Practicing Risk Management

An art form with a scientific backbone

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Short-Short Course in Risk Management

- Review the history, systematic approach and phases of risk management
- Introduce the key concepts of the risk management paradigm
  - Review the methods and application(s) of various risk assessment techniques
- Establish awareness of risk assessment and epidemiologic resources
  - Identify, analyze and characterize hazards and risks
- Present approaches and strategies for the implementation of controls
- Gain familiarization with formative and process evaluation concepts to assess effectiveness

Epidemiology & Risk Assessment

- Occupational injury epidemiology
  - Aim is to describe the distribution and determinants of occupational injuries and to make and test the inferences about their prevention
    - Hadgerb, 1997
- "Injury" characterized as an abnormal transfer of energy including:
  - Gravity, mechanical, chemical, thermal, electrical, biomechanics, biological, pressure and radiation
- There is no standard definition for injury or accident that is abided by all industry and nations
  - Is there a difference between an accident and an injury?

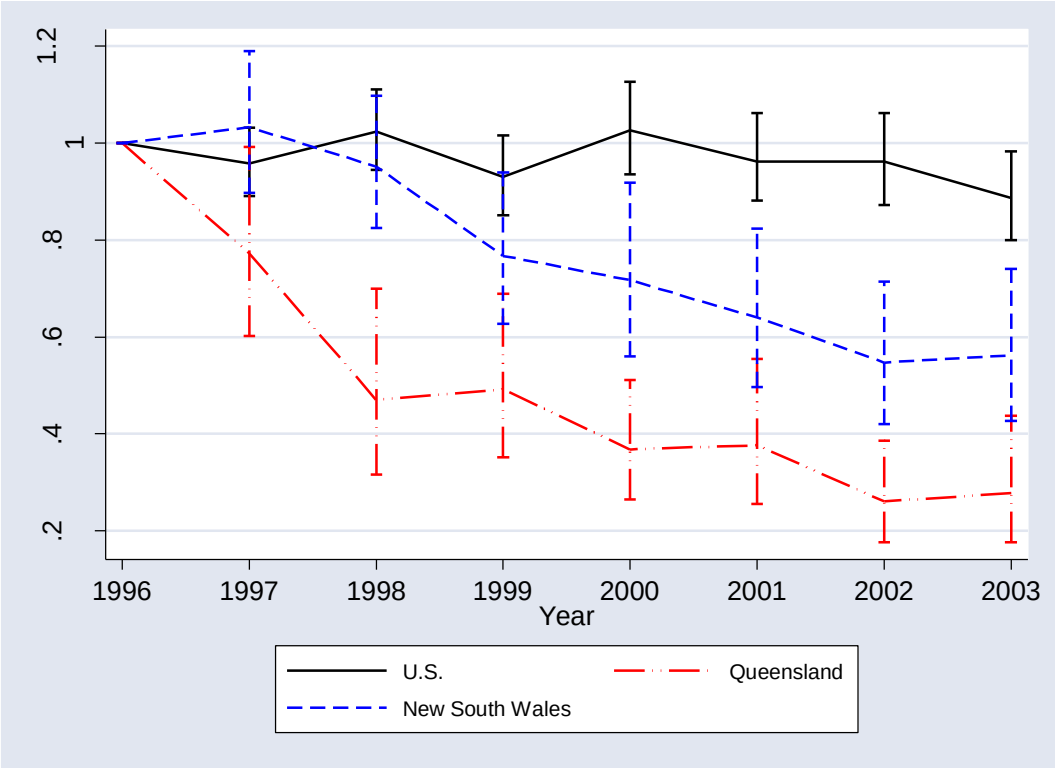
Coordinating Information

Risk Management

- A proactive and systematic approach for improving risk and decision making in the workplace.
  - Creates a structure for individual mines to develop solutions to the risks faced, based on the surrounding environment, conditions, equipment and personnel involved.
- Organizes information about an unwanted event in an efficient, orderly manner so that decision makers can make informed choices.
  - Can be used at all levels of the management structure.
  - Risk management tools help focus attention and resources on the most significant risks.
- Enables managers to better anticipate and mitigate risk

Background

- Adoption of a risk management-based regulatory approach in Australian coal mining was associated with a marked reduction in lost-time injuries compared to the United States, which maintains a compliance based system



Poplin GS, et al. *Safety Science*; 2008

History & Roots

- The risk-based regulation has its roots in the Nuclear Regulations Commission (NRC) and began its consideration in the Australian mining industry during the mid-to-late 1980s.
- It is a safety system approach
  - A structure for individual mines to develop solutions to the risks faced
    - Based on the surrounding environment, conditions, equipment and personnel involved.

