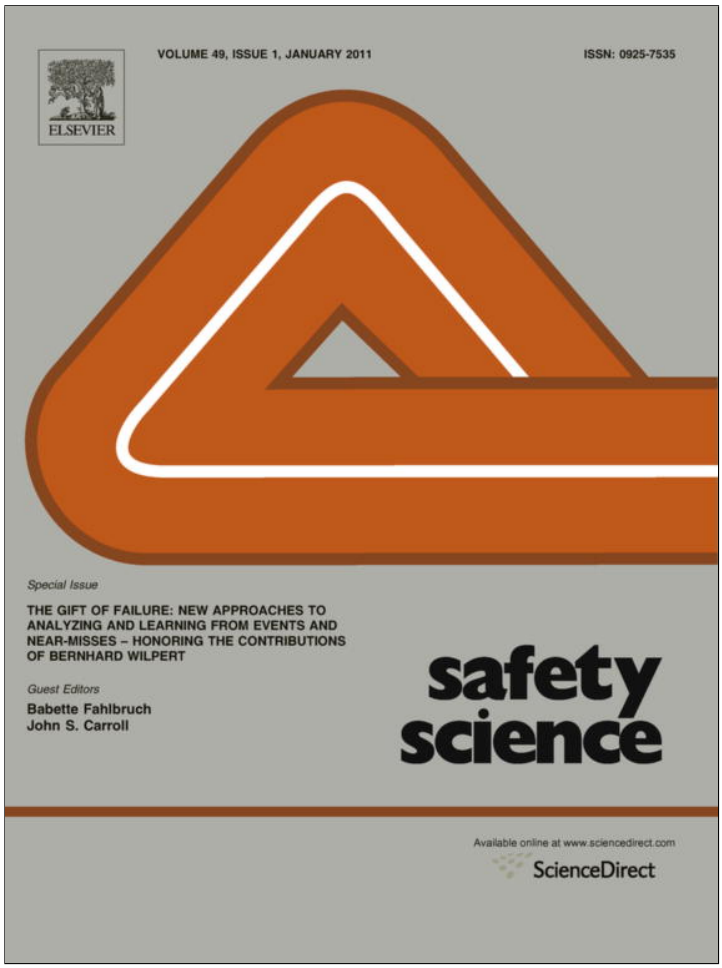

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The challenge of collective learning from event analysis

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ABSTRACT

This paper examines the difficulties of learning from event analysis. The central idea is that learning represents a distinct set of team-or unit-level outcomes and processes that is different from valid analysis, effective problem-solving, or individual learning. In other words, event analysis cannot automatically generate group learning. For learning to occur, several conditions must be satisfied: Change in the team's or unit's repertoire of behaviors (the learning) must be a clear outcome of the event analysis; this learning must be shared by the team members (i.e., members must become aware of both the content of the learning as well as of the fact that other members are aware of this learning); the shared learning must be stored in repositories for future retrieval; the stored learning must be retrieved when the team subsequently encounters situations where the learning is relevant; and, finally, these processes of sharing, storing, and retrieving the learning must continue to occur over an extended period of time. These requirements pose major dilemmas or challenges for learning from event analysis. We discuss these challenges using examples from event analysis teams in two hospitals and in a computer emergency response center. We offer some potential strategies for addressing these challenges.

1. Introduction

This paper examines the linkages between event analysis and learning. Event analysis involves an investigation of a focal event, such as an accident or error, which can be costly to an organization. The objective is to identify the major causes of the event and implement corrective actions to prevent the event from recurring. Learning refers to the acquisition of new repertoires of behaviors (e.g., corrective actions from event analysis). One premise in event analysis is that learning should follow from event analysis. We argue that many features of event analysis, as typically carried out, present significant obstacles to learning. In developing this argument, our specific goals are to (1) examine some of the obstacles that prevent event analysis from contributing to learning, and (2) identify strategies that might facilitate learning from event analysis. To this end, we address the following questions: What are the basic features of event analysis that are relevant to understanding the challenges of learning from event analysis? What do we mean by learning and how are the outcomes and processes of learning distinct and different from event analysis? What are the major obstacles or dilemmas in moving from event analysis to learning? And finally, what are the strategies for creating better linkages between event analysis and learning?

