

The University of Texas Threat and Error Management Model: Components and Examples

Robert L. Helmreich Ph.D.

David M. Musson, M.D.

Department of Psychology

The University of Texas at Austin

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University of Texas
Human Factors
Research Project

Notes

Robert L. Helmreich is Professor of Psychology, The University of Texas at Austin and Director, University of Texas Human Factors Project. The work reported was supported in part by a grant from the Carl Benz und Gottlieb Daimler Stiftung. Correspondence to Robert L. Helmreich, Department of Psychology, The University of Texas at Austin, Austin, TX 78712, U.S.A. helmreich@psy.utexas.edu

David M. Musson is a physician and a doctoral student in Psychology at the The University of Texas at Austin. He is supported by a Fellowship from the Medical Research Council of Canada. Musson@mail.utexas.edu

Project Website: www.psy.utexas.edu/psy/helmreich/nasaut.htm

A Model of Medical Error

- The Goal of this project has been to develop a model of error in the medical environment.
- Our experience in aircraft accident investigation has demonstrated the utility of such a model in identifying threats, errors, and opportunities to mitigate error.
- Our belief is that a model specific to medicine could prove useful to the understanding of the nature of error and its management in this somewhat more complex environment.

Why Develop Such a Model?

- To analyze adverse events
- To define training needs for medical personnel
- To define organizational strategies to recognize and manage threat and error

Specific Application of the Model

■ Ideally, a model of the error process in medicine should aid identification of:

- 1 the types of errors committed
- 2 deficiencies in training and knowledge
- 3 ineffective, lacking or potential error detection strategies
- 4 effective error mitigation or management strategies
- 5 threat detection and management strategies
- 6 systemic threats

A Model of Threat and Error in the Medical Environment

- An effective model should:
 - Capture the context of patient treatment including expected and unexpected threats
 - Classify the types of threats and errors that occur in the medical setting
 - Classify the processes of managing threat and error and their outcomes
 - Lead to identification of latent systemic threats in the medical setting

Definitions

- **Threats** - factors that increase the likelihood of an error being committed - these may be environmental (such as lighting), physician-related (fatigue), staff-related (communication), or patient-related (a difficult intubation).
- **Latent Threats** - aspects of the hospital or medical organization that are not always easily identifiable, but that predispose the commission of errors or the emergence of overt threats (call schedules and health policies, for example).

Definitions - 2

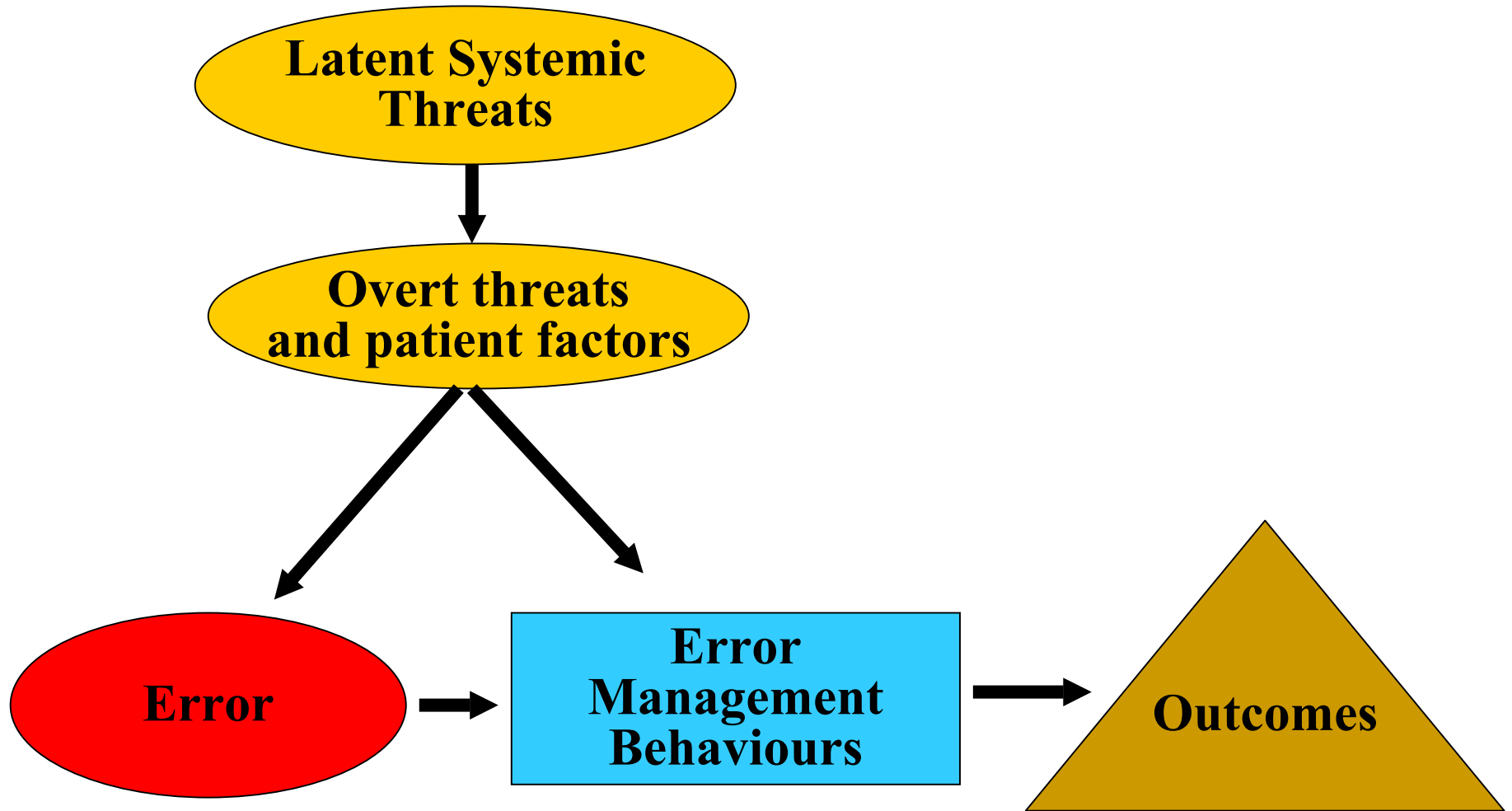
- **Error types** – as in the University of Texas Aviation Threat and Error Management model, we have classed errors with the following taxonomy:
 - » Communications errors
 - » Procedural errors (knowing what to do, but getting it wrong)
 - » Proficiency errors (not knowing what to do)
 - » Decision errors
 - » Violations of formal policies or procedures

- **Threat and error management behaviors** - actions taken by the medical team to reduce threat or manage error
 - Vigilance and monitoring
 - Effective decision making, etc.

