When Worlds Collide:
Two Medication Systems in One Emergency Department

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Abstract. Emergency Departments (EDs) use medication administration systems that are optimized to perform resiliently in the environment of dynamic, short-term care. In contrast, medical wards use a different medication administration system, optimized to perform resiliently in the environment of longer term, in-hospital care. The problem of overcrowding in EDs, which leads to the long-term holding of inpatients in ED areas, has brought these two systems into juxtaposition, where some patients are managed under one system, and some under another, at times by the same set of care-givers. The conflict between these two systems, each of which performs well in its native setting, has led to complex system failures. Thus, the resilient nature of these systems appears to lie in their situatedness – in their fit to their context – as much as in the systems themselves.

1 INTRODUCTION

Procedures for medication distribution and administration in hospital settings have evolved to meet the unique clinical demands of the work being performed. Emergency departments (EDs), for instance, are open, dynamic, high risk systems that address an ever-changing variety of poorly characterized patient problems over a very short time frame (minutes to hours). In contrast, inpatient wards are complex systems that serve to treat a better delimited and more clearly understood set of patient problems over a longer time frame (days to weeks); this is 1 - 2 orders of magnitude greater than that for an ED. Both settings have been subject to significant external constraints, such as medication security, accountability, inventory control, charging and billing.

The growing problem of ED overcrowding (Derlet, Richards, & Kravitz, 2001; Goldberg, 2000; Richardson, Asplin, & Lowe, 2002) has resulted in EDs routinely holding large numbers of inpatients for periods up to several days while awaiting a bed on the wards. This creates a mismatch between existing ED medication administration processes and the needs of admitted patients who are 'boarding' in the ED; therefore, the hospital implemented the ward medication system for only these 'boarding' patients in the ED. However, the conflict produced by attempting

to operate these two systems simultaneously in the same work space has led to a series of complex system failures. The purpose of this paper is to use case studies of this conflict to shed new light on issues of resilience, brittleness, and safety.

2 BACKGROUND

2.1 Study Setting

An urban 653 bed US teaching hospital that is part of an 8 hospital network. The ED sees nearly 100,000 visits per year, and is a Level 1 trauma center. One of its 5 treatment areas (comprising 22 beds) is reserved exclusively for 'boarders' and is staffed by both ED and inpatient nurses. However, aisles in ED treatment areas and two large hallways are also routinely used as additional treatment space for both ED patients and boarders.

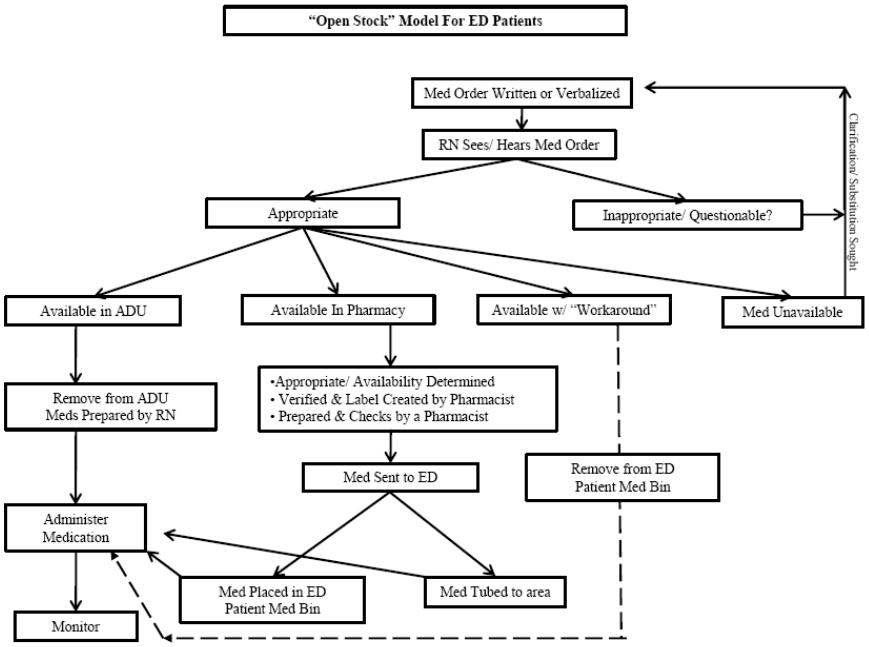
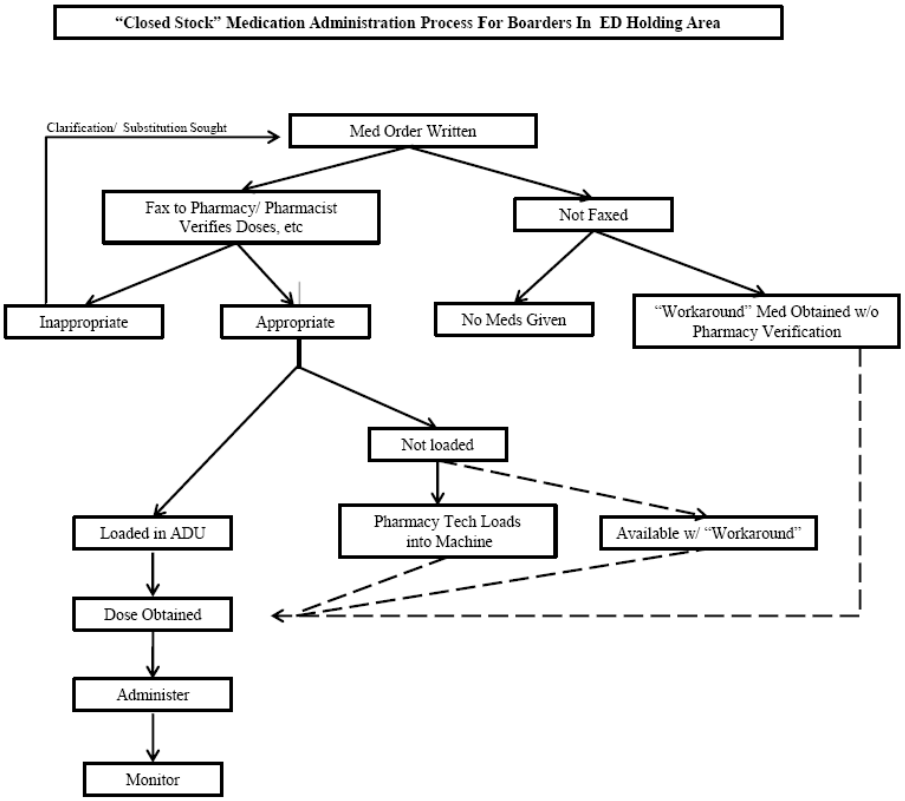