We have several objectives for drawing attention to these questions. First, we wish to clarify the notion of learning in the context of event analysis by discussing not only what learning is but also what learning is *not*. Such delineation is critical because discussions of event analysis frequently equate "learning" with effective problem-solving and improvement in safety outcomes. However, as we discuss later in this paper, learning refers to a distinct set of outcomes and processes that can occur with or without valid event analysis. Second, we seek to highlight an underappreciated feature of event analysis: it is almost always a *social* activity. The fact that event analysis is typically carried out by individuals or groups presents the challenge of determining *who* learns from the process. Not only is group or unit learning different from the learning of the individual members of the team, but the processes that contribute to group learning also differ from the processes that contribute to learning of individual group or unit members (Wilson et al., 2007). We identify and discuss the characteristics or features of group learning that are especially important for understanding learning from event analysis. Third, we wish to identify major dilemmas or challenges that teams encounter in attempting to learn from event analysis. Discussions of event analysis often tend to ignore challenges that are inherent in the complexity of group or unit learning. Finally, we discuss some strategies for strengthening the link between event analysis and learning. Simply stated, it is necessary to understand what learning

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is (and is not) in order to determine whether event analysis is effective with respect to one of its most important goals (i.e., learning) and to design targeted interventions for enhancing its effectiveness.

In addressing these questions, we draw from our ongoing work on event analysis in computer emergency response teams and hospitals. In one study (Goodman and Wilson, 2003), we observed teams at a national computer emergency response center that respond to threats or attacks, such as a widespread worm or virus, on the internet infrastructure. Whenever such an attack occurs, an incident response team is formed to deal with the attack. This team works with external experts to identify a fix or patch, keeps the broader community informed about the incident, and generally serves as an unbiased source of information (i.e., not affiliated with any software providers). We directly observed several meetings that the response team would hold after each event (e.g., a virus attack) to analyze how it had responded and to learn about improving its response to future events. In another study (Ramanujam et al., 2005; Anderson et al., 2010), we examined the efforts of two hospitals to analyze the adverse events in their medication administration processes. In each hospital, multi-disciplinary teams analyzed critical medication errors, defined as instances where the patient was harmed, with a view to identifying the underlying causes and learning to prevent future occurrences. We attended multiple meetings where the teams analyzed critical medication errors. In addition, we also interviewed participants individually to collect information about corrective actions that were implemented following the event analysis. Notes from the observations and interviews were analyzed to draw inferences, which were subsequently shared with the participants for validation. We provide examples from these settings below to illustrate our arguments.

2. Variations in the practice of event analysis

To set the stage, we discuss some basic features of event analysis that can vary across settings and can potentially influence the process of learning. Broadly, event analysis can be characterized in terms of the *focal event, purpose, analysis method, and participants*. With respect to the focal event being analyzed, the criteria used to select an event for in-depth analysis can vary across organizations. For instance, in both the hospitals that we studied, medication errors were defined as any instance of failure to administer the right dose of the right drug at the right time through the right route (e.g., oral or intravenous) to the right patient. Moreover, the internal procedures in both hospitals called for a formal analysis of any error that harmed a patient. However, each hospital used different criteria to determine whether a medication error harmed the patient and, therefore, warranted analysis. In Hospital A, "patient harm" referred only to those medication errors that produced visible consequences that were severe and potentially life-threatening (e.g., an overdose that resulted in temporary loss of consciousness). In Hospital B, "patient harm" referred to any medication error that required extended hospitalization and/or additional treatment for the patient; the definition specifically included errors where the patient was not physically harmed but was placed under extended observation as a precautionary measure.

Differences in the criteria used for identifying events determine the frequency of event analysis. For instance, Hospitals A and B were similar in many respects, including size, volume of patients, medication doses dispensed daily, and the number of safety incidents recorded in their internal databases. Yet during the same 12-month period, Hospital A identified two medication error events for event analysis whereas Hospital B identified 12 medication error events. Significantly, our interviews with the hospitals' risk managers suggest that had both hospitals used the same criterion each hospital would have identified more or less the same number of events as the other hospital. In other words, had both hospitals used the more severe criterion for harm, each hospital would have identified 2–3 incidents for event analysis; had both hospitals used the precautionary criterion for harm, each hospital would have identified 12–15 incidents for further analysis. The limited number of events in Hospital A limits opportunities for high-quality event analysis and learning.

