A Systems Based Approach to CRRT

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Case GA

- 36 year-old hispanic male presented with abdominal pain progressing to chest pain at outside hospital
- Consistent with acute MI
- PMH: lupus, hypercoagulable state
- Delay in intervention suffered transmural infarct of inferior wall
- Transferred to UCSD 6/2 for cardiac catheterization
- Received cardiac cath, stenting of thrombus in RCA
- Developed oliguric acute on chronic kidney injury secondary to contrast load

Dialysis Rx

- Started on CVVHDF 6/8

CVVHDF Rx 2/12

- Qb 100 mL/min
- Qd 1000 mL/hr
- UF 1500 mL/hr
- TSC 145 mL/hr
- CaCL 80 mL/hr

Dialysate

- NaHCO3 20mEq/L
- NaCL 20 mEq/L
- KCL 5 mEq/L
- Mag 3 mEq/L
- Dextrose 0.1%

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Laboratory

Parameter	6/7	6/8	6/8 pm
Scr	2.8	4.5	2.7
BUN	16	32	22
Na	137	136	128
K	4.1	4.2	4
Cl	97	99	96
HCO3	31	25	19
Mg	1.9	2	2.6

Laboratory

Parameter	6/8 1500h	6/8 1625h	6/8 2005h
Peripheral iCa	0.97	0.96	1.01
Post filter iCa	0.65	0.75	0.79

What actions would you take at this point?

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Plan of Action

- Citrate flow had been increased maximally
- Attending physician was called
- TSC bag was switched out with a new bag
- Rate maintained
- Samples sent to clinical laboratory for analysis

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Quality Assurance of Solutions

Sample	Sodium concentration mEq/L *	pH
Patient sample	105	5
Random sample bag #2 **	362	7.14
Random sample bag #3 **	<10	7.36
Random sample bag #4 **	361	7.14

*No assay for [citrate], [sodium] used as a surrogate test.

**Bags 2,3,4 pulled from pharmacy refrigerator, prepared on same day on citrate bag used for AG.

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Laboratory

Parameter	6/8 1500h	6/8 1625h	6/8 2005h	6/9 0200h	6/9 0500h	6/9 0930h	6/9 1200h
Peripheral iCa	0.97	0.96	1.01	0.96	0.91	1.03	1.08
Post filter iCa	0.65	0.75	0.79	<0.2	0.2	0.26	0.23

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Laboratory

Parameter	6/7	6/8	6/8 pm	6/9	6/10
Scr	2.8	4.5	2.7	3.8	3
BUN	16	32	22	30	31
Na	137	136	128	132	135
K	4.1	4.2	4	4.5	4
Cl	97	99	96	101	104
HCO3	31	25	19	20	28
Mg	1.9	2	2.6	2.3	2.3

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Case Analysis

- Error?
- Who's fault?
- What needs to be done?

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Quality Assurance

- Baxter CAPS compounding pharmacy prepares trisodium citrate 4% 2 liter bags for UCSD Medical Center
- CAPS internal QA revealed human and machine errors
  - No lot number recorded on batched solutions
  - New employee operating compounding machine
  - Machine was set in wrong mode!
- Tour of CAPS facility and review of QA Procedures by UCSD Pharmacy Dept
- Corrective action plan
  - Weigh each bag
  - Double check expected and actual weights
  - Improved training of new employees
  - Improved documentation procedures

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Error

"Human Error" is a generic term used to describe all those occasions where a planned sequence of mental or physical activities fails to achieve its intended outcome, and when these failures cannot be attributed to outside intervention.

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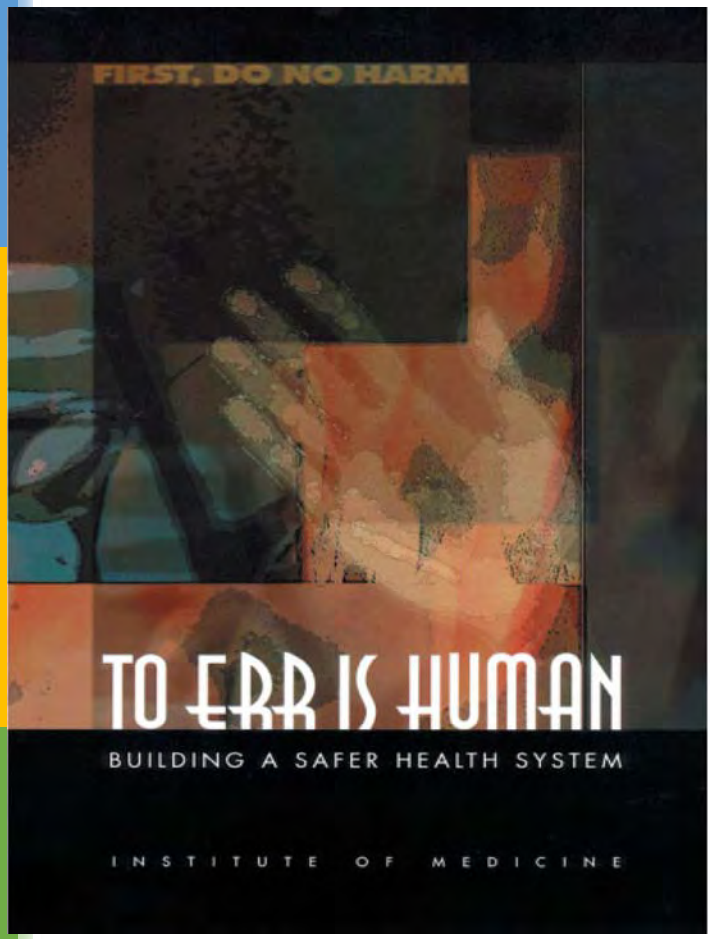
Institute of Medicine Report



A User's Manual For The IOM's 'Quality Chasm' Report

Patients' experiences should be the fundamental source of the definition of "quality."

by Donald M. Berwick **Health Affairs 2002**

The underlying framework analyzes the needed changes in American health care at four different levels:

- *the experience of patients (Level A);*
- *the functioning of small units of care delivery ("microsystems") (Level B);*
- *the functioning of the organizations that house or otherwise support microsystems (Level C);*
- *the environment of policy, payment, regulation, accreditation, and other such factors (Level D), which shape the behavior, interests, and opportunities of the organizations at Level C.*

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Robert Blendon et al: Views Of Practicing Physicians And The Public On Medical Errors N Engl J Med, Vol. 347, 2002

TABLE 1. RESPONDENTS' PERSONAL EXPERIENCE WITH PREVENTABLE MEDICAL ERRORS.

RESPONSE	PHYSICIANS (N=831)	PUBLIC (N=1207)	P VALUE
	percent		
All respondents			
Error made in own or family member's care	35	42	<0.001
Health consequences			
Serious	18	24	<0.001
Minor	10	13	0.03
None	7	5	0.06
Serious consequences			
Severe pain	11	16	<0.001
Substantial loss of time at work or school, or in other important activities	12	17	<0.001
Temporary disability	8	12	0.009
Long-term disability	6	11	0.003
Death	7	10	0.01
Respondents reporting an error*			
Parties who had "a lot" of responsibility for the error			
Doctors	70	81	<0.001
Nurses	25	25	0.15
Other health professionals	15	26	<0.001
The institution (e.g., a hospital, clinic, or nursing home facility)	22	43	<0.001
Health professional involved			
Told respondent that an error had been made	31	30	0.19
Apologized to respondent or family member	34	33	0.14
Respondent or family member sued health professional	2	6	<0.001

*A total of 290 physicians and 507 members of the public reported an error in their own care or that of a family member.

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Robert Blendon et al: Views Of Practicing Physicians And The Public On Medical Errors N Engl J Med, Vol. 347, 2002

TABLE 2. BELIEFS ABOUT THE FREQUENCY OF MEDICAL ERRORS AND PREVENTABLE DEATHS.*

QUESTION AND RESPONSE	PHYSICIANS (N=831)	PUBLIC (N=1207)	P VALUE
	percent		
How often are preventable medical errors made?			
Very often	1	10	<0.001
Somewhat often	19	39	<0.001
Not very often	59	37	<0.001
Not often at all	21	8	<0.001
No response	0	6	
How many Americans die in hospitals each year because of preventable medical errors?			
500	17	24	<0.001
5000	46	36	<0.001
50,000	25	20	0.002
100,000	9	7	0.12
≥500,000	1	4	<0.001
No response	1	9	
What proportion of these deaths could realistically have been prevented?			
All of them	8	11	0.04
Three quarters of them	27	29	0.48
Half of them	41	42	0.71
One quarter of them	21	13	<0.001
None of them	2	1	0.05
No response	1	3	

*Percentages may not always sum to 100 because of rounding.

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Reason's Error Taxonomy

- Errors
  - Slips: Errors in execution
  - Mistakes: Planning failures
- Violations:
  - Deliberate acts
- System Issues:
  - Leadership
  - Culture
  - Work design

James T Reason: in Clinical Risk Management: Enhancing patient safety BMJ Books 1999

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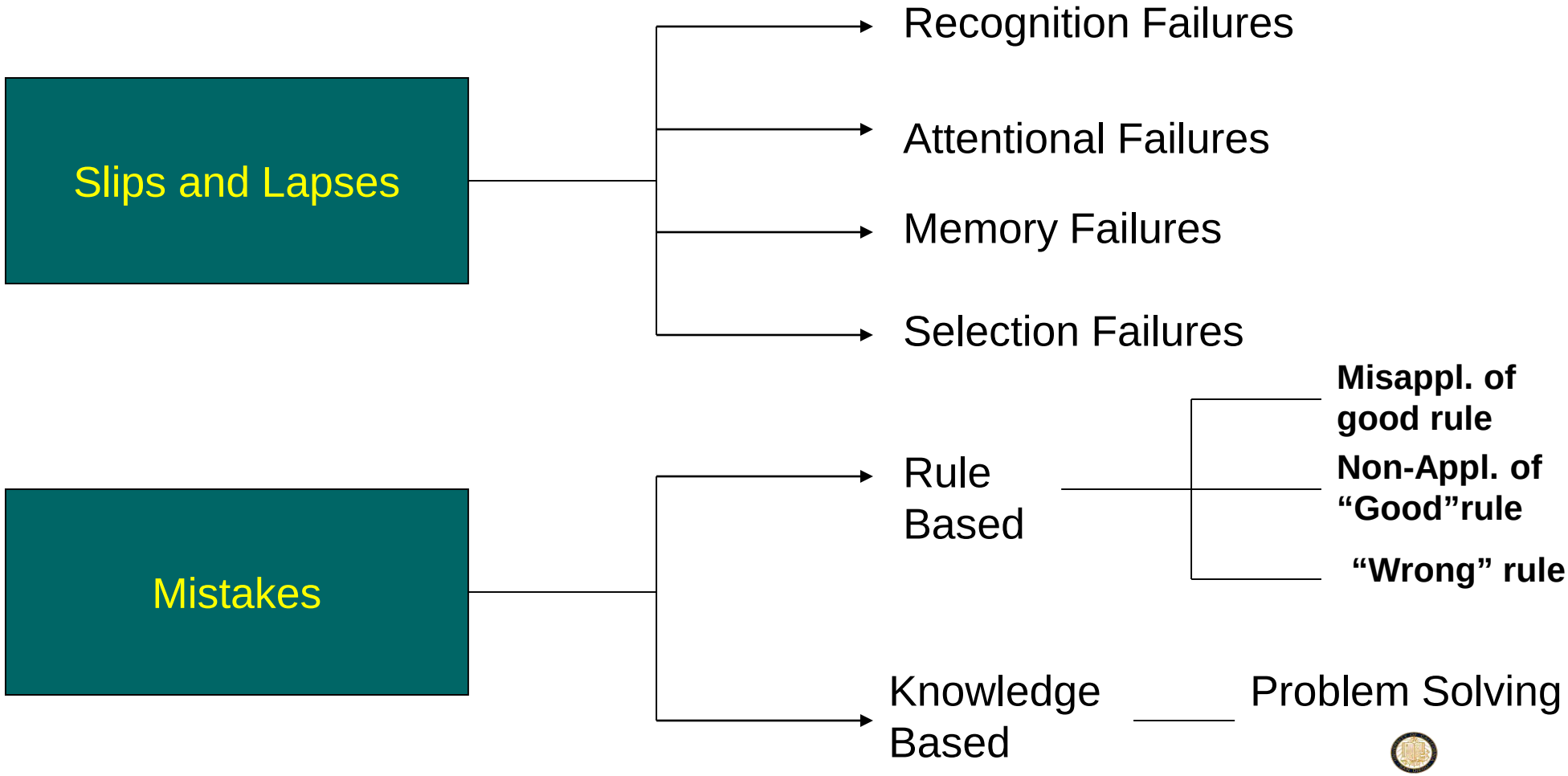
Reason's Error Taxonomy



