Organizational Errors: Directions for Future Research

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ORGANIZATIONAL ERRORS: DIRECTIONS FOR FUTURE RESEARCH

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ORGANIZATIONAL ERRORS: DIRECTIONS FOR FUTURE RESEARCH

Abstract
The goal of this chapter is to promote research about organizational errors—i.e., the actions of multiple organizational participants that deviate from organizationally specified rules and can potentially result in adverse organizational outcomes. To that end, we advance the premise that organizational errors merit study in their own right as an organizational-level phenomenon of growing theoretical and managerial significance. We delineate organizational errors as a construct that is distinct from but related to individual-level errors, and draw attention to its multi-level antecedents, mediating processes, and outcomes. We also discuss error management processes such as prevention, resilience, and learning, and call for research to expand our currently limited understanding of how these processes unfold over time i.e., before during, and after the occurrence of organizational errors. Further, in the light of a recurring critique of prior error-related organizational studies as being narrowly context-bound and therefore of limited interest to organizational researchers in general, we elaborate on the critical need for future research to explicitly take into account the role of contextual features. We conclude with a discussion of key themes, unresolved issues, and promising research directions.
Introduction

This chapter addresses some basic conceptual challenges to studying errors at the organizational level of analysis and identifies important future research directions. “Errors” are essentially unintended deviations from rules or procedures (e.g., failure to verify medication before administering it to patients, non-compliance with safety guidelines in a coal mine) that can potentially result in adverse organizational outcomes. Errors can invade various aspects of our lives such as physical safety, the economy, the environment, and the political arena. Just in the past two years, errors contributed to the BP oil spill in the Gulf of Mexico (National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 2010), the Massey coal mine explosion in West Virginia (McAteer & Associates, 2011), the mislabeling or loss of over two hundred graves of veterans at the Arlington National Cemetery (Davenport, 2010), and numerous preventable deaths in hospitals across the US (Landrigan et al 2010; Dentzer, 2011).

Significantly, these consequential events occurred in organizations and were typically the result of the erroneous actions of several people, not just a single individual.

The basic premise of this chapter is that organizational errors merit research in their own right as an important organizational-level phenomenon. However, although references to errors regularly show up in organizational accounts of accidents (e.g., Starbuck & Farjoun, 2005), reliability (e.g., Roe & Schulman, 2008), and safety (e.g., Zohar, 2008), errors themselves are rarely the primary subject of interest (for exceptions see Vaughan, 1999; Hofmann & Frese, 2011). Moreover, they are typically defined at the individual level of analysis as actions of an individual. These tendencies implicitly equate errors to adverse outcomes, and all individual-level errors that take place in organizational settings to organizational errors. However, although accidents symbolize a critical error-linked outcome, not all accidents involve errors (e.g., some
accidents result from willful rule violations; Vaughan, 1999). Nor do all errors culminate in accidents (e.g., Reason, 1990).

Similarly, although error-prevention represents a distinctive feature of the so-called high reliability organizations, which continuously manage to avoid major adverse outcomes while constantly carrying out high-risk work activities (Roberts, 1993), such organizations regularly encounter errors in their operations. They manage to limit the consequences of errors by enacting the collective processes of mindful organizing (Weick, Sutcliffe, & Obstfeld, 1999). In other words, the absence of errors is neither necessary nor sufficient for reliability, which can be undermined for reasons unconnected to errors such as unforeseeable events (Blatt et al., 2006; Weick & Sutcliffe, 2007). By the same token, errors are only loosely coupled to safety—the avoidance of physical harm (Reason, 1997). In other words, studying accidents, reliability, or safety is not necessarily the same as studying errors. Viewed in this light, we can identify several organizational studies that primarily focus on accidents (e.g., Turner, 1976; Perrow, 1984; Vaughan, 1996; Snook, 2006; Starbuck & Farjoun, 2005) or reliability/safety (e.g., Roberts 1993; Bigley & Roberts, 2001; Weick & Sutcliffe, 2001, 2007; Katz-Navon, Naveh, & Stern, 2005; Zohar, 2008; Roe & Schulman, 2008). By comparison, far fewer organizational studies have primarily focused on errors at the organizational level of analysis.

One contribution of this chapter is demonstrating that studying errors at the organizational level of analysis involves more than simply identifying and analyzing individual errors that take place in an organizational setting. It involves recognizing that some errors are inherently “organizational” in nature. We delineate “organizational errors” as an organizational-level construct that is related to but distinct from “individual” errors. That is, we propose that errors and their outcomes can occur at different levels of analysis (i.e., individual, group,
organization, or institution). Briefly, “organizational errors” refers to the actions of multiple organizational participants that deviate from organizationally specified rules and procedures and that can potentially result in adverse outcomes for the organization.

Another contribution of this chapter is its development of theoretical linkages among antecedents of organizational errors, key mediating processes, and organizational consequences. In addition, we examine the intersection between individual and organizational errors, as well as temporal and contextual issues underlying organizational errors. This theoretical focus also has clear implications for measurement and analysis, an issue we elaborate on later in the chapter. Importantly, our focus is not simply definitional. We want to stimulate new research by identifying a set of interesting and important research opportunities. Although we acknowledge existing literatures, our emphasis is on new research directions.

We begin by describing a specific case, based loosely on actual events, about medication errors and their consequences in the neonatal intensive care unit of a hospital (Sanz, 2006). This case provides the basis for our subsequent discussion that is organized around three major theoretical concepts in organizational research – levels of analysis, time, and context. The basic idea is that to better understand any organizational phenomenon, it is important to examine how it functions across multiple levels of analysis (Morgeson & Hofmann, 1999; Hackman, 2003), over time (Ancona, Goodman, Lawrence, & Tushman, 2001), and across different contexts (Rousseau & Fried, 2001). To this end, we first delineate organizational errors by separating the errors themselves from the outcomes of those errors and by contrasting individual vs. organizational errors. Second, we examine the multi-level antecedents, mediating processes, and outcomes of organizational errors. Third, we discuss variations in error-management processes such as prevention, resilience, and learning across different temporal phases, i.e., before, during,
and after the occurrence of organizational errors. Fourth, we consider the effects of context on
the multi-level processes contributing to organizational errors and on the temporal variations in
the processes for managing such errors. We illustrate these effects using three specific
contextual features – hazard profile, external pressures, and organizational strategy. We identify
questions for future research in each of these sections. Finally, we conclude with a discussion of
common themes, unresolved issues, and promising research directions.

Case Study: Medication Administration Errors in a Neonatal Intensive Care Unit

In 2006, a large Midwestern Hospital (MWH) reported that two babies in its neonatal
intensive care unit (NICU) had died after receiving a thousand-fold overdose of the blood thinner
heparin. Four other infants remained in critical condition. In a hurriedly convened press
conference, the hospital’s CEO summarized the events leading to this tragedy. Two days earlier,
on Friday, a pharmacist technician incorrectly stocked the NICU’s medication cart with vials
containing a higher than prescribed concentration of heparin (10,000 units/ml instead of 10
units/ml). Later, between early morning and noon on Saturday, five different nurses in the NICU
removed a total of nine of these vials and, using the heparin solution from these vials, flushed the
intravenous (IV) catheters of six prematurely born underweight babies in their care. It was early
afternoon on Saturday when the babies displayed symptoms that alerted the nurses to what had
happened. The NICU physicians and nurses commenced treatment immediately to counter the
overdoses but were unable to save two babies who had severe internal bleeding. A third baby
died shortly after the press conference. The three other babies ultimately recovered, but the long-
term effects of their overdose were unknown (Sanz, 2006).
At a hospital affiliated with MWH, five years prior to the overdose situation described above, a nurse in the pediatric intensive care unit administered an overdose of heparin to two infants, who remained in serious condition for a couple of days before recovering. A multidisciplinary team that reviewed this event recommended several changes to the then current procedures for dispensing heparin and called for nurses to be vigilant while administering heparin. Subsequently, the pharmacy at MWH reorganized the physical storage of medication to ensure that the vials containing weak concentration of heparin were not stored in close proximity to the vials with higher concentration. MWH also communicated to the nurses the need to always verify the dose of high-alert medications, including heparin, prior to administering such medication to a patient. The importance of the verification process was routinely reviewed in training programs for new nurses and regularly discussed in departmental meetings. In the light of such ongoing efforts to prevent heparin-related errors, many in the healthcare community viewed heparin overdose events as a dismayingly predictable and entirely preventable tragedy (Cohen, 2007; Phend, 2007; Institute for Safe Medication Practices, 2007).

The CEO of MWH concluded that the responsibility for the NICU incident was “institutional” and that the employees involved in the incident should not be blamed. Following the tragic events, officials at MWH arranged for the pharmacy technician and the five nurses to receive counseling. The hospital also carried out an extensive review of its procedures for stocking, dispensing and administering heparin. All nurses underwent training about the risks of heparin overdose and the need for vigilance in administering the drug. MWH also announced that it was replacing vials of the 10,000 units/ml heparin solution with syringes containing 5,000 units/ml heparin solution, which would better differentiate the two doses. Moreover, double checks for the accuracy of the heparin dose were implemented in the pharmacy as well as in the
Delineating Organizational Errors from Individual Errors

Determining whether an error is individual or organizational is not always simple on its face. At MWH, five different nurses separately failed to carry out the required verification of the heparin doses they administered; as a result, infants were harmed. Officials at MWH took responsibility for this as an organizational-level error. Now consider a hypothetical scenario where only one nurse in the NICU fails to verify the heparin dose, and two infants are harmed. Something very similar happened at Cedars-Sinai Hospital in Los Angeles one year following the events at MWH (Ornstein, 2007).

As we think about MWH and the hypothetical scenario, consider whether each case represents an organizational error. In both cases, the multiple failures to verify the concentration prior to administration represent errors because they are deviations from formal procedures. In both cases, the errors involved the actions of individuals. However, we argue that what happened at MWH represents an organizational error while what happened in the hypothetical scenario presents an individual error that took place in an organizational context. A basic feature of an organizational error is that multiple individuals deviate from the expected organizational practice. At MWH, both the pharmacists and the nurses, both highly interdependent, failed to verify. To explain organizational errors, we must identify the processes that cause multiple individuals within an organization to engage in a common pattern of behaviors (in this case,
deviations). In contrast, individual errors involve actions (deviations) of an individual that differ from the actions of other individuals within the organization. To explain individual errors, we must necessarily consider the factors that are idiosyncratic to that individual. It would be interesting to know more about the hypothetical nurse’s work behavior. Does she repeatedly fail to verify the dosage? Or is this a one-time event caused by acute stress or many outside interruptions that distracted her? Of course, as we discuss in this section, both organizational errors as well as individual errors can be linked to organizational-level causes and organizational-level consequences. From a theoretical viewpoint, the distinction between an organizational error and an individual error is the difference between explaining a pattern of errors involving multiple individuals and explaining the idiosyncratic actions of a single individual in an organization.