Second, the stated purposes of event analysis can vary. The goals can include assigning accountability, identifying root causes, fixing a previously unrecognized problem, preventing the recurrence of a similar event, improving safety outcomes, and learning. In both Hospitals A and B, the stated purposes of event analysis included identifying root causes and implementing corrective actions. Moreover, these goals were discussed in terms that were specific to the focal event (e.g., prevent errors related to a specific drug). However, in neither hospital was learning identified as an explicit goal.

Third, event analysis can vary in terms of the analysis method (formalized vs. ad hoc) as well as the time that is spent analyzing the event. In both hospitals, event analysis tended to be ad hoc; that is, the steps of analysis tended to vary from one event analysis to another. Typically, the event analysis started with the team collecting detailed information about the focal event. In a few cases, the analysis team interviewed the people who were directly involved in the event. More often, however, the team asked the manager of the unit where the event occurred to submit a formal report of what had happened. The team then discussed various "root causes" of the event and came to a consensus about a set of causes as well recommendations. Toward the end of our observation period, the management of Hospital B expressed the need to switch to a "more systematic and consistent" approach for analyzing events. They hired external consultants to train the event analysis team in a formal methodology known as Failure Mode Effect Analysis (FMEA; McDermott et al., 2008).

Our purpose in highlighting the availability of different methods for analyzing events is to point out some implications for information-sharing processes within the analysis team. In other words, we are not concerned here with the relative validity of one method over another. From a learning viewpoint, two aspects of the analysis may be especially important. First, the extent to which a method is formalized and how it is implemented can affect the opportunities for team members to exchange information and ideas. During the initial FMEA training session at Hospital B, several members of the event analysis team expressed concerns about the flow charts and protocols they would have to start using. The team leader remarked, "I am sure we will all learn to apply FMEA faithfully, but I do worry whether we will forget to analyze the event in the process." Later, she told us that her people on the team might apply these methods in a formulaic manner. The point here is not so much whether such concerns were justified, but rather that the extent to which a method is formalized can affect the communication among team members. The second important aspect is the length of time team members spend together analyzing an event. In Hospital A, each event analysis was completed in a single 2-hour meeting. In contrast, in Hospital B, each event analysis required multiple meetings. Again, the point here is that the duration of the event analysis (which is a function of the level of detail used in a particular analysis method as well as the time allocated for the analysis by the organization) influences the opportunities for information-sharing and learning within the team.

Fourth, the composition of the team carrying out the event analysis can vary. Are the team members the same as or different from the people directly involved with the focal event? To what extent

does the composition of the event analysis team vary from one event to another? In the case of the computer emergency response team, the "after attack reviews" typically identified actions that could help the team respond more effectively to future attacks. However, the opportunities for learning were limited by the variations in the composition of the team from one attack to another. Depending on the nature of the attack, the team might include members of other incident response teams, experts at vendor sites (for e.g., when vulnerabilities in their software are being exploited), and government officials.

Given such variations in how event analysis is carried out, we next turn to discussing what constitutes learning from event analysis and how the features of event analysis present conceptual and practical challenges for assessing such learning.

3. Differentiating learning from event analysis

Following Wilson et al. (2007), we define learning from event analysis as a change in the repertoire of behaviors in the entity that stems from the analysis activities. In this case, learning represents a shared understanding among group members of a new course of action to minimize or prevent the recurrence of negative events. In the hospital example, let's assume a unit had an increase in medication errors. An event analysis might lead to a new set of activities designed to reduce medication errors. If learning does take place from the event analysis, this new repertoire would be shared, stored, and enacted at the appropriate time. In this example, learning differs from problem-solving, which focuses on why the increase in medication errors occurred and what one might do in response (Tucker, 2007). Learning represents the shared understanding of a new repertoire to solve the problem. *Learning* also differs from *performance*. Performance in this example represents a reduction in medication errors, which is different from developing a new repertoire of behaviors to draw upon.