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Reasons for Mistakes and Slips

Mistakes

- Misinterpretation
- Lack of Knowledge
- Habits of Thought

Slips

- Interruptions
- Hurry
- Fatigue
- Anxiety
- Anger
- Boredom
- Fear

James T Reason: in Clinical Risk Management: Enhancing patient safety BMJ Books 1999

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Cognitive Mechanisms

Automatic

- Unconscious
- Rapid
- Parallel
- Effortless

Problem-Solving

- Conscious
- Slow
- Sequential
- Difficult

Approaches to Human Fallibility

- Person Approach
  - focuses on the errors of individuals, blaming them for forgetfulness, inattention, or moral weakness
- System Approach
  - concentrates on the conditions under which individuals work and tries to build defences to avert errors or mitigate their effects

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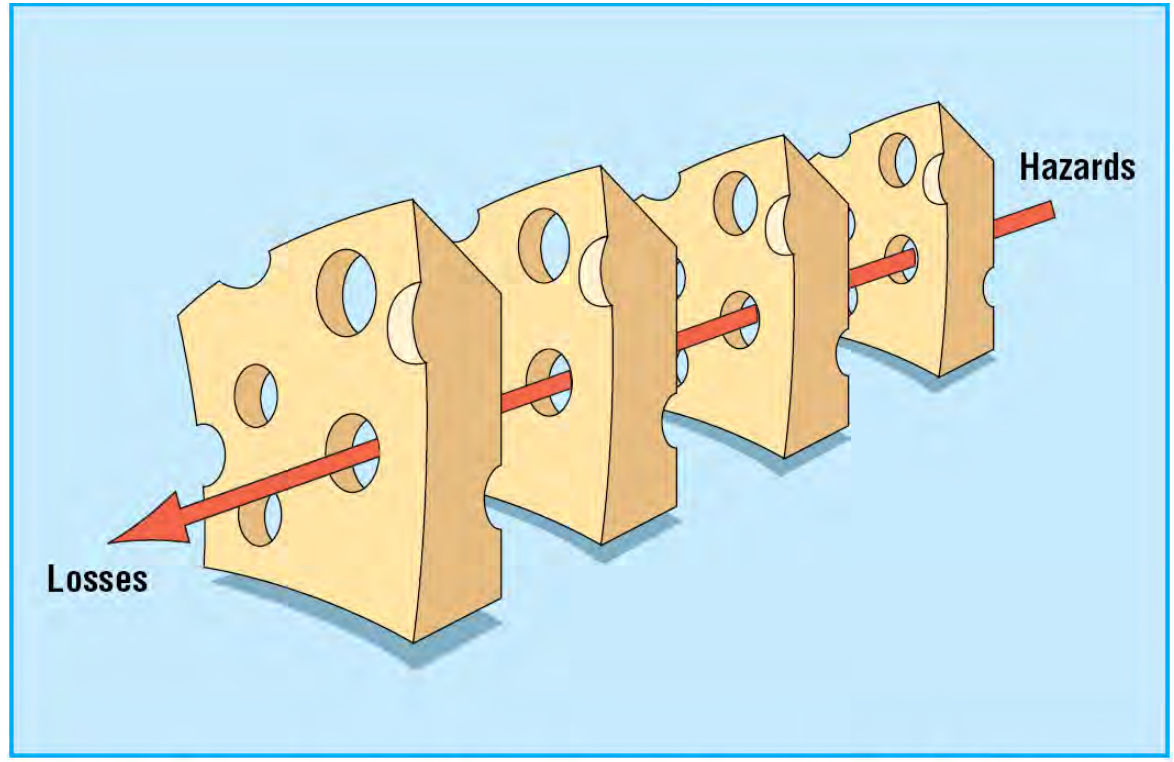
Reason's Error Taxonomy

- Active Failures
- Latent Failure Conditions

James T Reason: in Clinical Risk Management: Enhancing patient safety BMJ Books 1999

James Reason Human error: models and management

BMJ 2000;320;768-770



The Swiss cheese model of how defences, barriers, and safeguards may be penetrated by an accident trajectory

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High Reliability Organizations

- High reliability organisations—which have less than their fair share of accidents—recognise that human variability is a force to harness in averting errors, but they work hard to focus that variability and are constantly preoccupied with the possibility of failure

***James Reason* Human error: models and management**

***BMJ* 2000;320;768-770**

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James Reason Human error: models and management

BMJ 2000;320;768-770

High reliability organisations

So far, three types of high reliability organisations have been investigated: US Navy nuclear aircraft carriers, nuclear power plants, and air traffic control centres. The challenges facing these organisations are twofold:

- Managing complex, demanding technologies so as to avoid major failures that could cripple or even destroy the organisation concerned
- Maintaining the capacity for meeting periods of very high peak demand, whenever these occur.

The organisations studied[7 8] had these defining characteristics:

- They were complex, internally dynamic, and, intermittently, intensely interactive
- They performed exacting tasks under considerable time pressure
- They had carried out these demanding activities with low incident rates and an almost complete absence of catastrophic failures over several years.

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Lessons from Human Factors Research

- Many errors are caused by activities that rely on weak aspects of cognition
  - Short term memory
  - Attention span
- Errors can be prevented by designing tasks and processes that minimize dependency on weak cognitive functions
- Failures of communication, particularly those that result from inadequate “handoffs” between clinicians, remain among the most common factors contributing to the occurrence of adverse events.

Robert Blendon et al: Views Of Practicing Physicians And The Public On Medical Errors N Engl J Med, Vol. 347, 2002

TABLE 3. CAUSES OF PREVENTABLE MEDICAL ERRORS.

RESPONSE	PHYSICIANS (N=831)	PUBLIC (N=1207)	P VALUE
	percent		
Very important causes			
Understaffing of nurses in hospitals	53	65	<0.001
Overwork, stress, or fatigue on the part of health professionals	50	70	<0.001
Failure of health professionals to work together or communicate as a team	39	67	<0.001
Influence of HMOs and other managed-care plans on treatment decisions*	39	48	<0.001
Complexity of medical care	38	62	<0.001
Insufficient time spent by doctors with patients	37	72	<0.001
Poor training of health professionals	28	54	<0.001
Poor handwriting by health professionals	21	48	<0.001
Poor supervision of health professionals	16	50	<0.001
Uncaring health professionals	15	47	<0.001
Lack of computerized medical records	13	35	<0.001
The more important reason for errors			
Mistakes made by individual health professionals	55	55	0.72
Mistakes made by institutions	43	38	0.009
No response	2	7	
Volume of procedures†			
An error is more likely at a high-volume hospital	4	23	<0.001
An error is more likely at a low-volume hospital	71	49	<0.001
Volume does not make a difference	24	26	0.23
No response	1	3	
Patients are at least partially responsible for errors made in their own care			
Very often	10	11	0.51
Somewhat often	48	48	0.89
Not very often	41	35	0.002
Never	1	5	<0.001
No response	0	1	

*HMOs denotes health maintenance organizations.

†Percentages for the public do not always sum to 100 because of rounding.

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David M Gaba et al: Fatigue Among Clinicians And The Safety Of Patients N Engl J Med, Vol. 347: 949

TABLE 1. CURRENT AND PROPOSED RESTRICTIONS ON WORK AND ON-DUTY HOURS IN U.S. COMMERCIAL AVIATION.

CATEGORY	CURRENT REGULATIONS*	PROPOSED REGULATIONS†
Maximal hours in flight‡		
Per day	No limit (≥8 of rest required between flight periods)	10; extension to 12 allowed with restrictions; >12 allowed with relief crew and opportunities for sleep
Per week	30	4 Cumulative hours of extension (as above)
Per month	100	Insufficient data for regulation
Per year	1000	Insufficient data for regulation
Maximal hours on duty		
Per day	Not addressed	14
Per week	Not addressed	Insufficient data for regulation
Per month	Not addressed	Insufficient data for regulation
Per year	Not addressed	Insufficient data for regulation
Minimal hours of rest in preceding 24 hr		Addressed as minimal off-duty period
Scheduled flight time, <8 hr	9§	
Scheduled flight time, 8–9 hr	10§	
Scheduled flight time, ≥9 hr	11§	
Minimal hours off duty		
Per day	Addressed as minimal rest period	10 (>10 if flight period is extended)
Per week	24 (consecutive)	36 (consecutive), including 2 consecutive nights; 48 (consecutive) after flight duty in a circadian low¶
Other	Not addressed	48 after crossing multiple time zones

*Current regulations, which apply to major airlines, are set forth in the *Code of Federal Regulations* (14 CFR Part 121).

†Proposed regulations are described by Dinges et al.[34]

‡Flight time is defined as the period when the aircraft is moving under its own power.

§Rest may be reduced by one to two hours if the next rest period is increased.

¶Persons who are awake during the circadian low (between 2 a.m. and 6 a.m.) are at increased risk for fatigue and have an increased requirement for recovery.

Error Producing Conditions Ranked in order of Known Effect

Condition	Risk Factor
Unfamiliarity with Task	(x17)
Time Shortage	(x11)
Poor signal: noise ratio	(x10)
Poor Human system interface	(x8)
Designer use mismatch	(x8)
Irreversibility of errors	(x8)
Information overload	(x6)
Negative transfer between tasks	(x5)
Misperception of risk	(x4)
Poor feedback from system	(x4)
Inexperience (not lack of training)	(x3)
Poor Instructions or procedures	(x3)
Inadequate checking	(x3)
Educational mismatch of person with task	(X2)
Disturbed sleep patterns	(x1.6)
Hostile environment	(x1.2)
Monotony and Boredom	(x1.1)

Reason 1999, Williams 1988

Systems Based Practice

- Components
- Design (Relationships)
- Assessment
- Performance Improvement

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Systems Based Practice

Key characteristics of a system

- Pattern,
  - The pattern of organization describes the configuration of relationships that determine the system's essential characteristics,
- Structure
  - Represents the physical embodiment of the system's pattern of organization,
- Processes
  - Its processes describe the activities involved in the continual embodiment of the system's pattern of organization.

