Cognitive Ergonomics Lab

Threats & Strategies in Critical Care Nursing

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Children's Healthcare of Atlanta

The Medical Center of Central Georgia

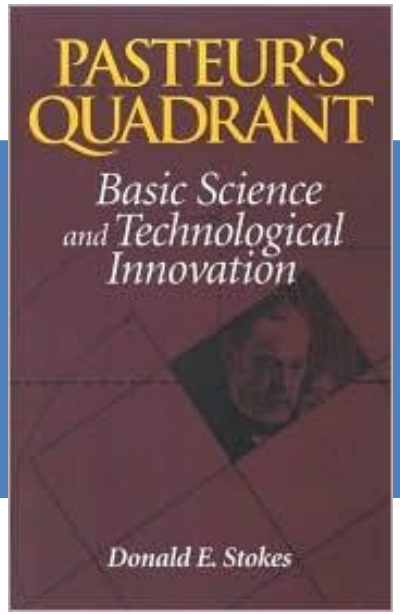
Overview

- Where I’m coming from
- Threat-Strategy Interview
- PICU Threats
- PICU Strategies
- A threatening threat

Collaborators

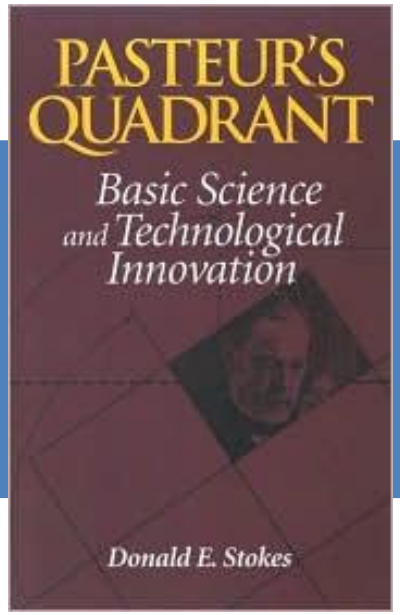
- Sadaf Kazi
- Ashley Ferguson
- Christina Ryan (MSN, RN), CHOA
- Charlene Cunningham (MSN, RN, CCRN), CHOA
- Rebecca Cogburn (CEN, CCRN-P, RN), MCCG

BASIC



APPLIED

Science and application are bound



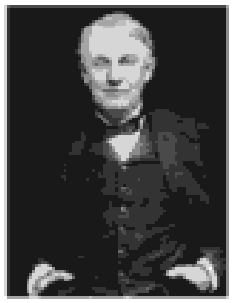
together like fruit and the tree that bears it.

The opposite of a profound truth may well be another profound truth

Without theory, practice is but routine born of habit

spired by:

Considerations of use?

	No	Yes
Yes	Pure basic research — Bohr	Use-inspired basic research — Pasteur
No		Pure applied research — Edison 

st for fundamental understanding?

Yes

No

Backoff man, I'm a scientist

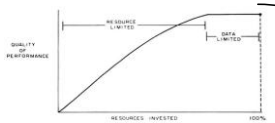
If I find 10,000 ways something won't work, I haven't failed…every wrong attempt discarded is a step forward

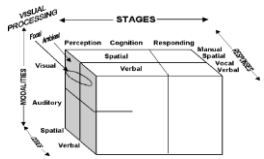
SA & Comprehension

- Cause of motor vehicle accidents & CFITs
- Distinguishes among OJT ratings
- Distinguishes expert pilots and novices
- Distinguishes active involvement from passive monitoring
- Predicts efficiency
- Measuring comprehension predicts ATC errors even after cognitive traits and personality are accounted

Management is central to behavior in dynamic environments

- Seek information to
- Understand “situation” in order to
- Change strategy and
- Maintain high performance, low workload
  - Helson’s (1949) Par hypothesis





Workload Subsystem

WL measures

Performance Level

Error or other Performance Threat

Situation Understanding Subsystem

On line SA measures

Residual Situation Image

Recall measures of SA

Error or other Workload Threat

LTM (prior knowledge, mental models)

Approach schema
[Mental model: Approach to ATL]
Typical entities: fix, runway [08R]
Typical action: reduce altitude, [direct approach]
Typical cause: clearance, proximity,
Typical location: airport [ATL]

Situation model

Entering ATL Approach
Pairs of parallels
Intent gate by 0530
Predicted to land on 8R
Cleared approach on 8L

Comm: [ATL approach, copilot]

Alt [140, descending]

Eventbase

Speed [in limits]

On track [confirmed]

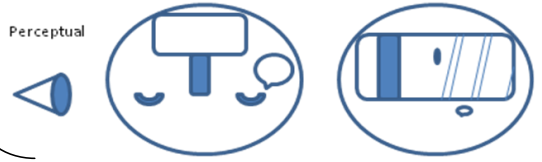
Comm [copilot, ATL]

Left of [downtown, ownship]

On track [confirmed]

Runways visible [5]

Perceptual



Glance x

Glance y

Management Subsystem

Goals

Strategy Selection

Strategy Prioritization

Goal management:
"high performance"
"manageable workload"