Risk-based Regulations

Duty of Care:

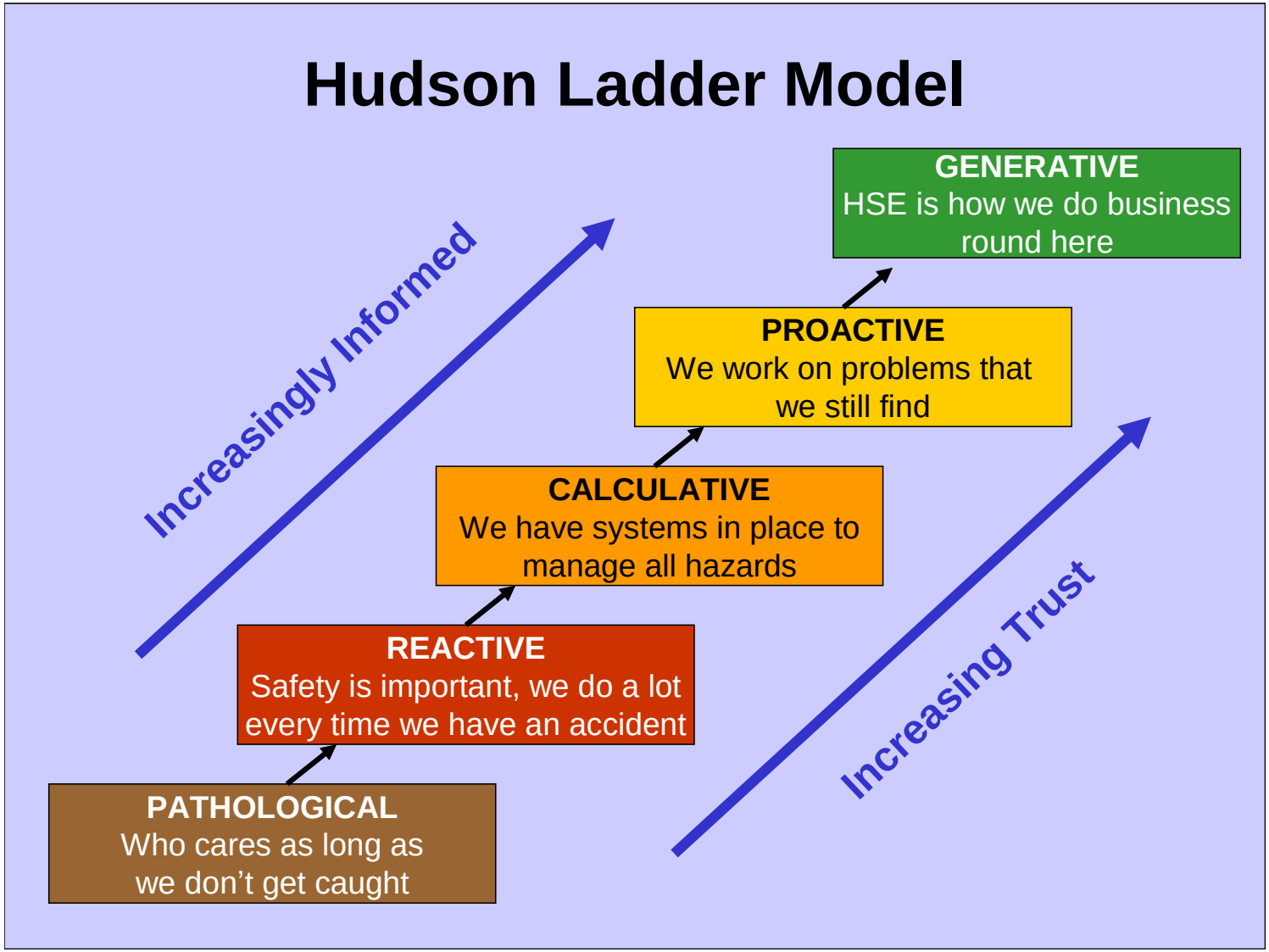
- Requires everything 'reasonably practicable' to be done to protect worker health and safety
  - Each identified risk is systematically defined by a team encompassing all branches of the industry workforce.
  - The magnitude of potential consequences and the likelihood of their occurrences are described.
  - Recommendations to control, mitigate, or eliminate these risks are outlined.
  - The recommended corrective actions are reviewed.
- Enables managers to anticipate and mitigate risk
- Has become the norm across many industries and businesses in Australia

Truter R. The AIH Diplomate. 2004; 15(12): iv-vi.