An important idea here is that learning is not the same as effective problem-solving or performance improvement. For instance, effective problem-solving may not lead to learning. In other words, the computer team might have managed a particular virus attack, but that does not necessarily increase the team's capacity to respond effectively to future attacks. Or, a hospital might have identified a specific overdose cause, but without identifying any additional actions to prevent similar overdoses in the future. Also, a reduction in the frequency of similar medication errors can happen for extraneous reasons such as a temporary drop in patient volumes that have little to do with the event analysis or with any new repertoires identified by the group. In this case, there would be a reduction in errors but not learning.

4. Articulating learning processes

Given our goals—to identify the dilemmas inherent in learning from event analysis and to explore potential strategies for managing these dilemmas—we need to further clarify the outcomes and processes of learning. As an outcome, learning represents the acquisition of new repertoires, representing a change in a group's potential behaviors (Huber, 1991). The repertoire, which is linked to the solution identified by the team following the event analysis, could be a new task strategy for administering a specific drug or knowledge about who has expertise in the group or unit about the use of the drug. However, teams often fail to identify effective solutions (Nutt, 1999). For instance, consensus-building rather than factual analysis can drive the search for solutions in team decision making contexts (Nutt, 2007). As a result, teams often limit their discussion to readily available and politically unproblematic solutions. They often fail to consider new and potentially more appropriate solutions. Therefore, the content of learning from event analysis is frequently incorrect (Nutt, 2007).

Learning is also a set of group-level processes for developing a shared understanding of the new repertoire and for storing, accessing, and retrieving this understanding (see Fig. 1). This means, given a similar situation, the group or unit can access the previously learned routine for administering that drug. Inherent in this definition of learning is the concept of time. The complete sequence of actions includes identifying an event, analyzing its causes, developing a solution or new repertoire, ensuring it is shared within the group or unit, finding a place to store the solution, and then later retrieving and applying it at the appropriate time and in the right situation (Hinsz et al., 1997). Time is inherent in these processes. Simply identifying a solution is part of event analysis, but does not entail learning.

Since these processes are central to understanding the challenges in collective learning from event analysis, we briefly discuss each of the learning processes below.

4.1. Sharing

We define sharing as the process by which new knowledge, routines, or behavior becomes distributed among group or unit members, and members understand that others possess that learning. Group learning must be shared, taking on structural properties and exerting influence beyond the individuals who constitute the collective, before it becomes a legitimate group construct (Morgeson and Hofmann, 1999). Group learning is a property of the group. It occurs when the members possess new knowledge about something as well as an understanding (either explicit or tacit) that others have the same knowledge. This means that a new group repertoire now exists, and it is independent of any particular individual. Several contextual conditions promote sharing, including the climate of psychological safety (Edmondson, 1996) and procedural fairness (Tangirala and Ramanujam, 2008).

4.2. Storage

Another feature of group or unit learning is that the change in the repertoire needs to be stored in memory. Storage is necessary for learning to persist over time (Moorman and Miner, 1998). A variety of repositories (e.g., human memory, computer databases) and different types of knowledge (i.e., tacit or explicit) must be taken into account in order to fully understand how groups store knowledge. One unexplored area is the fit between different types of repositories and different types of knowledge and the implications of fit (or lack thereof) for learning. The memories of group members constitute the most obvious group repository. Another type of repository includes formal group memory systems that emerge from groups' information technology structures. Shared databases, bulletin boards, and expert systems are examples of this type of repository (Olivera, 2000). Finally, structural storage repositories such as standard rules, procedures, and cultural artifacts can store group knowledge (Argote, 1999). Acknowledging these multiple repositories is important, because they represent different systems for storage and different functionalities for acquisition, retention, and retrieval of learned information.

Storage repositories have a number of common features that also impact learning. Indexing, filtering, and maintenance functions are important components of any storage system (Olivera, 2000). Good indexing systems facilitate both where information is stored and how it is retrieved. Filtering is a process that screens out irrelevant information before information is stored. Maintaining a memory system refers to updating information, deleting obsolete data, and so forth. We expect that these features of storage