**Features of Organizational Errors**

We define “organizational errors” as the actions of multiple organizational participants that deviate from organizationally specified rules and procedures and that can potentially result in adverse organizational outcomes. That is, the errors are essentially organizational in several key respects: First, they represent unintended deviations from organizational expectations about appropriate ways to carry out work activities; second, the deviations represent the actions of multiple individuals who are acting in their formal organizational roles and working toward organizational goals; third, the deviations can potentially result in adverse organizational outcomes; and, finally, such deviations are primarily caused by organizational conditions (i.e., they cannot be explained solely or even primarily in terms of idiosyncratic features of individuals). Thus, an organizational error is different from an individual level error that occurs in an organizational context.
Let’s consider each feature in turn. Errors represent *unintended deviations from pre-specified standards* such as rules, procedures, and policies. Unlike violations, which represent a deliberate choice of an individual to deviate from rules, errors are unintended actions (Hofmann & Frese, 2011). Although this is a basic definitional feature of errors, we note that “intention” represents an intra-personal process that is hard to observe or even infer. Nevertheless, this is an important qualifier to underscore that the nurses are not choosing to commit an error. Moreover, these actions are not intended to subvert organizational goals. Although several different types of errors are routinely discussed in the context of individual-level errors (e.g., lapses in judgment, mistakes, poor decision-making; Rasmussen, 1987), for our initial examination of organizational errors we focus on actions that deviate from pre-specified rules and procedures.

Organizational errors also involve the actions of multiple participants. This feature signals the essentially collective nature of the construct and underscores the relational aspect of organizational errors. Specifically, actions become collective when they involve multiple participants undertaking interdependent actions toward a common goal (Bell & Kozlowski, 2002; Weick, 1979). The multiple participants need to be relationally linked through formal workplace interdependence or other less formal interactions. In a hospital unit, there is a difference between one nurse failing to verify medications and all the nurses in the unit failing to verify medications. Although the actual number of errors in the first and second scenarios might be the same, the meaning and causes probably are different. In the single nurse incident there may be idiographic factors such as this nurse’s competence, training, or coping abilities with stress that underlie the deviations. When all the nurses in the unit deviate, there are likely to be unit level understandings, gained from talk or observation, that other aspects of work get priority, although the rules of verification are still acknowledged.
Organizational errors can lead to significant organizational consequences, especially in high-stakes settings such as hospitals (Leape & Berwick, 2005). Patients may be harmed or even die, which might lead to litigation and serious reputational loss, which in turn impact the financial well-being of the hospital. Other consequences include additional treatments and longer hospital stays, resulting in increased hospitalization costs and further loss of reputation. The key idea is that the potential consequences of organizational errors are significant at the organizational level.

Theoretically and empirically, organizational factors are the key drivers of organizational errors. Although it is conceivable that each of the five nurses at MWH may have had a stressful family situation that carried over to the work situation, increased their fatigue, and caused each nurse to commit the same errors, such a scenario is highly unlikely. What is much more plausible is that these errors were caused by organizational conditions (e.g., interruptions, workplace structure, or lack of oversight) that were part of the five nurses’ shared work context. Also, if the organizational conditions persist, which is likely, the deviations may also persist.

Finally, it is also important to recognize that organizational errors can occur in different organizational units. Most organizations are systems of interdependencies; hospitals for example, involve interlocking units (neonatal, pharmacy, etc.). Therefore, deviations could occur in activities within and between units. In the MWH case, verification errors occurred in the pharmacy as well as in the neonatal unit. The key idea is, given the features of organizational errors discussed above, they can occur in a single unit, multiple units, or in multiple combinations of entities within an organization.

There are many conceptual, methodological, and philosophical issues in defining organizational errors (cf Reason, 1990). The goals or rules may be ambiguous. There may be
different beliefs about the rules, potential deviations, and consequences (Tamuz & Thomas, 2006). The procedures or rules may be in conflict (March, Schulz, & Zhou, 2000). In some situations there may be few rules, while in others more. We also recognize there may be different motivations leading to deviations. A case where someone deviates from the rules intentionally to gain benefit for themselves or others is excluded from our definition of organizational errors (e.g., Lehman & Ramanujam, 2009). Studies of fraud or other problematic intentional behavior represent a different category of research (e.g., Lawrence & Robinson, 2007). Despite these qualifications, in a wide range of operational settings, the interpretation of rules tends to be objective, unambiguous, and unequivocal (e.g., rules for verifying the dose of a high-alert drug, safety procedures in coal mines, internal control procedures in stock-trading operations), and actions tend to be rule-based (March, 1997; March et al 2000). It is our position that such situations cover a sufficiently broad swath of organizational settings and operations, where errors can be unambiguously identified and formally investigated, to represent a useful starting point for conceptualizing organizational errors.

**Multi-level Conceptualization of Organizational Errors**

The central idea advanced in this chapter is that errors merit study as an organizational-level phenomenon in their own right. However, to examine organizational-level errors and to identify new research opportunities, we need to take a multi-level perspective (Kozlowski & Klein, 2000). Our discussion is organized around the following interrelated themes: 1) multi-level predictors and mediating mechanisms of organizational errors, 2) the relationship between individual errors and organizational errors and the processes that mediate them, and 3) the cross-level linkages between errors and their consequences.
Multi-level antecedents and mediating processes

Our first premise is that causes of organizational level errors are found at different levels of analysis. Several studies have identified the antecedents of errors at different levels of analysis, such as stress experienced by individuals (e.g., Reason, 1990), group safety climate (e.g., Katz-Navon et al 2005; Hofmann & Mark, 2006), mindful organizing (Vogus and Sutcliffe 2007), and organizational change (e.g., Ramanujam, 2003). However, we know very little about the interaction between such multi-level causes and organizational errors.

A second premise is that focusing on the mediating mechanisms is an important strategic research direction. Most research has linked antecedents such as organizational change to errors (e.g., Ramanujam, 2003), rather than tracing the effect of predictors to mediating mechanisms to errors and then to adverse outcomes. We think the latter path is important because (1) organizational errors are likely caused by multiple factors at different levels, and (2) the possible synergistic or negating effects among factors at different levels creates a complex process. Conceptually and empirically, deeply understanding these mediating processes should enhance our understanding of organizational level errors and their consequences (Goodman, 2000).

(1) Mapping out antecedents and mediating processes. Analyzing multi-level antecedents requires mapping out the predictors and the key mediating processes that are tied to errors. Figure 1 illustrates one possible set of multi-level antecedents of organization/unit-level errors, related mediating processes, errors, and consequences. Although these variables are drawn from our review of the literature, researchers need to select the set of factors that matches the theory and organizational context of the specific research question being addressed. At MWH, the errors were in the neonatal unit and in the pharmacy unit. If the other units (e.g., cardiology)
also were not verifying medications, we would assert that the errors are at the organizational level (above the unit level). Our basic theoretical arguments are about organizational errors that might occur in an organizational unit, combinations of units, or throughout the organization.

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Consider the classes of antecedents (or predictors) in Figure 1. A strong safety culture can focus people’s attention and vigilance on adhering to safety practices (Vogus, Sutcliffe, & Weick, 2010). Similarly, rapid large scale organizational change can use up attentional resources and lead to less monitoring, which increases the probability for errors (Ramanujam, 2003). Note the arrow from organization to unit signifying that the safety culture at the organization level can influence the safety culture at the unit level. The figure also indicates there can be differences between units. The task and technology infrastructure can lead to high levels of interruptions in one unit, which can affect monitoring and corrective action, which, in turn, can lead to organizational errors. Individual differences (e.g., skill level) can clearly lead to individual errors. Individual differences (e.g., stress tolerance; Raja & Johns, 2010) could interact with unit characteristics (e.g., high levels of interruptions; Rudolph & Repenning, 2002) to create organizational errors.

After identifying the antecedents of errors, a key requirement is to link those predictors to a set of mediating processes that impact errors at the unit or organizational level of analysis. Figure 1 illustrates three mediating processes: learning, error corrective systems and error amplifying systems. “Learning” refers to the acquisition of new behaviors and can occur at the individual, unit or organizational levels (Wilson, Goodman, & Cronin, 2007). Our focus is on predictors of unit- or organizational-level learning. “Error corrective systems” refers to the organizational processes for detecting and correcting errors (i.e., error reduction processes), and
“error amplifying systems” refers to organizational processes that cause errors to lead to further errors which, in turn, lead to even more errors (apart from the absence of error-reduction practices). An example of error amplifying processes can be seen in the demise of Barings Bank – a famous British financial institution. In the bankruptcy of Barings Bank, errors in multiple units interacted to create the collapse of this bank (Goodman, 2000). The financial control section of the bank failed to prevent a securities trader from both initiating as well settling trades. The standard operating procedure is to separate these two functions to provide better control on trading. The trader often exceeded trading limits and the requirement to cover trades. This accelerated over time in order to recoup losses. That these deviations were known and not corrected represents another series of deviations. Also, when the trader had exposed the bank to large potential losses, senior management provided funds to cover this debt exposure. All of these different acts from different units accelerated errors and losses exponentially, which in turn led to the demise of the bank. Our goal in Figure 1 is to suggest an approach to linking multi-level antecedent factors to organizational- or unit-level (vs. individual) errors, rather than a particular theoretical perspective.

(2) Analyzing the effects and interactions of antecedents and mediating processes. Once the possible antecedents and mediating processes are mapped out, several approaches can be taken to analyzing their interactions. For example, mechanisms for monitoring and correcting errors are one type of “mediating processes.” To the extent that predictors promote or impede these processes, they should impact the frequency of errors. High levels of interruptions at the unit or organizational levels should reduce attentional resources, lower monitoring and correction and therefore increase errors. In one study (Ramanujam, 2003), unit level changes in structure,
technology, and managers affected the attention to monitoring and corrective actions, leading to an increase in unit-level errors.