Increase in complexity: Pilot enters approach; ATC push

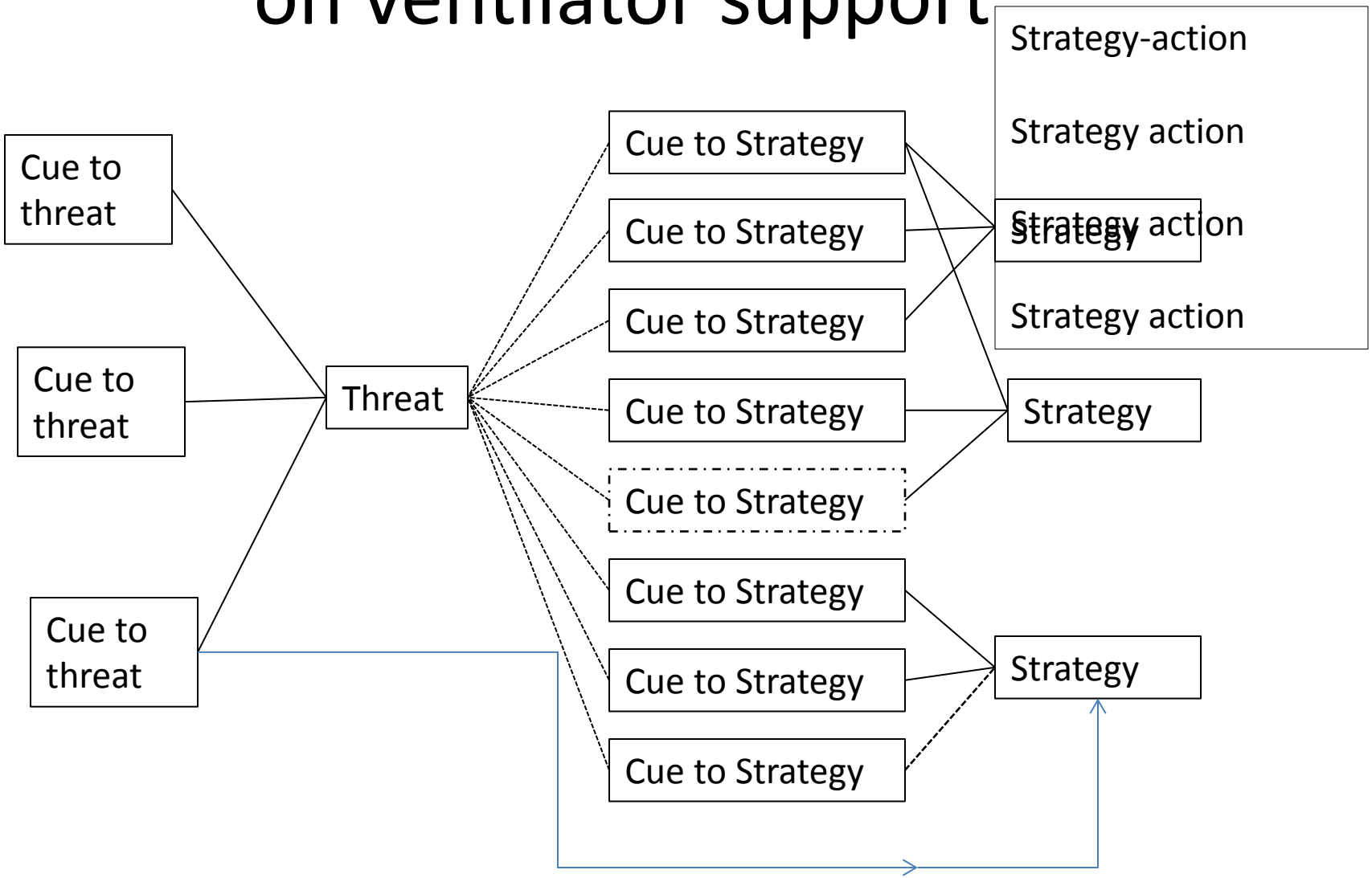
Performance Level

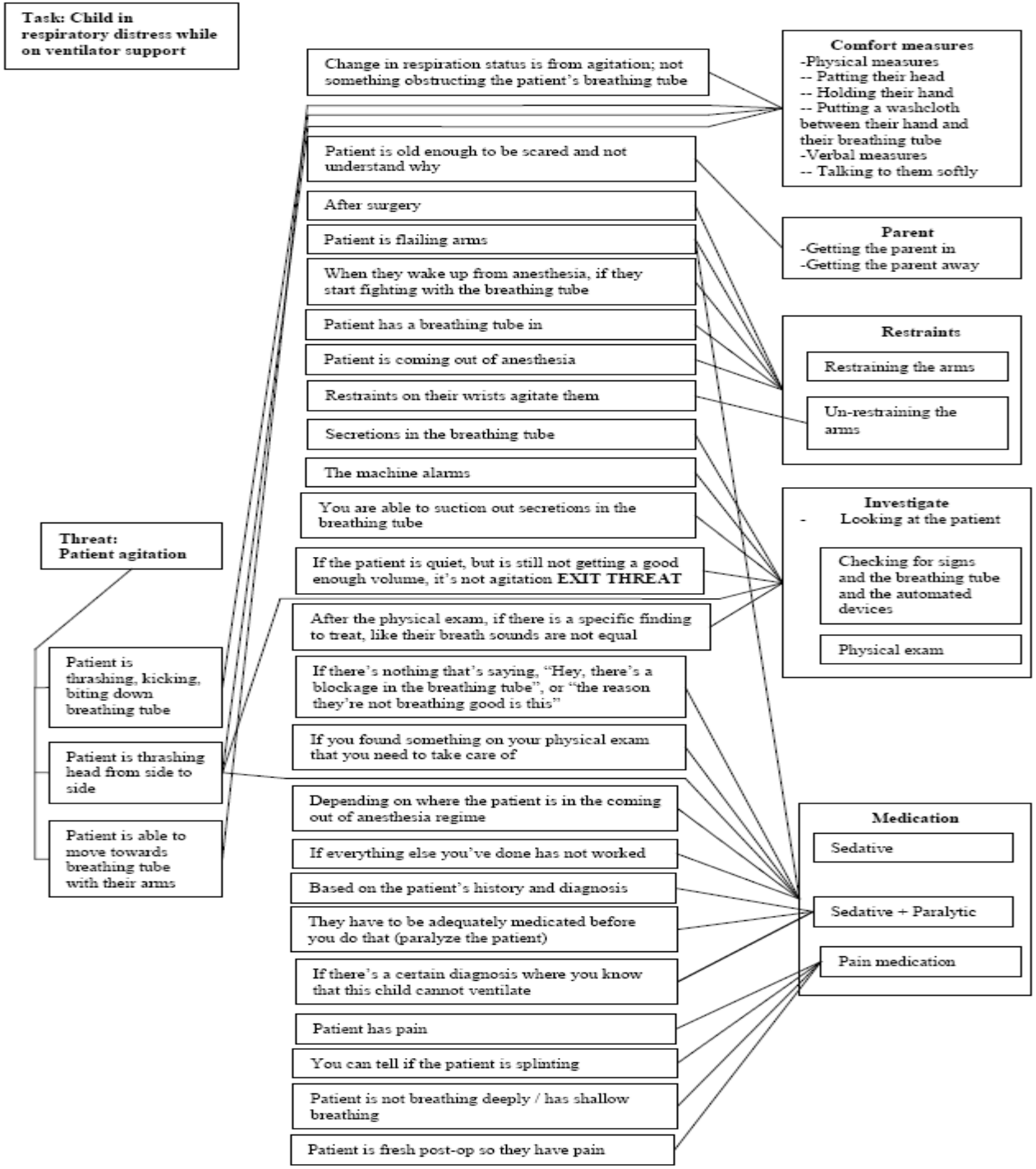
MANAGING THREATS

Threat-Strategy Interview

- Identify threat
- What strategy would you use?
- What cues suggest that strategy?
- Why this strategy and not that?
- Participants
  - Pediatric intensive care nurses
  - Airline pilots [automation]
  - Air traffic controllers
  - Locomotive conductors
  - GT undergraduates [registration]