Overall Structure of the Model

- **Latent threats** - what exists in the organization?
- **Overt threats** - what was present that day?
- **Human Error** - what was done wrong?
- **Error management** - how was the mistake handled?
- **Outcomes** - did a change in a patient's well being result from the error, and how was it managed?

Components of the Model



Using the Model

- The model is recursive; that is, each error either resolves itself, is successfully managed, or is unsuccessfully managed, and may precipitate further errors. These further errors may be analyzed in a similar fashion.
- As each error is analyzed, it is possible to look for error detection safeguards (such as a procedure, vigilance, or possible monitoring equipment), knowledge or training deficiencies, and mitigation strategies.

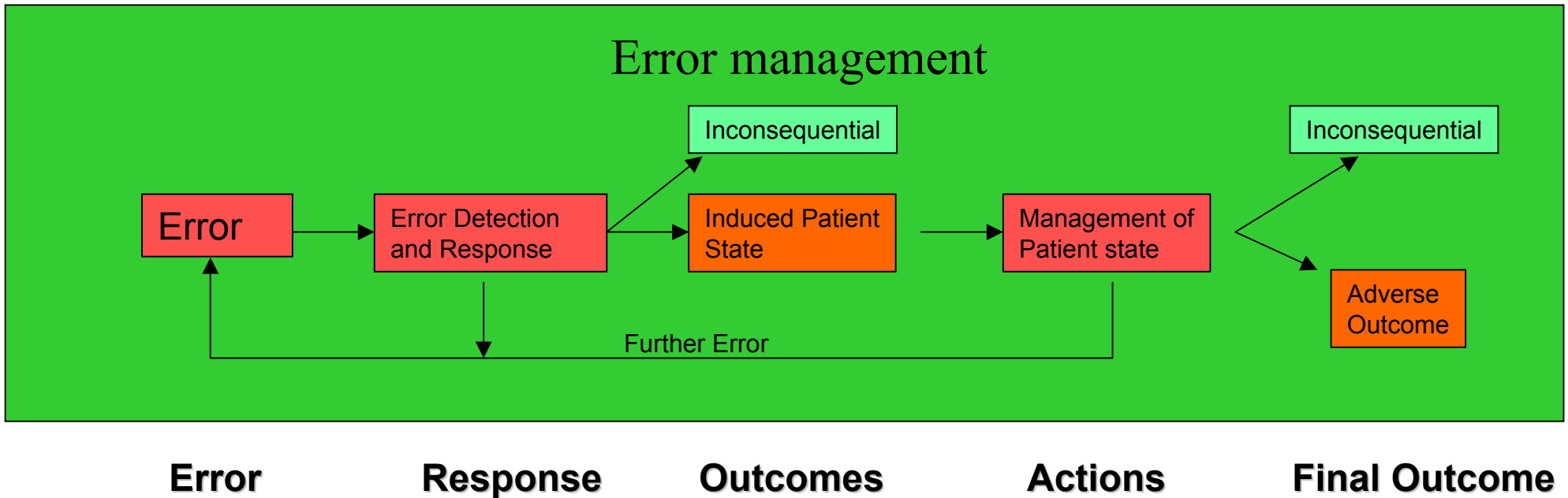
Using the Model (2)

- For each error, it is important to ask: what were the conditions present that helped this error to occur?
- For each error analysed, it may be possible to identify one or more specific threats.
- The analysis of many errors or incidents should lead to the identification of systemic threats and deficiencies within the organisation in question.

The Threat and Error Components

- It is possible to describe this model as consisting of two very different components
- First is the process of error commission and management. This is the usual subject of Mortality and Morbidity Rounds. In addition to the typical analysis at M&Ms, we include team, interpersonal and communication factors at this stage.
- The second component consists of the analysis of the threats that may have played a role in the induction of the error in question and in the subsequent management of that error.

Component 1: A Model of Medical Error



We propose a process model of human behaviour, illustrated above. The model flows from left to right, starting with the commission of an error, followed by the response to that error, the effect that the error has on the patient, the patient management in response to that effect, and the final outcome of the error on the patient. This model is recursive, with error at each stage feeding back into the model.

Latent Threats

National Culture, Organizational Culture, Professional culture, Scheduling, Vague policies

