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Resilience and precarious success

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ABSTRACT

This paper presents an empirical case study to illustrate, corroborate, and perhaps extend some key generalizations about resilient performance in complex adaptive systems. The setting is a pediatric hematology/oncology pharmacy, a complex system embedded in the larger complex of the hospital, which provides chemotherapy and other high risk medications to children with cancer, sickle cell disease and autoimmune disorders. Recently the demands placed on this system have dramatically intensified while the resources allocated to the system have remained static. We describe the adaptations of this system in response to this additional stress. In addition, we discuss the risks associated with miscalibration about the system's adaptive capacity, and the tradeoff between the need to invest in adaptive capacity (to sustain performance when the system is stressed) versus the need to invest in efficient production (to sustain performance under normal circumstances and economic pressures).

1. Introduction

Resilient systems may drift too closely to the boundary of failure [1] when the success of adaptations to external or internal challenges masks a loss of adaptive capacity [2,3]. This has been described as the "tragedy of adaptability" [4], in which a system adapts to a stressor, but where the fluency and success of its adaptations belie the difficulties involved, and obscure how close the system is to catastrophic failure [5] We describe a case in which a system's adaptive capacity is gradually consumed, and where the success of its adaptations is misinterpreted, leading the system to operate in a riskier state than its managers would knowingly choose. Without better recognition of the loss of capacity for adaptation, the addition of more resources or a restructuring of the system demands, the system is likely to fail, though the time frame in which this will occur is not predictable.

The case illustrates how actors in a field of practice express resilience by drawing on deep domain knowledge, and how this effort can become invisible to managers and leaders through habituation and a myopic focus on the wrong metrics. Thus resilient success can paradoxically lead to miscalibration, brittleness, and the risk of catastrophic failure. The case demonstrates both how individuals enact resilience, and how these resilient behaviors can mask the loss of adaptive capacity and so lead to drift into failure, codependency, and entrapment [6–8].

2. Case study

Following a minor medication error in a pediatric hematology/oncology pharmacy, the primary pharmacist requested we observe "work as performed" to better understand the threats to the safety of its work. Though the pharmacy has not suffered a serious adverse drug event in recent years, it became clear during the observation that the increasing demands on the system had negatively affected the process of preparing chemotherapy and substantially eroded its capacity to adapt. The system's adaptations to marked changes in work had principally involved the individual pharmacist's response to these demands. The success of this individual's adaptations "… makes dysfunctional work systems and practices appear to be performing better than they actually are", [3] leading the system to operate at levels of risk beyond that which leaders would explicitly accept [9].

2.1. Current work and resources

The observation of the pharmacy occurred for a full day in January 2014 and was followed by several short interviews to clarify observations and pursue further questions. During the observation, the observer asked questions and requested explanation as well as observing the work of the pharmacist.

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A pediatric hematology oncology (HO) pharmacy is a complex microsystem. At baseline, preparation of pediatric chemotherapy is a more complicated and more hazardous process than preparation of adult chemotherapy. The work is intensive and requires precise calculations, measurement and mixing of substances that are essentially poisons. Medications are customized for each patient, and dosing is calculated based on the patient's weight or body surface area (a changing metric in pediatric patients). Drugs must be diluted and mixed for a specific weight rather than using standard dilutions (as in adults). The pharmacist works with 300–400 pediatric chemotherapy protocols as well as protocols that are individually developed for patients with rare conditions. Individualized protocols may be developed based on published research articles.

The pharmacist receives paper orders with varying amounts of lead time before the medication is due (days to hours). The pharmacist must review the orders, assure that they match the patient's protocol, check the orders against previous doses, recalculate the body surface area (BSA) and dosing, reconcile any inconsistencies (for example changes in dosing due to changes in renal function) and transcribe the orders into the computer.

Much of this work is performed "just in time" due to scheduling and the instability of various medications. This means that some chemotherapy can only be mixed after the results of the day's laboratory tests are received and the patient is cleared to receive chemotherapy. Some agents are so unstable they can only be mixed minutes before administration. The pharmacist must also respond to multiple ad hoc requests and assist with patients who become acutely unstable on the inpatient unit.