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Key characteristics of a system

- 'Living systems' are described as complex adaptive systems. Such complex adaptive systems exist in a state far from equilibrium and have the ability to self organize. This means the processes occurring within the system are constantly changing its components, making the system unstable, but, despite this instability complex adaptive systems reproduce and maintain their overall structure and function.

- The important feature of any complex adaptive system is the interconnectedness of all its components, and the relationships between components are more important in understanding the system than the components themselves.

Components

- Patients
- Team
- Tasks
- Workplace (Environment)
- Institution

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A User's Manual For The IOM's 'Quality Chasm' Report

Patients' experiences should be the fundamental source of the definition of "quality."

by Donald M. Berwick

- Level B's microsystems are the small units of work that actually give the care that the patient experiences.
- A "microsystem" is a small team of people, combined with their local information system, a client population, and a defined set of work processes.

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Essential Elements of a Microsystem

- a core team of healthcare professionals;
- the defined population they care for;
- an information environment to support the work of caregivers and patients; and
- support staff, equipment, and a work environment.

J J Mohr et al: Improving safety on the front lines: the role of clinical microsystems Qual Saf Health Care 2002;11:45–50

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J J Mohr et al: Improving safety on the front lines: the role of clinical microsystems Qual Saf Health Care 2002;11:45–50

- Characteristics of Effective Microsystems
  - Integration of information
  - Measurement
  - Interdependence of the care team
  - Supportiveness of the larger system
  - Constancy of purpose
  - Connection to the community
  - Investment in improvement
  - Alignment of role and training.

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J J Mohr et al: Improving safety on the front lines: the role of clinical microsystems Qual Saf Health Care 2002;11:45–50

Table 1 Summary of microsystem characteristics

Characteristic	Operational definition
Integration of information	• Information is key, technology may be very helpful
Measurement	• Microsystem routinely measures processes and outcomes feeds data back to providers, makes changes based on data
Interdependence of care team	• Care provided by a multidisciplinary team, information is key to the relationship
Supportiveness of the larger system	• Microsystem views larger organisation as helpful
Constancy of purpose	• Integration of the aim throughout the microsystem
Connection to community	• Microsystem is a resource to the community, community is a resource to the microsystem
Investment in improvement	• Resources made available for improvement (training, money, time)
Alignment of role and training	• Health professionals expected to work at the upper limits of education, training

J J Mohr et al: Improving safety on the front lines: the role of clinical microsystems Qual Saf Health Care 2002;11:45–50

Key messages

- A clinical microsystem is a small organised group of clinicians and staff working together with a shared clinical purpose to provide care for a defined set of patients.
- The clinical purpose defines the essential parts of the microsystem. Use of information is key to its ability to function; information technology facilitates collecting, assessing, and sharing of information.
- Microsystems are usually part of a larger organisation and are embedded in a legal, financial, social, and regulatory environment.
- Answers to the following questions are needed to define the microsystem:
  - what is the aim or purpose?
  - who is the small population of people who benefit from this aim?
  - who do you work with daily (administratively, technically, and/or professionally)?
  - what information and information technology is part of the daily work?
- Senior leaders of the microsystem should:
  - look for ways in which the macro-organisation connects to and facilitates the work of the microsystem;
  - support the needs of the microsystem;
  - facilitate the coordination among microsystems.

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Is CRRT a Microsystem?

- Aim:
  - Organ support for critically ill patients with changing needs
- Team
  - Physicians (nephrologists, Intensivist, surgeon)
  - Nurses (critical care, Nephrology)
  - Allied Personnel (Pharmacist, Nutiritionist, Dialysis Technician)
  - Technical knowledge needed
- Tasks
  - Set-up
  - Monitoring and adjustments of CRRT delivery, fluid balance, anticoagulation
  - Handling alarms
  - Take-off
- Interactions
  - Multidisciplinary team approach required
  - Frequent interactions among caregivers

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Is CRRT a Microsystem?

- Information Technology
  - Written orders
  - Worksheets
  - Verbal communication
  - Device interface for device specific information
- Special Issues
  - Trained individuals
  - Duration of therapy requires multidisciplinary hand-offs
  - High likelihood of errors that may not be easliy discerned given nature of patient
- Organizational Structure
  - Hospital based
  - ICU/Nephrology Resources

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Is CRRT a Microsystem?

- Yes!

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Why Focus on Microsystems?

- Provides greater standardization of common activities and customization of care to individual patients
- Greater use and analysis of information to support daily work,
- Consistent measured improvement in performance,
- extensive cooperation and teamwork across disciplines and specialties within the microsystem,
- Provides an opportunity for spread of best practices across microsystems within their larger organisations.

J J Mohr et al: Improving safety on the front lines: the role of clinical microsystems Qual Saf Health Care 2002;11:45–50

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Peter J Pronovost et al: How can clinicians measure safety and quality in acute care? Lancet 2004: 363:1062

	Definition	Example
Patient's factors		
• Condition (complexity, seriousness, agitation) • Language or communication • Personality and social factors	Clinical or social characteristics of a patient that contribute to an adverse event.	• Patient does not speak English • Patient refuses treatment
Task factors		
• Availability of protocols • Availability of test results • Accuracy of test results	Characteristics of a specific task that contribute to an adverse event.	• Absence of protocol to guide therapy • Test results not available
Provider factors		
• Knowledge, skills, and competence • Fatigue • Motivation and attitude • Physical or mental health • Failure to follow established protocol	Characteristics or state of an individual provider that contributes to an adverse event.	• Lack of skill in understanding procedure • Fatigue
Team factors		
• Verbal or written communication during hand-over • Verbal or written communication during care • Verbal or written communication during crisis • Supervision and seeking help • Team structure and leadership	Characteristics of the work team that contribute to an adverse event.	• No standard procedure during hand-over at shift change • Perceived barrier for voicing concerns
ICU environment		
• Staffing levels • Skills mix • Workload • Availability or maintenance of equipment • Administrative and managerial support • Physical environment (eg, lack of space, noise)	Characteristics of the work environment that contribute to an adverse event.	• Workload in the ICU • Broken equipment
Institutional Environment		
• Financial resources • Time pressures	Decisions (or indecision) by management that contribute to an adverse event.	• Limited financial resources • Pressure to treat more patients

Table 1: **System Factors used in the ICUSRS that could have contributed to an incident**

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J F Bion, J E Heffner: Challenges in the care of the acutely ill
LANCET • 363 :970, 2004 970

	Level			
	Patient	Microsystem	Organisation	Environment
Resources and organisational structures	Equity Access	Outreach, medical emergency teams, hospitalists	Evidence-based resource management Patient safety officer at hospital board level	Patients' safety agencies Clinical networks Interhospital transport systems Health-care funding
Processes and delivery of care	Competence Compassion Timeliness	Transdisciplinary team-working Policies, protocols and procedures Computerised prescribing	Mapping the patient journey Admission, discharge, and transfers Infection control	Primary and secondary care linkages Best practice guidelines
Information management and communication	Electronic patient records including prescribing (computerised patient order entry, CPOE)	Continuity of care and information transfer Intranet access to information	Responsiveness Workplace-based access practice and training Collaborative planning	National framework linking safety, clinical
Monitoring and analysis tools	Severity of illness and early warning systems Questionnaires, feedback Patient-centred outcomes	Audit and PSDA cycles, including errors of omission Adverse event reporting and near-misses	Adverse event monitoring Consumer surveys Staff sickness and turnover rates Failure mode and effects analysis Root cause analysis	Benchmarking Target indicators Serious adverse event databanks Observational databases, standardised mortality ratios Control charts
Competence, training, education, and behaviour	Advance directives Public education in healthcare outcomes	Workplace-based training and assessment of knowledge, skills, attitudes, and behaviour	Investment in and appointment of appropriately skilled staff	Integrated transdisciplinary competency-based training at undergraduate and postgraduate level
Governance	Empowerment through education, participation and transparency	Local leadership and responsibility for individual patient outcomes	Culture of safety and learning Collaborative management in the front-line	Professional self-regulation Continuing professional development Hospital accreditation

PSDA=patient self-determination act.

Systems Based Practice

- Components
- Design
- Assessment
- Performance Improvement

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Essentials for Effective Health Care Delivery

- Knowledge-based care.
- Patient-centered care.
- Systems-minded care.

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Human Factors Principles and Systems Design

- Avoid Reliance on memory
- Simplify
- Standardize
- Use Constraints and Forcing Functions
- Use Protocols and Check Lists

Human Factors Principles and Systems Design

- Improve Access to information
- Decrease reliance on vigilance
- Reduce Hand-offs
- Increase feedback
- Decrease look-alikes
- Careful automation

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Robert Blendon et al: Views Of Practicing Physicians And The Public On Medical Errors N Engl J Med, Vol. 347, 2002

TABLE 4. POSSIBLE SOLUTIONS TO THE PROBLEM OF MEDICAL ERRORS.*

SOLUTION	PHYSICIANS (N=831)	PUBLIC (N=1207)	P VALUE
	percent		
Very effective			
Requiring hospitals to develop systems for preventing medical errors	55	74	<0.001
Increasing the number of nurses in hospitals	51	69	<0.001
Giving physicians more time to spend with patients	46	78	<0.001
Limiting certain high-risk procedures to hospitals that perform many of these procedures	40	45	0.03
Improving the training of health professionals	36	73	<0.001
Using only physicians trained in intensive care medicine on intensive care units	34	73	<0.001
Reducing the work hours of physicians in training to prevent fatigue	33	66	<0.001
Increasing the use of computers to order drugs and medical tests	23	45	<0.001
Requiring hospitals to report all serious medical errors to a state agency	23	71	<0.001
Encouraging hospitals to report serious medical errors voluntarily to a state agency	21	62	<0.001
Including a pharmacist on hospital rounds when physicians review the care of patients	20	40	<0.001
Increasing the use of computerized medical records	19	46	<0.001
Having hospitalized patients taken care of by hospital physicians rather than by their regular physicians	6	16	<0.001
Suspending the licenses of health professionals who make medical errors	3	50	<0.001
Increasing lawsuits for malpractice	1	23	<0.001
Having a government agency fine health professionals who make medical errors	2	40	<0.001
Physicians should be required to tell patients when errors are made in their care			
Yes	77	89	<0.001
No	22	9	
No response	1	3	
Hospital reports of serious medical errors			
Should be confidential (used only to learn how to prevent future mistakes)	86	34	<0.001
Should be released to the public	14	62	<0.001
No response	0	4	

*Percentages for the public do not always sum to 100 because of rounding.

Human Factors Principles and Systems Design for CRRT

- Avoid Reliance on memory
- Simplify
- Standardize
- Use Constraints and Forcing Functions
- Use Protocols and Check Lists

- Worksheets (electronic)
- Step wise protocols and check lists
- Orders and flow sheets and methods for recording
- Sliding scales and stopping rules
- Standard orders, monitoring, triggers for intervention

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Human Factors Principles and Systems Design for CRRT

- Improve Access to information
- Decrease reliance on vigilance
- Reduce Hand-offs
- Increase feedback
- Decrease look-alikes
- Careful automation

- Common tools for information transfer e.g. worksheets
- Automated alarm systems with built in safety parameters
- Safety alerts
- Trained individuals with step wise protocols for handoffs
- Ongoing communication to caregivers from bedside
- Color-coded labels and solutions
- User friendly device interfaces with guidance on troubleshooting

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Systems Design for CRRT: Requirements

- Organizational Resources
- Training
  - Physicians
  - Nurses
  - Pharmacists
  - Ancillary Staff
- Standardized Protocols
  - Roles and Responsibilities
  - Explicit methods for communication
  - Hand off Procedures
- Tools to monitor and improve performance
- Efficient safe and user friendly devices
- Information systems to integrate the patient, device and provider data for analysis and effective communication.