Overt Threats

Environmental
Factors

Organizational
Factors

Individual (Physician)
Factors

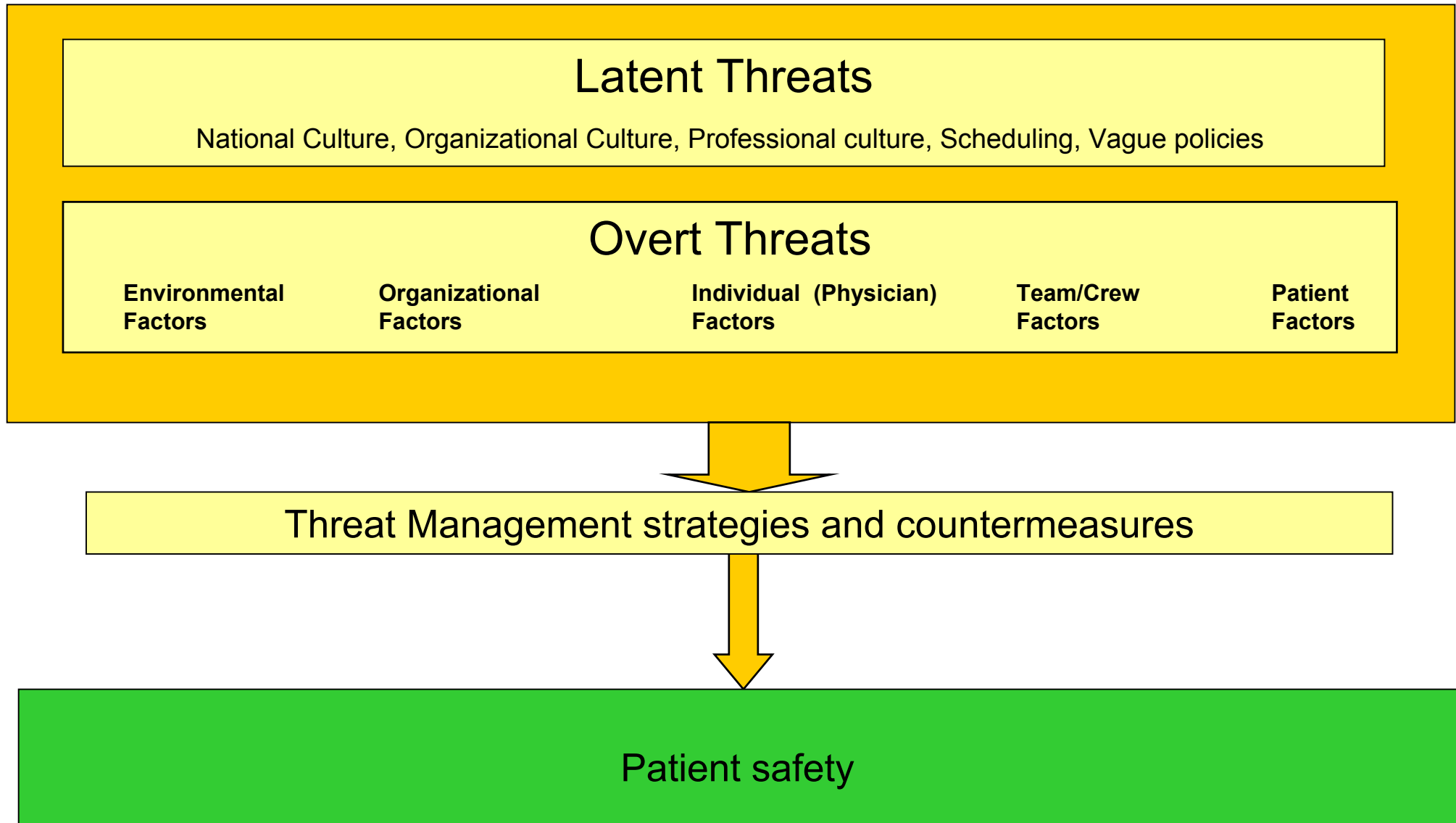
Team/Crew
Factors

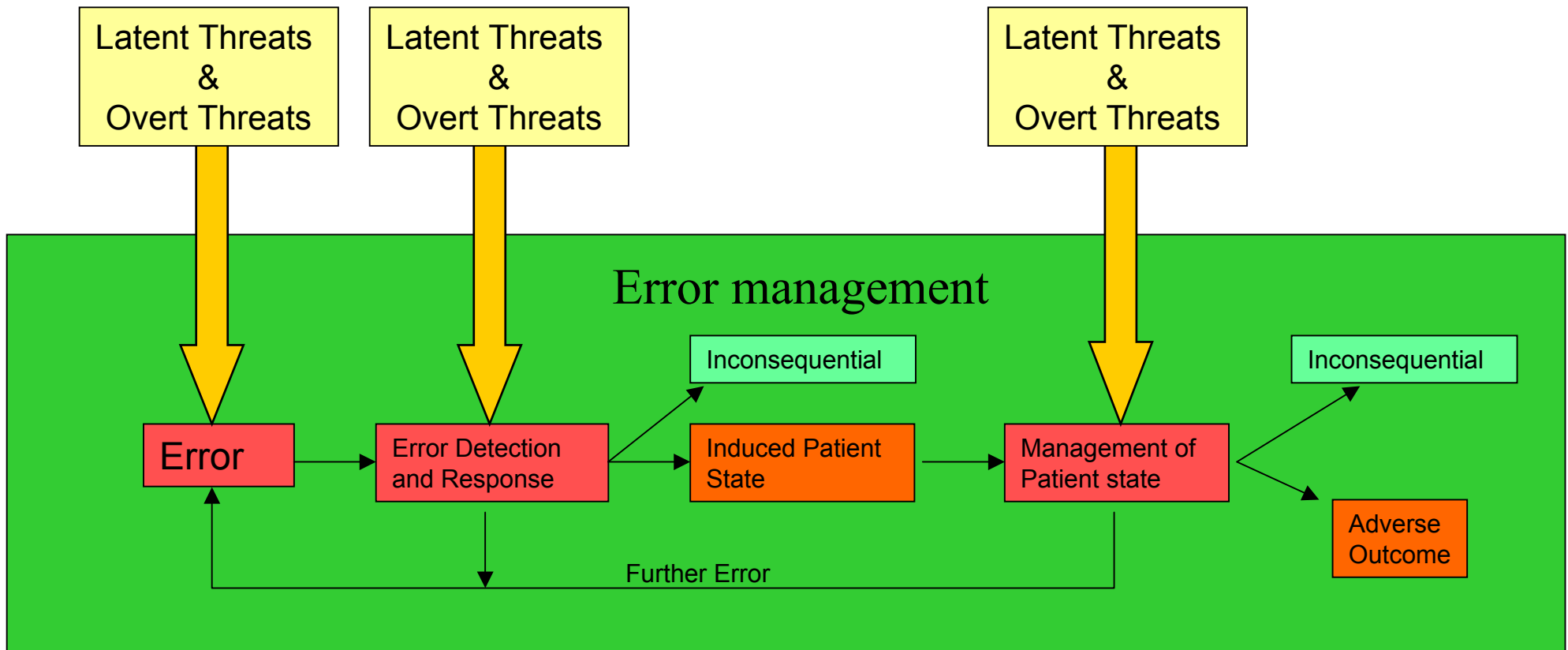
Patient
Factors

Patient safety

Second, we look at the impact of latent and overt threats on patient safety. Countermeasures may prevent these threats from inducing error and interfering with its management, as demonstrated in the next slide...

Component 2: A model of threat management





Note that both overt and latent threats may act at each point during the error management process where human action occurs. In analysing an incident, it is crucial to ask what factors affect behaviour at each stage of the error management model.

We can combine these two components,
producing the full model of threat and
error management...

Latent Threats

National Culture, Organizational Culture, Professional culture, Scheduling, Vague policies

Overt Threats

Environmental Factors

Organizational Factors

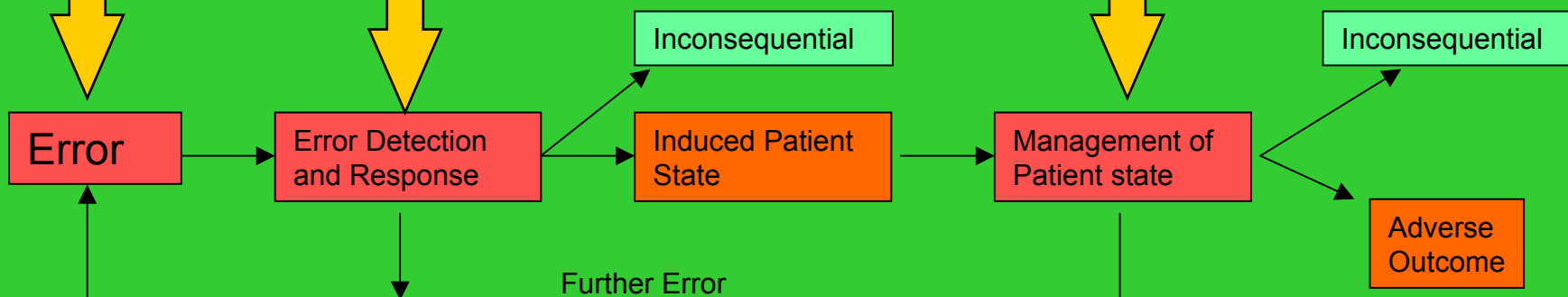
Individual (Physician) Factors

Team/Crew Factors

Patient Factors

Threat Management strategies and countermeasures

Error management



Using the model to examine a complex
incident...

