A Comprehensive Approach: Seattle Children's Hospital

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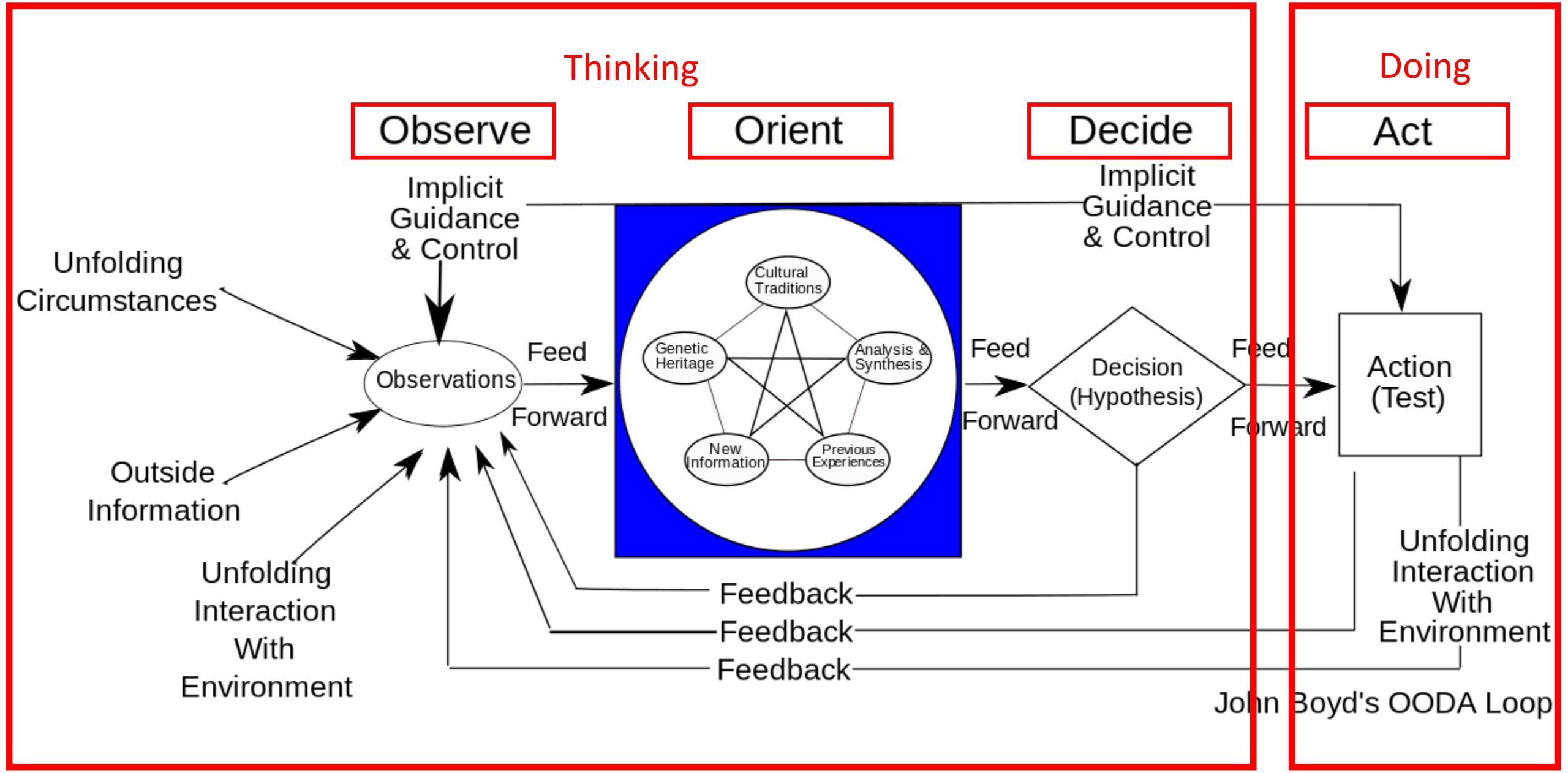
First Principles: Solo Provider