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Systems Based Practice

- Components
- Design
- Assessment
- Performance Improvement

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Assessing Systems Based Practice

- What to Assess?
  - Professional competence
  - System Factors

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Professional Competence

The habitual and judicious use of communication, knowledge, technical skills, evidence-based decision-making, emotions, values and reflection to improve the health of the individual patient and the community.

Epstein RM, Hundert EM. JAMA 2002

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Levels of Assessment

- Knows (demonstrates knowledge)
- Knows how (describes how)
- Shows how (in real and controlled situations)
- Does (when nobody's looking)

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What we know how to assess reliably

-- decontextualized factual knowledge
-- performance of specific maneuvers (Hx, PE)
-- some interpersonal skills

What we typically assess

-- descriptions of events rather than observed performance
-- individuals rather than groups

What we tend not to assess

-- causes of common errors
-- habits of mind
-- systems, teamwork

Assessing Health Systems: High-Reliability "Mindful" Organizations

- **Vigilance** (focus on safety; preoccupation with failure)
- **Tolerance of complexity** (reluctance to simplify)
- **Critical curiosity** (promoting learning)
- **Sensitivity to operations** (avoiding the Marie Antoinette syndrome)
- **Open communication** (transparency of intent; non-punitive reporting)
- **Informed flexibility** (commitment to resilience)
- **Deference to expertise, wherever it may reside**

after Weick, 2001

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Assessing Systems-Based Practice

- Critical incidents
- Typical incidents
- Root cause analysis
- Systems ethics -- insurance coding / charting

- Interdisciplinary review rather than M&Ms
- 360-degree assessments
- Surveys -- patients, staff, clinicians
- All levels

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D J Cook et al: Improving patients' safety locally: changing clinician behavior Lancet 2004; 363:1224

Step	Activity	Outcome
Do an environmental scan	ED and ICU directors informally surveyed use of hypothermia in comatose survivors of VF cardiac arrest	ED directors reported no patients treated with hypothermia in pre-hospital phase or in the ED, ICU directors reported occasional use in the tertiary ICU, planning for use in one university affiliated ICU, but no use in other ICUs
	Prospective audit of comatose survivors of VF cardiac arrest admitted to local ICUs	Majority of suitable patients did not receive hypothermia; when used, the timing and effectiveness were sub-optimal
Understand current behaviour	Structured interviews with ED and ICU MDs and RNs	Some ED physicians and most ICU physicians were aware of RCTs showing less neurological dysfunction using hypothermia; some scepticism was expressed about the results and generalisability
Target the behaviour to change		
• Why change	Two published RCTs in comatose survivors of VF cardiac arrest showing that hypothermia decreased neurological dysfunction	Agreed that hypothermia should be used for all comatose survivors of VF cardiac arrest who satisfy the entry criteria for the HACA Trial.
• What to change	Comatose survivors of VF cardiac arrest who satisfy entry criteria for HACA Trial will receive hypothermia management	Detailed protocol prepared (external cooling to 32–34°C, ice packs as necessary, sedation, and paralysis)
• When to change	After multidisciplinary ED and ICU journal clubs in which two RCTs were critically appraised	Agreed that RCT evidence is strong enough to prevent neurological dysfunctional and should be implemented locally
• Where to change	Ambulance, ED, ICU, cardiac catheterisation laboratory	Agreed that hypothermia should start in the ambulance, continue in the ED, during investigation and treatment in the cardiac catheter laboratory, and in the ICU
• Who to change	Target paramedics, ED, ICU, and cardiac catheterisation teams	Ideally, paramedics in pre-hospital phase, ED team and ICU team always, and cardiac catheterisation team if necessary
Adopt effective behaviour change strategies	Interactive education with paramedics	Paramedics agreed that hypothermia protocol is needed for managing comatose survivors of VF cardiac arrest. ED; ICU will consult early to check patient eligibility for hypothermia using entry criteria for HACA Trial
	Collaborative creation of protocol for ambulance service, ED, and ICU	Draft hypothermia protocol developed and pretested
	Audit of hypothermia protocol compliance by ICU research coordinators using structured questionnaire	After feedback of audit results to ambulance service, ED and ICU, increased compliance with hypothermia protocol aided by local opinion leader
	Identification of senior ICU MD as local champion at each hospital for academic detailing	Increased compliance with hypothermia protocol
Synergise	Case based discussion and two RCTs presented at medical grand rounds.	ED and ICU team enthused about this preventive intervention
	Further discussion in multidisciplinary ED and ICU journal club, including additional joint journal clubs with neurologists and cardiologists	Neurologists agree that patients should receive hypothermia even though sedation and paralysis may delay neurological prognostication
		Cardiologists agree that patients should receive hypothermia in the catheter laboratory as needed

System-wide hypothermia protocol modified from one used by the Northern Sydney Area Health Service. VF=ventricular fibrillation. ED=emergency department. ICU=intensive care unit. MD=medical doctor. RN=registered nurse. RT=respiratory therapist. RCT=randomised clinical trial. HACA Trial=Hypothermia After Cardiac Arrest Trial.

Example of the five step approach to patients' safety using hypothermia for comatose survivors of VF cardiac arrest to prevent neurological dysfunction

D J Cook et al: Improving patients' safety locally: changing clinician behavior Lancet 2004; 363:1224

Strategies to change professional behaviour in the acute care setting

Single-faceted interventions

Educational materials

Conferences

Local consensus process

Educational outreach visits

Local opinion leaders

Patient-mediated interventions

Audit and feedback

Reminders (manual or computerised)

Marketing

Multifaceted interventions

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Systems Based Practice

- Components
- Design
- Assessment
- Performance Improvement

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Richard Lilford et al: Use and misuse of process and outcome data in managing performance of acute medical care: avoiding institutional stigma. Lancet 2004; 363: 1147-1154

Performance measures and indicators
The distinction between a measure of quality and an indicator of quality is important. Generally speaking we have very few real measures of quality. For example, post operative length of stay is a measure of the patient's hospital stay, but only an indicator of quality—eg, a patient's long stay might represent postoperative complications or poor discharge arrangements. Thus, the term indicator is preferable.

Performance monitoring
Regular review of performance by use of any combination of structure, process, or outcome data.

Performance management
External judgment of the quality of care based on performance monitoring data followed by a system of reward and punishment.

Process of continual improvement
Application of the scientific method to deliver improvement based essentially on an understanding of variation and the plan-do-study-act cycle, akin to the hypothesis generation and testing cycle of the scientific method.

Safety, medical error, and quality of care
Safety is defined as the absence of clinical error, which can be classified as errors of commission (unintentionally doing the wrong thing) or omission (unintentionally not doing the right thing). So although performance monitoring might focus on safety and error, it is not possible to disentangle this from quality of care. We therefore use the term quality of care in its broader sense which includes medical error and safety.

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Richard Lilford et al: Use and misuse of process and outcome data in managing performance of acute medical care: avoiding institutional stigma. Lancet 2004; 363: 1147-1154

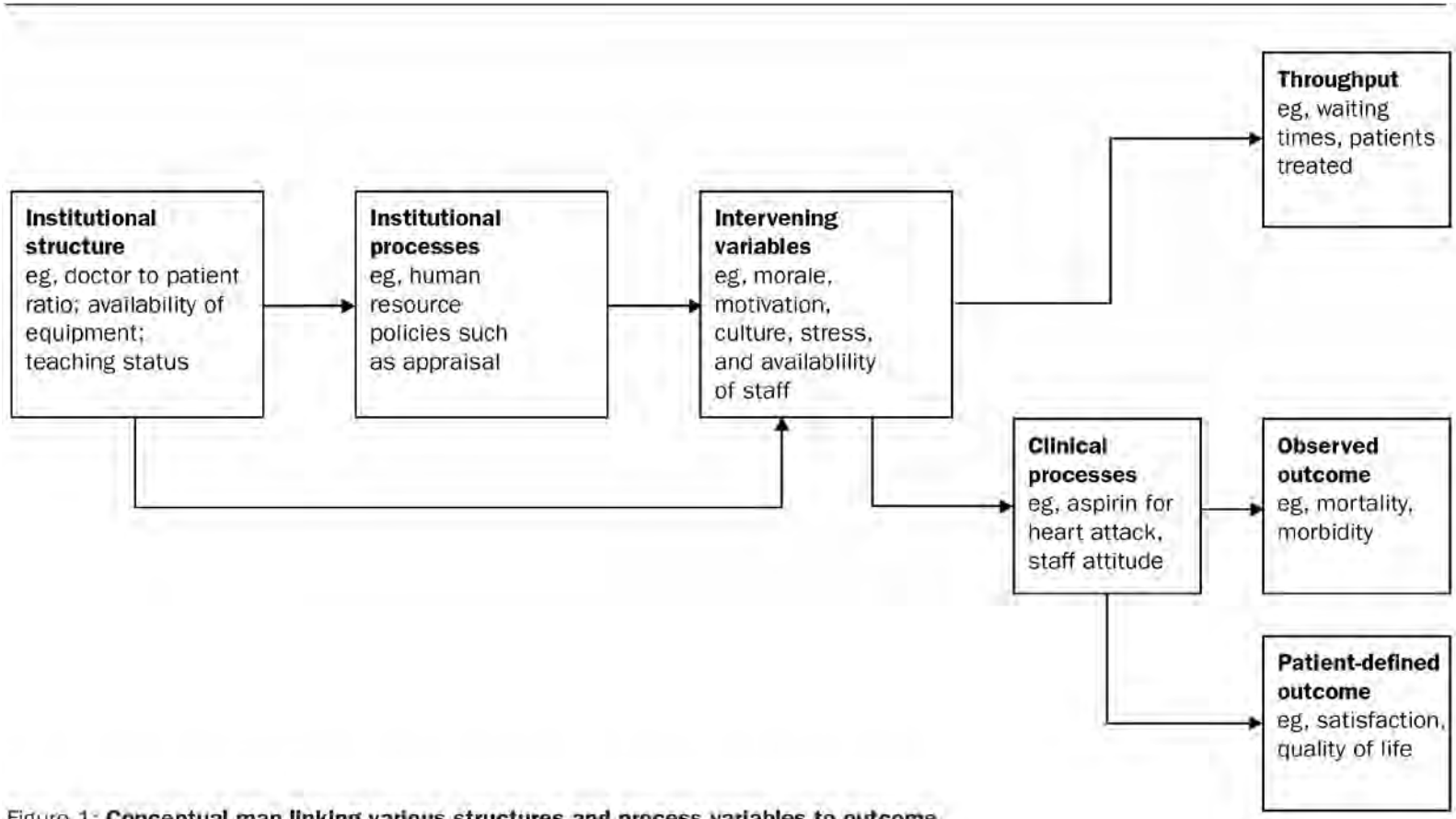

Figure 1: **Conceptual map linking various structures and process variables to outcome**