Task: Child in respiratory distress while on ventilator support

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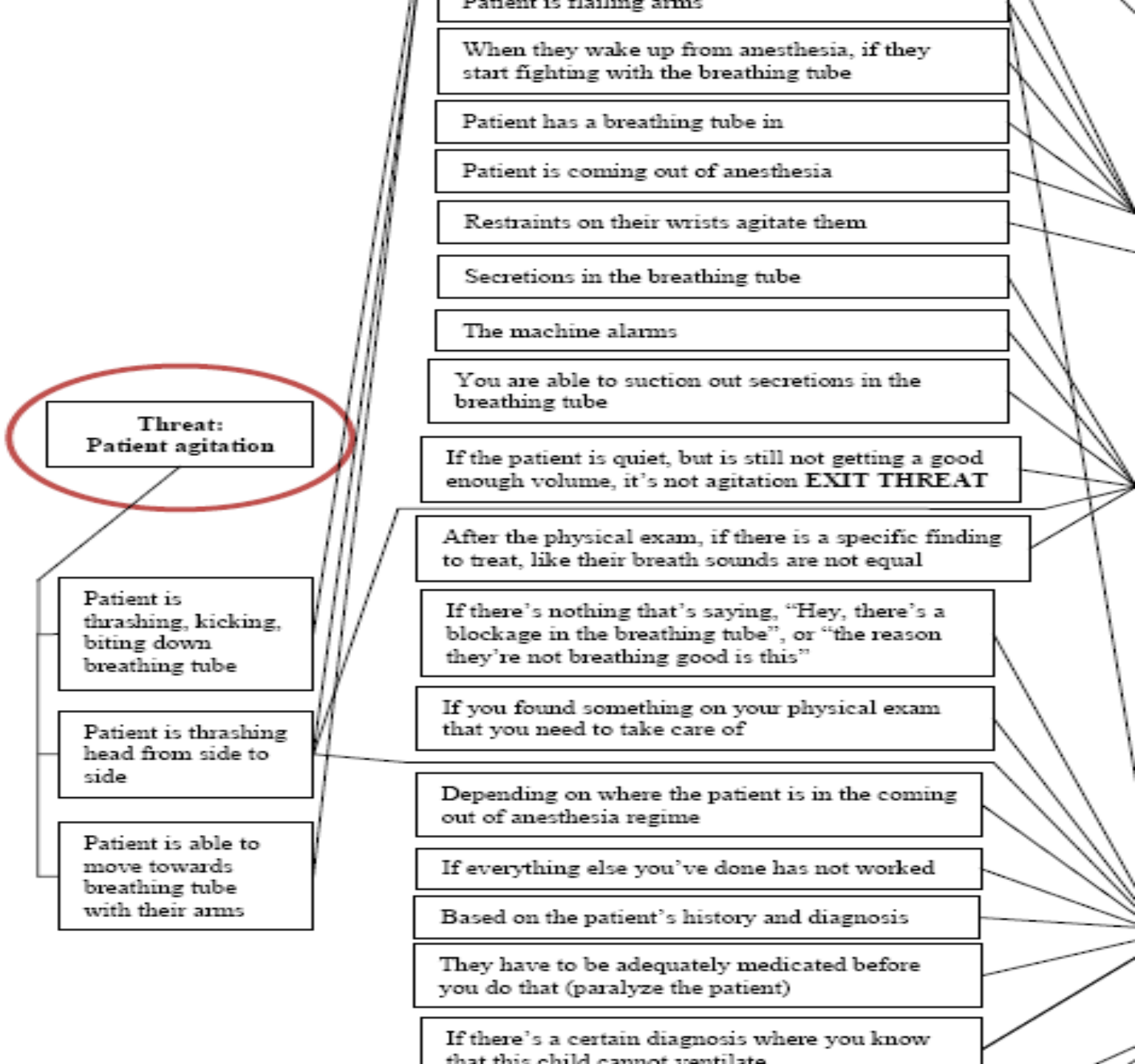
Threat: Patient agitation
Patient is thrashing, kicking, biting down breathing tube
Patient is thrashing head from side to side
Patient is able to move towards breathing tube with their arms
Change in respiration status is from agitation; not something obstructing the patient's breathing tube
Patient is old enough to be scared and not understand why
After surgery
Patient is flailing arms