The Case

- The case that follows was a sentinel event in the United States.
- All information for this analysis appears as a matter of public record - the result of civil and criminal court proceedings, and highly publicised media coverage.

Synopsis of the Event

- An 8 year old boy admitted for elective surgery on the eardrum.
- He was anesthetized and endotracheal tube inserted, along with internal stethoscope and temperature probe.
- Anaesthetist did not listen to chest after inserting ET.
- Temperature probe connector was not compatible with monitor (hospital had changed brands the previous day). Anaesthetist asked for another but elected not to connect it when it arrived.
- Anaesthetist also failed to connect stethoscope.
- Surgery began at 0820 and CO2 levels began to rise after about 30 min.
- Anaesthetist stopped entering CO2 and pulse on chart.
- Nurses observed anaesthetist nodding in chair, head bobbing.
- Nurses did not speak to anaesthetist because they 'were afraid of a confrontation.'

Synopsis - continued

- At 1015 surgeon heard gurgling sound and realized that airway tube was disconnected.
- Problem was called out to anaesthetist who reconnected it.
- Anaesthetist did not check breathing sounds with stethoscope.
- At 1030 patient was breathing so rapidly the surgeon could not operate – notified anaesthetist that rate was 60/min.
- Anaesthetist did nothing after being alerted.
- At 1045 monitor showed irregular heartbeats.

Synopsis - continued

- Just before 1100 anaesthetist noted extreme heartbeat irregularity and asked surgeon to cease operation.
- Patient given dose of Xylocaine, but condition worsened.
- At 1102 patient's heart stopped beating. Anaesthetist called for code, summoning emergency team.
- ET tube was removed and found to be 50% obstructed by mucous plug.
- New ET inserted and patient was ventilated.
- Emergency team anaesthetist noticed that airway heater had caused the breathing circuit's plastic tubing to melt & turned it off.
- Patient temperature was 108F.
- Patient died despite efforts of code team.

It is possible to identify at least 9 discrete errors committed during the operation. We will conduct a full analysis of two of them for illustration.

Summary of Sequential Medical Errors

■ Anaesthetist

1. **Decision** – Initiated anesthesia without temperature monitor
2. **Procedural** - failure to auscultate after initial ET insertion
3. **Decision** -failure to connect internal stethoscope

■ Nurse

4. **Decision** - failure to awaken anaesthetist

■ Anaesthetist

5. **Violation** - failure to maintain anesthetic record
6. **Procedural** - failure to maintain alertness, monitor patient and notice ET disconnection
7. **Procedural** - failure to confirm ET placement after reconnection
8. **Decision** - failure to act promptly on elevated respiratory rate

■ Surgeon

9. **Decision** - failure to act on inadequate response from anaesthetist

Each error may be analysed separately
using the Threat and Error
Management Model

Note how many of these errors actually
occur in response to previous errors....

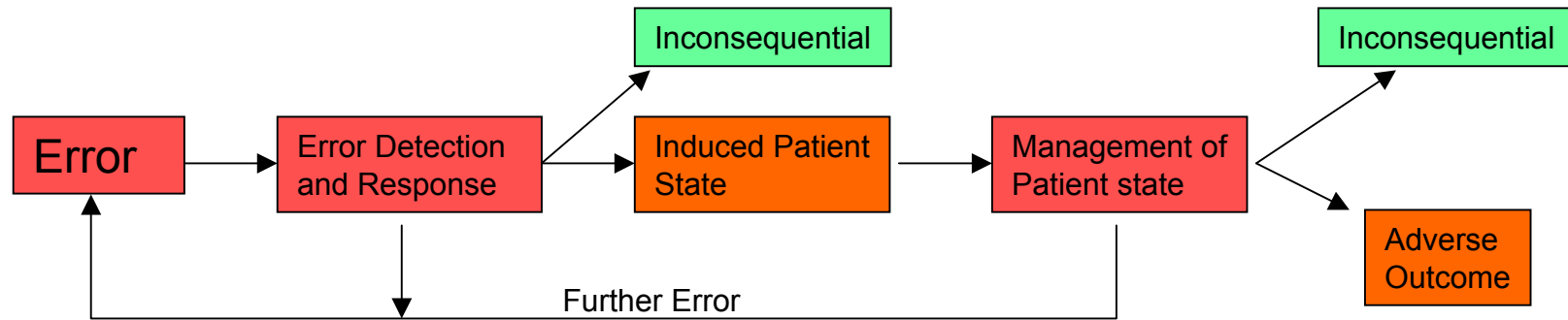
First we will examine error #1 - the decision to proceed without connecting the temperature probe to the temperature monitor.

- This analysis will consist of both an examination of the external and latent threats, as well as a stepwise look at the management of the error once it had been committed.

Error # 1. Decision – Anaesthetist initiates anesthetic without connecting the temperature monitor

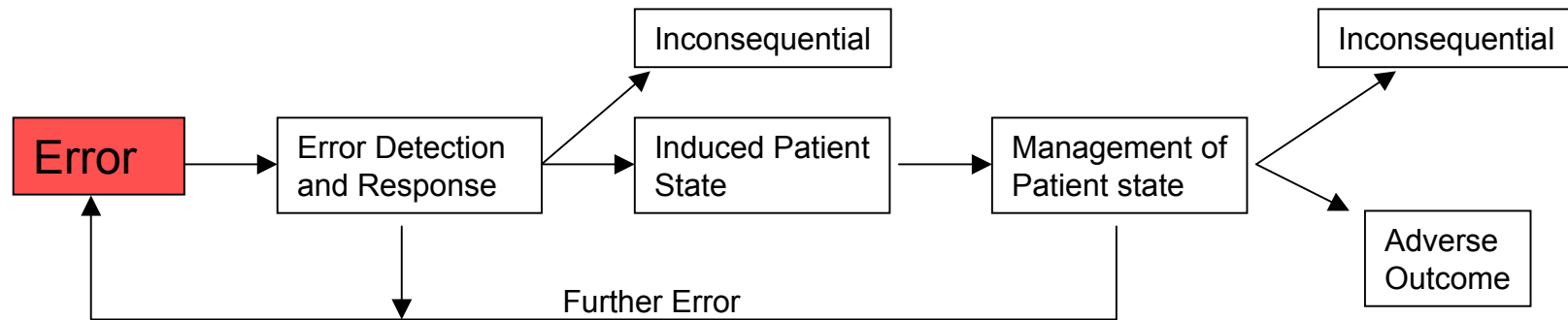
Narrative for this error: While preparing the patient for anesthesia, the anaesthetist realised that the temperature probe did not fit the monitor present in the operating room. This problem was due to change in equipment manufacturers and only partial restocking of this equipment in the operating rooms. Although the anaesthetist requested that an appropriate monitor be sent to the OR, he elected not to connect it once it arrived. The patient remained unmonitored for the duration of the operation. The lack of monitoring was discovered during the cardiac arrest when the airway tubing was found to be hot. The airway heater had continued to warm the airflow in the absence of feedback data from a monitor.