Execution

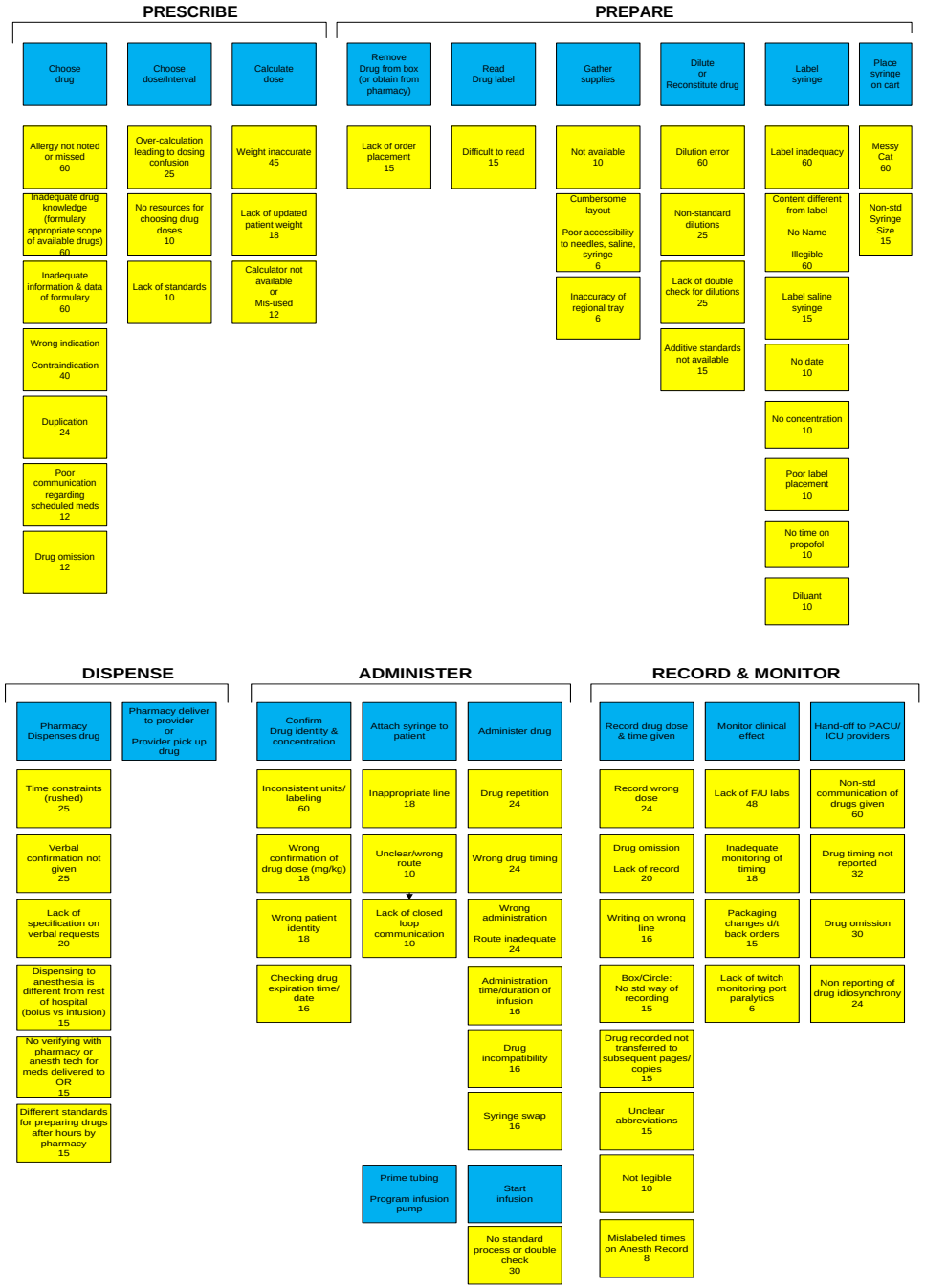
Intent → Outcome

A B



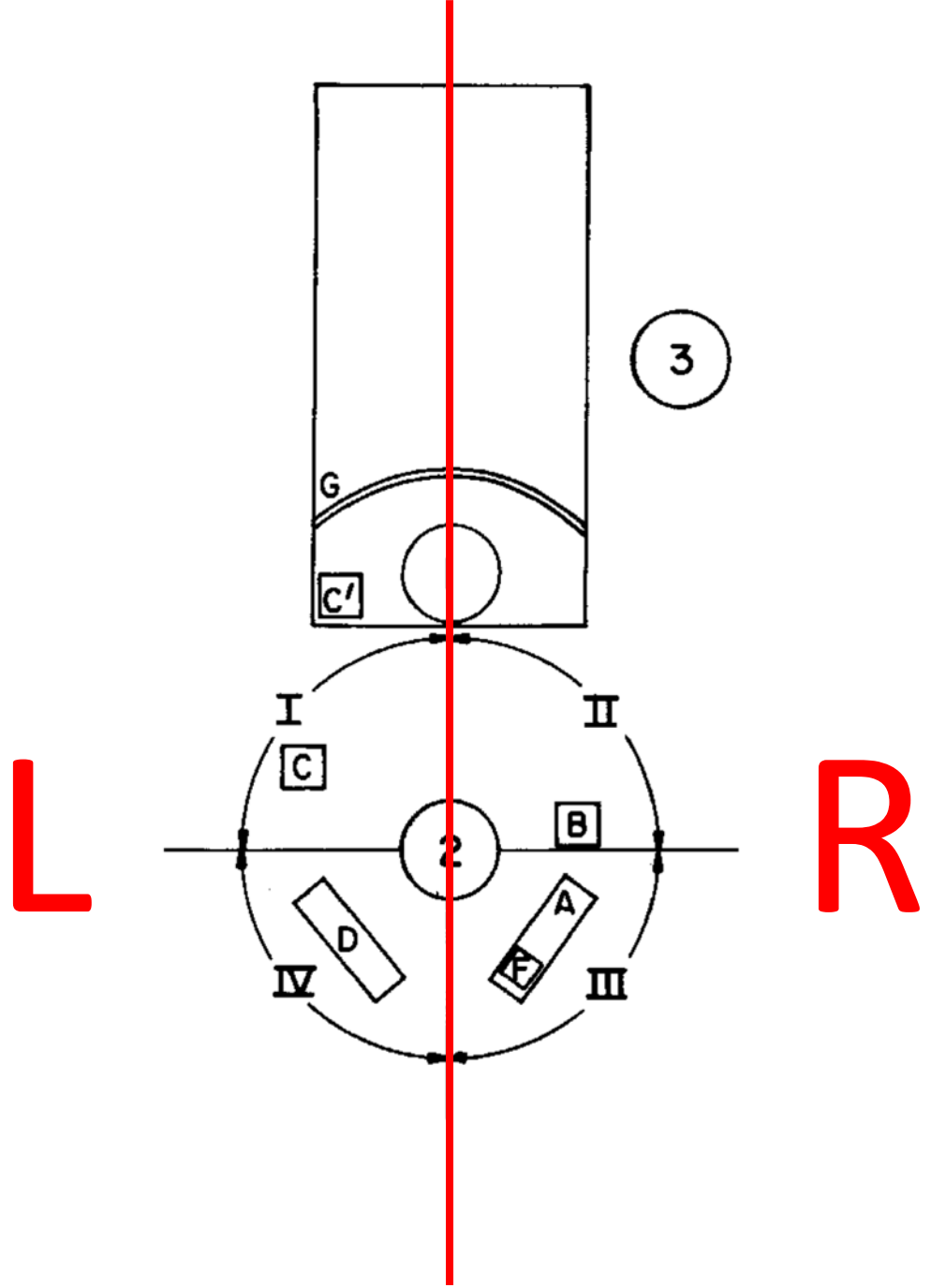
Act: Medication Cycle

- Failure Mode and Effects Analysis
  - 5 Steps
  - 19 Sub-steps (blue)
  - 68 possible failure modes (yellow)
- Relies on accuracy and vigilance*
  - Single Point Failures



Martin et al. Pediatr Anesth 27(6): 571-580, 2017.

45 Years Ago…



SYMBOLS

1. PATIENT
2. ANESTHESIOLOGIST
3. SURGEON
A. ANESTHESIA MACHINE
B. VENTILATOR
C. IV STAND
C'. IV INJECTION PORT
D. CART
E. ECG
F. RECORD
G. ANESTHESIA SCREEN
——→ ACTIVITY
– – –→ INFORMATION FLOW