Fig 1. Open stock model for medication administration to ED patients. "ED Patient Med Bin" is a designated drawer in the ED ADU for all medications from the pharmacy to the ED.

2.2 Medication Systems

ED Medication System. The ED medication administration system is based on an 'open stock' model and is illustrated in Figure 1. Since the numbers and types of patients and the medications they might require is unknowable in advance and often time dependent, the ED stocks a wide variety of medications. These are accessed through an automated dispensing unit (ADU) by the medication's name. No

pharmacy checks are required of these routinely stocked medications prior to access and administration. Nurses retrieve medicines from the ADU based on the physician's written or verbal order and document their administration in the medication administration section of the ED nursing notes. Pharmacy review can be requested by the ED nurse prior administration if there are concerns about medication appropriateness or dosing. Orders that are not deemed appropriate or unavailable by the ED nurses or pharmacy are not prepared and require the ordering physician be contacted for clarification and possible substitution. Medications not available in the ED ADU can be requested from the pharmacy and require a fax of the written order for review by pharmacy staff for appropriateness, preparation and labeling and a second review before being sent to the ED. The system provides no prospective memory or prompt for subsequent medication administrations as over

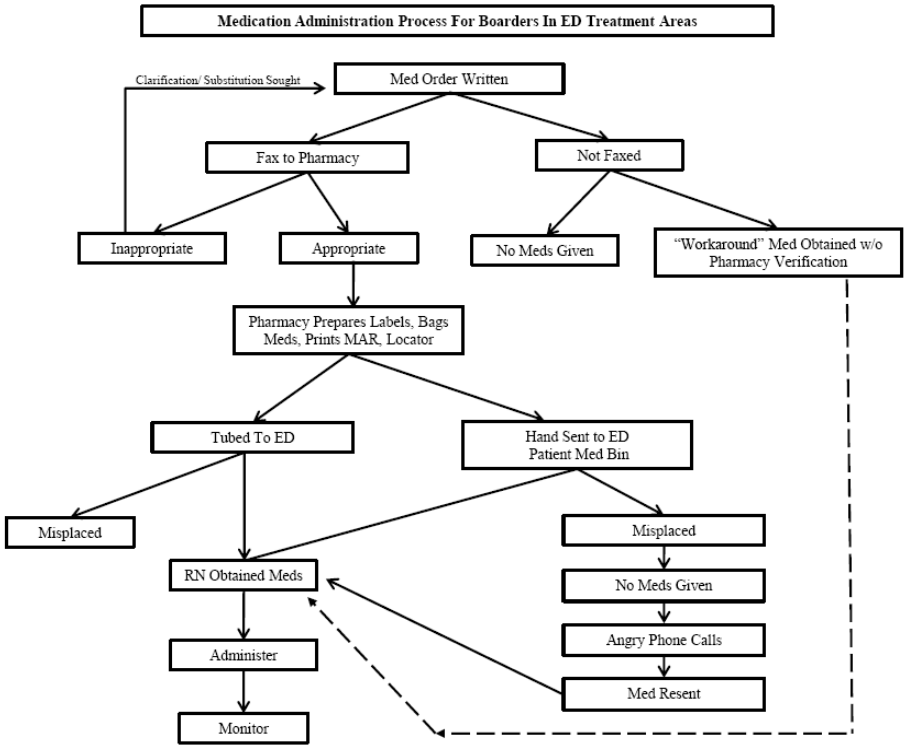


90% of all ED orders are for one-time only administrations. No formal medication administration record (MAR) is used in the ED.

Fig. 2. Closed stock inpatient model for medication administration to boarders in ED holding area. Dotted lines signify alternate pathways or 'workarounds'

Inpatient Ward Medication System. The ward medication administration system is based on a 'closed stock' model (see Figure 2), in which a unit's ADU inventory consists primarily of medications that have been ordered for the specific patients admitted to that unit, because the number of patients on the ward, their

problems and medication requirements are largely known in advance. Medications in the ADU become available to a nurse for administration only after a physician order has been written and reviewed by the pharmacy. A pharmacist checks every order for appropriateness of indication, route of administration, dosing, frequency, contraindications, allergies, *etc*. These medications are accessed by patient name and uniquely assigned patient number. Documentation is accomplished with a formal MAR which also provides the system with a memory of the medication administrations to each patient. The MAR is initially prepared by the inpatient ward nurse at the time of the patient's arrival to the ward; subsequently, it is generated by the pharmacy computer system each night and placed on the patient's chart the next morning. This is an important feature of the ward system as the vast majority of orders are for repetitive administrations (*eg*, daily, twice daily, every 8 hours, *etc*). The MAR provides a ready reference for medication administration history and also



serves as a prospective memory aid.

Fig. 3. Process for medication administration to boarders not moved to the holding unit but held in ED treatment areas. Dotted lines signify alternate pathways or 'workarounds'