One can also focus on specific antecedents that lead to relatively error-free environments. Monitoring and corrective processes are likely to be quite strong in high-risk settings (Bigley & Roberts, 2001). That is, deviations are quickly identified and corrected through error correcting feedback systems. It would be interesting to explore how these units deal with more or less visible behaviors. Visibility is important because it facilitates monitoring. For example, in any hospital there are more visible procedures (e.g., accessing narcotic drugs from the central pharmacy), while other practices are less visible (e.g., verifying drug dosages in a patient’s room). The question is how units manage practices that are not easily visible. In the case of verifying dosages, it might not be an error correcting system but rather the development over time of strong norms of verification via one or more learning processes. The focus here would be on understanding the processes leading to strong norm development and the sustainability of relevant error-correcting behavior over time. In much behavioral science research, these mediating processes are inferred, not measured (for exceptions see Vaughan, 1996; Perin, 2006). Future research on errors could extend our understanding about how these processes work for both organizational and individual errors.

Another important approach in research on multi-level antecedents is to examine conflicting and synergistic forces (Goodman, 2000). For example, at the unit level there may be high interdependence and visibility for employees as well as high levels of interruptions and demands on employees. The high level of stress reduces monitoring and corrective action in the unit, which in turn increases the probability of errors. However, if there is a strong reward
system at the hospital level that reinforces safe behavior, it might help to reduce the frequency of errors in such a high-stress environment.

One rationale for exploring these issues on multiple levels is to identify the forces facilitating and inhibiting errors, and understand their joint effects. Is proximity in time or relevance to the job situation a more important determinant? In the MWH example, the demands and interruptions mentioned above are daily and directly impactful on the employees, while the organizational reward system, though potentially quite important, is only enacted periodically. Significantly, most studies of errors rarely consider the possibility that opposing forces may be acting simultaneously within and across different levels of the organization (Ramanujam & Goodman, 2003). Studies typically focus either on error-enhancing processes or on error-reducing processes, but seldom on both together.

The fundamental goal of this section is distinguishing organizational errors where multiple individuals in an entity are deviating from similar standard operating procedures versus an individual deviating from the rule or procedures. To identify the causes of organizational or unit errors, we want to use multiple antecedents at different units of analysis, particularly unit and organizational predictors. In addition, we want to trace how the mediating mechanisms help us understand how errors at the organization and unit level come into being.

The relationship between organizational and individual errors

The above discussion focused on the multi-level antecedents and processes of organizational- and unit-level errors. A different multi-level perspective focuses on the relationship between individual errors and organizational errors. For instance, through what processes do individual errors give rise to organizational errors? What are the organizational
conditions that facilitate or impede organizational errors that lead to individual errors? Such questions remain largely unaddressed in the organizational research on errors and point to a second set of research opportunities.

First, we need to identify an organizational unit where people work on common and interdependent activities. An example would be the neonatal unit at MWH where nurses deal with newborns needing special attention. This is a defined work area with common work processes. Nurses come together at formal meetings and informal social gatherings. Another condition is that there is visibility in this organizational unit. It is possible to see what others are doing (e.g., deviating from or adhering to verification procedures). In a distributed work setting, employees have more limited visibility of each other’s work practices.

Second, we need to identify key processes. Learning is one key process in the movement from individual to organizational errors (Wilson et al 2007). Both by observing others and communicating with others, members of the entity can learn. Consider again the events at MWH. There had been a death in a neonatal unit in an affiliated hospital because of the administration of a high dose of heparin. This hospital and MWH were part of the same system. What followed was a flurry of activities at MWH to prevent this error and its consequences from happening there. An extensive training program addressed the importance of verifying dosages. In addition, there were structural changes in the pharmacy, which separated the different heparin dosage levels in different bins. Only one concentration of heparin was allowed in the neonatal unit. These changes seemed to work. The unit was regularly receiving the right dosages, and, in turn, so were the patients.

This was an ideal situation for learning. One initial, positive lesson was to be sure to verify heparin administrations. A later, negative lesson was that the changes were successful; the
units always received the correct vials; and, over time, the nurses might have assumed that they need not be so vigilant. That is, if an organizational defense appears to be functioning reliably (as it seemed to be at MWH, at least initially), one lesson could be that the activity (i.e., administering heparin) is less risky and, therefore, does not warrant the same level of vigilance as before. Such learning is especially possible when, drawing from principles of systems engineering, organizations implement redundant controls involving people to enhance the reliability of a system. However, because people in these redundant systems are mutually aware of their roles, redundancy might lead to reduced vigilance overall because of social processes such as diffusion of responsibility (Sagan, 1995). We do not know exactly how or even if this learning may have taken place at MWH. One scenario is that frequent conversations among the nurses about the high quality of the new system created a collective awareness. Another scenario is that a nurse observing another nurse skipping the verification step eventually adopted this practice. The underlying scenario is that nurses face many competing demands in their work; the new system for dispensing and administering heparin had been functioning without errors or adverse outcomes; and as a result, the nurses directed their attention toward other competing demands.

The road from organizational errors to individual errors follows a path that is similar to the one from individual to organizational errors. But the lessons are different. We start again with the two conditions. We need an organizational entity with formal rules and practices and some level of employee identification within the unit. We need to establish the existence of an organizational error (e.g., multiple individuals deviating from the standards).

Let’s return to the MWH case. If I share in the collective awareness about not verifying heparin because of the new procedural safeguards implemented in the pharmacy, then it is quite
easy to generalize this belief to other medicines. Although the structural changes in pharmacy were not implemented for other medications, over time a collective understanding might develop about the reliability of the pharmacy. Given this understanding, moving to not verifying other medicines seems an easy step. Individual nurses, given competing demands, will begin deviating from verifying other medications. The learning and change occur at the individual level.

**Cross-level linkages in adverse outcomes from errors**

The “linkage” question addresses how outcomes or consequences from errors at one level of analysis affect outcomes at another level of analysis (Goodman, 2000). This is substantially different from the previous question about the relationship between organizational and individual errors, which was about how individual errors lead to organizational errors or vice versa. Here, we are asking how changes in the consequences of errors at one level may lead to changes in the consequences of errors at a different level.

Some examples will sharpen the linkage question and some of its complexities. Consider the three deaths that occurred in the neonatal unit. A linkage question is how those unfortunate outcomes at the unit level affected the hospital (i.e., the organization), a different level of analysis. In this case, the unit outcomes should have a direct effect on the hospital. These errors and their consequences would be counted as part of the hospital’s outcomes. Other related outcomes at the hospital level could include reputation loss, legal actions, employee turnover, and additional costs.

However, there are other examples of the linkage problem. Let’s say in the above example, the nurse verified the heparin dosage and found the mistake before administering the drug. This would have identified a potentially consequential error at the pharmacy unit, but it
was avoided by the nurse’s verification behaviors. Would this error at the pharmacy unit be reported or have consequences for the hospital? It might be reported to the pharmacy and have consequences for the pharmacy and its staff, but probably would not have consequences at the hospital level. Most hospitals we have visited do not have a measurement system at the unit or hospital level to capture this “near-miss” event. The presence or absence of such measurement systems at the organizational level could help to facilitate or inhibit future errors of this nature from occurring at the unit or individual level. The fundamental question is, can you trace through the consequences of errors at one level of analysis to another level? Do increases or decreases of errors and their consequences at one level impact the consequences at another level of analysis or have no impact? What are the organizational arrangements that facilitate (or inhibit) adverse consequences from errors at one level affecting other organizational levels?

Multi-level conceptualization of organizational errors: Research Directions

We have developed three conceptual areas around levels of analysis. Each area – multi-level antecedents of organizational errors and related mediating processes, the relationship between individual and organizational errors, and the linkage between adverse outcomes across different levels of analysis – offers new research opportunities. In this section we delineate some of these research opportunities.

Explicit in the discussion of multi-level antecedents is a suggestion that the phenomena of organizational errors require a multi-level perspective. We did not prescribe a specific set of variables at different levels. That is up to the researcher. We did argue that explicitly capturing the processes that mediate the effects of multi-level antecedents contributes to theory and research findings.
However, a critical requirement for examining multi-level predictors of unit or organizational errors is the alignment of theory, measurement, and analysis (Kozlowski & Klein, 2000; Morgeson & Hofmann, 1999). If theory specifies predictors at the unit or organizational levels, measurement and analysis should be congruent. For example, let’s assume there are differences between different hospital units regarding the frequency and type of interruptions to nursing staff. This is of interest because interruptions can reduce attention to monitoring and correction of behavior, which, in turn, can increase errors. One could collect survey data on how frequently individuals perceive interruptions in their work and aggregate this to the unit level. But this would not necessarily be a clear measure of unit-level interruptions. One could obtain an independent, objective measure of the number of interruptions at the unit level (e.g., number of phone calls received per week, number of emergencies that result in a call for nurses to leave their current tasks immediately). Creating a valid estimate of the aggregated individual-level measure that is convergent with a different unit-level measure strengthens the argument that there is alignment between theory and measures.

This argument also applies to the dependent variables, organizational errors and adverse consequences. It is not adequate to aggregate all the individual errors reported to the unit level. If all the errors were associated with one person rather than being spread out over a number of people in the unit, this would not provide an accurate picture of unit-level errors. It also would make a difference if the errors were the same type or very diverse. In the MWH case, it was multiple nurses performing the same type of error with similar consequences.

The question of how individual-level errors become unit or organizational errors or vice versa is challenging. Assuming some learning has occurred at the unit level that led, at least in part, to the errors, what is the role of observation vs. communication in this learning? How does
the level of interdependence of the group moderate the learning process? To study the relationship between individual and organizational errors requires a deep understanding of the work and social interactions occurring within the unit. A strong ethnographic approach with observation and interviews over time is necessary to uncover both explicit and implicit learning. During such an investigation, one wants to understand individual perceptions, shared understandings, and structural indicators of the switch from individual-level errors to a shared understanding in a unit or organization about deviating from standard operating processes. This deeper research approach generates different insights than the survey methodology used in most error-related research, and would be helpful for understanding error correcting and error amplifying processes as well.

To examine the linkage question of how errors and consequences at one level affect those of another level, we need new research approaches. First, we need to distinguish between errors that occur with and without consequences. Errors represent deviations from standard operating procedures with the potential for adverse consequences, meaning there are not always short-term visible outcomes due to a particular error. Requiring a nurse to check the medication to make sure it is being given to the right patient at the right time seems to be a reasonable rule. However, over time, if the nurse does not verify, the likelihood increases that an incorrect dosage from the pharmacy will ultimately do harm to a patient. Starting with the distinction between potential and actual consequences and understanding the time lag between them is a first step in tracing how consequences at one level get translated to another level.