When they wake up from anesthesia, if they start fighting with the breathing tube
Patient has a breathing tube in
Patient is coming out of anesthesia
Restraints on their wrists agitate them
Secretions in the breathing tube
The machine alarms
You are able to suction out secretions in the breathing tube
If the patient is quiet, but is still not getting a good enough volume, it's not agitation EXIT THREAT
After the physical exam, if there is a specific finding to treat, like their breath sounds are not equal
If there's nothing that's saying, "Hey, there's a blockage in the breathing tube", or "the reason they're not breathing good is this"
If you found something on your physical exam that you need to take care of
Depending on where the patient is in the coming out of anesthesia regime
If everything else you've done has not worked
Based on the patient's history and diagnosis
They have to be adequately medicated before you do that (paralyze the patient)
If there's a certain diagnosis where you know that this child cannot ventilate
Patient has pain
You can tell if the patient is splinting
Patient is not breathing deeply / has shallow breathing
Patient is fresh post-op so they have pain
Comfort measures
-Physical measures
-- Patting their head
-- Holding their hand
-- Putting a washcloth between their hand and their breathing tube
-Verbal measures
-- Talking to them softly
Parent
-Getting the parent in
-Getting the parent away
Restraints
Restraining the arms
Un-restraining the arms
Investigate
- Looking at the patient
Checking for signs and the breathing tube and the automated devices
Physical exam
Medication
Sedative
Sedative + Paralytic
Pain medication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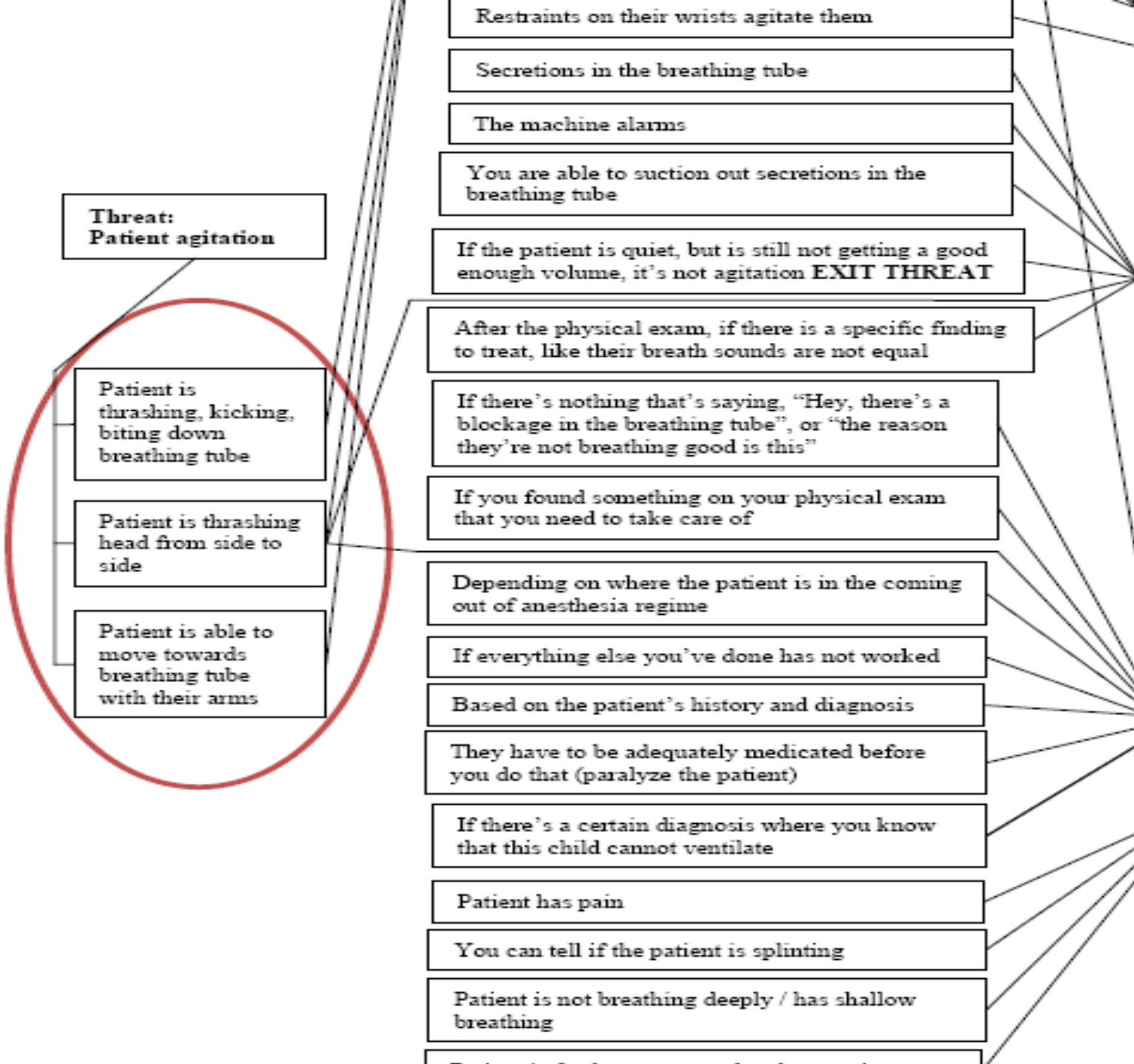