Error # 1. Decision – Anaesthetist initiates anesthetic without connecting temperature monitor.



We can examine the evolution of this error as we trace its path through the model. The key to uncover the external threats that precipitate errors or affect the management of errors is to consider the Threat Management component of the model at each stage of the analysis.

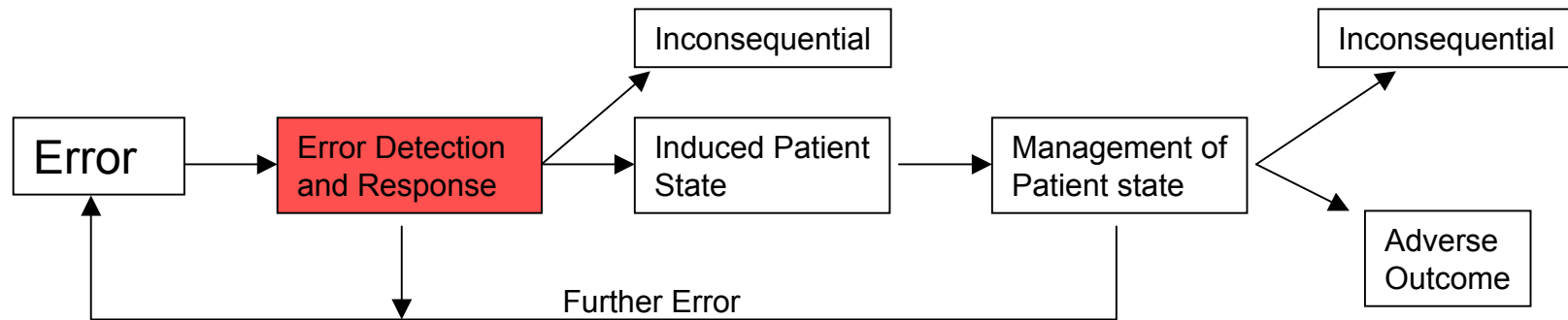
Error # 1. Decision – Anaesthetist initiates anesthetic without connecting temperature monitor (continued).



Error type: Decision error- despite asking for a suitable monitor, the anaesthetist elects to initiate the case without connecting the probe to the monitor.

Implications: This error in judgement may indicate a norm of practice that might be substandard for this practitioner (i.e. a general lack of proficiency), or a singular occurrence (instance of poor judgement).

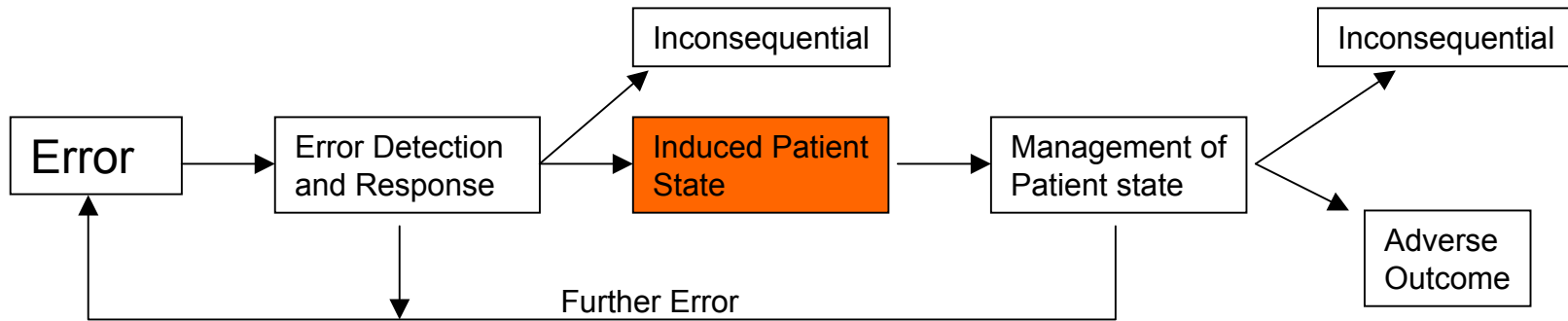
Error # 1. Decision – Anaesthetist initiates anesthetic without connecting temperature monitor (continued).



Error detection: The error in this decision is detected by no one. No detection mechanism was present to aid in detection of this error.

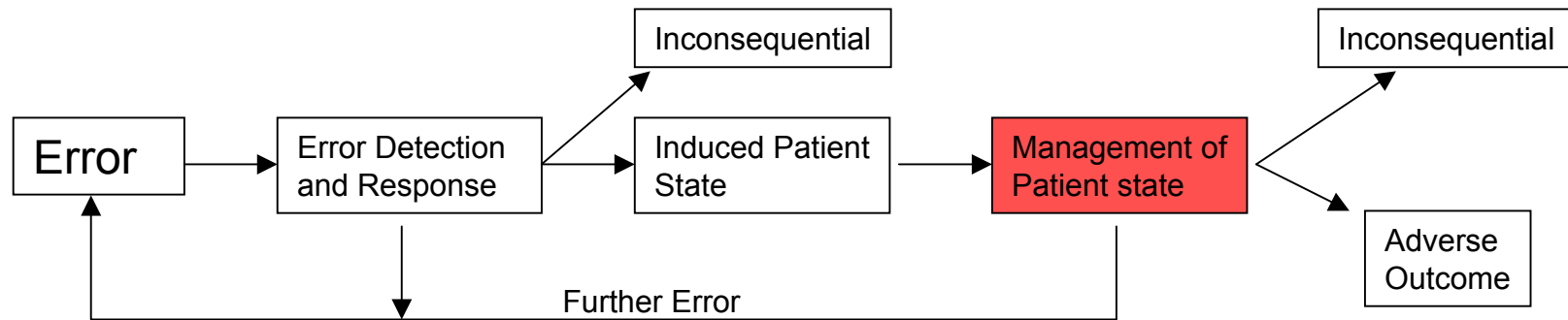
Implications: The presence of a detection instrument, such as a standardised policy of temperature monitoring, or a procedure checklist might have detected this error.

Error # 1. Decision – Anaesthetist initiates anesthetic without connecting temperature monitor (continued).



Patient status: The decision to not connect the temperature probe to the monitor resulted in the patient being inadequately monitored.