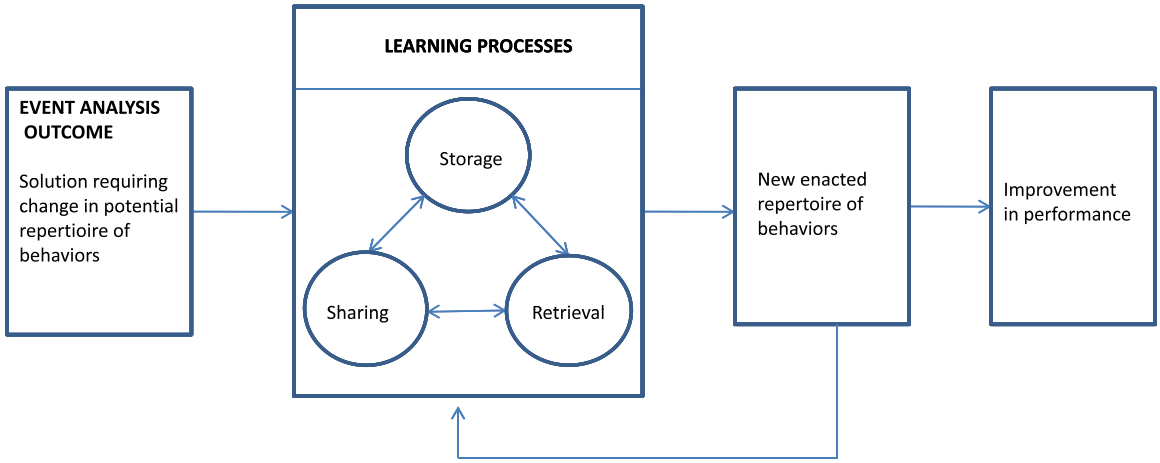

Fig. 1. Learning from event analysis.

systems will affect both the use and the utility of the storage process.

4.3. Retrieval

Retrieval means that group members can find and access the knowledge for subsequent inspection or use (Anderson, 2000). For a group to effectively retrieve stored knowledge, several subprocesses must take place: (1) the group or one of its members, faced with some stimulus object, must recognize the need to access stored knowledge; (2) the group, or at least one member, must identify where the knowledge is stored; and, finally, (3) the group must actually retrieve the knowledge. Eventually, we must also consider whether the group or unit can apply the retrieved knowledge in the new situation.

It is not unusual for members of a group or unit to think that they have stored new learning, only to discover that the group does not access it when the next opportunity to apply the learning presents itself. We observed this multiple times with the emergency response teams, when, for instance, members shared learning about the importance of establishing a protocol for real-time updating of all team members' technical understanding of an incident as it unfolded. Even though this learning was repeatedly shared among team members and was stored in at least one formal After Action Review document and in the memories of at least four team members, core team members failed to even mention the learning, much less enact it, during subsequent incidents. Despite the importance of retrieval for group learning and the fact that retrieval has been identified as the most critical part of the learning process at the individual level (Anderson, 2000), this process has been largely ignored in the literature on group learning.

Taken together, these features signal that several conditions must be satisfied before we can conclude that event analysis resulted in learning. Change(s) in the team's or unit's repertoire of behaviors (the learning) must be a clear outcome of the event analysis; this learning must be shared by the team members (i.e., members must become aware of both the content of the learning as well as of the fact that other members are aware of this learning); the shared learning must be stored in repositories for future retrieval; the stored learning must be retrieved and enacted when the team subsequently encounters situations where the learning is relevant; and, finally, these processes of sharing, storing, and retrieving the learning must continue to occur over an extended period of time.

Viewed in the context of these requirements, the immense challenges in learning from event analysis become more evident. The teams we observed in the computer emergency response centers as well as the hospitals were made up of skilled and committed professionals working together to make sense of consequential events. However, despite being highly motivated and capable, these teams encountered significant challenges with respect to every single aspect of learning from event analysis. We believe that these problems are not unique to these teams or units, but rather represent basic dilemmas that are inherent in any effort to generate team learning from event analysis. We discuss these dilemmas in the next section.