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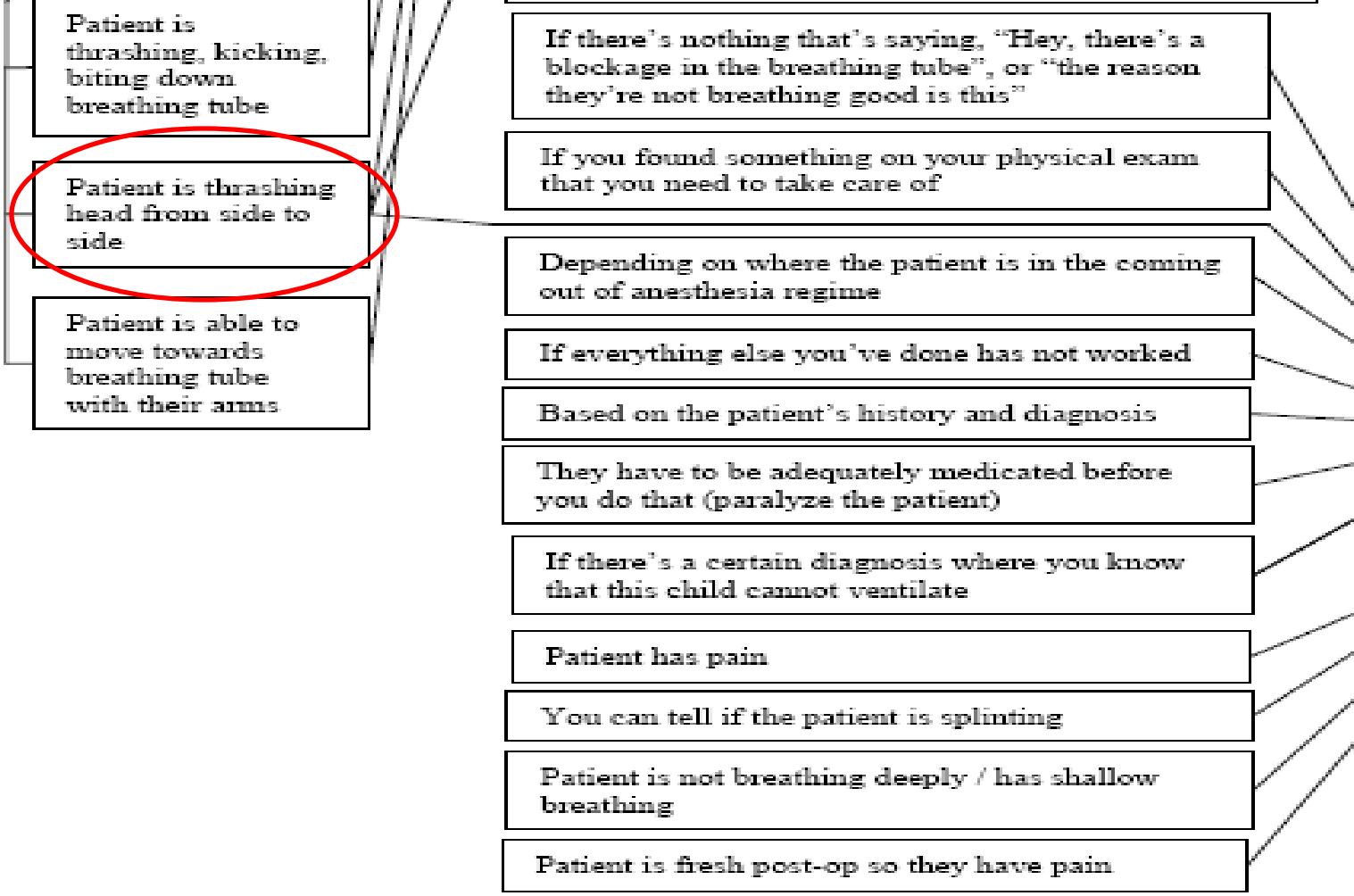
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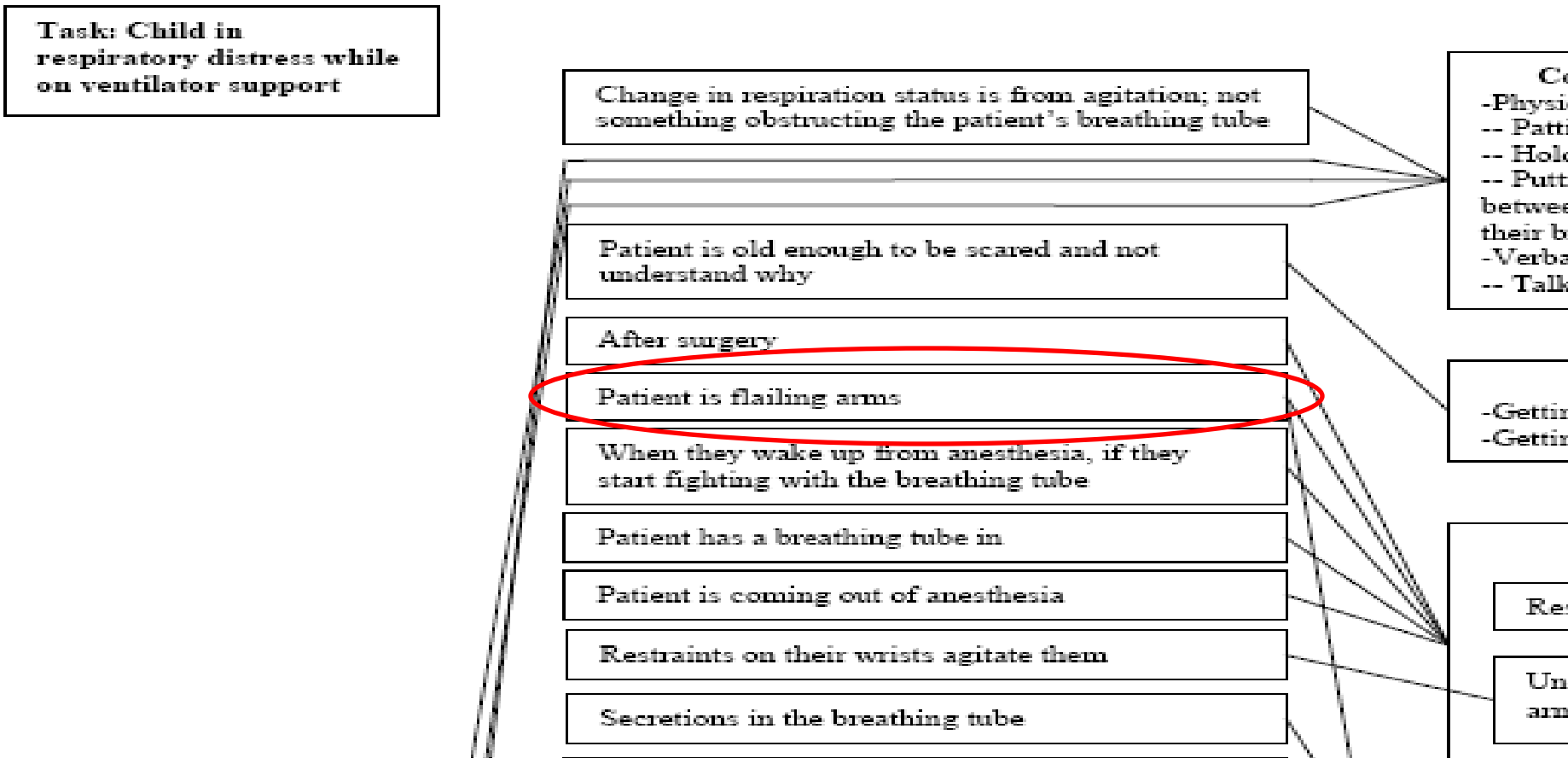
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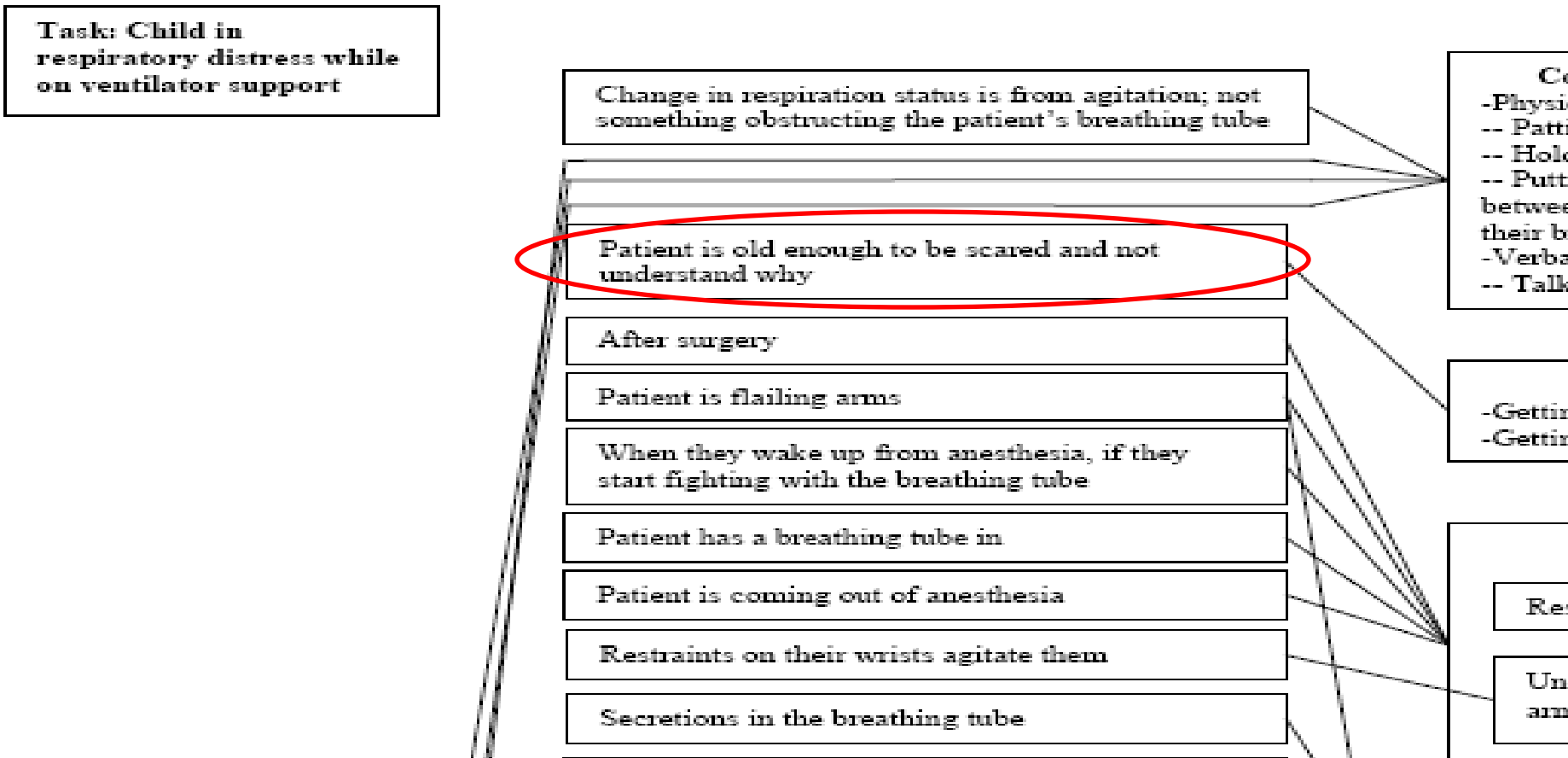
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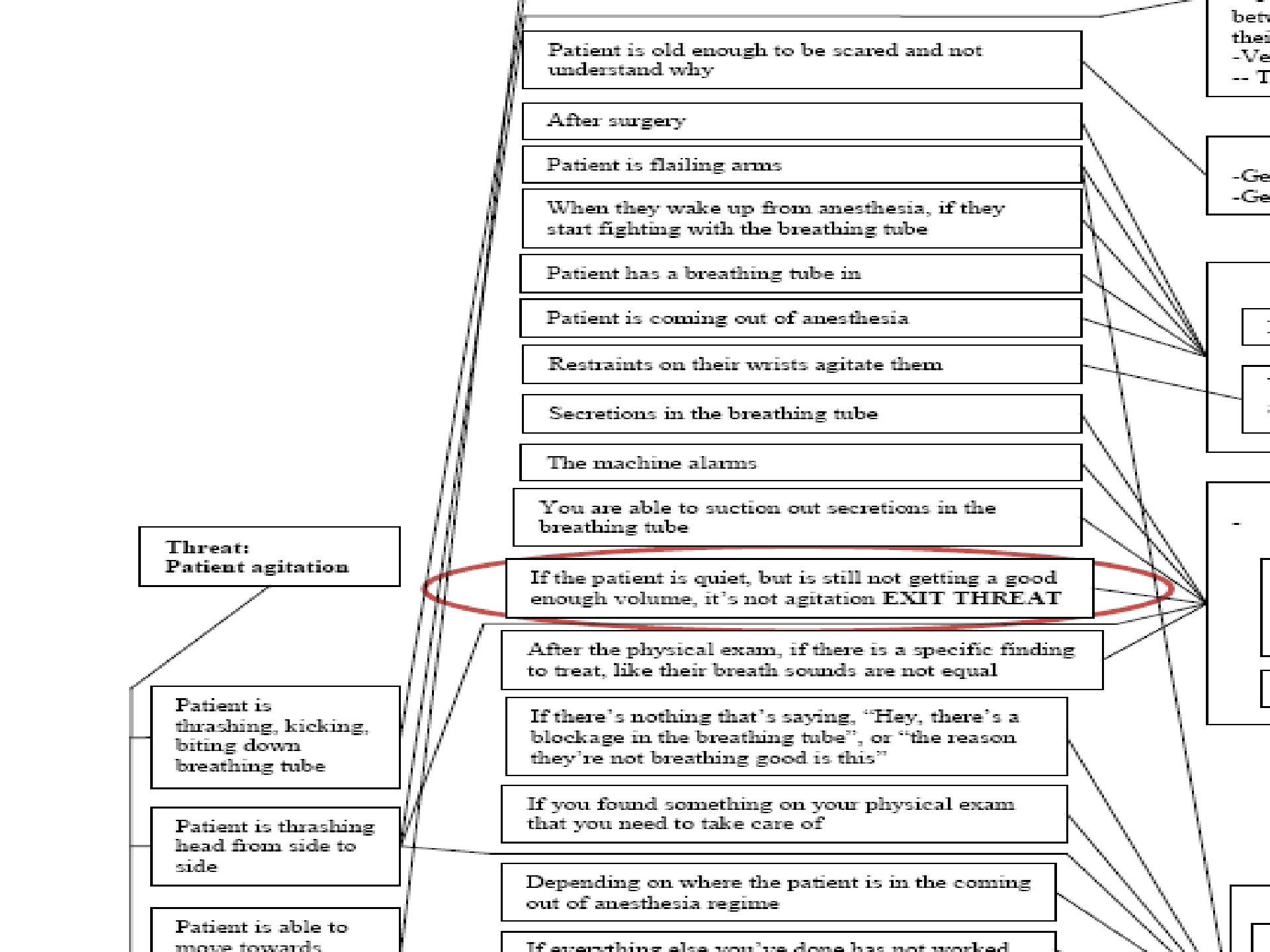
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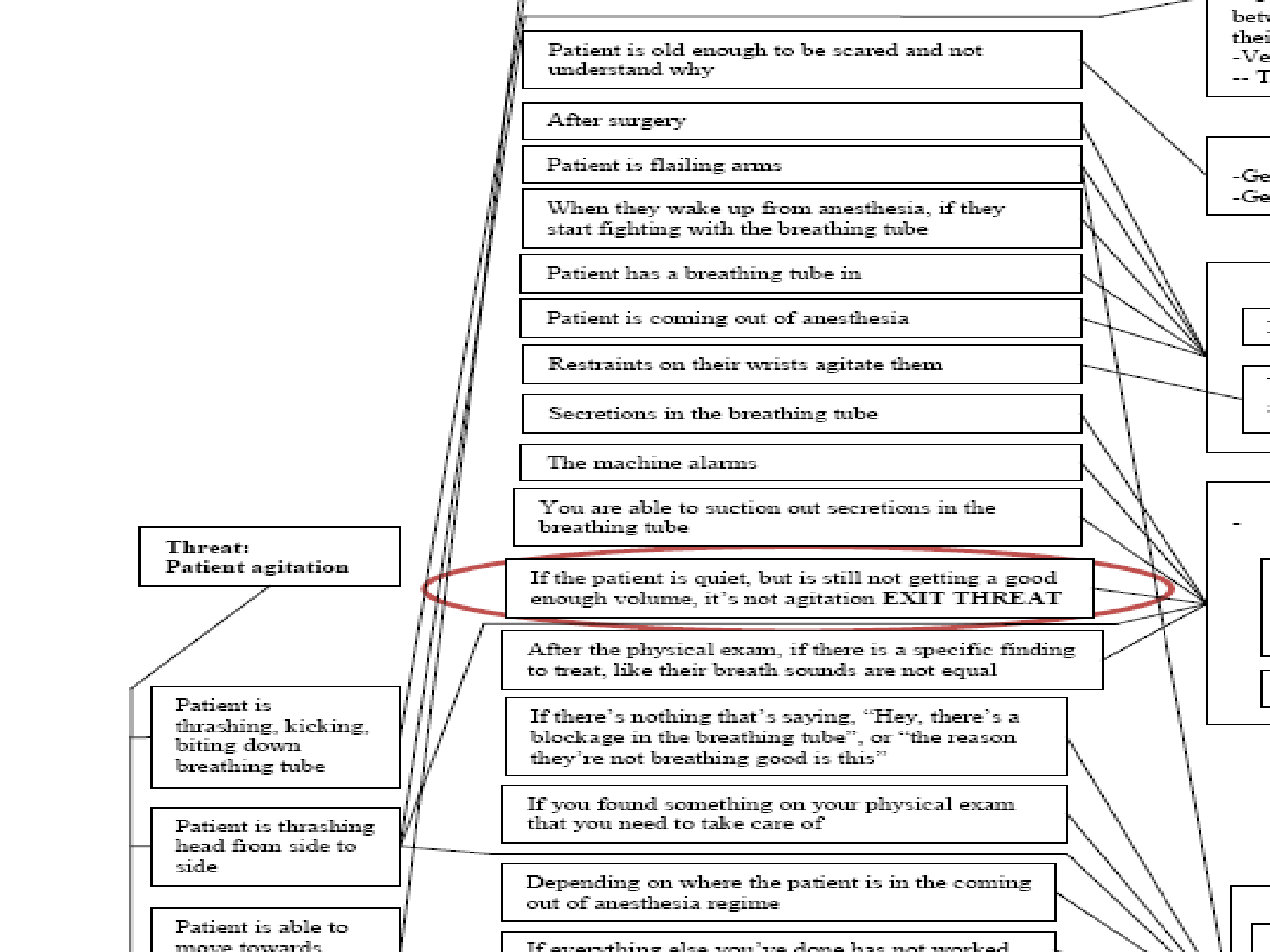
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Cues