Compliance-based Regulations

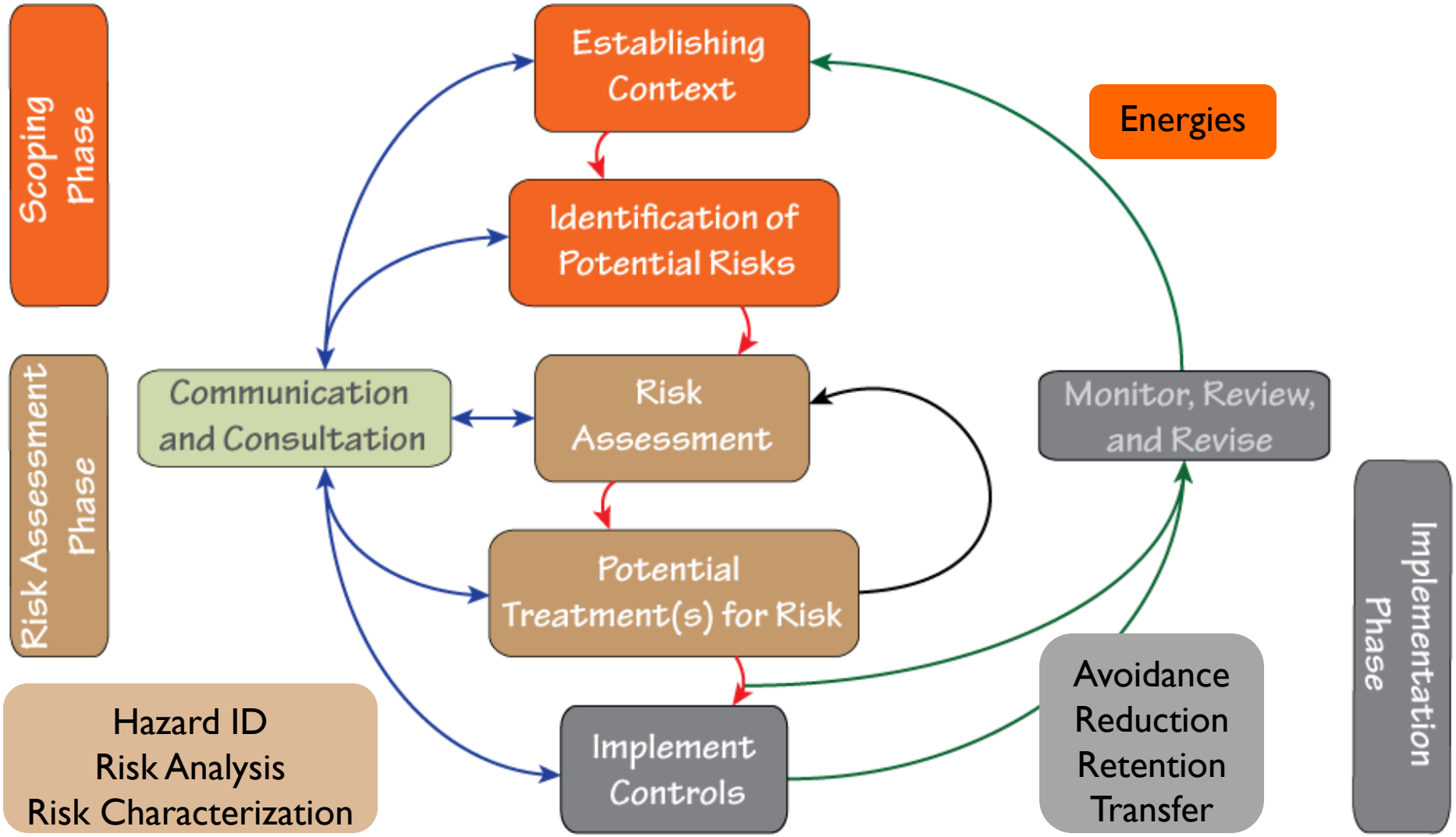
- Set of regulations from governing body
- Defined as a "measurable standard or outcome that a company must meet." (Chinander, 1998)
  - Often no clear definitions or guidelines as to how a firm goes about to meet the requirement
  - Risks will vary more greatly from mine-to-mine
- Regulations tend not to keep up with technology
  - With advancements made in technology, mining rigs, tools and management structure, regulations can easily become outdated, inappropriate, or even irrelevant for a particular job task

"The Journey"
Evolution of Safety Culture



Hudson P. Qual Saf Health Care. 2003; 12:7-12.

Risk Management



Modified from MISHC: Univ. of Queensland

Phase 1: Scoping the Risk Assessment

Session I

- Review available data on outcome of interest (injury/event)
  - Identify what isn't known
- Identify task, event or system
- Overview and prioritize tasks, events and systems
- Outcome: A document scope for the risk assessment
  - Task analysis (e.g., roof bolting) or unwanted event (e.g., roof collapse)

Session II

- Identify relevant variables (hazards and activities) related to the priority task, event or system
- Develop flow chart for task or system – a clear description of event
- Outcome: A flow chart of the priority tasks or detailed unwanted event

- Next:
  - Select the right tool – Risk Identification Method
  - Select the right method – Risk Analysis Method