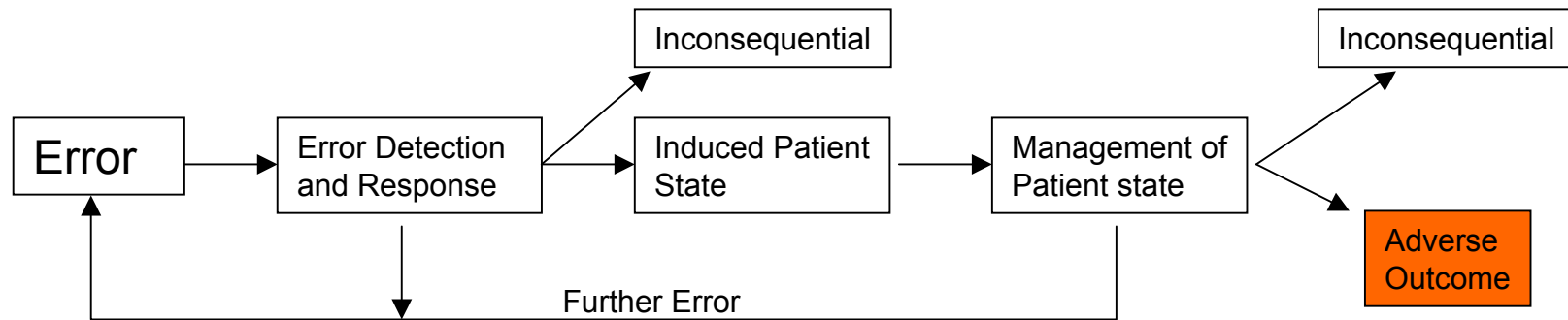
Error # 1. Decision – Anaesthetist initiates anesthetic without connecting temperature monitor (continued).



Patient status detection: The inadequate degree of monitoring was not detected until after the patient arrested. This lack of detection resulted in the problem not be managed or rectified.

Implications: Again, no means existed to detect this lack of monitoring. A checklist or periodic review of monitoring status may have detected this problem.

Error # 1. Decision – Anaesthetist initiates anesthetic without connecting temperature monitor (continued).



Outcome: The lack of adequate monitoring contributed directly to the the sentinel event. Regardless of whether the cause of the arrest was hypoxia or malignant hyperthermia, early warning of hyperthermia might well have allowed appropriate and timely intervention. With no probe connected, the airway heater continues to apply heat, eventually heating the airway tubing and possibly contributing to the rise in core temperature.

Analysis with the model suggests the following latent factors are relevant to the management and outcome of this particular error (error #1):

- Lack of either proficiency (training issue) or alertness (fatigue issue) on the part of the anaesthetist.
- Lack of standardised induction protocol that specifies mandatory temperature monitoring
- Lack of checklist to ensure proper execution of this protocol.
- Lack of periodic review of monitors and equipment.
- Airway heater continued to apply heat despite having no temperature monitor connected.

Safeguards and interventions suggested by the analysis of error #1:

- Review training to ensure currency and competency.
- Peer monitoring/self assessment with respect to human limitations due to fatigue.
- Standardized induction protocols that mandate temperature monitoring during anesthesia.
- Checklist to ensure compliance with this protocol.
- Required periodic review of monitor and equipment status during procedures.
- Safeguards in airway heaters that prevent unregulated heating (problem since rectified for this equipment)

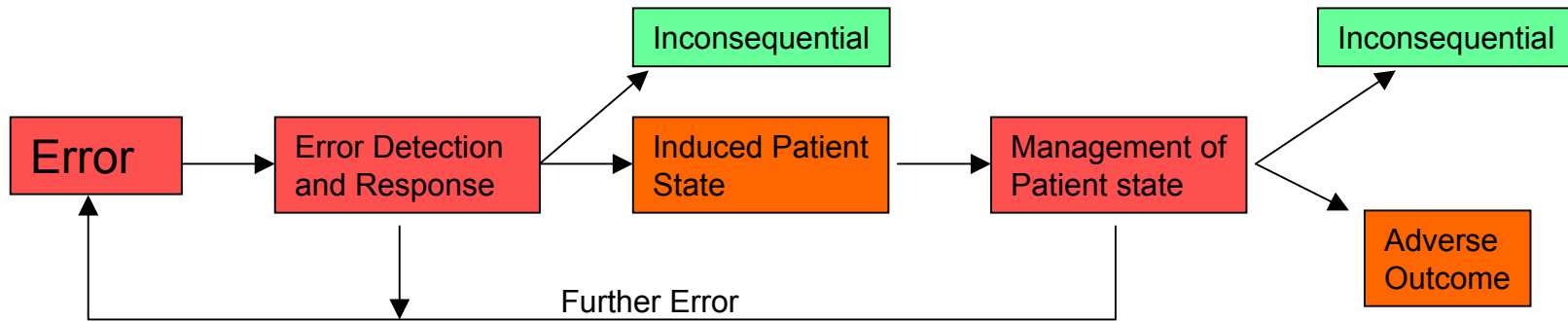
Further analysis...

- Similar analysis can be conducted for errors 1 through 9.
- For contrast, we will examine error #4 - the decision of the nurse to not awaken (or at least check) the anaesthetist when she observed his head bob up and down as he sat in his chair.

Error # 4. Decision – Nurse elects to neither awaken nor check the status of the anaesthetist when she observes his head bob up and down as he sat in his chair.

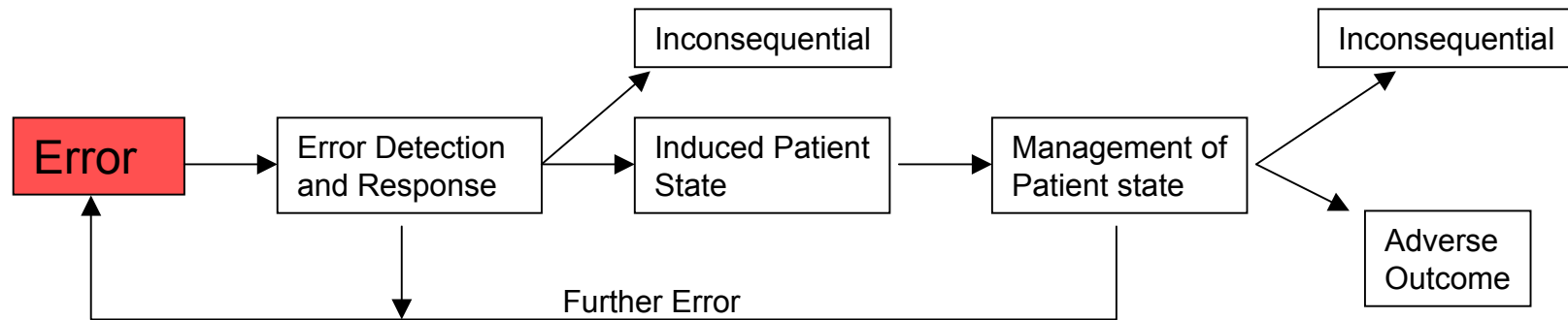
Narrative for this error: Upon observing the anaesthetist's head bobbing up and down, the surgical nurse elected to not check and see if he was sleeping. Although the anaesthetist maintains he never fell asleep, accusations of similar behaviour in the past had been made. Furthermore, his inaction subsequent to this point suggests that he was at least inattentive to the happenings that day in the operating theatre. The nurse cited a fear of a hostile response in her explanation as to why she chose to not disturb the anaesthetist.