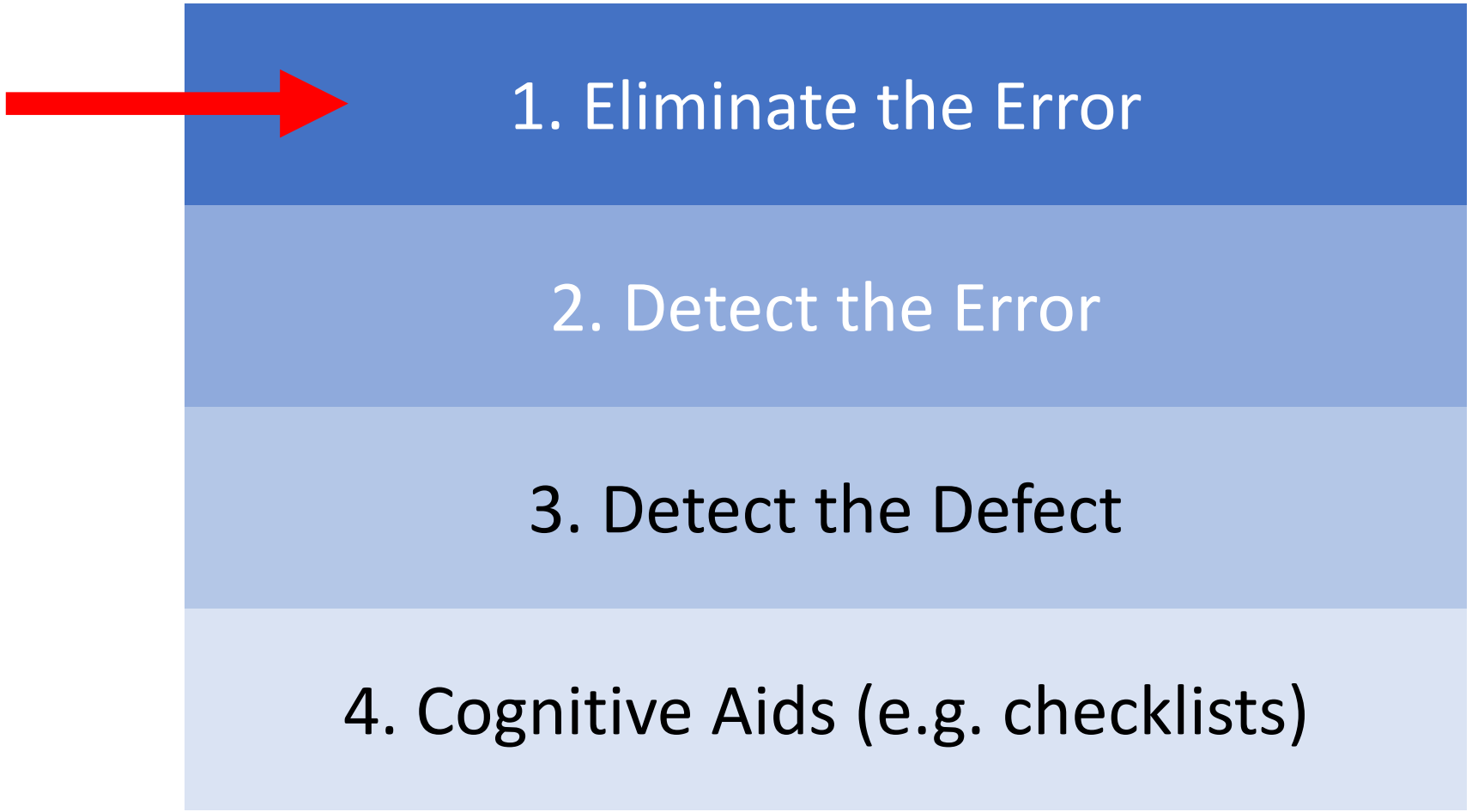
Drui AB et al. Anesth and Analg 1973; 52(4):584-91.

Anesthesia Safety Tools

Left (Medication) Side	Right (Machine) Side
No Dose Checking	Color-Coded Gases / Lines
No Alarms	Diameter and Pin-Index Safety Systems
No Way to Detect Errors	Oxygen-Nitrous Coupler
No "Exhaled" Propofol Monitor	Gas Monitors and Alarms
	Pressure and Flow Sensors and Alarms
	Keyed and Colored Vaporizer Fillers
	Patient Monitors: SpO_2, $ETCO_2$
	Flow Meter Assembly Order
	Oxygen Pressure Failure Device
	Vaporizer Transport Setting
	Machine Check

Grigg and Roesler. Anesth Analg 126(1): 346-50, 2018.