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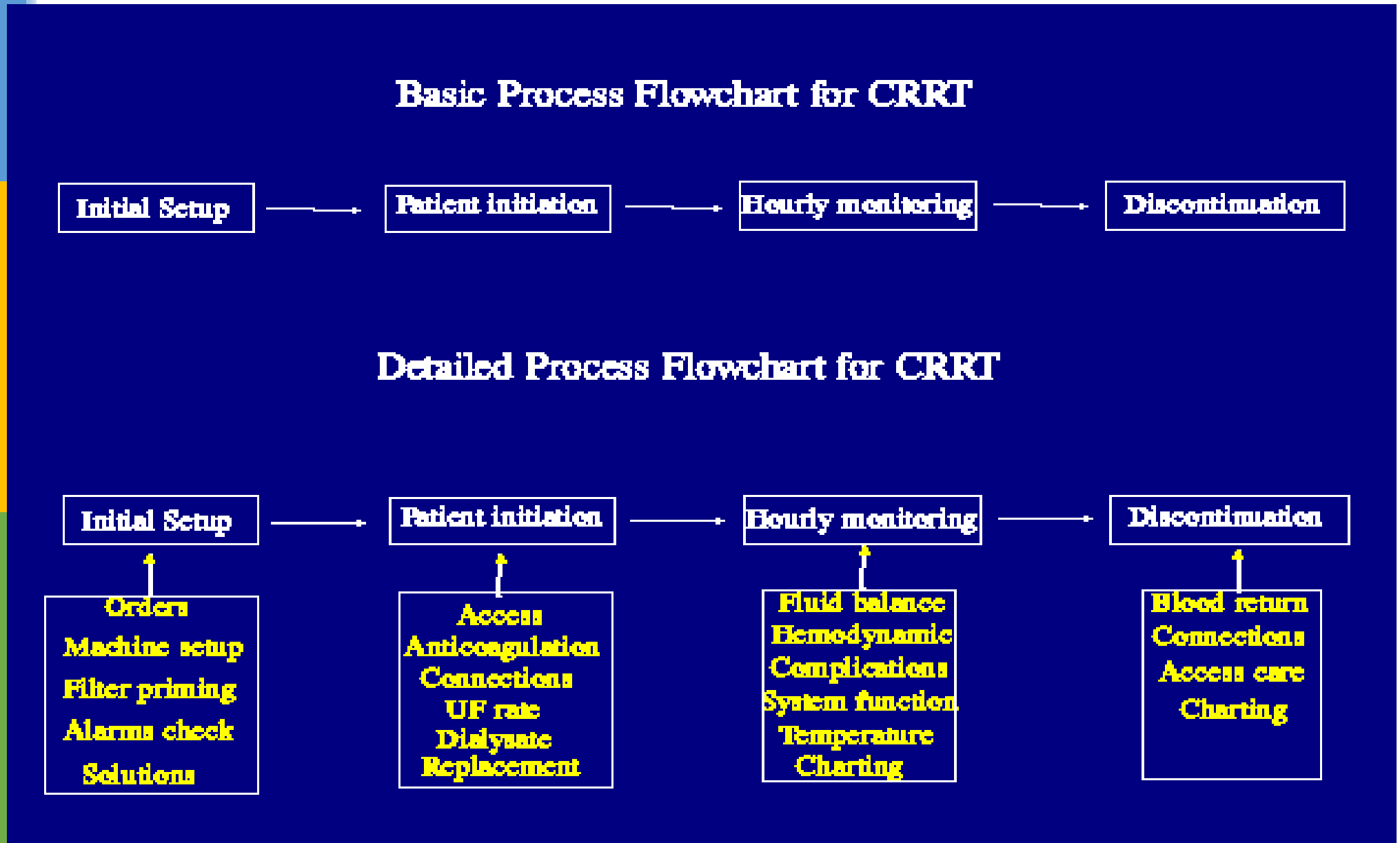
Performance Improvement in CRRT: Process Charting



Richard Lilford et al: Use and misuse of process and outcome data in managing performance of acute medical care: avoiding institutional stigma. Lancet 2004; 363: 1147-1154

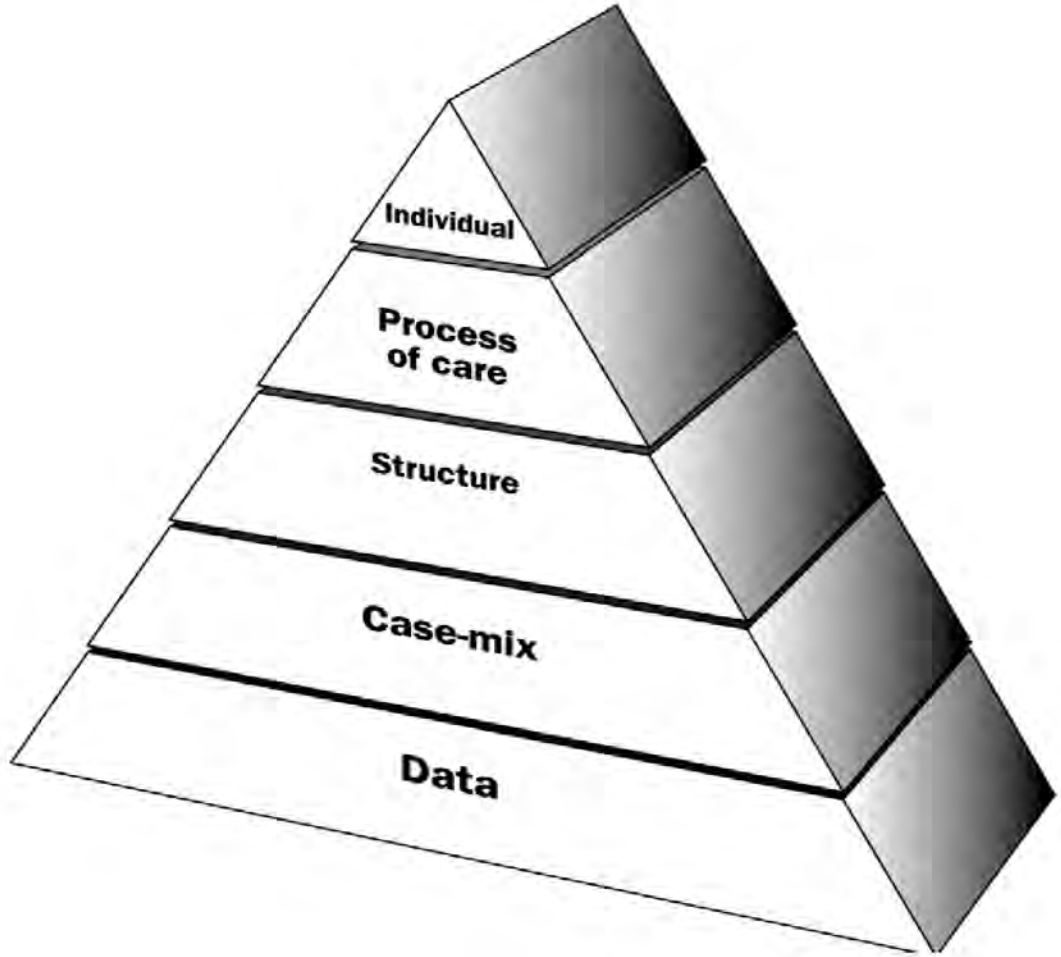


Figure 3: **Pyramid of investigation for special cause variation**
Investigation should start with data and end with individuals.

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Peter J Pronovost et al: How can clinicians measure safety and quality in acute care? Lancet 2004: 363:1062

	Considerations
Prioritise clinical area for assessment	Area should be important: affect morbidity, mortality, or costs of care Caregivers' performance varies Caregivers can change the system
Select the type of measures	Rate, continuous or time to event, ratio
Write design specifications	Define: who, what, when, where, and how they will collect the data?
Develop data collection tools	Evaluates validity and reliability Evaluates feasibility and burden on staff
Pilot test	Does the consumer of the data believe it is important? Does the data collection system work?
Develop scoring and analytical specifications	Develop dummy run chart What will be the measure of performance? What will be the unit of analysis?
Obtain baseline data	Identify baseline performance Ensure data collection systems works

Table 2: **Steps to develop quality measures for use in a health system**

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Systems Based Approach to CRRT: Performance Improvement

- Information on current status
  - Tracking quality measures
    - Process
    - System
  - Incident capture and reporting
- Define system improvements needed
- Develop Strategy and Tools
- PDSA cycle

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System Based Approach to CRRT: Error Assessment

APPENDIX 4: DEFINITIONS OF OCCURRENCES WITHIN CHR

CRITICAL INCIDENT means an unexpected an unusual occurrence or variation involving death or serious injury or risk thereof. This would include any process variation resulting in an actual serious adverse outcome, which may or may not be successfully reversed. Also included is any process variation or near miss, whereby a recurrence carries a 50% or greater change of an actual serious adverse outcome. The Calgary Health Region categorizes the severity of client outcome based on a four-point classification scale.

CLINICAL INCIDENT CODE CLASSIFICATION

Severity Code 1:	There is no adverse outcome, e.g. a fall with no significant symptoms or injury.
Severity Code 2:	There is no apparent adverse outcome, or the injury is minor and self-limiting. If action is required, only simple first aid or monitoring is necessary.
Severity Code 3:	The incident has adverse outcomes, (which is more than minor) that are successfully reversed with treatment (e.g. a fall resulting in a fracture followed by a full recovery) or there is no adverse outcome, but there is a significant potential for future adverse outcomes. Major system policy or process review may be required.
Severity Code 4:	These incidents result in actual serious physical injury not reversed by clinical intervention, or death. In addition to immediate clinical intervention, in some cases a critical review of policy and process is required.

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Reasons's Error Analysis Method

Step 1: Lay out the sequence of the accident. Tell the story of what happened, who did what, and how.

Step 2: Identify the unsafe act, acts, or conditions that are apparent from the sequence.

Step 3: Identify the error type. Determine whether the error was a planning or execution error.

Step 4: Identify causal/contributing factors. At this point we are moving from what happened to why it happened. To uncover underlying causes behind a particular action or decision, it is important to determine whether there is anything in the system that could lead anyone else to the same action.