Error # 4. Decision – Surgical nurse elects to not awaken (or check) anaesthetist.



This decision, which may be viewed in retrospect as an error in judgement, will be traced through the model.

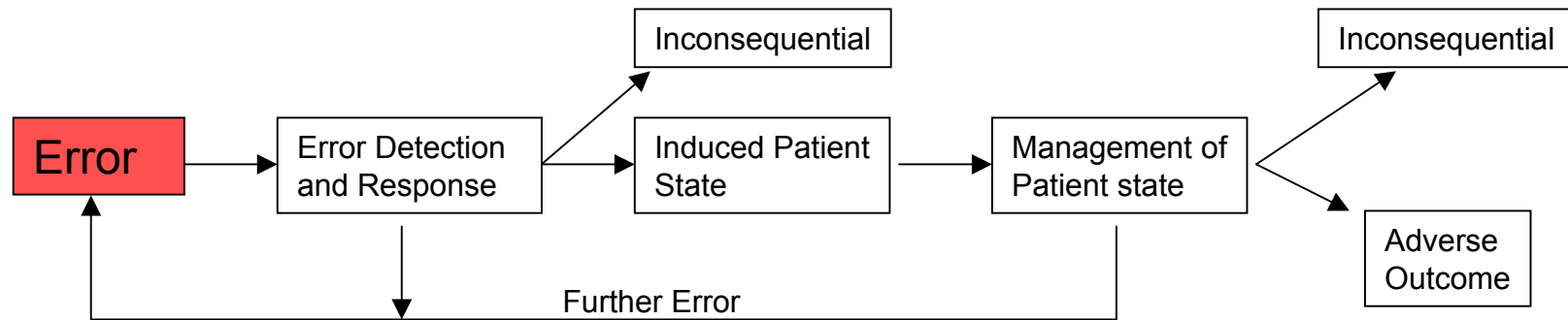
Error # 4. Decision – Surgical nurse elects to not awaken (or check) anaesthetist (continued).



Error type: This error may be classed as a decision error. A lack of formal policy or guidelines implies that the nurse was required to decide whether or not to act on her observation. In testimony, she stated that she feared a hostile response. Records also show that complaints had been filed citing this anaesthetist's tendency to hostile interactions with staff members.

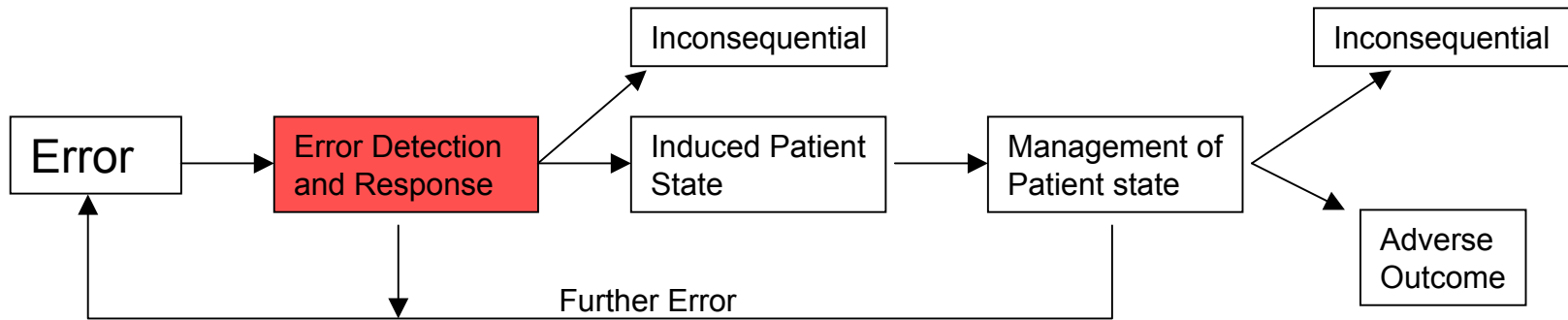
Implications: Possible factors behind this decision include the nature of the cultural environment of the operating room, specifically the hierarchy of physicians and nurses (staff factor in the threat model). (continued)

Error # 4. Decision – Surgical nurse elects to not awaken (or check) anaesthetist (continued).



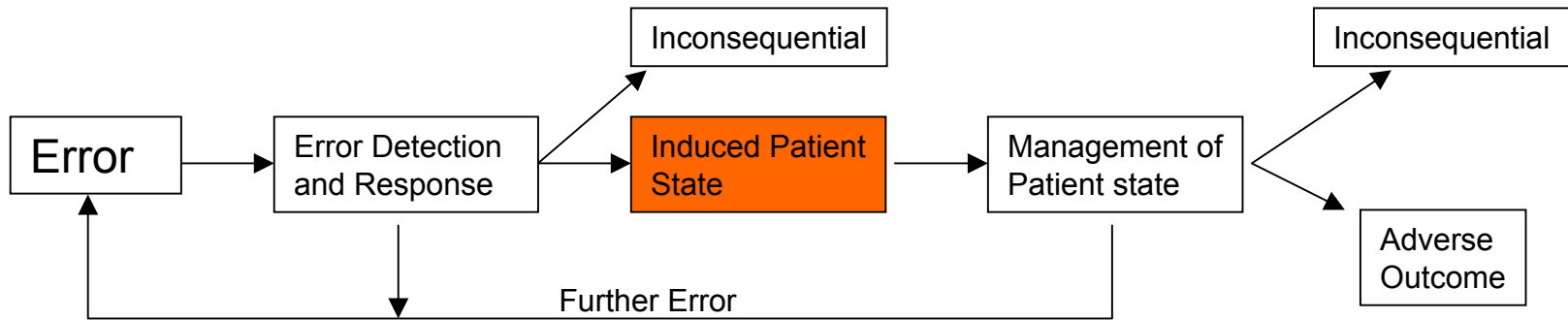
Implications (continued): Furthermore, the fact that this physician had formal complaints lodged against him in the past may suggest a deficiency in the peer review process in dealing with this individual, as the nurse apparently still felt intimidated in his presence. An analysis of the threat s in this error also begs the question as to why the anaesthetist was so fatigued, and why the surgical procedure was initiated when a key player may have been too tired to perform (Cultural factor - working when fatigued, Cultural factor - lack of physician monitoring of peer status).