A second consideration is the outcome itself. A death generates multiple negative consequences at all levels. But reconsider some of the examples mentioned above. The pharmacy sends the wrong dosage of heparin, the nurse does not verify, but there are no
observable effects on the patient, at least in the short run. Or there are negative observable consequences that the nurse can fix on her own (i.e., the patient survives with only a mild illness). In these examples, there are errors by the pharmacy and nurse, and there are consequences, some more observable than others. In either case, to identify whether these errors had consequences for the unit and hospital, we would need some multiple-level measurement system to identify the deviation and its consequences (such as incremental costs of many small incidents, or patient wellbeing both within and outside of the hospital). Most hospitals’ measurement systems do not directly measure such deviations (i.e., no verification of dosage) and do not record minor adverse consequences or consequences to the patient after the particular hospital stay has ended.

A third factor is the extent to which the hospital units are relatively independent of or interdependent with others. In an emergency room, a new patient could be admitted, treated, and released without meaningful interaction with any other unit. Errors in this case can be directly attributed to the unit, and if there were errors and consequences (e.g., patient had to return for extra care), these would be attached to the unit and hospital. Another scenario is a patient is diagnosed, sent to a cardiac unit in the hospital and then to a rehabilitation unit. This is a sequential form of interdependence. In addition to sequential interdependence, most hospital units also exhibit complex, reciprocal forms of interdependence. That means many units (e.g., radiology, nutrition) are working on the patient, often at the same time. In both sequential and reciprocal interdependence, it is harder to trace errors and negative consequences across levels because a variety of different units are acting on the patient. Some units may commit errors, but these may be offset by the actions of other units. Or the actions of multiple units could accentuate the effects of errors on the patient’s well-being (Leveson, 2011). For example, a
Managing Organizational Errors: A Temporal Framework

In this section, we examine fundamental perspectives about error management, i.e., the organizational processes for anticipating, preventing, detecting, containing, responding to, coping with, and learning from errors, using a temporal framework to identify what is known and where research is needed. Compared to prior research on the antecedents of errors, an even more extensive body of research addresses the processes for managing errors. However, similar to the research on antecedents, research about the error management process has tended to be unclear about the kind of errors that are being managed, particularly whether they are individual errors or organizational errors. In this section, we examine organizational approaches to managing and learning from organizational errors and offer suggestions for future research.

The topic of organizational error management is informed by other research streams in organizational theory. For example, research on managing risk, particularly pertaining to high-hazard industries, provides insight into management approaches to inherently dangerous
activities such as nuclear power and space exploration (e.g., Perin 2006; Reason, 1997; Roe & Schulman, 2008; Starbuck & Farjoun, 2005; Wildavsky, 1991). The recent economic crisis has heightened awareness of risk in financial organizations and institutions (e.g. Taleb, 2007). But understanding how to manage risk is not equivalent to understanding how to manage organizational errors. Some recent research has explored the potential for organizations to learn from errors (Keith & Frese, 2008; Van Dyke, Frese, Baer & Sonnentag, 2005; Edmondson, 1996). This work suggests that organizations face psychological, social, technical, and practical barriers that prevent them from extracting many or all of the lessons their errors provide (Cannon & Edmondson, 2005; Argyris, 1990).

**Approaches to Error Management**

Two basic orientations toward error phenomena exist in the organizational literature – prevention and resilience. Wildavsky (1991) contrasts these two basic orientations and Schulman (2004) provides a more recent analysis, particularly as they pertain to healthcare. Scholars with the former perspective suggest that errors can be controlled – precluded or eradicated – and that “zero tolerance” is a desirable and even achievable organizational objective (Spencer, 1994). Other scholars argue that error-free performance is an illusory concept (Clarke, 1999) and that, no matter how much organizations prepare, inevitable surprises tax existing knowledge and capabilities (Weick & Sutcliffe, 2007). Although errors occur in all types of situations, knowledge errors—which are particularly likely in dynamic and changing contexts as people “seek to obtain at a low cost (in terms of energy, attention etc.) ‘sufficient’ capacities and resources to treat problems they have to resolve” (Gilbert et al., 2007: 966)—are more difficult to both prevent and manage. This perspective thus emphasizes resilience, because understanding
is never perfect and people are under pressure to make wise choices without sufficient information. In short, organizations are filled with errors waiting to happen (e.g., Weick & Sutcliffe, 2007). These contrasting orientations give rise to competing approaches to error management that embody separate logics of action (see Wildavsky, 1991).

First, advocates of the prevention approach argue that the tools of science and technology make it possible for organizations to identify and define risks and the events and occurrences that must not happen (i.e., errors); identify all possible causal precursor events or conditions that may lead to these errors; and then create a set of procedures for avoiding or preventing them (Reason, 1997; Schulman, 2004; Wildavsky, 1991). The underlying logic of action relates to a belief in the ability to more or less “control” the behavior of organizational participants by elaborating norms, rules, and procedures that not only frame potentially dangerous activities but also enable organizations to manage them (Gilbert et al., 2007; Schulman, 2004). This perspective views error-free performance as feasible or more likely assuming there is compliance with norms, rules, and procedures. To illustrate, as we discussed in the heparin case, in response to the 2001 incident in which two infants received an overdose but subsequently recovered at an affiliated hospital, MWH had revised the procedure for stocking and administering doses of heparin. The new, elaborate procedure required multiple changes in technology (e.g. hep-lock vials stocked in particular storage cubes), human behavior (e.g. a pharmacist technician stocking the medication carts daily so that heparin doses were not kept on the patient floors and an additional verification required when dispensing hep-lock vials), and organizational activities (e.g., periodic bulletins that listed “high alert drugs”). As the prevention approach suggests, if individuals had followed these procedures, the ensuing organizational error could have been prevented. Yet, as psychologist James Reason argues (1997: 24-25), “human failures happen frequently…Human
fallibility, like gravity, weather, and terrain, is just another foreseeable hazard…” The implication, of course, is that prevention alone is not enough, which gives rise to an alternative approach.

The second, alternative approach focuses on resilience, the ability to maintain positive adjustment or to bounce back under challenging conditions (Sutcliffe & Vogus, 2003). Scholars in this tradition argue that in addition to trying to preclude or prevent errors, error management entails finding ways to cope with, circumscribe, or contain errors as they occur, before their effects escalate and ramify (Weick & Roberts, 1993; Weick, Sutcliffe, & Obstfeld, 1999; Wildavsky, 1991; Hofmann & Frese, 2011). The underlying logic for action in the resiliency model relates to an organization’s ability to mitigate, rather than prevent – to improvise and recombine knowledge and resources to cure or catch and correct problems in the making, before they incur negative consequences. The resilience approach pertains to the heparin case in several ways. For example, MWH set up a patient safety program early in 2000, before any serious events had occurred, and also launched the Safe Passage Program, which included two days of training. These actions enabled the hospital to expand its repertoire of capabilities, promoting resilience in the face of process failures (e.g., Tucker and Edmondson, 2003). To examine the implications of these error-management approaches for future research, we introduce a temporal framework below.

**Temporal Aspects of Error Management**

The occurrence of an organizational error can be partitioned into phases – before, during, and after the occurrence of error-linked adverse outcomes. From the viewpoint of managing errors, these phases draw attention to different sets of questions. Before an organization
experiences a significant adverse outcome, a major error-management challenge is preventing or minimizing errors. During the short phase when errors threaten to produce adverse outcomes, but have not yet done so, the challenge is averting or containing the adverse outcomes by responding quickly to delink these errors from their adverse outcomes. In the aftermath of a consequential error, the challenges are twofold – to recover and to learn. These distinctions provide a useful organizing framework, which we combine with the two primary approaches to error management (prevention/resiliency) to identify insights into managing, responding to, and learning from errors. Further, these distinctions reflect a need to move beyond a narrow view of errors as discrete, time-specific events. We should also underscore the reality that at any given time in an organization, these phases co-occur. That is, the organization may be in the before phase for some errors, the during phase for other errors, and the after phase for still other errors.

**Before.** Typically, organizations try to defend against errors through conventional “prevention” mechanisms such as designs, plans, standard operating procedures, and professional rules. This was the approach taken by MWH when it created an elaborate procedure designed to prevent errors related to heparin administration, (e.g., supplementing other prevention-related activities such as instituting a review of the medication administration processes for “high-risk drugs,” and developing risk communication practices). Structural mechanisms like those undertaken at MWH require that organizations understand key risks and distinctly specify core events that must not occur (Schulman, 2004: ii41); understand cause-effect relationships and the precursor conditions that could lead to the events it wants to prevent (i.e., Failure Mode and Effect Analysis; Mikulak, McDermott, & Beauregard, 2008); institute norms, rules, and procedures that outline how people must act to prevent errors from occurring; and establish mechanisms to motivate, regulate, and reward/sanction organizational members for
their behaviors (Schulman, 2004). Organizations additionally rely on training to promote and reinforce safe behaviors (cite). As the above discussion suggests, the prevention approach takes place largely in the “before” phase of organizational error management. Its dominant logic favors putting safeguards and rules in place to create a foundation for effective operations. The goal is to prevent organizational errors rather than eliminate idiosyncratic features related to individual errors.

The logic of prevention is dependent on organizations facing repetitive activities, so they can standardize processes and control the inputs and outputs. Prevention approaches such as standard operating procedures (SOPs) are effective in part because they reduce the amount of information that people have to process, lowering the chances of judgment errors that contribute to crucial failures. This logic further assumes that consistent error-free outcomes will be produced in the future if people repeat patterns of activity that have worked in the past. Clearly, there are limits to the logic of prevention. One limitation is that standard routines cannot handle novel events or surprises. A second limitation is that people may lose flexibility in the face of extensive rules and procedures. Thus, reliance on routines sometimes reduces an organization’s ability to change and to react swiftly to surprises (e.g., Edmondson, et al, 2001; Staw, Sandelands, & Dutton, 1981).

A third limitation relates to prevention’s backward-looking aspects. Mechanisms of prevention, particularly standard operating procedures, are designed to guide work as it relates to the current environment. When people design procedures, they create them to produce an articulated result (often in the form of an integrated system of actions and decisions) in the “ideal” context that they perceive to exist in the present. They assume that the world will unfold in a predetermined manner. Thus, the logic of prevention is based on an assumption of stability,
rather than one of dynamism or volatility. But organizational systems are neither stable nor fixed. Rather, working conditions, technologies, human and other resources, and other aspects of organizational life constantly fluctuate, change and are modified intentionally or unintentionally. This means that over time the gap between the actual work system and official procedural system can widen and procedures become inaccurate. Consequently, when people apply existing procedures they often are applying them to yesterday’s organization rather than today’s.