James Reason's Generic Error Modelling System (GEMS)

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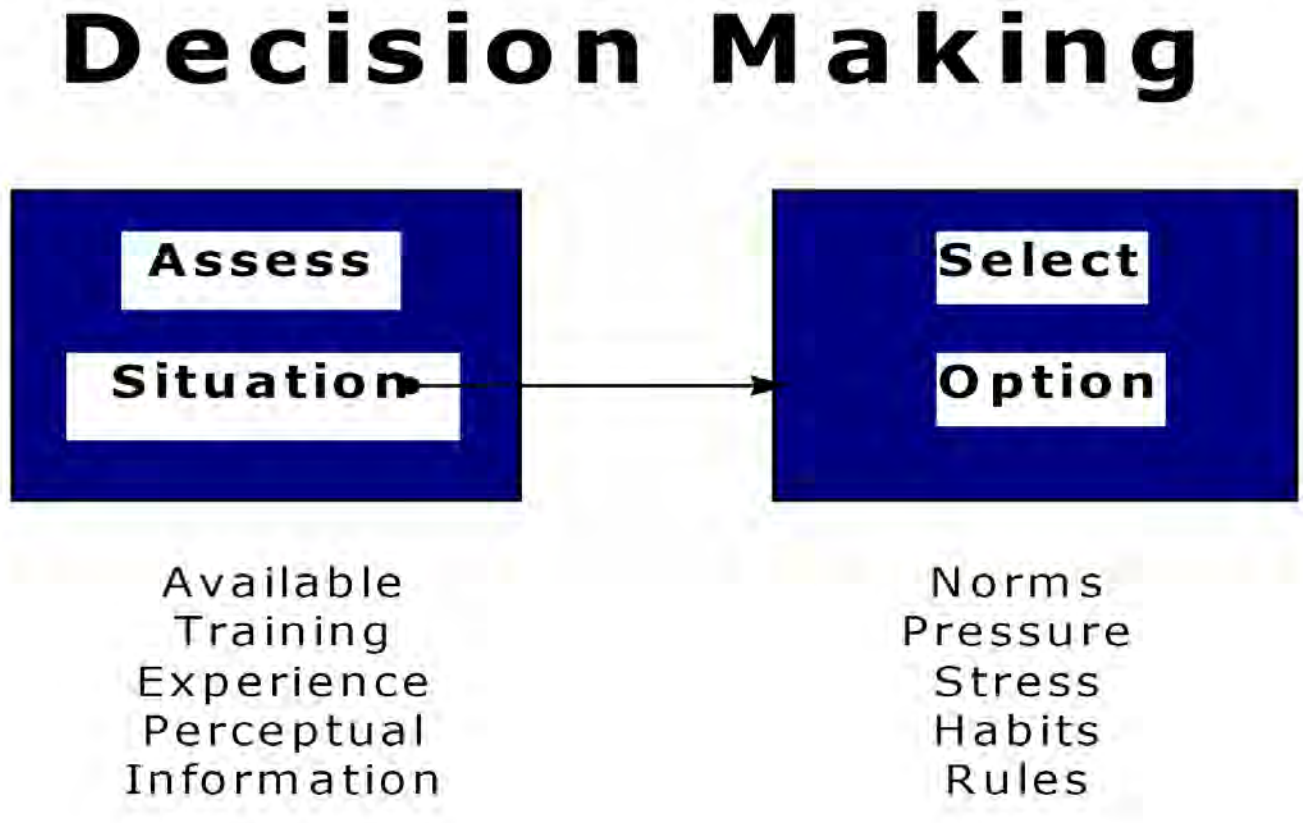
Reasons's Error Analysis Method



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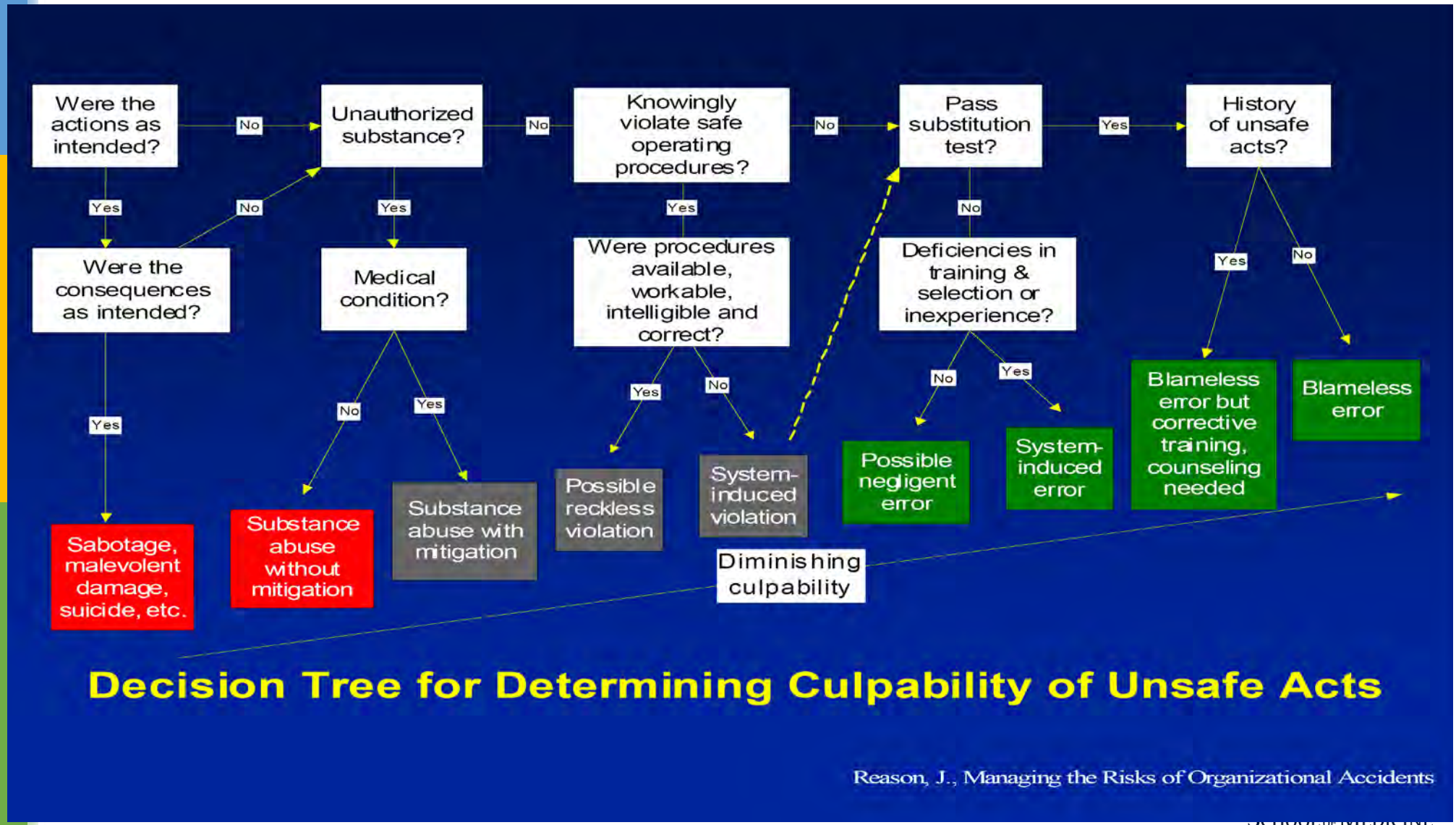
System Based Approach to CRRT: Error Assessment



Requirements for an Effective Incident Reporting System

- Identifying the incident, issue, or safety concern;
- Collecting data and analysing to determine the causal and contributing factors;
- Developing corrective action or recommendations;
- Implementing the corrective action; and
- Evaluating to determine the efficacy of the corrective action.

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UCSD Electronic QVR System

UCSD Healthcare

Create Profile

Log in to view Incident #29026.

User ID Password LOGIN

If this is your first time using We Listen or eQVR, please select "Create Profile" above.

To enter an eQVR incident, click HERE.

For questions or concerns, please contact BRENDA ESTIGOY @38207 or pager 290-5104. In addition you may email bestigoy@ucsd.edu

Need help logging in? Click HERE.

Need other help? Click HERE.

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UCSD Electronic QVR System

Incident #……. (Complete)

CONFIDENTIALITY STATEMENT - NOTICE
This Incident Report may be protected as a document prepared in anticipation of litigation. It may also be protected by Evidence Codes 1156 and 1157. In order to maintain these protections and the confidentiality of this document, **do not distribute** outside the scope of the quality or legal investigative process.

Incident Data

Step 1 - General
Incident Type: Patient
Patient Name: ……..
MRN: --------
DOB:---------
Gender: -----
Department: Medicine
Division: -------
Location: Ambulatory Care Center
Unit: Medicine Specialties
Incident Date: 00/00/2004 09:00 AM
Is it likely that this incident will result in a lawsuit? No
Is this incident related to research? No
Is this event related to one of the following National Patient Safety Goals? Not related to patient safety goals
Was the Chain of Command used in this event? Not answered
Check all applicable. Not answered

Step 2 - Category/Subcategory
Category: We Listen
Subcategory: Compliment

Step 3 - Compliment Questions
This subcategory contains no questions.

Step 4 - Incident Description
PER WE LISTEN BROCHURE:
The doctors and nurses were wonderful. In particular Dr. ---, Dr. ---,
Dr. ---, ----, and nurse ---.
Thank you for everything.

Step 5 - Witnesses
1. Name: ----
   Title: patient
   Phone: ------
   Type: Non-Employee
   Notes: Have forwarded compliment to ACC Hillcrest Medicine Specialities, K. Brewster, for follow-up. Thank you.

Reporter Details
Name:Marta S. Basile
E-Mail: msbasile@ucsd.edu
Supervisor E-Mail: dwagoner@ucsd.edu
Phone: 619-471-9635

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UCSD Electronic QVR System

Severity Ranking

Type of Harm: Not Ranked
Level of Harm: Not Ranked

Follow Up Comments

02/23/2005 05:08 PM	S. Antrum	Good job everyone! Sheila

System Messages

02/28/2005 06:57 PM	System	Viewed by R. Mehta
02/28/2005 05:48 PM	System	Viewed by j. merrill
02/23/2005 05:08 PM	System	Viewed by S. Antrum
02/23/2005 02:23 PM	System	E-Mail notification(s) sent to: msbasile@ucsd.edu, jmerrill@ucsd.edu, dwagoner@ucsd.edu, santrum@ucsd.edu, jjulian@ucsd.edu, amccarthy@ucsd.edu, kbrewster@ucsd.edu, rmehta@ucsd.edu
02/23/2005 02:23 PM	M. Basile	Incident created

Administrative Options

Follow Up Comment Entry

E-Mail Notification

Send incident notification to the following manager(s):

---------- Select Manager(s) ----------

Send incident notification to the following e-mail addresses (e.g. email1, email2, email3...):

Subject:

We Listen E-Mail Forwarded Notification - Incid

Custom Text Comments:

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Strategies to Prevent Errors and Adverse Events in CRRT What's Needed?

- Tools that can improve communication
  - Make knowledge more readily accessible
  - Require key pieces of information (such as the dose of a drug),
  - Assist with calculations,
- Perform checks in real time,
- Assist with monitoring
- Provide decision support.

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Error Producing Conditions Ranked in order of Known Effect

Condition	Risk Factor
Unfamiliarity with Task	(x17)
Time Shortage	(x11)
Poor signal: noise ratio	(x10)
Poor Human system interface	(x8)
Designer use mismatch	(x8)
Irreversibility of errors	(x8)
Information overload	(x6)
Negative transfer between tasks	(x5)
Misperception of risk	(x4)
Poor feedback from system	(x4)
Inexperience (not lack of training)	(x3)
Poor Instructions or procedures	(x3)
Inadequate checking	(x3)
Educational mismatch of person with task	(X2)
Disturbed sleep patterns	(x1.6)
Hostile environment	(x1.a)
Monotony and Boredom	(x1.1)

Reason 1990, Williams 1988

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PHYSICIAN'S ORDERS
ADULT
CRRT PROTOCOL

Source Request Date

Citrate
Initiation and New Filter Orders
Page 1 of 3

Patient Identification

PHYSICIAN: Use ball point pen. Cross off and initial nonapplicable orders. Use the metric system when filling in blanks or writing additional orders. To reinstate or add additional orders after signing and dating this set, use blank Physician's Orders.

NURSE: Remove Nursing and Pharmacy copies. Retain Nursing copy. Check drugs needed, then forward Pharmacy copy, whether or not medications are ordered or appear on that page.