Error # 4. Decision – Surgical nurse elects to not awaken (or check) anaesthetist (continued).



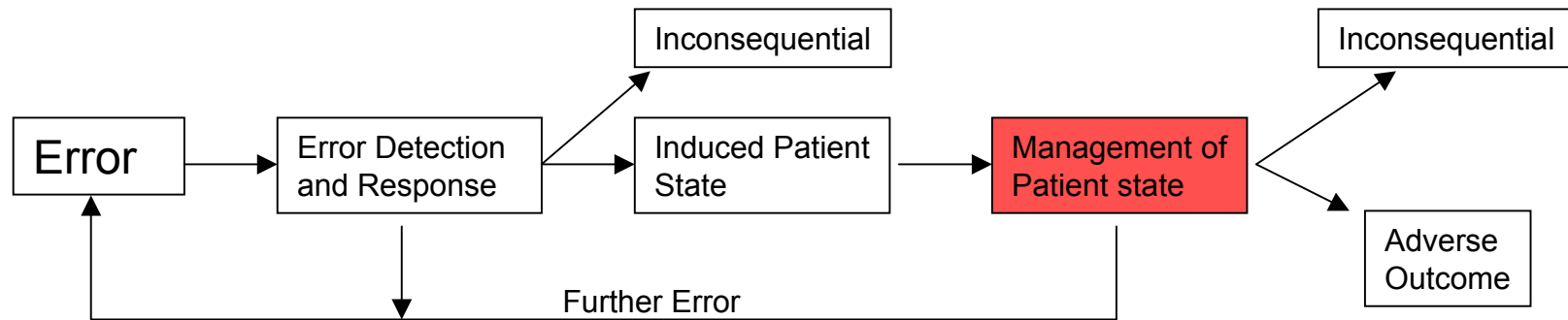
Error Detection and Response: Not detected, no response.

Error # 4. Decision – Surgical nurse elects to not awaken (or check) anaesthetist (continued).



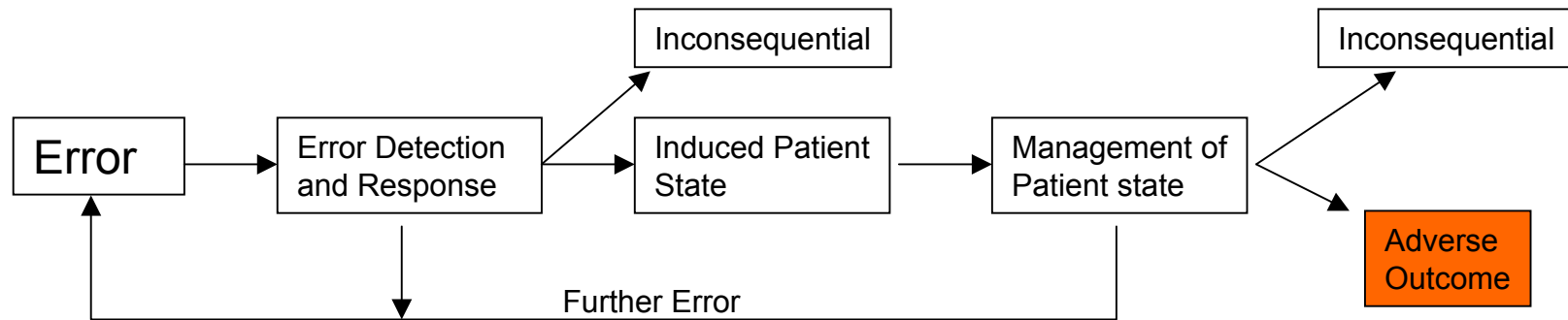
Induced Patient Status: Patient poorly monitored

Error # 4. Decision – Surgical nurse elects to not awaken (or check) anaesthetist (continued).



Management of Patient State: The result of this error, the decreased level of patient monitoring, remained largely unnoticed. It may be argued that the decreased level of awareness that may be assumed on the part of the anaesthetist led to further errors, such as the anaesthetist's failure to notice the endotracheal tube disconnection.

Error # 4. Decision – Surgical nurse elects to not awaken (or check) anaesthetist (continued).



Outcome: It is difficult to know how much this decision to not check the wake/sleep status of the anaesthetist affected the ultimate outcome of this case. Although the individual maintains he never fell asleep, the evidence suggests otherwise. At the very least, an inattentive anaesthetist is less likely to notice equipment detection and early signs of change in a patient's status.

Analysis with the model suggests the following factors are relevant to the management and outcome of this particular error (error #4):

- The decision to not disturb the anaesthetist may have been driven, in part, by the reluctance of the nurse to act outside her perceived role. Furthermore, she may have hesitated because of fear of an altercation.
- The anaesthetist had a history of interpersonal conflict that corroborates this fear.
- His behaviour had been the subject of complaints in the past.

Safeguards and interventions suggested by the analysis of error #4:

- Examination of the peer review process to determine if previous complaints about this physician were dealt with in an adequate manner.
- Establish of clear guidelines of responsibility both in general in the operating environment and specifically for each operation (perhaps in the form of a pre-operative briefing).

A full analysis...

- A complete analysis of this rather complex incident is beyond the scope of this presentation.
- Each error identified can be examined through the use of the model, and contributing factors identified for each.
- Some threats will be identified more than once in such an analysis, and it is the investigators job to identify those factors that are most significant.
- The slide that follows shows an initial listing of threats, both overt and covert that are identifiable in this case - no doubt more can be found.

Some overt and latent threats identified in this case:

FDA certification

1. airway heater functions without temperature probe with possible overheat

Organizational

2. change in brand of temperature probe used in OR without complete notification of staff that a new connector needed
3. failure to act on reports about anaesthetist's behavior and performance
4. lack of procedural requirement for patient monitoring in all operations
5. lack of policy for cross-checking other team members in OR
6. lack of training for teamwork in the OR

Organizational and Professional

7. pressure to perform when fatigued

Professional

8. willingness to tolerate peer misbehavior without taking action
9. denial of fatigue effects on performance
10. Culture - the nurses role in dealing with physicians

A Cautionary Note...

- We hesitated to present this case since it involved what seemed to be an unusually high degree of incompetence or negligence on the part of one participant.
- We reasoned, however, that this case demonstrated how medical misfortunes can be more complex than initial inspection would suggest.
- Our research group is aware that in the vast majority of cases, errors are committed by highly competent, well meaning practitioners.
- The true value in this analysis is to show:
 - 1 - How interventions, checks, and safeguards may have prevented the tragic death of this healthy child
 - 2 - That systemic problems throughout medicine, such as fatigue, and a lack teamwork work to the detriment of patients