The elaborate procedure instituted by MWH in response to the 2001 heparin incident required nurses to verify the heparin dose twice. Yet, it is plausible that NICU nurses had stopped verifying heparin doses long before the 2006 incident in which three babies died. Several authors argue that organizational procedures often decay over time in the absence of serious incidents, which provides ambiguous feedback as organizational members push the boundaries of safety (Rasmussen, 1987; Reason, 1997; Vaughan, 1996). In part this is because performance (i.e., growth, profit, market share) and production imperatives crowd out concerns over protection. As Reason (1997:6) notes, “[i]t is easy to forget to fear things that rarely happen.” These events illustrate the important and understudied phenomenon of *procedural decay* – the tendency to fail to execute SOPs faithfully as the length of time between significant failures goes up (e.g., Sutcliffe & McNamara, 2001; Edmondson, Bohmer, & Pisano, 2005; Vaughan, 1996). Developing theory and evidence about the causes and effects of procedural decay represents a theme in this chapter about new research opportunities on organizational errors.

The resilience approach also suggests opportunities for management action in advance of organizational errors. Wildavsky (1991: 220) suggested that – given the existence of possible unexpected risks – organizations have to choose between anticipation (what we call prevention),
understood as “sinking resources into specific defenses against particular anticipated risks,” and resilience, or “retaining resources in a form sufficiently flexible – storable, convertible, malleable – to cope with whatever anticipated harms might emerge.” Wildavsky argued that anticipation (prevention) makes sense when organizations can predict and verify risks. When risks are uncertain and speculative, however, resilience makes more sense as we cannot know which possible risks will become manifest (Wildavsky, 1991: 221). Thus, managing errors before they occur through a resilience approach means that organizations commit to developing a “capability for resilience” (see Weick and Sutcliffe, 2001; 2007). This implies expanding people’s general knowledge and technical capabilities, their behavioral repertoires and skills to improvise, and social and relational networks that can help compensate for lapses. We saw evidence that MWH was committed to enhancing a broad capability for resilience at the unit and organizational level. Questions remain, as noted earlier, about the limitations of the resilience approach and its efficacy for preventing organizational errors before they occur.

**During.** In a prevention approach, contingency plans and emergency procedures provide a means for mitigation once errors have occurred – to avoid the full ramifications of errors or to prevent untoward consequences from escalating. This requires that organizational actors be attentive to feedback and recognize the occurrence of errors in real time. Moreover, organizational actors must have the knowledge, capabilities, resources, and motivation to enact contingency plans. Even so, the real-time intervention may not be effective. In the heparin case, we saw that rescue and recovery efforts after the overdoses had occurred were unsuccessful, in three cases, and our data do not clarify whether a formal “rescue/recovery” procedure existed and was widely understood. More generally, once organizational errors have occurred, there may not always be actions that can be taken to counteract the damage.
The logic of a resilience approach to management emphasizes actions “during” an organizational error’s unfolding. Managing an error in real time requires that errors – particularly smaller ones that might not otherwise be detected – be made visible to actors and assumes that actors can take steps to halt or remedy the situation before harm occurs. A resilience approach thus recognizes that errors in work processes can occur without harming the ultimate product or patient, such that catching and correcting errors quickly can be crucial to minimize consequential outcomes. Managing via a resilience approach seeks to increase the chances of this kind of corrective response, through a mindset of vigilance on the part of multiple actors based on explicit, shared understanding that human error can occur at any time. This requires a strong culture in which people worry about vulnerability and feel accountable for preventing failures, as this enhances vigilance and attentiveness to the context (Westrum, 1997; Weick et al 1999). It also requires a climate where people feel psychologically safe (Edmondson, 1996) to report and discuss errors rather than hide them.

Detecting an organizational error as it unfolds remains a challenge (Edmondson, et al, 2005). Doing so requires that people have generalized capabilities to act on what they see and to improvise a response. When people enlarge their behavioral repertoires, for example through job rotations or generalized training before they encounter emergencies, they expand the range of issues they can identify and their capabilities to effectively respond: If people are unable to act to correct errors, then they are less likely to see those errors (Westrum, 1993; Weick & Sutcliffe, 2001).

After. For many errors, the majority of the damage occurs after an initial triggering event. And in some cases, there is no way to mitigate the damage. Therefore, managing organizational responses following these adverse events is critical both to organizational learning
and to shaping an organization’s error culture (Edmondson, 2004). A prevention lens views analysis following an organizational error as useful for improving the system’s reliability going forward. Such analysis is aimed at providing knowledge about the system, to illuminate how understanding is incomplete or inadequate and how norms, policies, or practices should be changed. Through a resilience lens, in contrast, analysis is focused on the process. The aspiration is to help people gain insight into the nature of organizational systems by taking part in the analytic process, and to deepen participants’ understanding of how the organization’s processes give rise to the potential for error.

Organizations often employ a hybrid approach. To illustrate, after the initial heparin incidents, MWH undertook a number of actions aimed at preventing further events and at strengthening the hospital’s capabilities to catch and correct errors in the making, as described above. However, these management actions prior to 2006 were insufficient to prevent the occurrence of the three deaths.

To be useful to organizations, error-related lessons must be extracted and distributed. However, errors can occur in settings that range from simple task execution to complex systemic breakdowns (MacPhail and Edmondson, 2011), and the lessons vary accordingly. Analysis of simple execution errors presents opportunities for targeted fixes and fine-tuning of work process, while errors involving novel activities or system interactions are more difficult to diagnose and may require creative problem-solving to identify viable solutions. Work carried out exclusively by a defined unit or group can be effectively understood and improved within that group, while breakdowns that occur at the linkages between individuals or groups require broader organizational involvement in diagnosis and in designing strategies for future avoidance.
The goal of learning from errors after they occur is, of course, improvement activity that reduces future error or the consequences of future error (Carroll et al, 2002). Such learning can identify vulnerabilities in existing work processes – such as aspects of the task that are particularly challenging to execute reliably or supply problems that limit the availability of materials specified by the work processes. For simple execution errors, local actors should be sufficiently capable to conduct after-error analysis and recommend process improvements that reduce the chances of future operator error. For more complex organizational errors, the learning process requires the perspectives of multiple disciplines to analyze the complex interactions that might have occurred. Participants must be both diverse and sufficiently senior to command broad organizational attention, enact changes with wide-reaching implications for organizational practice, and access resources necessary for change implementation (McPhail and Edmondson, forthcoming). In addition, any subsequent learning that occurs must reflect our fundamental distinction between organizational- and individual-level learning. In the former case, we need to understand the reasons for “procedural decay” and then design system-level prevention and/or resilience-based strategies. In the individual case, depending on the diagnosis, the solution may be more individually based (e.g., more training for the nurse, managing stress at home, moving individuals out of sensitive jobs).

A psychologically safe environment for discussing errors is crucial across our temporal spectrum, particularly given the possibility that individuals who do not work closely together will be required to have personally threatening discussions about “what went wrong.” Psychological safety will help to mitigate defensive posturing, allowing groups and individuals to benefit from the dialogue (Edmondson, 1999).
Managing Errors over Time – Directions for Research

Our temporal framework and the two forms of error management provide an interesting matrix of research opportunities. Examining the effectiveness of prevention vs. resilience strategies in the before, during, and after phases creates a map for research on organizational errors (see Table 1)

**Insert Table 1 about here**

Let’s return to the neonatal unit of MWH, in the “before” period. Although there are high-risk patients, there are many routine tasks, such as monitoring health signs, providing medication, and so on. We thus would expect an emphasis on prevention for ensuring error-free performance in these routinized or standardized tasks. For instance, procedures require clinicians to check the medication in hand against medication orders, which are in turn checked against the patient’s identification. One would also expect a prevention focus at the unit level with the potential for unit-level measures about the extent to which these activities are routinized, and the clarity of normative expectations about following SOPs. There might be other activities within the unit that are less programmed, where we would expect more of a resilience approach. Examining variations within the unit or across units on prevention vs. resilience activities as they relate to standardized or non-standardized activities is a research option worth exploring.

A different scenario and research opportunity involves examining conditions under which prevention and resilience interact to reduce errors and their consequences, in order to identify the potential for an ideal balance between the two. For example, Vogus and Sutcliffe (2007a, b) found that nursing units that combined a logic of prevention (unit’s use of care pathways) with a logic of resilience (unit’s use of mindful organizing practices) experienced
fewer medication errors and patient falls. It is possible that the combination of standardized protocols with more resilient organizing practices structures interactions and creates connections that ultimately result in more effective organizing (Vogus & Sutcliffe, 2007b). This suggests that, together, the two approaches can reduce organizational errors and their consequences, but it doesn’t shed light on the mechanisms through which the combination has its effects or the issue of balance under specific conditions. We might hypothesize that the more uncertain the context, the more necessary a logic of resilience; and, alternatively the more certain the context, the more necessary a logic of prevention. Research examining the relative balance between the two under specific organizational conditions may provide more insight into the mechanisms through which these two approaches combine to influence organizational errors.

In the “during” phase, an error has already occurred. Potential research issues include whether the error is measured, whether there are feedback and remediation processes, and how well the measurement and feedback processes match up with the errors that could occur. In the MWH example, there was no measurement of deviations from verification, and the nature of the error created immediate adverse consequences – once the error occurred, the organization moved from “before” to “after” very rapidly, so the feedback was nearly immediate but left no time for remediation prior to adverse consequences. One research opportunity is to examine how different types of deviations require different remediation systems to avoid adverse consequences, for those errors where doing so is possible. Another idea is to explore differences in feedback and remediation mechanisms for organizational vs. individual errors. For example, when organizational errors occur at the unit level, should the design of a system to reduce adverse consequences be carried out within the unit or be developed more broadly, outside the unit? How do the answers to these questions change if an individual is the source of multiple
errors? Finally, why are some organizations better able than others to identify and correct organizational errors before adverse consequences occur? That is, how they do acquire process engineering and systems thinking capabilities? What can other organizations learn from those successes?