Their Superposition. In principle, the two medication administration systems are largely separable, since most boarding patients are held in a separate ED treatment area dedicated to that purpose. However, the boarding unit is often full; transfers to that unit are sometimes delayed; and some boarding patients require

higher levels of care and must remain in the ED's critical care areas. These circumstances force admitted patients to be managed in other ED treatment areas, thus superimposing the inpatient medication system onto the ED medication system. Figure 3 illustrates this hybrid of the two systems. Nurses must operate in all three, and switch among them as they attend to different patients, or even sometimes while caring for the same patient if his/her status changes.

3 THE CASES

In this section we present three case studies of near misses and failures associated with the superposition of the closed stock medication administration process for admitted patients 'boarding' in the ED onto the open stock process operating for all other ED patients.

Case 1

A 47 year old male with a history of alcohol abuse and hypertension was admitted to the hospital for dizziness. He was moved to the ED holding area for boarders to await full admission orders, with an ED physician order for an intravenous anti-hypertensive to be given every 6 hours until admission orders were received. Rather than faxing the order to the pharmacy and awaiting pharmacy verification, the nurse walked to another area of the ED and obtained the medication from the open stock system. Prior to administration, the nurse asked the patient about medication allergies, was told that he had none, and proceeded to administer the medication.

Approximately one hour later, the ED pharmacist came across the original order during a routine review, and noticed that the patient had a history of a life-threatening reaction to the same drug when given in the past. The pharmacist immediately sought out the patient, who denied any allergies but stated he had previously experienced his "tongue swell[ing] up with something". When questioned as to why the order was not faxed to pharmacy for verification prior to administration, as is the procedure with ED holding area patients or boarders, the nurse expressed concern about the patient's blood pressure and felt it would be more expeditious to simply obtain and administer the medication without this additional delay. The patient suffered no noticeable adverse effect from the medication and had an otherwise uneventful course.

Case 2

A 26 year patient was brought to the ED with a significant acetaminophen overdose in an apparent suicide attempt. The amount of ingested required the prompt administration of an antidote to avoid potentially fatal liver damage. The antidote regimen consists of an initial loading dose followed by 17 additional doses every six hours. The patient received the appropriate loading dose of the antidote in the ED, using the ED open stock administration system. She was subsequently admitted to the hospital, but changed to the inpatient closed stock administration system once she was identified as a boarder and moved to the ED holding area. She missed two subsequent doses of the antidote and developed liver toxicity, which ultimately resolved without permanent injury.