5. Dilemmas in learning from event analysis

One of the questions we posed at the beginning of this paper was about identifying the major obstacles or dilemmas in moving from event analysis to learning. Our descriptions of event analysis and learning point to various reasons that make it difficult for groups to learn from event analysis and utilize these new and more effective repertoires. Some of the reasons include:

Failure to distinguish between stopping at analysis and learning from analysis. As discussed earlier, learning differs from problem-solving and performance. Yet, the event analysis teams that we observed rarely identified team learning as a specific objective. They referred to learning in general terms as reflected by the questions driving their analysis, "What contributed to the event?" and, "How can we prevent a similar event from happening again?" Teams often responded to these questions in such a way that the behavioral implications were unclear. For e.g., in the case of a medication error event involving administration of the wrong drug, the team concluded that the event was caused by the previously known potential for a mix-up between two drugs with very similar sounding names. The team recommended that the pharmacists and nurses "should be more vigilant" in dispensing and administering that drug. From the viewpoint of learning as a change in the repertoire of a group's behaviors, it was unclear whether the behavior of pharmacists and nurses could potentially change based on this vague recommendation. As result, it was difficult to determine whether learning was even an initial outcome of this event analysis. Interestingly, team managers as well as individual team members acknowledged the usefulness of event analysis for their personal learning. However, when asked about what they had learned, they pointed to the conclusions and recommendations of their analysis. In other words, they tended to view analysis and learning as being equivalent.

Failure to distinguish between learning and other related outcomes means that, even when teams acknowledge that learning

is an important purpose of event analysis, they might set goals for learning that are incorrect (i.e., limiting it to an understanding of what caused the event) and/or general (i.e., stating it in terms that make it difficult to verify goal attainment). This makes it less likely that learning will emerge as an outcome of the analysis.

Inability to create a shared understanding. Learning from an event analysis requires a shared understanding of the new repertoire, which goes beyond simply identifying a solution. This is a group or unit-level phenomenon. If someone leaves the group, the shared understanding must persist. If a new person joins the group, they must be socialized in the new repertoire. The group needs to possess and utilize good process skills to check for understanding and commitment to the new repertoire. Failing to do this may mean that problem-solving, but not learning, has transpired.

Another issue deals with group composition. Many of the groups we have observed in hospitals doing event analysis on errors are not the same groups that would implement any new procedure that might be identified. Typically, the event analysis teams attract people from multiple areas in the hospital while implementation of a new drug administration procedure would be done within a specific, defined unit (e.g., the cardiac unit). This creates an interesting problem: The work involved in developing a shared understanding has primarily occurred in the event analysis team, not the main unit implementing the repertoire. In this case, the chances for improved performance are reduced, and learning will not occur. That is, the team's learning and the unit's learning were not linked.

Insufficient understanding of the role of storage repositories. In the research literature there is not much work on the storage process in group-level learning. Earlier, we mentioned that multiple storage mechanisms exist. Despite the options, groups often rely on members' memories rather than using shared databases, bulletin boards, expert systems, or structural storage repositories such as standard operating procedures. The challenges include selecting a repository method, designing good indexing and filtering mechanisms and maintaining the repository, all of which are especially difficult when such activities are not part of a conscious, explicit process at the group or unit levels. Often when an event analysis team comes up with a solution or new repertoire, the team does not explicitly state where the solution is stored or how it is to be accessed in the future. Another problem mentioned above is that the event analysis team might store its solution in the meeting notes, but these are not available to the units that are responsible for actually implementing the solution on the front line. As an example, our computer emergency response teams were being deluged by the media when an internet attack occurred. This disrupted their work, which needed to be done quickly. They agreed to initiate a press conference to control the media requests. However, in future attacks, they did not use the press conference solution. The new repertoire was stored, but its location was not visible to the group. Also, in each attack, the composition of the group changed. Thus, there was storage but no learning. Accessing and using the new repertoire are important conditions of real learning.

The challenges of retrieving stored information. Retrieval is a critical process for learning. Also, it is a difficult process. For one thing, the length of time that might lapse between the occurrences of similar events inhibits retrieval. In the emergency response team, many members also were geographically distributed, which further reduces the effectiveness of retrieval. We also know from the learning literature that the rate of organizational forgetting can be high and that subsequent learnings can interfere with prior learnings (Argote, 1999). For all these reasons, retrieval is difficult.