Another question is how organizations develop the capacity to respond to errors. Research is needed to investigate the link between the breadth of behavioral repertoires or organizational capabilities and the occurrence, remediation, and consequences of organizational errors. Scholars have argued that there is a link between action capabilities and cognitive capabilities such that when people enlarge their capabilities to act on problems, essentially bringing new domains of expertise under their control, they enlarge the range of issues they see (Weick and Sutcliffe, 2001:93). This logic suggests that errors with adverse consequences will be less frequent and/or less severe in organizations with broader response repertoires. We need to explore whether broader capabilities means more skills or the ability to re-combine existing skills. This study would also assess whether this tendency, if observed, is mitigated by error-management approaches. Again, research in this topic area would best be done in the field, with a large enough sample of organizations to test the significance of these relationships. This work might also be extended to investigate the conditions under which organizations develop contingency/rescue/recovery plans, and to explore the organizational mechanisms that contribute to the diffusion of such knowledge. Klein (1999), for example, has found that some high-hazard organizations require their members to simulate worst-case conditions regularly.

In the “after” phase, learning is probably the most important process to understand (MacPhail & Edmondson, forthcoming; Carroll et al. 2002, Tamuz & Thomas, 2006). Learning could be about new prevention strategies or resilience capabilities. A key issue is whether
learning should occur at the unit or organizational level (vs. individual) and the consequences of these learnings on future errors. If learning is at the unit level, we need to identify what is the new shared understanding about managing errors, how that information is stored in the unit, and the process by which that learning is retrieved.

Another research project could investigate the effects of balancing sometimes-competing organizational values. To remain competitive in an increasingly dynamic and complex world requires that organizations value production and innovation as well as protection – values that sometimes conflict. Thus, error management may require organizations and their members to cope with the tension of conflicting aims rather than choosing one goal over another (Weick & Sutcliffe, 2001). As Rasmussen (1997) reminds us, error-free performance is not a fixed property, but rather a variable location within a space of possibilities within a system. Although a more exploratory research topic, it seems plausible that organizations that learn to maintain a balance of values will be better equipped to prevent organizational errors. More research is needed to understand the factors that influence production/protection tradeoffs or the extent to which leaders and managers spend time identifying potential hazards and things that they do not want to go wrong.

**The Role of Context**

In the preceding sections, we identified two major arenas for future research – developing a multi-level conceptualization of the antecedents and processes contributing to organizational errors and advancing a temporal perspective for studying the processes for managing organizational errors. In this section, we discuss a third theme – incorporating the role of context in the theoretical and empirical analyses of organizational errors and their management. For
example, is the MWH heparin case unique to this NICU or this hospital, or to the healthcare industry, or can the principles be generalized to other organizations? We begin by clarifying the meaning of context and its significance for studying organizational errors. We then identify a sample set of contextual features to discuss how a contextual perspective can extend and add depth to the two primary themes in this chapter. We conclude with a discussion of future research directions.

By “context,” we refer to a set of relatively stable features of a setting that shape processes and behaviors of interest (Rousseau & Fried, 2001) – in this case, organizational errors. This notion of context as a discrete bundle of features represents a more specific elaboration of the broad description of context as the “surroundings” of the research variables (Cappelli & Sherer, 1991; Mowday & Sutton, 1993). Hackman’s (2003) analysis of context in terms of levels above and below the focal variables of analysis is consistent with our theoretical position and extends our multi-level conceptualization of organizational errors. Specifically, we will examine context variables that may explain differences in organizational errors between organizations in the same industry or between organizations in different industries.

MWH has several distinctive contextual features that are relevant for understanding the generation of organizational errors and their management. These features include numerous organizational goals (e.g., caring for patients, advancing medical research, containing costs, maintaining safety, educating physician and nurse trainees), employees from several highly specialized professions, and work that is both highly structured, highly uncertain, risky, and interdependent (Ramanujam & Rousseau, 2006). Contrast this setting with a hospital that only focuses on patient care and does not do medical research or training, or with organizations in the
mining, aviation, or nuclear power industries. How would these contextual differences affect the genesis and management of organizational errors?

A contextual perspective directly addresses a persistent critique that studies of errors have limited relevance to mainstream organizational research because they have been narrowly context-bound. For instance, Scott (2002) pointed out that many early studies focused on extreme settings – where errors are linked to hazardous and dramatic outcomes. As a result, the generalizability of the findings from studies of errors in one setting (e.g., aviation) to another setting (e.g., healthcare) has been called into question. Also, although others have brought attention to the relevance of contextual variables such as competitive pressures, resource availability, regulatory intensity, and legal structure (cf., Bovens & Hart, 1996), these have not been prominent in recent research on organizational errors, and this research has not addressed the distinction between organizational errors and individual errors in organizations. To effectively address such foundational issues, studies of errors must begin to systematically take into account the role of context, both in their theory and methods.

By way of illustration, we identify three contextual features that may be relevant to understanding within-industry and across-industry differences in the antecedents of organizational errors, mediators, and the processes for managing organizational errors (see Figure 2). These features are: (a) hazard profile, (b) external pressures and resources, and (c) strategy. We selected these three variables because they are theoretically relevant to understanding organizational errors. A research program exploring issues of context could start with one or more of these variables and later expand to others, such as national and corporate culture, safety climate, employee demographics, and so on (See Figure 2).

**Insert Figure 2 about here**
Hazard Profile

Perrow (1984), in his classic *Normal Accidents*, labeled some types of organizations as “high-hazard,” signaling that they are in industries where there are more hazards built into the work and therefore safety is relatively more important. The hazards that organizations face in daily work can be physical (e.g., flammable or explosive materials), emotional (e.g., interdepartmental conflicts or fear of layoffs), economic (e.g., foreign exchange rate fluctuations, sovereign debt default), social (e.g., reputation loss with customers, investors, and regulators), and so forth.

Additionally, the hazards associated with errors can vary in terms of the potential victims, the magnitude of physical harm, and the time lag between errors and adverse consequences. For example, the primary victims of a consequential error may be employees in coal mines, patients in a hospital, shareholders in a bank, or passengers in an airplane. Perrow (1984) argued that airlines have been at the forefront of safety because elites are directly exposed to hazards, in contrast to coal mines where the risks are borne by less powerful groups. The magnitude of the hazard can also vary from the death of a few patients in a hospital to hundreds of deaths in air crashes and explosions in chemical plants. The perceived threats are much greater when there are rare events with large numbers of victims in contrast to common events that kill one at a time or when the manner of injury is dreadful or unfamiliar (Slovic, 1987). Moreover, in some settings, the adverse outcomes resulting from errors may not be immediately noticeable. For example, at MWH, the error in the design of the heparin vials that made it difficult to distinguish dosages took place months or years before the fatal events; the pharmacist’s error was days
before; the nurses’ errors took place hours before the adverse outcomes were noticed. There are distinct lags associated with different hazards.

One question is whether and how the hazard profile affects the processes leading to organizational errors. For instance, will the processes that mediate the link between individual errors and organizational errors be stronger or weaker in settings such as coal mines where the consequences of errors threaten the physical safety of employees? One could argue that workers in high-hazard settings will be more vigilant and immediately correct deviations from standard operating procedures. In this type of setting, the movement from individual to organizational errors will be more difficult, as deviations are actively identified and eliminated. Organizational errors would be even less frequent if there was a powerful union and/or an active CEO that had adopted worker safety as a key value. However, a counterargument is that miners become used to the hazardous conditions, and if there are not visible errors, the objective hazard conditions become more normalized and have less effect on vigilance and error frequency. Some organizations have a culture of pride at facing hazards, in which missing fingers and other injuries are a badge of honor. This condition at least creates the possibility of individual-level errors leading to more organizational errors. Although this is a somewhat simplified argument, it underscores the kind of basic issues that are not adequately discussed in the errors literature, but yet must be taken into account to enhance the generalizability of this research.

Another question is whether and how differences in hazard profile set up different challenges for error-management processes. For example, will the prevention and resilience approaches be equally effective for different hazard profiles? Error-management systems have evolved to deal with workplace hazards that have been around for long periods of time, such as falls, collisions, fires, explosions, and toxic releases. Rules and procedures, checklists, audits,
probabilistic risk assessments, and other risk-management technologies are reasonably effective at managing these physical risks. We understand both how to prevent errors that lead to adverse outcomes and how to mitigate errors by managing the consequences of errors. The heparin overdose is a good example of a hazard that can be prevented in various ways, but offers little opportunity for mitigation or resilience once an error is made. Many modern hazards are less easily envisioned and prevented, such as software-related accidents where the software functions perfectly but the interactions of software modules were not anticipated (Leveson, 2011), and human-related accidents where operators responded to problems in ways that designers did not imagine (e.g., Three Mile Island, Perrow, 1984; Chernobyl, Reason, 1990; the BP Deepwater Horizon oil rig disaster, National Commission, 2010). The destruction of economic value in the recent mortgage-backed securities disaster is a startling example of a software- and human-based system that was far more complex and tightly coupled than imagined.

External Pressures and Regulation

A second contextual feature is the organization’s external environment, comprising regulators, industry organizations, strategic partners, competitors, customers, and so forth. The external environment can influence error-related processes through regulation and scrutiny of organizational operations (Vaughan, 1999). For instance, aviation is widely viewed as a highly regulated industry where consequential errors are subject to intense public scrutiny by multiple stakeholders (e.g., the Federal National Transportation Safety Board, pilots, airlines, aircraft manufacturers, air traffic control, passengers). By contrast, other industries (such as financial or oil companies), at least in the past, have tended to be less regulated, and organizational errors
and adverse consequences are not as systematically investigated (Perrow, 1984). In both of those industries, however, recent events have brought more attention and a likely result will be greater external scrutiny and regulation.

The external environment can exert pressure on organizations within an industry to share information with one another about errors. One of the most positive influences on safety in the nuclear power industry was the formation of the Institute of Nuclear Power Operators following the Three Mile Island accident. INPO is an industry organization that disseminates reports of best practices, accredits training programs, organizes peer assistance and benchmarking, and so forth. It was formed with an expressly political purpose: to avoid intrusive regulation from the U.S. Nuclear Regulatory Commission; the industry argued that it could self-regulate (Rees, 1994). The offshore oil industry, in the wake of the Gulf oil spill, is discussing the creation of an analogous self-regulatory industry group.