Patient Transport

START

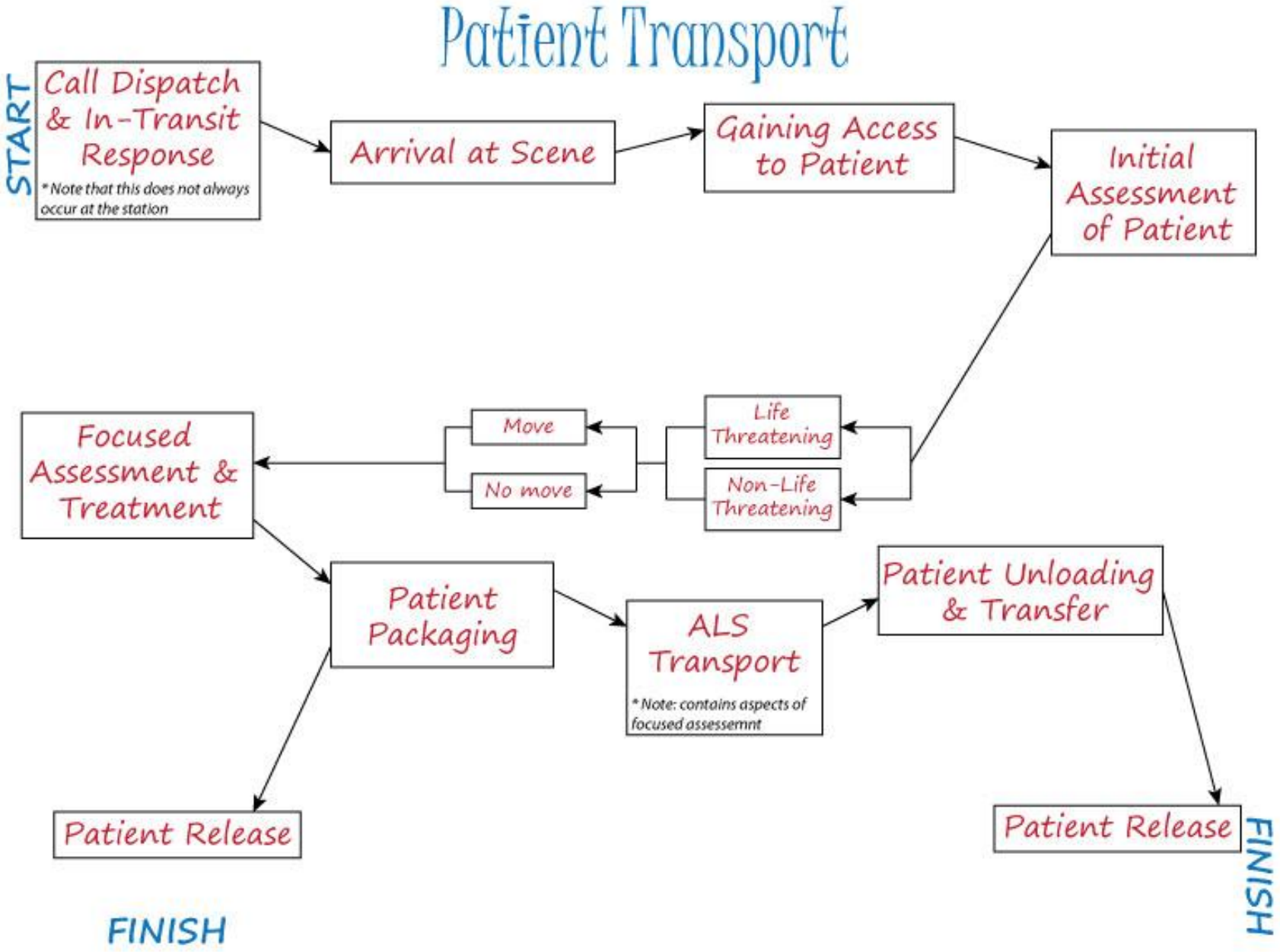
Call Dispatch & In-Transit Response

*Note that this does not always occur at the station

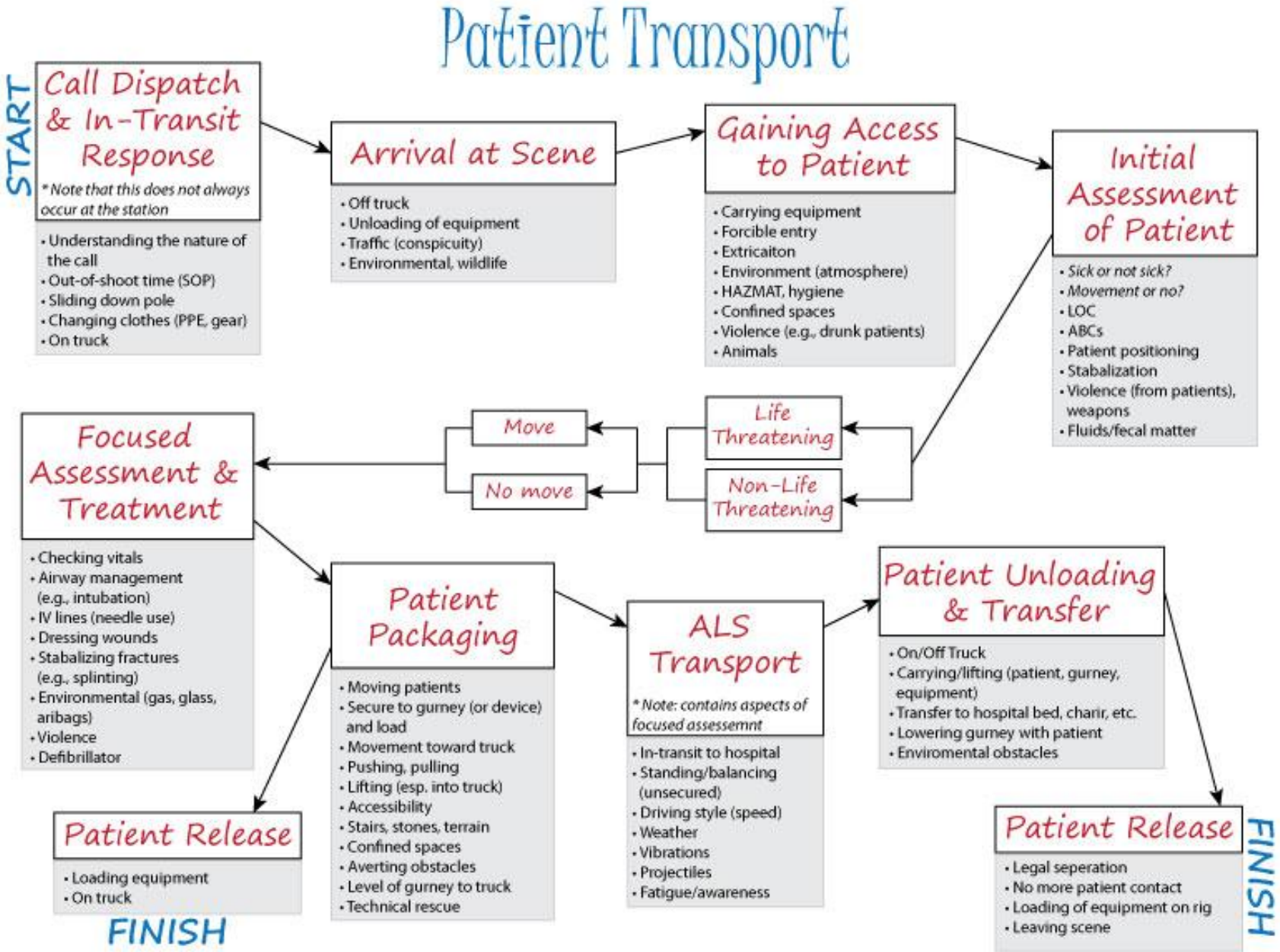
Patient Release

FINISH

Patient Transport



Patient Transport



Phase 2: Risk Assessment

- A proactive and systematic approach to improving risk
- The process of quantifying the probability of a harmful effect to individuals or populations from certain human activities
- Practical definition
  - "...an activity that occurs after some harmful event, to try to figure out what happened, how it happened, and then trying to devise a way of preventing the same or similar harmful events from occurring again."
    - Wassell JT. Hum Ecol Risk Assess. 2003; 9(5)

Basic Risk Assessment Methods

Hazard Identification

Risk Analysis

Risk Characterization

www.firefighterclosecalls.com

I. Hazard Identification

- What is the unwanted event?
  - Determine the extent of the problem

    Low frequency, high impact event

    or

    High frequency, low impact event
- Who is exposed to what and for how long?
- What are the routes of exposure?
  - Sources of energy
- Establish what risk analysis technique(s) to use

Energy Types

- **Biological** – bacteria, viruses, contagious disease, natural poisons, etc.
- **Chemical** – coal, gases, fuels, lubes, degreasers, solvents, paints, etc.
- **Electrical** – high voltage, low voltage, batteries, etc.
- **Gravitational**
  - Objects – falling rocks, tools, components, structures, etc.
  - People – falling from or into equipment, structures, ladders, sumps, etc.
- **Machine**
  - Fixed – powered by electrical, hydraulic, pneumatic, combustion, etc.
  - Mobile – trucks, service vehicles, tools, etc.
- **Magnetic** – handling metal objects in strong magnetic fields
- **Noise** – from machines and other sources
- **Mechanical** – pressurized systems, cylinders, springs, chains, flying bits, etc.
  - Kinetic
  - Potential
- **Thermal** – conducted (contact), convected (airstreams), radiation
- **Vibration** – from vehicles, equipment, tools, etc.
- **Other** – bio-chemical

- $E = mc^2$

II. Risk Analysis

- Purpose is to
  - Increase awareness
  - Set priorities