Levels of Mistake Proofing



Pitfalls: Layering (additive)

- RCAs → Layered Countermeasures
  - Added steps: “TSA problem”
- Complexity / Dual-Use
  - Smart Carts: inventory, security
  - Barcodes: documentation
- Machine does not require compliance*
  - Removing options / errors
  - Constraints without impacting workflow

Feedback v. Constraints

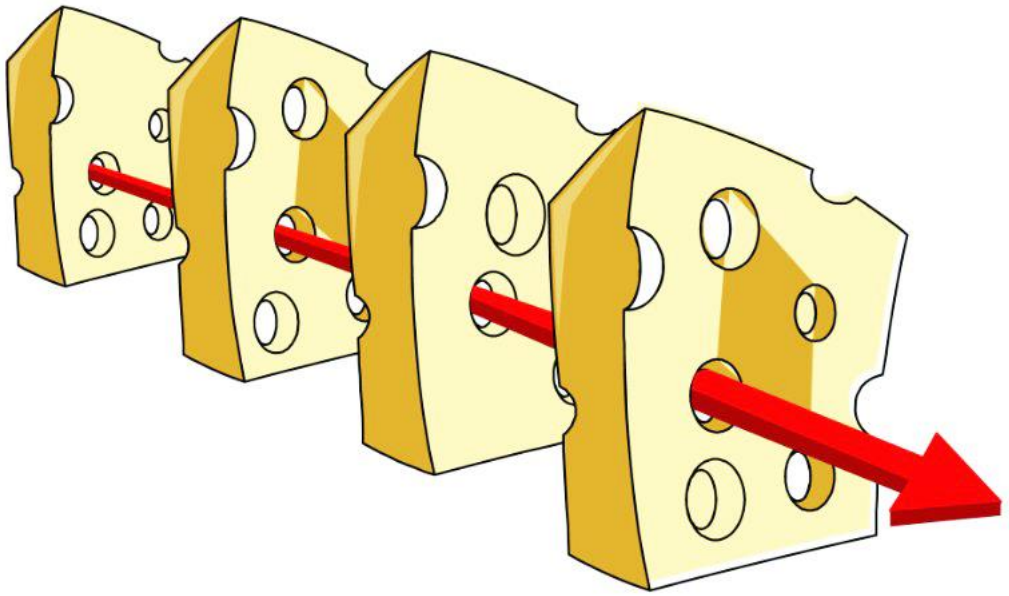
- Feedback requires compliance and engagement
- Constraints are more robust

Feedback	Constraints
Color-coded syringes*	Smart pump guardrails
Barcode scanners	Standard pharmacy concentrations
Labels	Prefilled syringes
Two-provider checks / Checklists	Standard layouts
Alarms	(Machine examples…)

Grigg and Litman. Feedback and constraints: rethinking medication safety countermeasures. BJA *In Press*, 2018.

Constraints

- Eliminate steps / options
- Automate processes
- Physically prevent mistakes



- Types
  - Interfaces (pin-index, filler keys, GEDSA)
  - Coupling (O2-nitrous)
  - Segregation
  - Standardization: syringe size, concentration, layout

- Without impacting workflow / decision-making

#1: Medication Trays

- Too many options (22)
  - Organized alphabetically
- High and low *use* together
  - High and low *risk* together
- Different look similar
  - Same look different