Current staffing in the HO pharmacy is very limited, with a patient to pharmacist ratio over 3 times greater than comparable pediatric hospital pharmacies. While this level of staffing is low compared to a number of other pediatric HO pharmacies, it is likely that there are HO pharmacies with similar staff limitations. More importantly, pediatric HO pharmacies, for the most part, are subject to the same economic pressures. There is one expert chemotherapy pharmacist and two experienced pharmacy technicians. (Only one pharmacy technician works at a time). Pharmacists and technicians from the main hospital pharmacy are not as experienced with chemotherapy as the regular HO staff. Currently the HO pharmacy is open Monday through Friday from 0800–1630, so chemotherapy is supplied on weekends by the on call pharmacist. The chemotherapy pharmacist works every third weekend, but then is required to take a day off the week before and the week following the weekend.

One example of the special skills of the HO pharmacist is that when he had a day off (due to working the weekend), he received 10 phone calls and was asked to come in to assist those covering the HO pharmacy. Three pharmacists were required to complete the work that the chemotherapy pharmacist usually completes himself.

Despite recent renovation, the physical environment requires a good deal of wasted motion due to a smaller size hood in the chemotherapy mixing room, limiting the ability to place a second diluent dispenser in the chemotherapy mixing hood. In addition it is difficult for pharmacist and pharmacist technician to communicate when located in separate rooms as doors separate them and there is no intercom.

The pharmacist has developed ways to assess patient conditions and changing needs as well as anticipating and monitoring the work; particularly where the team is in the multi-step processes of chemotherapy preparation and dispensing. For example, the renovation plans had called for replacement of a Dutch door with a closed door between the pharmacy and the nursing station. The pharmacist resisted this because he is able to "hear" about patients with the upper half of the door open. For example, by monitoring nursing conversation, he learns which patient has developed a fever (possibly representing a life-threatening infection for an oncology patient) and will need antibiotics emergently. Nurses also come in and out of the pharmacy frequently to share information. (This also represents a source of stress on the system in terms of multiple interruptions for ad hoc requests).

The pharmacist keeps the computer in all three rooms of the HO pharmacy open to a screen showing patients checking into clinic. He knows that he will need to wait for laboratory results on some patients, but, anticipating a future bottleneck, he can prepare the correct volume of diluent when the patient arrives and wait to add the more expensive and less stable chemotherapy agent. For patients who do not need lab results prior to chemotherapy, their arrival is a signal to begin preparing their medication.

In performing high risk work, the pharmacist and technician have identified means to anticipate, monitor and confirm the correctness of their work. They use visible artefacts to mark the points in medication preparation they have reached. For example, bags containing diluents only are capped with blue foil; when medication is added, the bags are capped with green foil; biologic infusions are capped with silver foil.

High risk medications for example intrathecal medications (delivered into the spinal canal in order to reach the central nervous system) are placed on a designated shelf in the rear of the pharmacy. Nurses have learned not to remove medications from this shelf without checking with the pharmacist. The pharmacist personally hands off these medications and nurses must sign for them.

The pharmacist places medication labels only on actual syringes or IV bags containing chemotherapy, not on the outside "hazard bag". The pharmacist wants the nurse to be holding the syringe when verifying medication, not looking at the outside hazard bag. This provides an additional opportunity for the nurse to confirm that the physical characteristics of the medication are consistent with the medication label.

Pharmacist and technician use visual cues (in addition to other checks) to double check medications. For example, the drug etoposide has a "thick, and ropy" texture when injected into the diluent bag. Only a few drugs look like that, and they are yellow or clear and "not ropy". All competed chemotherapy administration bags are weighed and verified against standard weight for the volume; the bags must be within 5% of the standard.

Finally, even after chemotherapy is delivered, the pharmacist continues to verify the process. When inpatient chemotherapy administration is completed, the pharmacist reviews the medication administration record (MAR) to assure that all doses required by the protocol were administered.

The pharmacist is interested in learning from even small errors. (Recall that the pharmacist was the person who requested an observation of the HO pharmacy following a relatively minor event.) He also tries to share learning with covering pharmacists. For example, he has created a reference binder for covering pharmacists that includes special information: drugs that precipitate if drawn up in one ml syringes require special syringes; or certain other medications that require silicon free tubing and syringes; and so on. In addition, the clinical hematology oncology team (including nursing) huddles at 1545 each day and all near misses and "small errors" are reviewed in at that time.

The responses of the pharmacist to the change in workload can be categorized as individual responses (first order problem solving) as well as second order problem solving in terms of creating a standard approach and standard processes for covering pharmacists. In terms of second order problem solving, the pharmacist has attempted to develop standard work instructions for covering pharmacists, but the work instructions change frequently so are often outdated before they are completed.