  - Determine the acceptability of risk
- No single method of risk analysis applies effectively to all possible objectives
- Methods of Analysis:
  - Qualitative
  - Semi-Quantitative
  - Quantitative

Qualitative Risk Analysis

- Much more subjective
  - Low, medium, high
  - Green, Yellow, Red
- Informal risk awareness for day-to-day tasks
  - Depends on the experience and expertise of the person applying it
- Quick and cheap

		Consequences		
		High	Medium	Low
Likelihood	High			
	Medium			
	Low			

Semi-Quantitative Risk Analysis

- Includes some aspects of quantification
  - i.e. number values
- Retains the categorization approach used in qualitative
- Use of risk matrices often used in industry
  - Typically a 4 x 4 matrix of likelihood and consequences
  - Numerical ranges for the levels must be carefully defined to meet objectives as well as provide discreet and suitable choices
- Various dimensions are used and depend on the objectives and unwanted event

Risk Matrix

RISK MATRIX		HAZARD EFFECT/CONSEQUENCES			
		1. Minor	2. Moderate	3. Major	4. Maximal
		First aid case; Exposure to minor health risk	Medical treatment case; Lost time injury; Reversible impact on health; Exposure to major health risk	Loss of quality of life; Irreversible impact on health	Single/Multiple fatalities; Impact on health ultimately fatal
LIKELIHOOD		**RISK RANKING**			
4 (Almost certain)	The unwanted event occurs with regularity, and will continue to occur *(>75% likelihood)*	7 (M)	11 (H)	14 (EX)	16 (EX)
3 (Likely)	The unwanted event has occurred frequently, and is expected to occur *(30-75% likelihood)*	4 (L)	8 (M)	12 (H)	15 (EX)
2 (Possible)	The unwanted event has happened at some time (infrequently), and will occur under some circumstances *(10-30% likelihood)*	2 (L)	5 (M)	9 (M)	13 (H)
1 (Unlikely)	The unwanted event has happened in the past (rarely), and may occur in exceptional circumstances *(<10% likelihood)*	1 (L)	3 (L)	6 (M)	10 (H)

RISK RATING	RISK LEVEL	GUIDELINES FOR RISK MATRIX
14 to 16	(EX) – Extreme	Eliminate, avoid, implement specific actions plans/procedures to manage and monitor
10 to 13	(H) – High	Proactively manage
5 to 9	(M) – Medium	Actively manage
1 to 4	(L) – Low	Monitor and manage