The learning literature notes some factors that can facilitate retrieval and learning (Anderson, 2000). The question is whether these factors emerge in event analysis. As one example, practice can facilitate and strengthen ties to retrieving past learnings. The frequency and timing of practice can make a difference. In our experience, many hospital event analysis teams meet monthly and deal with different events each time. If the opportunity to practice root cause analysis with similar events, create a solution or reach a level of shared understanding does not present itself, learning will not occur. Similarly, the concept of elaboration is central to retrieval. Say that you develop a new repertoire about dispensing a particular class of medications. Elaboration means you practice the processes inherent in event analysis (e.g., root cause analysis) and learning (e.g., creating shared understanding) across a variety of medications in the same class. This will build a more differentiated repertoire that is sensitive to slight variations in the stimulus object. The basic idea is that retrieval is difficult in the most simple learning tasks; in the group or unit setting it is that much more complicated. The variability in events, the different group constituencies (i.e., event analysis team vs. actual front-line unit), and time lags all create difficulties in retrieval. Even with a good event analysis, no retrieval means no learning.

6. Strategies to improve the event-analysis-learning link

The above dilemmas present major challenges to learning from event analysis. In this section, we draw from the literature on learning as well as our observations to suggest some strategies for addressing these dilemmas. We recognize, however, that there is much in this regard that remains unknown and further research is warranted.

There are several strategies that can *potentially* strengthen the linkage between event analysis and learning. Our discussion draws from our conceptualization of team learning presented earlier as well as our observations of event analysis teams in two different contexts. The discussion is necessarily qualified, because we observed few instances that included all aspects of learning from a single event analysis. In our study of the teams in the hospitals and computer emergency response center, we observed several separate examples of effective individual learning processes. However, in no single instance could we identify learning (i.e., a change in the group's repertoire of behaviors) that was shared, stored, and retrieved over a period of time at the team-or unit-level. While part of our inability could be the result of the narrow window of our observations (12 months), we believe that much of it underscores the conceptual and managerial challenges in recognizing learning, let alone promoting it. There is much that remains unknown about learning from event analysis. What follows is our effort to identify several strategies for promoting a better linkage between the two.

Any attempt to promote team learning from event analysis must take into consideration the conceptualization of event analysis and learning advanced in this paper. Learning is a complex set of outcomes and interrelated processes. To be effective, the strategy must mirror as well as address this complexity. In other words, no single strategy can sufficiently bridge the gap between event analysis and learning. Learning from event analysis requires a *set* of integrated strategies.

Based on our work with event analysis teams in the computer emergency response center and hospitals, we think that the following strategies may be useful in promoting learning from event analysis.

(a) *Develop an understanding of learning*: One of the specific goals of training team members for analysis must be to develop an understanding of learning as a distinct set of behaviorally-oriented outcomes and processes, including an understanding of the key components of sharing, storage and retrieval. In the hospitals that we observed, the training for event analysis focused almost exclusively on the analysis

technique, and very little on learning. From a learning viewpoint, it is critical that managers treat the completion of the analysis not as learning in and of itself, but rather as a first step toward learning. One strategy could be discussing analysis and learning in separate training sessions.

(b) *Identify learning as an explicit goal*: Team leaders and members must be trained to derive behavioral implications from the results of the analysis. For e.g., if the analysis identifies the potential for confusion between two similar sounding drugs as the cause, then rather than recommend "increased vigilance," the team could say that telephone orders of these drugs must require a call back including not only a confirmation of the order but also spelling back the name to verify that it is drug A and not drug B. That is a specific new repertoire to implement greater vigilance, rather than a vague notion that some unspecified person should be more vigilant about the two drugs.

(c) *Develop a learning protocol*: A consistent feature of the event analyzes that we observed was the useful role of questions. Across teams and organizations, questions such as, "What caused the event?" and, "How can we prevent it from happening again?" were infused in the conversational routines and played an important role in directing attention to particular issues. However, we heard few targeted questions about learning. It is possible that an appropriately designed protocol of learning-oriented questions might be useful in helping teams actively manage the processes of learning from event analysis. Examples of such questions include:

i. Based on our analysis of what caused the event, what should we do differently if and when a similar situation arises in the future?
ii. Do we all agree that this is what we will do differently?
iii. What can we do to ensure that we will remember this learning down the road?
iv. If we are not the ones to implement this specific solution, how do we communicate this solution to the people who will be implementing it?
v. How can we reliably recognize situations where this learning is relevant?
vi. How sure are we that if a similar situation were to come up, we (or someone else) will respond appropriately?
vii. How confident are we that, one year from now, we (and others) will use what we learned from this event analysis when appropriate?
viii. If we are not satisfied with the answers to these questions, what can we do to address the underlying problems?