Patient Parameters:

1. Diagnosis _____
2. Allergies _____ Reaction _____
3. Weigh patient before starting CRRT and once daily (if possible same time every day). Record the time of weighing and type of scale used (eg: sling, bedscale).
4. Use standard CRRT procedures/protocol of unit.
5. **Access:** ❍ Temporary Catheter ❍ Fistula **Site:** ❍ Left ❍ Right
   ❍ Tunneled Cathether ❍ Graft **Location:** ❍ Femoral ❍ Jugular ❍ Subclavian
   ❍ ECMO Circuit ❍ Other _____ ❍ Arm ❍ Leg ❍ Other _____

Treatment Parameters:

6. Modality: ❍ SCUF ❍ CAVH ❍ CVVH ❍ CAVHD ❍ CVVHD ❍ CAVHDF ❍ CVVHDF
   ❍ Other _____
7. Machine: ❍ BSM22 ❍ Prisma ❍ Braun ❍ Fresenius 2008H ❍ Baxter BM11 ❍ Baxter BM25
   ❍ Other _____
8. Filter: ❍ AN69S Hollow Fiber ❍ F40 ❍ F60 ❍ Prisma Set ❍ Other _____

Solutions and Flow Rate:

9. CVVHDF - Maintain blood flow rate at ____ ____ ____ mL/minute (usually 100 mL/minute).
10. Ultrafiltration flow rates:
    A. For all machines other than PRISMA, set UF pump speed to provide net UF rate of:
       ❒ 1000 mL/hour OR ❒ Other: _____ _____ _____ _____ mL/hour (range = 700 to 2000 mL/hour)
    B. For PRISMA use prefilter replacement set: (dilution fluid is normal saline)
       1) Set prefilter dilution rate: ❒ 500 mL/hour OR ❒ Other: _____ mL/hour (range 250-700 mL/hour)
       2) Net fluid balance at: ❒ -700 mL/hour OR ❒ Other: _____ mL/hour (range –500-1000 mL/hour)
       NOTE: Setting the two parameters on the PRISMA will dictate the UF (effluent) pump speed and the UF rate.
11. Dialysate composition: choose STANDARD or CUSTOM:
    ❒ STANDARD: Base solution: dextrose 0.1% + NaCl 0.45% plus additives: NaCl 40 mEq/L (10 mL of 23% NaCl), $MgSO_4$ 1.5 mEq/L, KCl ____ mEq/l.
    ❒ CUSTOM dialysate: mark items below (final concentration)
    Dextrose ____ . ____ % (01-1.0%) KCl ____ mEq/L $MgSO_4$ ____ . ____ mEq/L
    NaCl ____ ____ ____ mEq/L $NaHCO_3$ ____ ____ mEq/L
    Other 1 ____ ____ ____ . ____ ____ Other 2 ____ ____ ____ . ____ ____
12. Dialysate flow rate (mL/hour): ❍ 1000 ❍ Other _____
13. Use fluid warmer to maintain patient's temperature at ____ ____ . ____ °C

Physician Signature/PID# Date & Time Nurse Signature Date & Time

D1743(2-00)6

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PHYSICIAN'S ORDERS
ADULT
CRRT PROTOCOL

Source | Request Date

Citrate
Initiation and New Filter Orders

Patient Identification

PHYSICIAN: Use ball point pen. Cross off and initial nonapplicable orders. Use the metric system when filling in blanks or writing additional orders. To reinstate or add additional orders after signing and dating this set, use blank Physician's Orders.

NURSE: Remove Nursing and Pharmacy copies. Retain Nursing copy. Check drugs needed, then forward Pharmacy copy, whether or not medications are ordered or appear on that page.

14. Replacement fluid composition: ❒ 0.9% sodium chloride
    ❒ Other 1: _____ ❒ Other 2: _____
15. Replacement fluid flow rates: Choose **one** method below to maintain net fluid balance:
    ❒ Set hourly fluid removal rate:
    ❒ Net negative ___ ___ ___ mL/hour for ___ ___ ___ hours.
    ❒ Keep even for ___ ___ ___ hours.
    ❒ Net positive ___ ___ ___ mL/hour for ___ ___ ___ hours.

    ❒ Sliding scale (below):
    Parameters:
    ○ MAP ○ PAWP
    ○ CVP ○ Other _____

	Suggested Hourly Fluid Target Parameters	OTHER Hourly Fluid Target Parameters
_____	+ 200 mL	_____
_____	+ 150 mL	_____
_____	+ 100 mL	_____
_____	+ 50 mL	_____
_____	EVEN	_____
_____	- 50 mL	_____
_____	- 100 mL	_____
_____	- 150 mL	_____
_____	- 200 mL	_____

NOTE: For all machines other than PRISMA: infuse fluid into replacement fluid line (prefilter, postpump).
For PRISMA: give replacement fluid postfilter via venous return line.

Anticoagulant:

16. Regional CITRATE anticoagulation 0.14 molar citrate to run into 4-WAY STOPCOCK at vascular access exit at ___ ___ ___ mL/hour (usually 2 to 3% of BFR; eg: 140-180 mL/hr for a BFR = 100 mL/min) to maintain POST-FILTER IONIZED CALCIUM at 0.25-0.30 mmol/L.
    NOTE: Start at lower rate (120 - 140 mL/hr) for patients with hepatic failure.
17. Check POST-FILTER IONIZED CALCIUM at initiation of CRRT and every 4 hours x 24 hours, then every 8 hours x 24 hours, then every 12 hours. Adjust CITRATE flow rate according to sliding scale below.

Citrate Replacement Sliding Scale

Postfilter Ionized Ca	**Citrate Flow Rate**
< 0.20	decrease by 10 mL/hour (call Renal MD)
0.20-0.24	decrease by 5 mL/hour
0.25-0.30	NO CHANGE
0.31-0.40	increase by 5 mL/hour
0.41-0.45	increase by 10 mL/hour
> 0.45	increase by 15 mL/hour (call Renal MD)

Physician Signature/PID# Date & Time

Nurse Signature Date & Time

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PHYSICIAN'S ORDERS
ADULT
CRRT PROTOCOL

Source | Request Date

Citrate
Initiation and New Filter Orders
Page 3 of 3

Patient Identification

PHYSICIAN: Use ball point pen. Cross off and initial nonapplicable orders. Use the metric system when filling in blanks or writing additional orders. To reinstate or add additional orders after signing and dating this set, use blank Physician's Orders.

NURSE: Remove Nursing and Pharmacy copies. Retain Nursing copy. Check drugs needed, then forward Pharmacy copy, whether or not medications are ordered or appear on that page.

Citrate Replacement Sliding Scale (continued)

Do not decrease citrate rate below ___ ___ ___ mL/hour (usually 120 mL/hour).
Do not increase citrate rate above ___ ___ ___ mL/hour (usually 200 mL/hour).

18. Calcium chloride solution: 8 g $CaCl_2$ in 1 L 0.9% sodium chloride (1080 mL total). To run into CENTRAL LINE at ___ ___ ___ mL/hour (usually 40-45 mL/hour) to maintain PERIPHERAL IONIZED CALCIUM 1.12-1.2 mmol/L.
19. Check PERIPHERAL IONIZED CALCIUM at initiation of CRRT and every 4 hours x 24 hours, then every 8 hours x 24 hours, then every 12 hours. Adjust calcium chloride according to sliding scale below.

Calcium Chloride Sliding Scale

Peripheral Ionized Ca	Calcium Chloride
< 0.85	increase by 15 mL/hour + 2 g Ca gluconate (call Renal MD)
0.85-0.94	increase by 10 mL/hour + 2 g Ca gluconate
0.95-1.04	increase by 5 mL/hour + 1 g Ca gluconate
1.05-1.11	increase by 5 mL/hour
1.12-1.20	NO CHANGE
1.21-1.30	decrease by 5 mL/hour
1.31-1.45	decrease by 10 mL/hour
> 1.45	decrease by 15 mL/hour (call Renal MD)

Do not decrease calcium chloride rate below ___ ___ ___ mL/hour (usually 30 mL/hour).
Do not increase calcium chloride above ___ ___ ___ mL/hour (usually 80 mL/hour).

Labs:

20. Labs to be drawn IN SEQUENCE at **0200** hours:
    a. Peripheral: CBC, differential, platelet count, Chem 7, Mg, Ca, PO_4, liver panel.
    b. Postfilter: BUN, creatinine.
    c. Prefilter (postpump): BUN, creatinine.
    d. Ultrafiltrate: BUN, creatinine (measure and record UF for 10 minutes at the time of collectrion and send 3 mL sample).
21. Labs to be drawn at start of every new filter and at 1400 hours. Same sequence as #20 above.
    a. For peripheral labs do: BUN, creatinine, electrolytes, Ca, PO_4.
    b. Labs for post, pre, and UF same as 0200.

Maintenance Orders: Renal MD pager # _____

22. Check blood pressure and fluid loss every 4 hours and notify Renal MD for systolic blood pressure less than ___ ___ ___ mm Hg.
23. Notify Renal MD for UF rate less than 300 mL/hour for 2 consecutive hours.
24. Check for line patency and presence of peripheral pulses every 4 hours. Notify Renal MD of problems prn.
25. Special orders: _____