Quantitative Risk Analysis

- Involves the calculation of probability
  - Uses real numbers, not ranks
    - Probability of a structural collapse = 0.003 per year
- Requires disciplined approach to recording and interpreting incidents, accident and maintenance information for accurate measures
- Best for low frequency, high consequence events

Quantitative Examples

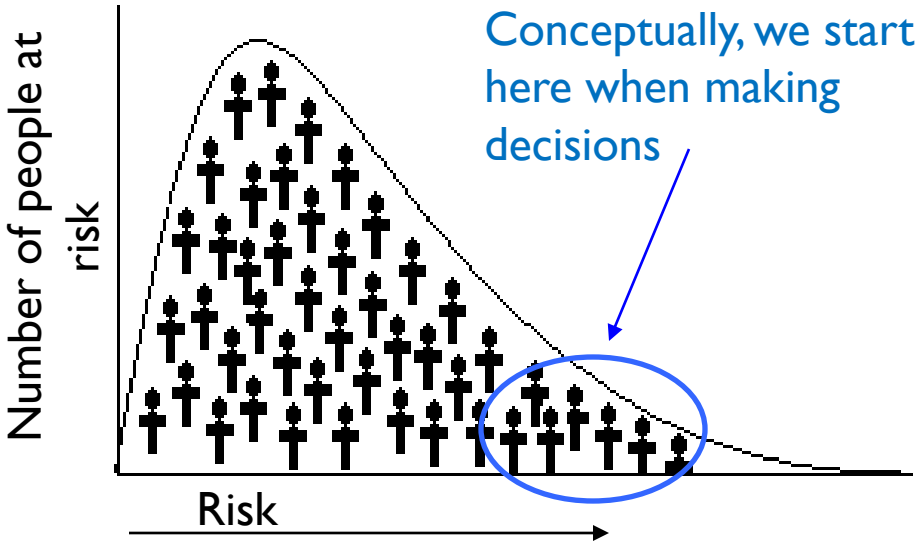
1. Failure Mode and effect analysis (FMEA)
2. Hazard and operability studies (HAZOP)
3. Human error analysis (HEA)
4. Reliability block diagrams
5. Fault-tree analysis
6. Event tree analysis
7. First order reliability methods (FORM)
8. Monte Carlo methods
9. Probabilistic risk and safety assessment (PRA & PSA)

III. Risk Characterization

- Presents an integrated discussion of
  - Hazard identification
  - Risk analysis
- Evaluates the overall quality and degree of confidence in the assessment
- Describes extent and severity of risk to
  - Individuals
  - Populations
- Must include a description of uncertainty

