tradeoff between cost and flexibility has led to experimentation with novel approaches that attempt to find the optimal amount of flexibility. The benefits of flexibility increase up to a point, but then may decrease beyond that point. Therefore, the goal should not be to maximize flexibility, but to determine the degree of flexibility that can return the most benefits (eg, lowest wait time) relative to its associated costs. For example, a discrete event simulation of one ED modeled a flexible bed allocation policy between low- and high-acuity patients. Introduction of a so-called flex track area was found to reduce overall patient waiting more than in either a fully flexible ED (ie, any bed could accommodate any patient) or a rigidly separated fast track area (ie, beds could accommodate only

specific patient types).¹² Additionally, research on operating room policies for emergency patients found significantly shorter overall wait times when a partially flexible policy was used.²⁶ Although these examples demonstrate the potential benefit of an intermediate level of physical resource flexibility, the optimal amount of flexibility will depend on the particular ED (resources, patient mix, etc), the specific performance measures of interest, and the levels of the other forms of flexibility, all of which require further investigation.

CONCLUSION

The goal of this article is to introduce the concept of operational flexibility and its potential benefits and provide illustrative examples for measuring it in practice. Flexibility has long been central to ED care but it is often not formally recognized as a specific tool to improve ED operations and, subsequently, the value of care delivered by EDs. As a result, interventions to increase flexibility are often unsystematic and reactive. Applying concepts from operations research and organization theory to potentially help resolve persistent issues in ED flow and quality may help clinicians and administrators think differently about flexibility and their work. Furthermore, recent work on partial flexibility suggests that too little and too much flexibility are both problematic and the challenge is to find the optimal level of flexibility tailored to the specific ED and its current status. These concepts are intended to provide a foundation for furthering empirical research on operational flexibility, thereby increasing the value delivered by emergency care.

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IMAGES IN EMERGENCY MEDICINE

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DIAGNOSIS:

Acute generalized exanthematous pustulosis. Typically associated with antibiotic use, this rare, diffuse, pustular eruption is characterized by fever and leukocytosis, with a mortality rate of up to 5%.¹ Symptoms include pruritus or a burning sensation, followed by development of hundreds of small, pinhead-sized pustules over edematous erythema hours to days after drug initiation. Dermatologic manifestations are accompanied by fever and neutrophilic leukocytosis without organ involvement. These findings often lead to a presumption of an underlying infectious cause. Differentiating this condition from life-threatening drug eruptions, including toxic epidermal necrolysis and drug reaction with eosinophilia and systemic symptoms, is difficult in severe manifestations. Features favoring these worrisome alternatives include oral involvement, positive Nikolsky sign, eosinophilia, and visceral involvement.² Treatment includes withdrawal of the offending drug, as well as corticosteroids. Prognosis is excellent and the condition typically resolves within 2 weeks.³

Our patient was admitted to the intensive care unit. Skin biopsy revealed characteristic histopathology. She recovered after antibiotic discontinuation and corticosteroid administration.

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