An investigation found that the subsequent doses of her antidote were not delivered

to the ED holding area because the specific physical location of 'boarding' patients could not be represented in the computerized medication administration system used for inpatients. The medications were delivered to another ED treatment area where they were placed in a bin for patients whose location was uncertain. In addition, she was assigned to an inpatient nurse who was only familiar with the inpatient medication distribution process, and so interpreted the absence of medications for this patient in the ADU to mean that none were needed.

Case 3

A 57 year old male diagnosed with the onset of a new irregular heartbeat and a urinary tract infection following an ED evaluation. Admission orders were written, but the patient remained in the ED treatment area for closer monitoring and was not moved to the ED area for boarders to await an available inpatient bed. The admission orders included six medications, one of which was an intravenous anti-coagulant ("blood thinner") and two others with significant sedative properties. The medication orders were faxed to pharmacy approximately one hour after they were written. The medications were promptly verified by a pharmacist, prepared and labeled for transport to the ED. While the medications were in transport from the pharmacy to the ED, the patient's nurse independently removed several of these medications from the ED medication ADU, administered them and documented this on the ED nursing documentation record (following the ED 'open stock' procedures, but for a patient who was now admitted. Additionally, the word "done" was written next to one of the medication orders on the physician order sheet.

Approximately four hours later, after a shift change, an inpatient nurse placed an angry call to the pharmacy demanding the patient's medications be sent immediately as they were significantly delayed. Additional medications were sent, but when the chart was reviewed by a pharmacist it was found that the drugs had been administered several hours earlier but documented on the ED nursing notes. The second set of medications were not given to the patient. The original set of medications ordered from the pharmacy had arrived but been misplaced and were also never given to the patient.

4 ANALYSIS

These cases the problem of cross-scale interactions between different levels of the medical care system, and suggest some potential ironies of resilient adaptations.

At the hospital level, the problem of a shortage of beds for patients admitted from the ED was handled by storing such patients in the ED. This is a resilient adaptation at the hospital level; it allows the organization to continue to function (in particular, to keep beds available for elective surgery and other procedures that are critical to organizational revenue), and it uses a resource (the ED) that is known for its flexibility and extensibility.

However, this adaptation at the hospital level led to problems at the ED level, where multiple medication administration failures, primarily missed doses (*eg*, Case 2) led the organization to extend the inpatient medication administration system into the ED. This created considerable brittleness at the ED worker level, because it coupled ED work tightly to the pharmacy in ways and on a scale not previously experienced.

In addition, the introduction of the inpatient system was necessarily incomplete, because, in contrast to the inpatient wards, in which patients rarely change location, patient location could not be easily specified or maintained in the system for ED boarders, particularly because the flexibility of the ED meant that they changed location often.

ED staff responded by resilient adaptations at the individual level; creating 'workarounds' that took advantage of the presence of the highly flexible, open stock ED medication system to overcome the brittleness of the inpatient medication administration system. However, this resilient adaptation at the individual level created additional hazards and failures at the organizational level in the form of decreased medication security and tracking, in addition to new mechanisms for medication misadministration.

These cross-scale interactions seem to result from two sources. First, at any level of the organization, actors' views of the world and particularly of the consequences of their actions are necessarily bounded; thus they will be inherently limited in their ability to assess the potential reverberations of adaptations on levels other than their own. Second, the tendency to view organizations as static frameworks or mechanistic systems limits the requisite imagination needed to develop cross-scale foresight (Nathanael & Marmaras, 2008). This dialectic between levels offers the potential for understanding the differences between what is actually done in practice and what is officially espoused and for using it to inform change.

5. DISCUSSION

The case studies presented above are the result of failures of adaptations aimed at minimizing the effects of ED overcrowding. They might be thought of as side effects, but in a larger sense, "… there are no side effects, there are just effects." (Sterman, 2000, p 11). Resilience in this setting was dependent upon the workers' ability to adapt and evolve in the face of change; however, these adaptations ironically created brittleness in other parts of the system.

The ED medication administration maximizes flexibility, rapid response to change and tolerance of uncertainty; in this sense it is innately resilient. However, when applied to ward-type activities, the emphasis on resilience makes it too pliant, affording greater opportunities for failures and mistakes especially in a state of continuous stress (overcrowding). These failures arise in part from the same resilient behaviors critical to normal ED function.

In contrast, the ward system maximizes safety, predictability and regularity at the expense of flexibility and expedience. When applied to the ED setting, it is too brittle and breaks down, but when applied to the inpatient setting, it experiences fewer failures than does the ED system.

Finally, these cases illustrate that although the humans in the system remain its most adaptable element, their adaptive capacity is limited in characteristic ways; staff found it difficult to switch between the ED and the inpatient system, often on the same patient. The fast paced, high-risk, high consequence nature of emergency increases the likelihood of bypassing the safeguards of the closed stock inpatient ward medication system, especially in situations of overcrowding. Ironically, this is when they are most needed.

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