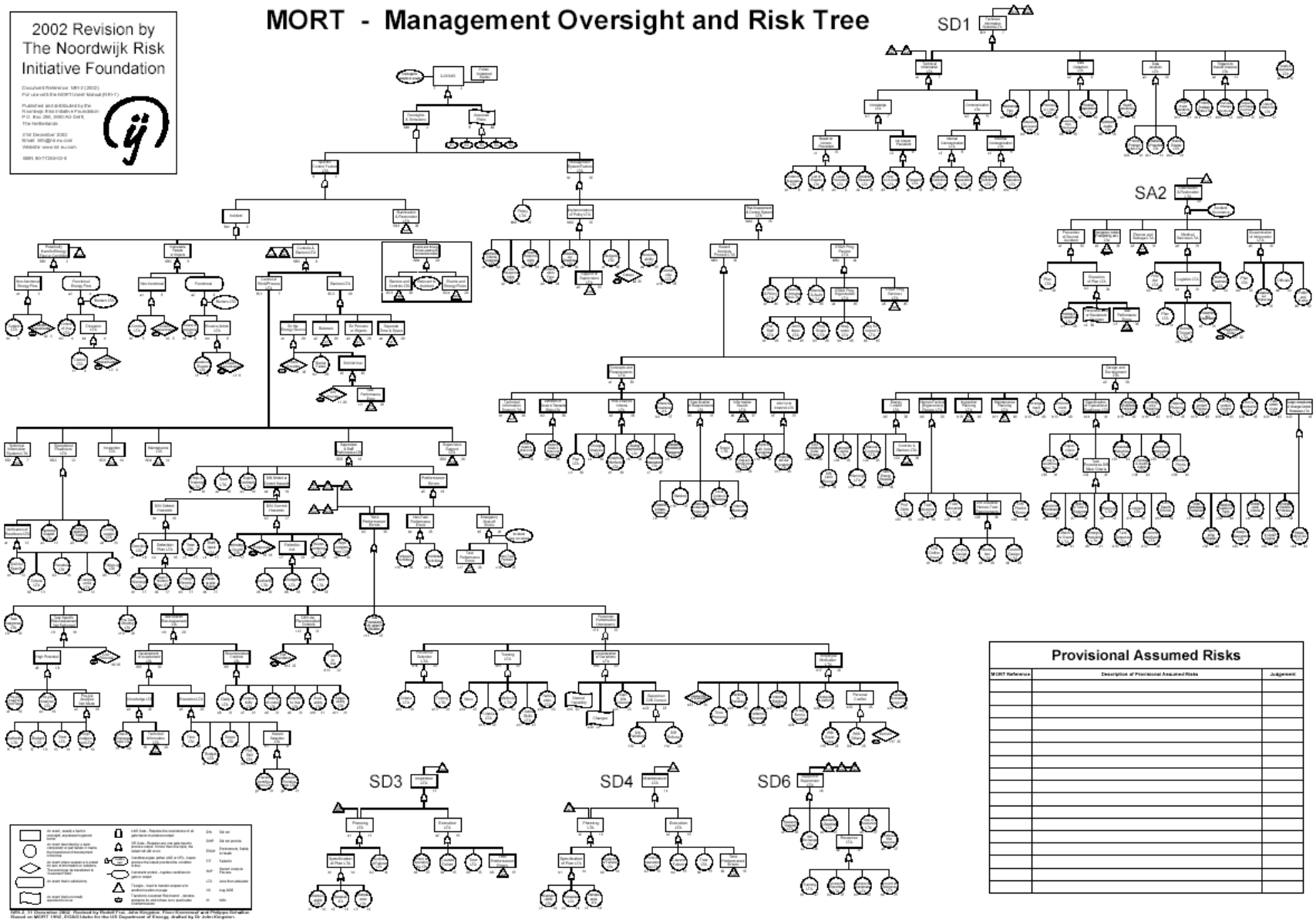
Uncertainty

- Knowing what you don't know
- Will aid in the decision making process
- Epidemiologic studies
  - Potential confounding factors, length of follow-up, section bias, multiple exposures and routes, limited sample size
  - Negative studies may set upper bounds of human exposure risk



Risk Assessment Tools

- Hazard Identification (HAZID)
- Preliminary Hazard Analysis (PHA)
- Job Hazard Analysis (JHA)
- Fault Tree Analysis (FTA)
- Failure Modes and Effects Analysis (FMEA)
- Hazard and Operability (HAZOP)
- Stakeholder Mapping
- Many, many more



From the Noordwijk Risk Initiative Foundation (www.nri.eu.com)

Bowtie Analysis Model

Courtesy of Jim Joy

Workplace Risk Assessment & Control (WRAC)

Project Title: Risk Management Strategies to Prevent Injuries among Firefighters - SPIFi			**Date Originated:** 5/21/10 **Date Revised:** 7/29/10
Operation Description: Patient Transport	**Team Members:**	**Team Facilitator:** Jerry Poplin **Recorded By:**	**Relevant SOPs & Docs:** Equipment & Procedure EMT manual

No	A Step in operation	B Potential Incident(s)	C Likelihood	D Hazard Effect/ Consequence	E Risk Rating	F Current Controls	G Possible New controls
1	Call Dispatch & In-Transit Response	MVC, rollovers	1	4	10 (High)	• speed to scene (≤ 10 mph over limit) • seatbelts (people & equipment) • no horseplay protocol • 3-points for on/off truck • foam landing pads • swing-down steps **fatigue status prior to call dispatch may affect likelihood*	• Improved dispatched questioning • Zone dispatching in station (clausen & hearts saver system for dispatch) • No running in station to apparatus • Training (CE) at academy *("first to truck" academy training & mentality)* • Responsibility lies upon the individual FF with the captain's enforcement • Captain sets the tone
		struck by vehicle	1	4	10 (High)		
		sprains/strains, including static motion (e.g., ankles)	2	2	5 (Medium)		
		falls, slips, trips	3	1	4 (Low)		
		crush, caught between (e.g., doors)	1	2	3 (Low)		
		struck by (e.g., head, "Nissen")	2	1	2 (Low)		
		struck by (e.g., projectiles)	1	1	1 (Low)		
2	Arrival at scene	struck by vehicles	1	4	10 (High)	• placement of engine to block medic or other truck • reflective vests (conspicuity tape)	• SOP/training for medic/truck placement *(At scene, medics should pull in front of truck with best ease of access to patient location)* • Training and communication with Captain
		sprains/strains (w/ gear)	2	2	5 (Medium)		
		sprains/strains (w/o gear)	2	2	5 (Medium)		
3	Gaining Access to Patient	combative patient	2	4	13 (High)		• Don't turn your back (combative patient) • Additional CE on street survival (DVD?) • Captain's role in improving knowledge & awareness • Awareness of situation and environment
		fall from height	1	4	10 (High)		
		cuts, lacerations, bruises	3	2	8 (Medium)		
		electrical shock, burn	1	3	6 (Medium)		
		hydraulic line pressure (pinhole)	1	3	6 (Medium)		
		struck by, crush (w/ equipment)	1	3	6 (Medium)		
		sprains/strains	2	2	5 (Medium)		
		airbag deployment	1	2	3 (Low)		

Haddon's Matrix

Event Phase	Epidemiologic Factors			
	Human Factors	**Agent or Vehicle**	**Physical Environment**	**Sociocultural Environment**
Pre-event	What factors determine whether an event will occur that has the potential to cause injury?			
Event	What factors determine whether an injury will occur in this event?			
Post-event	What factors determine what the final severity of the injury will be? What factors determine the outcome?			