Will organizational errors emerge differently depending on the extent of external regulation and pressures? Analyses of operational errors in financial institutions such as Barings Bank suggest that these errors were widespread and were likely to be organizational errors (Basel Committee on banking Supervision, 2008). Moreover, these errors accumulated at an accelerated pace and led to major adverse outcomes over a short period of time. Although there had been inquiries from external regulatory agencies, the bank management deflected the external inquiries. This reinforces an environment where multiple organization members can deviate. External regulation and pressure can also shape error-management processes. For example, the aviation safety reporting system has been widely credited for reducing errors and improving safety in aviation by requiring every incident, including those involving errors, to be publicly reported and shared (Tamuz & Thomas, 2006). This model emphasizes error
management through ongoing and often vicarious learning from errors. That is, airlines regularly update their procedures and routines to incorporate the lessons from recent incidents and accidents. Moreover, they utilize many checklists, a prevention approach often credited for enhancing flight safety. So one question is whether a similar prevention approach that is based on checklists would contribute to effective error management in other contexts where the external pressures to report errors and share information are weaker? Airline-type checklists have been used recently to reduce hospital-borne infections (Pronovost & Vohr, 2010), but the mechanisms that spread infection are amenable to simple behavior changes such as hand-washing and gowning, in contrast to errors that arise from more complex cross-boundary interactions.

Finally, the external environment is composed of different constituencies with different interests, which impact how organizational errors are managed (Perrow, 1984). For instance, regulators may reinforce blame and drive error reporting and learning underground, sometimes without realizing the consequences of their actions. When the safety reporting system for airline near-misses was made blame-free, reporting frequency went way up, but when the laws were changed to allow reports to be used to punish pilots, reports went way down (Tamuz & Thomas, 2006). In short, regulatory and legal practices create a supportive or resistant environment in which organizations struggle to advance their own safety. An event such as the heparin overdose can bring insurers, lawyers, regulators, accreditation organizations, unions, professional societies, patient advocacy groups, and others into significant conflict. It is difficult for one organization to develop an advanced way of dealing with organizational errors if powerful external organizations resist because of entrenched interests or misaligned mental models, for example, a legal or regulatory system that encourages blame and undermines learning.
Organizational Strategy

A third contextual feature that is especially relevant for inter-organizational differences within an industry is strategy. An organization’s business strategy determines the allocation of scarce organizational resources (including attention) to various activities. In other words, strategy shapes the resources that are allocated to maintaining routine operations (e.g., nurse/patient ratio in a hospital), innovating with new technologies and practices (e.g., R&D, continuous improvement), and managing errors (e.g., internal audits, time for problem solving) and, hence, we can expect strategy to shape organizational error-related processes.

Organizations (or the executives and boards of directors at the top) choose what industries to compete in and what products and services to offer. Partly due to their industry identity, partly due to the way leaders frame strategy, and partly due to what has worked in the past and become ingrained in the culture, organizations differ in their approaches. Although organizational strategy is thought of as a malleable choice and therefore not part of the “context” that is relatively fixed outside the organization, for purposes of discussion around organizational error, we consider strategic choices to be part of the context. Such choices are mostly made far away (and far “above”) such events as medication errors and usually become relatively fixed over time. Hence, for example, founders and leaders of the hospital in which the heparin administration errors occurred had long ago decided whether to be part of a larger health system, to be for-profit or not-for-profit, to be a teaching hospital, how much to focus on research, and how much to strive to be among the best hospitals in the country. Some organizations are first movers, explorers, or prospectors that seek to innovate, some are analyzers or nimble copiers of
innovation, others are laggards, reactors or defenders of their turf that copy only when they are forced to match their competition (March, 1991; Miles & Snow, 1978).

Consider, for example, two commonly discussed strategies – cost leadership and product innovation. It is conceivable that a for-profit hospital might view business in terms of managing costs, whereas a not-for-profit hospital such as MWH might view business operations as an investment in infrastructure for research and innovation. The question is whether the two strategies would affect rates of organizational errors. If a strong cost orientation weakens the negative feedback mechanisms designed to control errors, organizational errors might increase. Similarly, from an error-management viewpoint, would these two different hospitals emphasize different phases and approaches? We think the answer is yes. A cost-leadership strategy might lead one hospital to reduce safety training and the time available for employees to reflect on their work (two requirements for learning from errors and pursuing a resilience approach). On the other hand, an innovation strategy might cause the other hospital to value creativity and experimentation and potentially undermine the importance of rules and procedures. The impacts of strategy may depend on how that strategy is pursued and how it is embedded in culture and practices: Bureaucracy, standardization, and rules can be antagonistic or facilitative to innovation and learning (Adler, 1999).

Role of Context – Research Directions

The task of developing context-based explanations provides several promising opportunities for future research. First, further research is needed to elaborate and verify the effects of each contextual variable we identified. Delineating the construct of hazard profile (or any other feature) will require both construct development and measurement validation through
studies of error-related processes in settings where the feature (e.g., hazard profile) varies widely. A second research goal is to identify the boundary conditions for the operation of various error management processes – e.g., are there limits to relying on a resilience (prevention) approach when the external environment is highly (loosely) regulated, when there are significant cost pressures from competition, when the labor market is unfavorable for hiring professionals, when the unions are antagonistic, and so forth? Such comparisons could be pursued by research examining a large database of companies across industry that can be coded for error-management approaches, numbers of organizational errors, and contextual features. A small number of in-depth case comparisons across companies and industries, selected on the basis of variation in contextual features, could be complementary. Further, research projects could examine organizations or even industries that are changing key contextual variables, such as their regulatory approaches or corporate strategy.

The third research goal is to trace the interplay between the contextual forces and organizational responses on mediating processes, errors, and consequences. The theoretical development needs to capture the complex relationships among the contextual variables, the antecedents, mediating processes, errors, and consequences. In the BP oil spill disaster, there were multiple regulatory agencies, multiple organizations responsible for aspects of the drilling operation (i.e., BP, Halliburton, and Transocean) and multiple designers of the equipment. In the Massey Coal Mine disaster, there were strong regulatory procedures from federal and state officials and strong oppositional pressures from the company. The challenge is to trace the contextual effects and company reactions and the impacts on multiple people deviating from standard rules and the subsequent adverse consequences. In the BP case, there is some evidence that an individual worker did not react to a pressure test result, but at the same time, there is
evidence there were multiple people engaged in errors. This seems like a case of organizational (or even industry-level) errors. One important issue is how contextual issues in the form of hazard profiles, regulatory pressures, and strategies lead to such great adverse consequences.

The problem with these examples is that they have already occurred. They lead to sampling on the dependent variable and making sense, *ex post*, about what happened (Fischhoff, 2007). It might be more appropriate to study mines similar in size and technology but who have different strategies of reacting to external regulations. This should be a longitudinal study using observational and survey methods to track how management reactions to federal violations or fines affect other antecedents such as safety climate, and supervision, and in turn, how this affects any of the mediating processes and subsequent organizational errors.

A different but related approach might be to consider organizations with different strategic goals. For example, what are the effects on medication verification processes in hospitals focused only on patient care versus those that also do research and training? It could be argued in the latter hospitals, attention is divided and there will be less monitoring and corrective actions relative to verification. An alternative argument is that hospitals with multiple goals may be more attentive to learning and norms about verification could be stronger. Again, the challenge is to find hospitals with similar resources, size, and patient profile, which endorse different goals. A simple first step might be to analyze training similarities and differences for front line workers. A complementary approach might be to look for other safety artifacts (e.g., posters) and collect survey data about prevailing norms.

Research must identify other contextual features that are relevant to developing a generalizable understanding of organizational errors. While we identified three features to illustrate the contextual perspective, other contextual features may be as important (e.g., national
culture). Future research should examine differences between settings where work is distributed and settings that are co-located, as well as differences between countries with very different cultural assumptions about errors.

Lastly, future research should consider the effects of bundles of these contextual features. As mentioned earlier, context is essentially about a set of features rather than any single feature. Hence, although a detailed understanding of the effects of each feature is important, a contextual perspective requires the researcher to consider the joint effects of these features. For instance, the context of MWH could be described in terms of a hazard profile where errors in the NICU can cause physical harm to the high-risk patients, a punitive external environment that penalizes errors and adverse outcomes, and an organizational strategy that emphasizes the goals of quality and safety. To what extent can we apply our analysis and conclusions from this context to a hospital unit where the hazard profile is less severe (e.g., outpatient services), the external environment is less punitive (e.g., less stringent state laws about malpractice), and the strategy emphasizes more efficient utilization of resources (e.g., for-profit hospital)? In order to investigate such questions, it is important to develop a reasonably specific description of contextual features. In addition, this opens up a whole research space about how to measure contextual features in a way that illustrates construct, convergent and discriminant validities. In addition, this will require selecting organizations that are representative of different bundles of context. One interesting opportunity is to focus on the transfer of “best practices” within and across industries. In this regard, ongoing efforts to apply practices from aviation (e.g., error reporting as an error-management strategy) to healthcare delivery may provide valuable opportunities for studying the role of context in safety and safety management.
Lessons and Contributions

This chapter sought to focus on organizational errors as an important organizational phenomenon that warrants further research attention. To this end, we proposed a conceptualization of organizational errors as distinct from, but related to, individual errors and identified several promising opportunities for future research. We hope to shed new light on the theory, processes, and consequences of organizational errors. For this promise to be realized, however, several important shifts must occur in how organizational researchers conceptualize and study errors:

(1) Delineation/elaboration of the “organizational” features of errors. The distinction between individual and organizational errors is fundamental to this chapter. Our focus is on organizational entities that have goals, rules, and standard operating procedures. These could include different forms of organizations and different organizational levels such as work units or departments or the organization itself.

In prior research, there has been confusion and ambiguity between individual and organizational errors, both theoretically and methodologically. At a unit or organizational level, errors occur when there are multiple persons deviating from standard practices (e.g., medication verification), and the drivers of organizational errors are more closely tied to persistent unit and organizational characteristics than individual idiosyncrasies. However, a clear definition and picture of organizational errors is still elusive. For example, how many people need to be deviating to categorize something as an organizational error vs. individual errors that happen to occur in an organization? To what extent do the related errors need to be similar (e.g., not verifying the proper heparin dosage vs. not verifying different potentially dangerous medications)? Our goal was to sharpen the concept of organizational errors by identifying and
elaborating on some key characteristics. We see these tensions as valuable since they can stimulate creative research opportunities.

Studying organizational errors requires a different orientation from prior research on errors. We need to understand why organizational errors come into being – what are the critical processes and antecedents? What are the conditions when organizational errors lead to adverse consequences and when they do not? We have identified some theoretical and empirical approaches to these questions, but future research can further elucidate these questions.