(d) *Redesign and manage the processes of event analysis*: We observed managers displaying tremendous sensitivity about the selection of a method in terms of its validity, costs (in terms of people and time), and relevance. For instance, they discussed design choices such as purpose, team composition, time, and the specific method in these terms. It is equally important that the design choices of event analysis take into account the implications for learning. Two questions are immediately apparent: Given the current design, what can be changed to promote learning? If the existing process cannot be modified, then what are the learning dilemmas arising directly from these features, and what can be done to address these dilemmas? For e.g., event analysis is frequently designed in such a way that the analysis is carried by a separate team that presents its conclusions to another team that is actually responsible for the routine work, such as the hospital team that was largely unconnected to the personnel responsible for prescribing drugs. Another common design is one where the membership of the team varies from one analysis to another, as with the computer emergency response teams we observed. Such features present some obvious challenges both for identifying effective solutions following event analysis (Nutt, 2007) as well as for the key learning processes of sharing, storing, and retrieval. We recognize that the design features of event analysis teams sometimes stem from a need to manage constraints such as costs, time, and scarce expertise. In such cases, it is even more important that managers consider developing strategies to overcome the learning dilemmas presented by these features.

(e) *Develop targeted strategies to enhance specific learning processes*: In terms of the learning processes discussed earlier, several strategies can potentially facilitate learning. For example, analysis teams could spend time discussing the specific learning outcome of an event analysis for some period of time so that they can observe and verify that everyone on the team agrees with the specific learning. If the team analyzing the event is different from the one carrying out the task, then steps must be taken to facilitate the sharing, retrieval, and future application of this learning. For example, those responsible for implementing a new repertoire could be invited to observe or participate in the event analysis. If this is not possible, they could be asked to carry out an event analysis on their own to arrive at the same conclusion. This will provide them the opportunity to develop a shared understanding. Team leaders play an especially important role in creating the conditions that facilitate sharing. This includes displaying procedural justice (Tangirala and Ramanujam, 2008), engaging in learning behaviors (Nembhard and Edmondson, 2006), and creating a climate of psychological safety (Edmondson, 1999). They should also ensure that procedures are in place to make newcomers to the team aware of past learnings so that changes in team composition do not diminish what has been learned.

Event analysis must involve identifying how the learning will be stored, especially with retrieval in mind. Teams should consider different storage devices including computer databases, wall charts, etc. before selecting a mix of devices that will facilitate retrieval. As discussed before, practice and elaboration are two important ways that retrieval can be enhanced. However, event analysis poses a particular problem in this regard. Typically, the focal events tend to be dissimilar and rare. In other words, following an event, teams may not encounter a similar set of conditions that require the learning to be retrieved. One way to verify the team's capability for retrieving past learning could be to analyze more similar events (for e.g., by changing the selection criteria to result in more analyzes). Another possibility includes using computer simulations to expose teams to several similar events and verify whether they can retrieve the learning.

Taken together, these strategies suggest that any effort to assess learning from event analysis must assess whether learning has occurred, whether it is shared and stored so that it can be (and is) retrieved when appropriate and whether these conditions are satisfied not just in the immediate aftermath of an event analysis but also over a period of time. Although many of the individual strategies discussed above are widely used, what is important is that they are used in an integrated manner by taking into account the distinctive features of learning from event analysis.

7. Conclusions

The goal of this paper was to draw attention to the conceptual and managerial challenges in learning from event analysis. The central idea is that, both in theory as well as in practice, learning represents a set of team-or unit-level outcomes and processes that

are different from valid analysis, effective problem-solving, or individual learning. In other words, event analysis cannot automatically generate group learning. Teams must develop an informed and purposeful set of strategies to learn from event analysis. This will require managers to better understand what learning is and what it is not and recognize that the design of event analysis presents challenges for learning that must be actively managed. The conceptualizations of learning advanced in this paper point to several implications for training, design, and assessment of event analysis. Several questions remain unanswered and warrant future research.

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