Back Sprains & Strains		Epidemiologic Factors			
		Human Factors	**Agent or Vehicle**	**Physical Environment**	**Socio-cultural Environment**

Event Phase	**Pre-event**	• Age
		• Previous injury
		• Height of individual
		• Flexibility
		• Strength
		• Conditioning
		• Hydration
			• Condition of equipment
			• Amount of weight used for exercise
			• Speed or running pace
			• Climbing/descending height
				• Uneven terrain
				  ○ on foot
				  ○ road
				• Location of patient
				• ground floor or elevated
					• Strength training from certified trainer
					• Education toward proper technique
					• Presence and knowledge of SOPs
					• Presence of training partner or co-worker

	Event	• Lifting technique/ergonomics
		  ○ Grip
		  ○ Balance
		• Pulling technique
		• Experience
		• Position/stability in truck
		• Alertness
		• Ego
			• Speed and force in lifting equipment
			  ○ gurney/stretcher
			  ○ hose
			  ○ ladder
			  ○ mannequin
			  ○ extraction tools
			  ○ SCBA
			• Patients
			  ○ weight (obese)
			  ○ aggressiveness
			• Chronic or acute energy exposure
			• Physical exercise
			• Multi-planar motions
			• Assistance
				• Emergency scenes
				  ○ Fire (7.8%)
				  ○ Non-fire (i.e., medical, 40.4%)
				• Fire station (30.0%)
				• Training facility (16.6%)
				  ○ Outdoor temperature
				  ○ Training surface
				• Internal truck environment
				  ○ Jump-seat height
				  ○ position of SCBA
					• Time of day
					• Fatigue from multiple responses
					• Lack of support from fellow recruits or training officers
					• Presence of safety officer

	Post-event	• Time to treatment • Amount of recovery time/rehab • Previous injury	• Continuation of activity • chronic exposure • No available assistance	• Other hazards presented from fire location • Availability of bed or recovery zone	• Health insurance • Department resources toward rehab • Staffing to cover shifts

Countermeasures for Injury Control

A conceptual model for developing intervention strategies:

1. Prevent the creation of the hazard
2. Reduce the amount of hazard brought into being
3. Prevent the release of the hazard
4. Modify the rate of release of the hazard from its source
5. Separate the hazard from that which is to be protected by time and space
6. Separate the hazard from that which is to be protected by a physical barrier
7. Modify relevant basic qualities of the hazard
8. Make what is to be protected more resistant to damage from the hazard
9. Begin to counter damage done by the hazard
10. Stabilize, repair, and rehabilitate the object of damage

Formal Implementation (Hazard) Plan

General contents may contain:

- Control Definition & Rationale
- Scope & Deliverables
- Implementation Timeline/Schedule
  - Work Breakdown
- Governance & Accountability
- Resources
- Continued Risk Management
- Stakeholder Management

Monitor, Review & Revise

- Measurements of effectiveness
  - Physical inspections
  - Reduction of injuries, near misses, citations, etc.
- Control effectiveness
- Process Evaluation
  - Did those involved in the process learn anything, change behavior, appreciate the process, etc.?
- Management review meetings
- Reviews of organizational policies, strategies and processes
  - Internal audit
  - External audit

Successful Implementation

- Culture, leadership and behavior are 3 main ingredients for successful change
- Successful implementation includes:
  - a strong, positive climate for implementation;
  - management support for innovation implementation;
  - financial resource availability;
  - and a learning orientation

Klein KJ. Innovation Implementation. 2005
Weiner BJ. Using Organization Theory. 2009

Driving Forces for Change

- In Australia, was it inspectorate, industry or legislature?
  - It depends on who you talk to
  - Main message is that each feel they played a significant role in driving change
- Driven by a number of personalities that filter down from the top
  - Has to originate from the top and find support as it is passed down
- Most recognize that leadership in the industry and at mine sites can be the most influential component for effective and efficient change
  - This translates to the organization as a whole
  - There has to be an ownership to the level of risk
  - More aware of the differences in various states – because workforce is in all states
- Technologies enabled the legislation
- Disasters
  - Moura: 1994 explosion killing 11
  - Gretley: 1996 flooding, drowning 4

Keys to Success…

The Value of Planning

- Team management
  - Identify right people and assign to the right roles
  - Ensure a cross-section of the workforce
- Leadership & facilitation
  - Consider outside facilitator…provides fresh perspective
- Appropriate Risk assessment methods, tools, instruments
- Aids in keeping things simple
- Physical venue
- Anticipate constant scheduling
  - Took approx. 2 years to fully develop hazard plan for outburst
- Consider timing and potential barriers

…Keys to Success

Reporting

- Reporting culture is integral to safety culture (J. Reason)
- Near-miss reporting
- Fear of retribution (i.e., distrust)
  - Liability (both miners, managers, and inspectorate)
  - Fines today are still rare, however, prosecutions of miners (in particular mine managers) are increasing.
- Getting ahead of the fatal curve
  - Mines with severe injuries have an increased odds of fatalities (*see notes below*)

…Keys to Success

Effective communication

- Behaviors and culture have changed over time
- Communication is essential to safety culture
  - Enables the same language to be shared
  - Allows learning from experiences and sharing those among the industry
  - Dependent on the individual H&S manager

Added Benefits

- The health and safety management will better represent the workforce
- Improves the understanding as to why things are done, at all levels of the workforce
  - Making the right decision because they understand the reasons why
- Having direct input into protocols translates to improved ownership and accountability

Summary of Risk Assessment

- Proactive and systematic approach to improving risk
- Involves the identification and assessment of hazards of particular operations
  - Will vary from industry to industry, mine to mine
- No single method of risk analysis applies effectively to all possible objectives
- Results lead to:
  - Relevant control measures
  - What to do when hazardous events occur
- Underlying goal is to improve decision making