(2) Alignment of theory, methods, and measurement across multiple levels of analysis.

This distinction between individual and organizational levels has important implications for aligning theory, measurement, and analysis. If we were studying medication errors in a hospital, simply aggregating the number of errors by unit would not be a suitable measure. If all of the errors were committed by one or two individuals, for example, we would not be measuring organizational errors. When we find multiple people in a unit creating the same kind of errors, then this would signal a potential organizational error. If we are measuring unit- or organizational-level errors, we need to match the measurement strategy to that level of analysis. Further investigation is needed on the meaning of shared understanding and how to empirically capture the degree of sharing and its persistence.

Alignment also pertains to independent variables. If we argue that safety climate or the delineation of safety practices is an important predictor of errors, then it is important to think about how we measure these constructs. Collecting individual-level perceptions, testing them for homogeneity, and then aggregating individual scores to represent unit or organizational phenomena is one approach. A different approach is to recognize that safety practices and rules are a structural phenomenon, not primarily an individual-level perception. We call for
convergent validity estimates that use individual and structural level measures. Our distinction between individual, unit, or organizational errors has important implications for theory, measurement and analysis.

(3) **Attention to mediating processes.** Greater attention to processes that mediate errors would represent an improvement in research. Our point is not simply to state it in the theory, but to move toward more explicit measurement of the key mediating mechanisms. For example, while examining the transition between individual and organizational errors, a key mediating process we discussed was learning (in this case, mis-learning). Yet we do not know how such learning unfolds. Did the nurses at MWH learn from observing others or communicating with other nurses that the system was very reliable? Did a collective understanding emerge? We also mentioned that vigilance, feedback, and corrective actions are critical processes to identifying and reducing errors and avoiding negative consequences. There is a need for studies that investigate the interaction among these mediating processes. One challenge is to develop measures of these processes at the unit or organizational levels of analysis.

(4) **A temporal perspective that recognizes errors as interacting dynamic processes and outcomes unfolding over time.** The temporal perspective permeates this chapter. It comes in a variety of forms and creates new research opportunities. First, we conceptually separated errors from their consequences. An organizational error can occur without an immediate consequence, and consequences may unfold over time and be the result of multiple inter-related errors. Identifying the functional forms linking the type and frequency of errors to adverse consequences and measuring the presence and development of such forms is a challenge for future research.
A second temporal link is the relationship between organizational and individual errors. We discussed how individual errors can lead to organizational errors, but the temporal lag is undetermined. How long did it take for other nurses in the neonatal unit to learn that others were not verifying the medication, and more importantly, to develop a shared understanding that this kind of deviation was unit-wide? We said learning was a mediating process, but when learning occurs, and how it develops and spreads within the organization over time, is yet to be specified.

A third temporal issue is implicit in our discussion of the antecedents of organizational errors and their consequences. The change in antecedents (internal or external to the organization) and their impact on the frequency or type of errors is inherently complex and time-based. Changes in regulation will lead to organizational responses that may affect a whole set of practices, such as monitoring, reporting errors, learning, and so on. One important challenge is understanding these causal connections and their timelines. In the light of our earlier discussion about the need to move away from viewing errors narrowly as discrete time-specific events, a temporal lens is important in understanding the rate of accumulation of errors and the onset of adverse consequences. We discussed earlier the role of negative and positive feedback systems in inhibiting or facilitating errors. However, we do not have a clear temporal perspective of the rates of these activities and the subsequent timing of organizational consequences. This will require the use of a diverse set of methodologies such as system dynamics modeling and longitudinal designs.

Finally, our examination of error management practices was framed within a temporal view of errors – before, during, and after. For each time period, we contrasted the prevention vs. resilience approaches to error management. This 2 x 3 matrix points to a host of potential research questions on organizational-level errors. One variant of the temporal perspective is
capability development. This refers to developing capabilities over time at the unit or organizational level to better identify, respond to, and reduce both the frequency of errors and their consequences. Capabilities could mean new structures or processes developed within the organization. Prevention and resilience were initially posed as opposing forces, but there is acknowledgment they may be synergistic. Indeed, how to spur the development of both prevention and resilience capabilities may be a reasonable area for research. Similarly, we can think about a continuum that ranges from short-term, local problem-solving to systemic, focused, and long-term learning and problem-solving. The argument is that different stages of capability (cf Carroll et al 2002) will impact the management of errors. But a broader question is how organizations move along this continuum and develop their capabilities to manage errors. Is it a natural evolutionary process or one characterized by discontinuous changes? What are the critical exogenous or endogenous forces? If learning is an underlying process in this capability development, how do we ensure the right learning occurs at the unit and organizational levels, not just at the individual level?

(5) Assessing the role of context. We introduced the concept of context because it is receiving more attention as an important theoretical construct in organizational theory. We also examined context because it is a critical construct in organizational errors. Consider the recent major organizational failures – BP, Massey Energy, Arlington National Cemetery, and so on. It is impossible to understand any of these failures without a contextual lens. In BP, as an example, there was a dangerous hazard profile, many external regulations but an apparently ineffectual regulator, and multiple “owners” with different strategies. The interesting intellectual challenge is tracing through the effects of these features on organizational structure, mediating mechanisms, organizational errors and their consequences.
Lessons learned—Linking Practice and Theory. Although our primary focus has been on theory development, throughout this chapter we have indicated implications for practice. The simple distinction between individual and organizational errors has clear implications for practice. In the Continental Airlines crash in 2009, the analysis showed that the pilot pushed the lever the wrong way, given a stall signal, and the plane crashed (Wald & Robbins, 2009). This was an individual error; other pilots were doing this procedure correctly. If the pilot had lived, he might have been given some remedial training, but not all the pilots. On the other hand, where multiple nurses in MWH were not verifying, there clearly was a need for structural change in terms of training, new forms of monitoring, new ways of labeling drug containers, and so on. Distinguishing between individual and organizational errors makes a difference in theory and practice.

Limitations and Conclusion

We acknowledge that our conceptualization of organizational-level errors has some limitations. For our initial conceptualization, we focused on situations where formal pre-specified rules are available, unambiguous, and not in conflict. We believe that this captures a broad range of organizational settings where organizational errors occur frequently and yet remain poorly understood. However, we recognize that in many other situations rules may be ambiguous, in conflict, or even unavailable. Further, informal rules and norms can shape behaviors, not just formal organizational standards. Clearly, expanding the scope of our initial conceptualization to take into account such possibilities is an important area for future research.

Second, our discussion of the relationship between organizational errors and adverse organizational outcomes focuses on execution errors, which are deviations from known and
accepted standard operating procedures. We recognize there are other types of decisions within organizations that lead to adverse outcomes (Hofmann & Frese, 2011). For example, a surgeon may follow all the approved practices, but make a poor strategic decision that leads to a patient’s death. Or a designer may create a part in an automobile that causes unexpected acceleration, leading to vehicle crashes and injuries to the occupants. It might be possible to extend our thinking on organizational errors to these other types of errors. In many organizational settings, it could be the interaction of strategic and/or design errors with execution errors that creates significant adverse organizational outcomes. This phenomenon represents another avenue for research.

A final issue deals with intentionality (Hofmann & Frese, 2011). We excluded intentional rule deviations from our analysis. In cases of fraud, for example, such deviations are consciously made for personal gains. At the same time, we realize that intentional deviations do occur, and they are complex to understand and measure. In this chapter, since our goal is to introduce a new conceptualization of organizational-level errors, we needed to draw some boundaries. We excluded explicit intention to commit fraud or other illegal acts. However, intentionality in this context is a fascinating construct. Future work on organizational errors should explore it in more detail.

Despite some limitations, the fundamental idea of this chapter is to focus on organizational errors rather than just errors caused by individuals who happen to be operating in organizations. Organizational errors present a host of challenging theoretical and methodological issues, many of which we have identified. We call attention to this particular focus on levels of analysis in hopes of directing future work in this area. Underlying this call for new theory and measurement practices is the recognition of the social and human impacts of
organizational errors in our daily lives. The BP oil disaster, which includes many examples of organizational errors, affected our environment, peoples’ livelihoods, and most important, peoples’ lives. In West Virginia, the coal mine explosion took peoples’ lives, led to changes in government practices, and continues to create substantial costs. In Arlington National Cemetery, an important symbol in American history and life, organizational errors resulted in disrespectful treatment of people who had given their lives in the service of their country. Organizational errors are not simply a new object of study; they have broad human and social ramifications and, therefore, present a rich and important area for future research.
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**Figure 1: Multiple-Level Predictors and Mediating Mechanisms**

- **Levels**
  - Individual
  - Unit
  - Organization

- **Predictors**
  - Stress tolerance
  - Experience in unit
  - Family/work distractions
  - High interdependence
  - High visibility
  - High interruptions
  - Safety Culture
  - Rate of change
  - Reward Systems
  - Safety Culture
  - Emphasis on learning

- **Mechanisms**
  - Learning
  - Error correction
  - Error amplification
  - etc.
  - Organizational/Unit Errors
  - Consequences
    - Death
    - Costs
    - Reputation
Figure 2: Contextual Perspective of Organizational Errors

Contextual Features
(e.g., hazard profile; external pressures; organizational strategy)

Multi-level antecedents

Mediating processes

Organizational Errors
Table 1: Error management approaches

<table>
<thead>
<tr>
<th>Phases</th>
<th><strong>Prevention approach</strong></th>
<th><strong>Resilience approach</strong></th>
</tr>
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<tbody>
<tr>
<td><strong>Before</strong></td>
<td>Design rules and standard operating procedures</td>
<td>Promote a climate of psychological safety to facilitate open communication</td>
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<tr>
<td></td>
<td>Provide training</td>
<td></td>
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<tr>
<td></td>
<td>Carry out audits and inspections to enforce compliance</td>
<td>Develop a culture of high reliability</td>
</tr>
<tr>
<td></td>
<td>Develop contingency plans, safety drills</td>
<td>Build vigilance and improvisation skills</td>
</tr>
<tr>
<td><strong>During</strong></td>
<td>Rely on pre-specified emergency response plans</td>
<td>Initiate a fast response; Improvise as needed by drawing on collective experience and expertise</td>
</tr>
<tr>
<td><strong>After</strong></td>
<td>Carry out after event analysis to identify system vulnerabilities</td>
<td>Involve participants to develop capabilities in process improvements</td>
</tr>
<tr>
<td></td>
<td>Implement system level improvements (e.g., new rules, technology)</td>
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