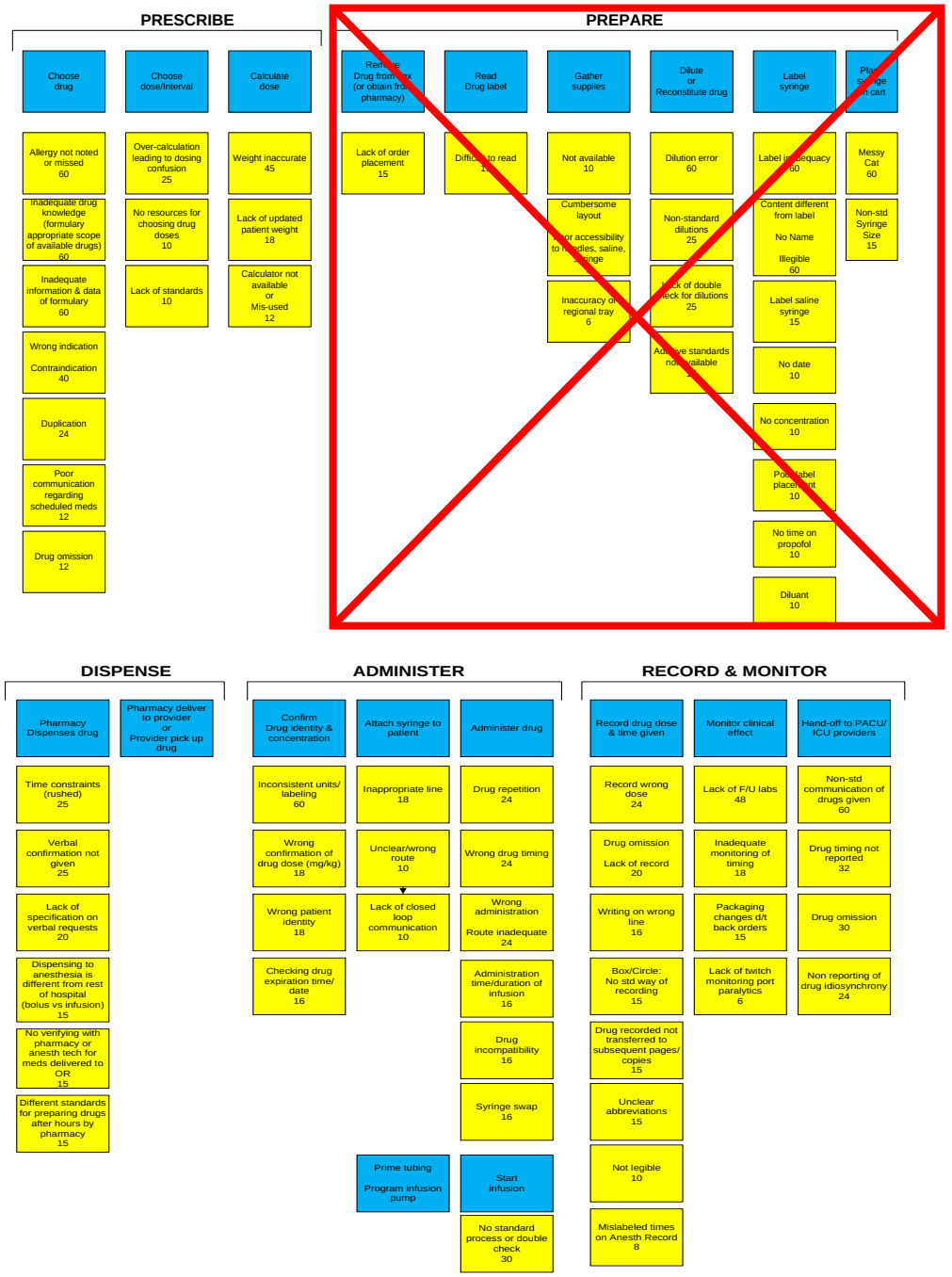
New Tray Design

- Primary Tray: 85% use, 7 meds
- Secondary Tray: 15% use, 9 meds

- Themes:
  1. Simplification – par levels
  2. Separation – grouping
  3. Signifiers – orientation

#2: Pre-Filled Syringes

- Eliminates *Preparation* step
  - 6 Sub-steps
  - 19 Failure modes
- Level 1 mistake proofing



Before


23.19
NEEDLES
ALCOHOL
TAGADERM
2X2
CHLORHEX
Cefazolin (100 mg/mL)
1 x 10mL Syringe
50% DEXTROSE
Purell

#3: Anesthesia Medication Template

1. Simplification
2. Standardization – flexibility
3. Separation
4. Signifiers – white space

Grigg et al. Anesth Analg 124(5): 1617-1625, 2017.

Takeaways

- Rethinking workspace design will reduce medication errors

- *Keep the thinking, streamline the doing*
  - Simplify execution
  - Standardize (options + interfaces)
  - Constraints (v. Feedback or Layers)

- Unique workflow…
  - From liability to opportunity
  - Unique solution (lead not borrow)*

Subtractive Questions

- How to *eliminate*…
  - …vials?
  - …syringes?
  - …labels?
  - …mental calculation?
  - …interoperability?
- How to *automate*…
  - …drug selection?
  - …concentrations?
  - …recording?
  - …interaction detection?
  - …?

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