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## System Safety in Healthcare

### Swiss Cheese Model for Investigating the Causes of Adverse Events

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by Dev Raheja, Maria C. Escano, MD

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One appealing approach to mitigating human errors is the one proposed by James Reason [Ref. 1]. Generally referred to as the "Swiss cheese" model of human error trapping, he describes four levels of human failure, with each level influencing the next (seen in Figure 1). These failures are likened to holes in a Swiss cheese. Working backwards in time from the adverse event, the first level depicts those "unsafe acts" that ultimately led to the mishap.

This level generates the most investigation and, consequently, is the level where most causal factors are uncovered. After all, it is typically the actions or lack thereof that are directly linked to the adverse event. For instance, failing to properly administer a medication may yield grave consequences, as in the recent death in a California hospital where a nurse gave a cancer patient an enteral solution intravenously instead of through a feeding tube [Ref. 2]. Represented as "holes" in the Swiss cheese model, these active failures are typically the last unsafe acts committed by caregivers.

What makes the "Swiss cheese" model particularly useful in investigating adverse events is that it forces investigators to address latent failures within the causal sequence of events. The latent failures are also "holes," but in different slices of cheese. As their name suggests, latent failures, unlike their active counterparts, may lie dormant or undetected for hours, days, weeks or even longer, until one day, they adversely affect the unsuspecting caregiver. Consequently, they may be overlooked by investigators — even those with the best intentions.

Within this concept of latent failures, Reason described three more levels of human failure. The first involves the condition of the caregiver as it affects performance. Referred to as *preconditions for unsafe acts*, this level involves conditions such as mental fatigue, poor communication and coordination practices, and frequent interruptions. Not surprising, if fatigued caregivers fail to communicate and coordinate their activities, poor decisions are made and errors often result.

Human Factors Analysis and Classification System (HFACS)

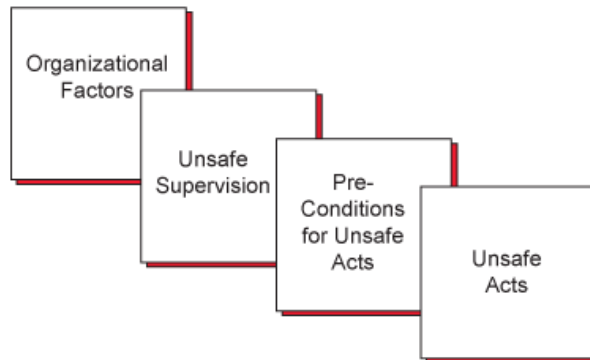


Figure 1 — The "Swiss Cheese" Model of Human Error Causation [Ref. 3].

But why do communication and coordination break down in the first place? In many instances, the

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breakdown in good practices can be traced back to instances of *unsafe supervision*, the next level of human failure. If, for example, inexperienced caregivers are unfamiliar with certain tasks, such as medication delivery and dosing, or lack experience with utilizing medical equipment — from ventilators to laboratory machines — errors from lack of sufficient supervision are prone to happen. To make matters worse, the lack of quality assurance audits, support system, training and availability of qualified personnel can increase the potential for more errors. In a sense, these caregivers were "set up" for failure.

Reason's model doesn't stop at the supervisory level; the organization itself can impact performance at all levels. For instance, in times of fiscal austerity, funding is often cut and as a result, training is curtailed and work load becomes excessive. Not surprisingly, failures will begin to appear, all of which will affect performance and errors. Therefore, it makes sense that if the adverse events are to be prevented, they must be analyzed in entirety and foreseen beyond the caregiver. Ultimately, causal factors at all levels within the organization must be addressed if any prevention system is going to succeed. One needs to know what these system failures or "holes" are, so that they can be identified during investigations or, better yet, detected and corrected *before* an adverse event occurs.


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The FDA monitors these adverse events. In the case of adverse events secondary to medical devices, the FDA recommends three levels of follow-up. This model might prove useful if applied in a hospital setting. The first level involves damage control — "correction." It refers to recognizing the error and providing an immediate intervention to prevent further harm. The second level involves finding a permanent solution so that the same event never happens again. This level is called the "corrective action." The third level is called "prevention action." This involves looking for system-wide solutions so that similar events never happen in other areas of the hospital. The FDA guideline makes sense in light of the Swiss cheese model.

The Swiss cheese model in healthcare facilities can be applied in numerous ways. We can constantly monitor symptoms and causes of latent hazards in all three levels, namely the conditions of the caregiver, unsafe supervision and causal factors at the organizational level, and mitigate them before any patient safety issue arises. Below are some examples.

**Caregiver level factors:**

- Failure to prioritize; lost focus and attention
- Omission of a step in a procedure
- Inadequate procedure
- Omission of a checklist item
- Inadvertent use of medical device controls
- Use of improper procedure
- Inadequate ability or training
- Wrong response to emergency
- Insufficient safeguards in delivery of medications

**Unsafe supervision factors:**

- Inadequate sanitization habits
- Occasional ignoring of the checklist
- Lack of availability of caregiver support
- Inadequate training of staff and inadequate supervision
- Insufficient enforcement of policies
- Time pressure prevents a junior caregiver from speaking up
- Inadequate use of lessons learned to prevent mishaps
- Insufficient focus on system thinking
- Insufficient training

**Organization level factors:**

- No ongoing senior management reviews of risks and mitigations
- Lack of documented procedure on risk assessment
- Lack of regular review of prevention of adverse events
- Lack of policy for prevention of adverse events
- No measure of policy effectiveness
- Poor cross-functional teams to prevent latent hazards

**Conclusion**

The Swiss cheese model offers a highly effective approach in understanding and preventing adverse


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events. It facilitates a multi-dimensional view of healthcare delivery, and offers preventive strategies and mitigation solutions in different levels.

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