Physician Signature/PID# | Date & Time

Nurse Signature | Date & Time

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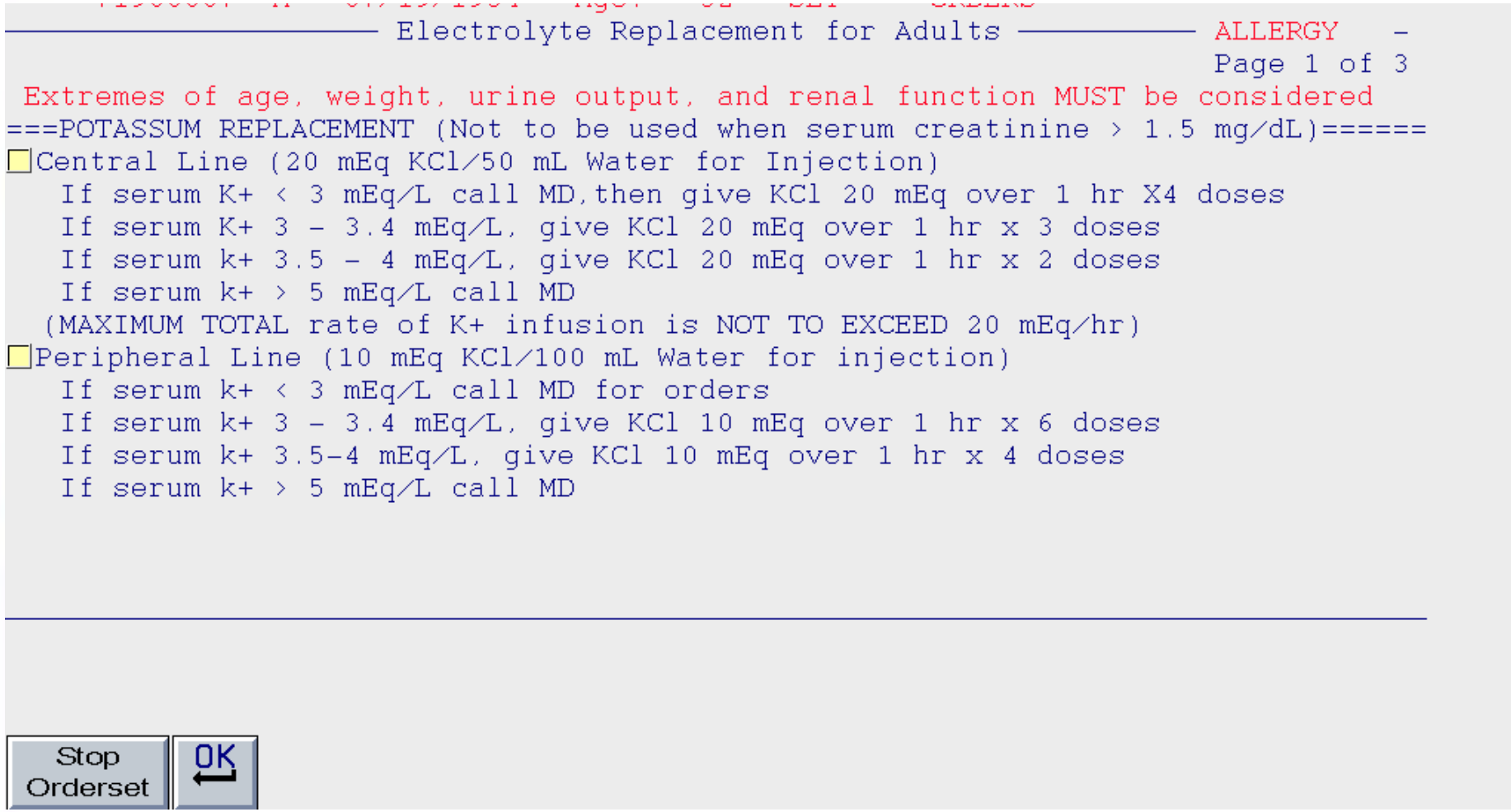
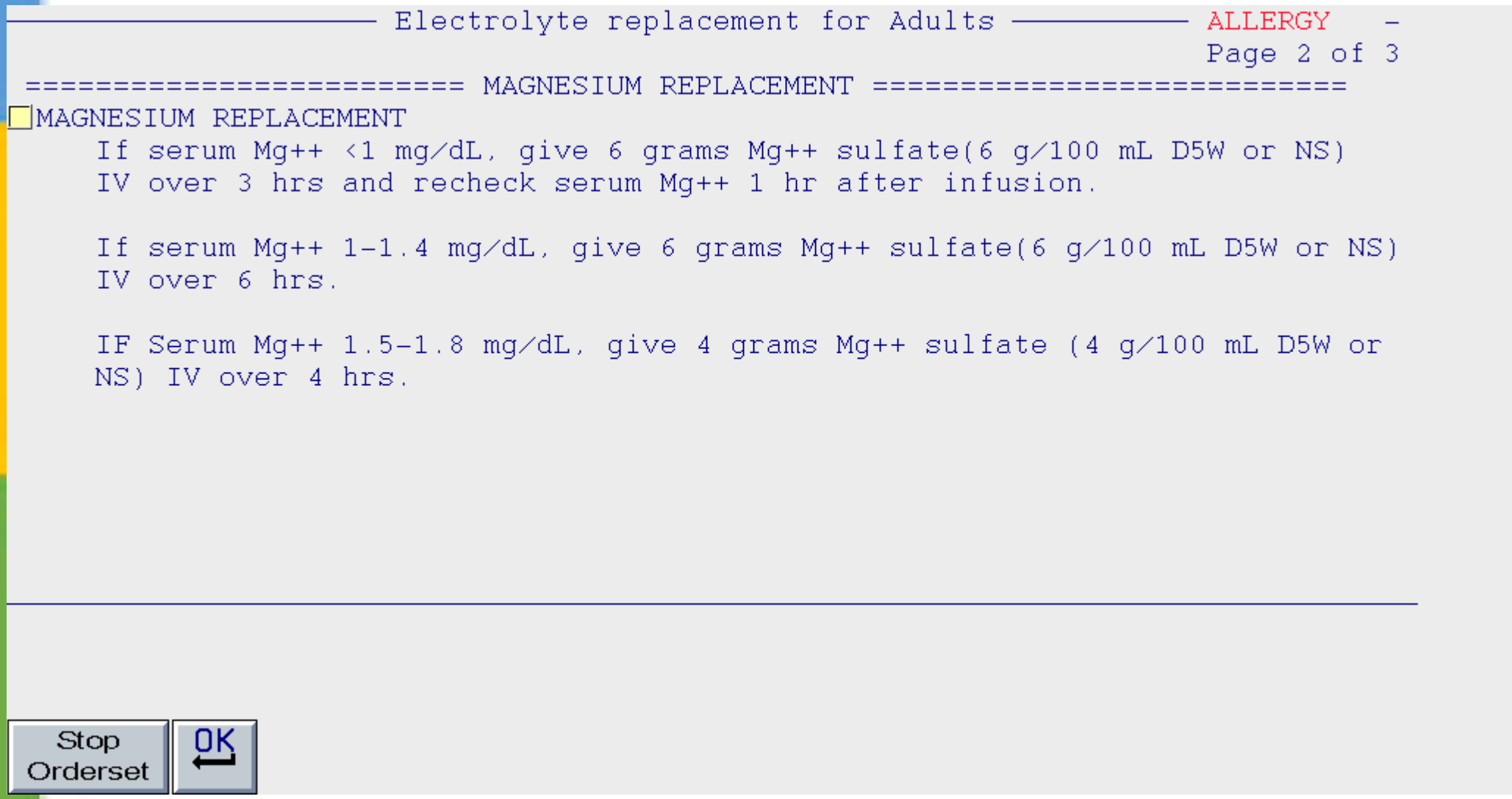
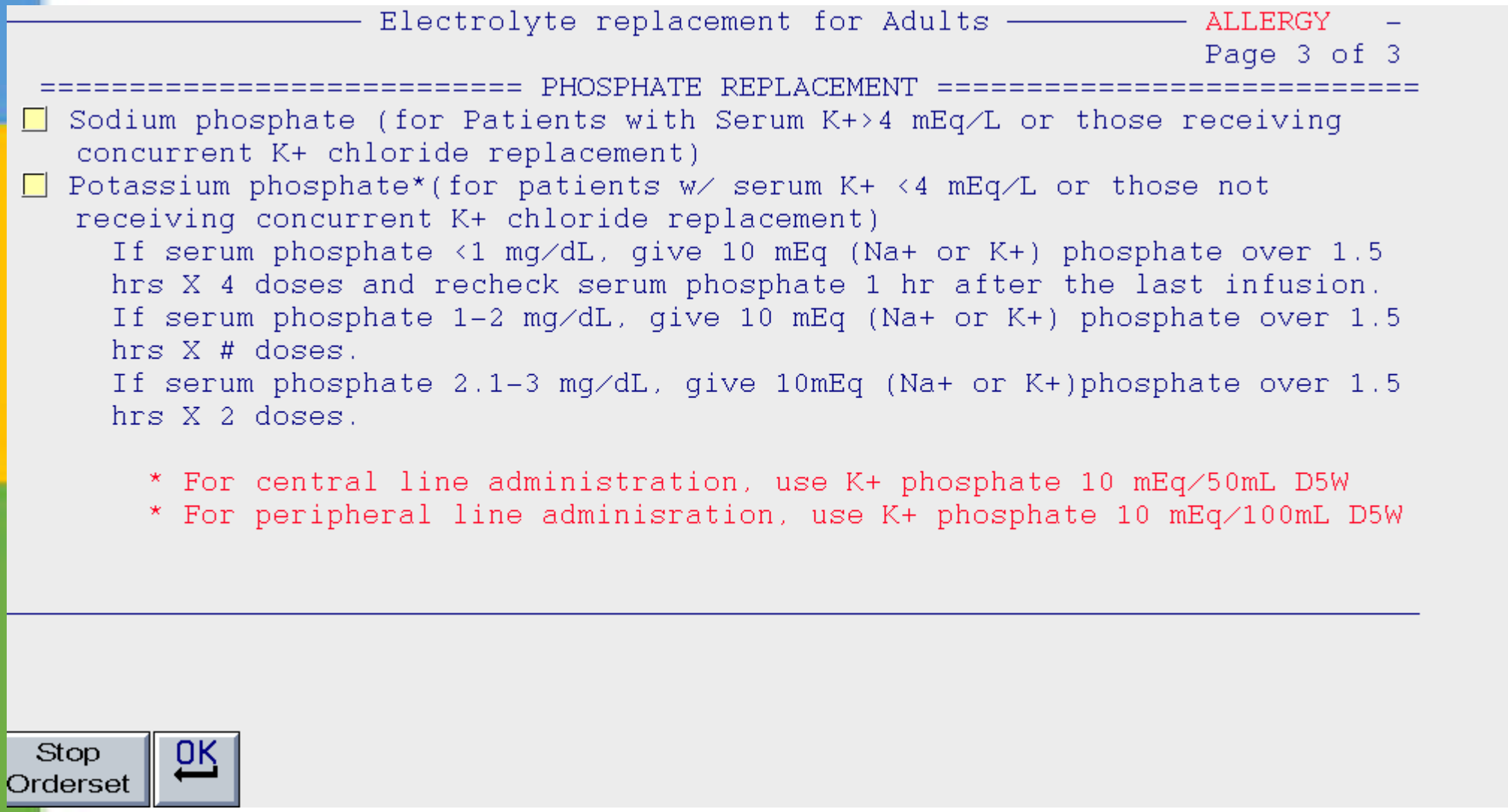

Electrolyte Replacement for Adults
ALLERGY -
Page 1 of 3
Extremes of age, weight, urine output, and renal function MUST be considered
===POTASSUM REPLACEMENT (Not to be used when serum creatinine > 1.5 mg/dL)======
Central Line (20 mEq KCl/50 mL Water for Injection)
If serum K+ < 3 mEq/L call MD,then give KCl 20 mEq over 1 hr X4 doses
If serum K+ 3 - 3.4 mEq/L, give KCl 20 mEq over 1 hr x 3 doses
If serum k+ 3.5 - 4 mEq/L, give KCl 20 mEq over 1 hr x 2 doses
If serum k+ > 5 mEq/L call MD
(MAXIMUM TOTAL rate of K+ infusion is NOT TO EXCEED 20 mEq/hr)
Peripheral Line (10 mEq KCl/100 mL Water for injection)
If serum k+ < 3 mEq/L call MD for orders
If serum k+ 3 - 3.4 mEq/L, give KCl 10 mEq over 1 hr x 6 doses
If serum k+ 3.5-4 mEq/L, give KCl 10 mEq over 1 hr x 4 doses
If serum k+ > 5 mEq/L call MD
Stop Orderset
OK

Computerized Physician Order Entry



Computerized Physician Order Entry



Systems Based Approach to CRRT: Resources

- Critical Care
  - ICU Safety Reporting System (ICUSRS) project in the USA (http://www.icusrs.org/)
  - 100K Lives Campaign (http://ihi.org/IHI/Programs/Campaign/)

- CRRT
  - Calgary Report (http://www.crha-health.ab.ca/newslink/robson1.pdf)
  - ADQI. Net
  - Crrtonline.com
  - Pcrrt.com

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Systems Based Approach to CRRT

- Summary
  - CRRT represents a microsystem that requires attention to system based factors for effective implementation.
  - Current methods of care delivery with CRRT do not have effective tools to monitor system based factors that influence outcomes.
  - An integrated approach to CRRT will require development of innovative approaches based on established principles for systems based thinking.

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Managing Change

Vision	+	Skills	+	Incentives	+	Resources	+	Action Plans	=	CHANGE
		Skills	+	Incentives	+	Resources	+	Action Plans	=	Confusion
Vision	+			Incentives	+	Resources	+	Action Plans	=	Anxiety
Vision	+	Skills	+			Resources	+	Action Plans	=	Gradual Change
Vision	+	Skills	+	Incentives	+			Action Plans	=	Frustration
Vision	+	Skills	+	Incentives	+	Resources			=	False Starts

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