- Mostly patient oriented
- Mostly perceptual/memorial
- Cues to both threat & strategy
- Exit cues
- Investigative cues (Implicit/Explicit)
- Blocker cues

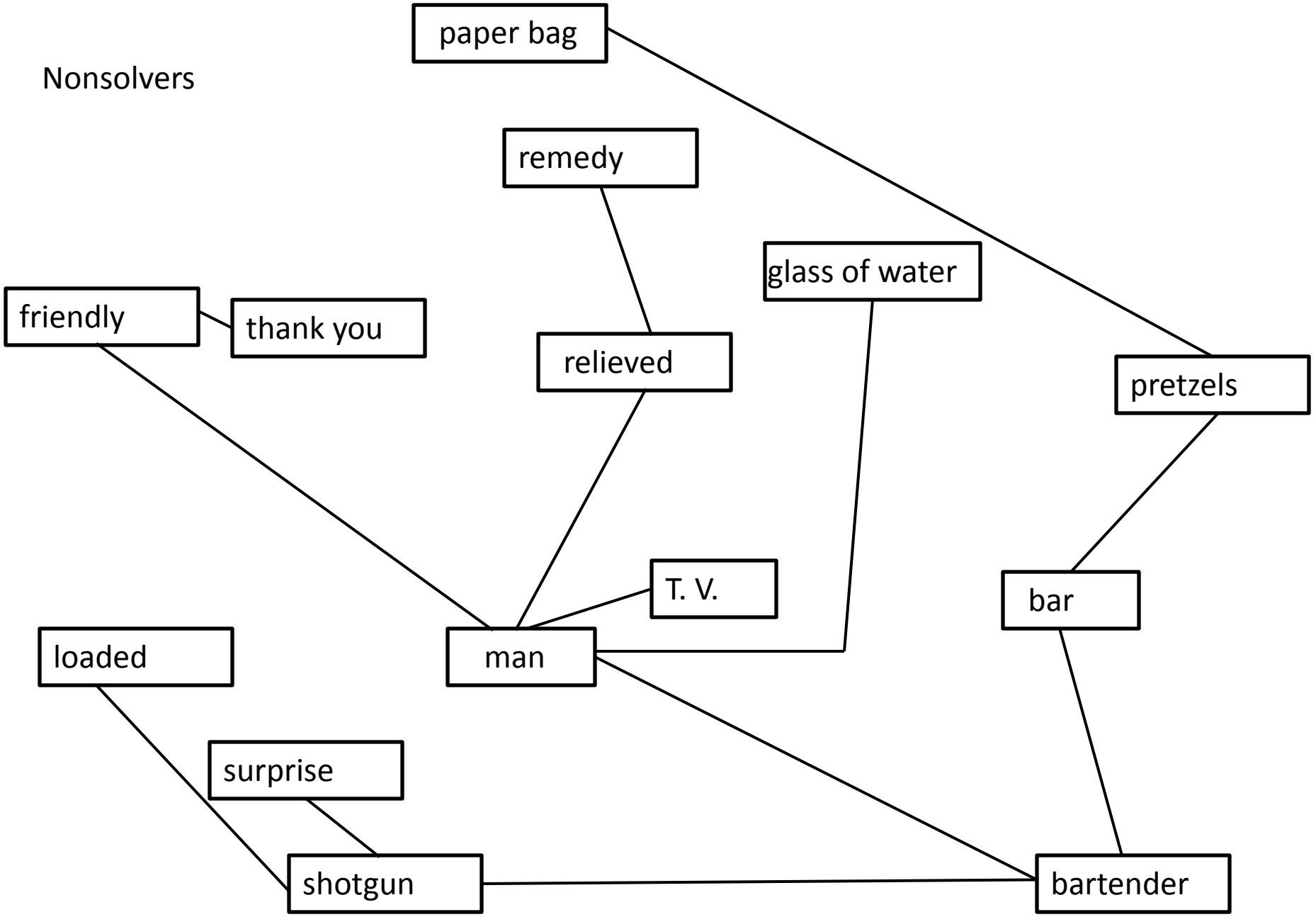
THREATS

- Do threats change your cognitive landscape?

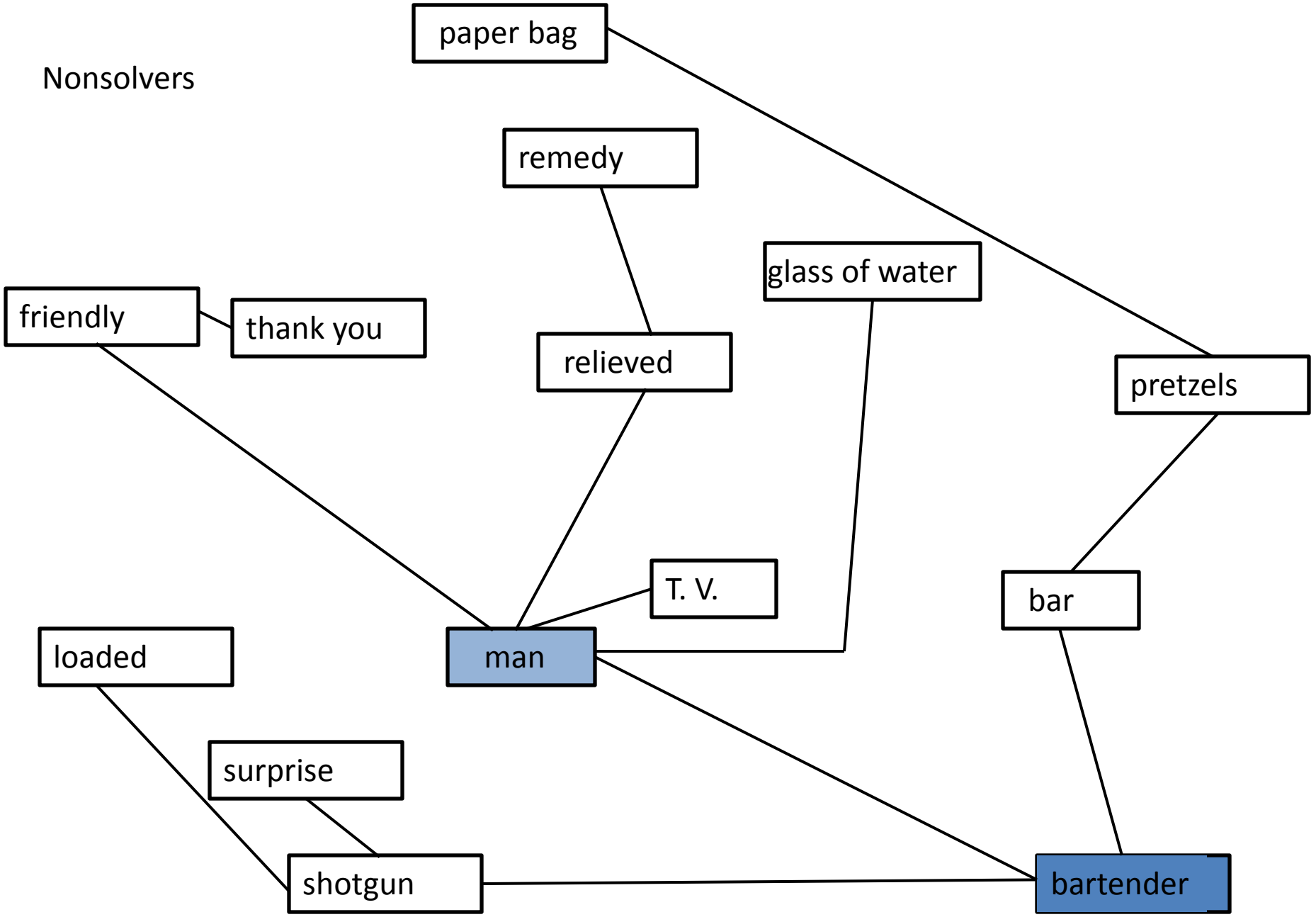
Pathfinder Scaling Algorithm

- Man walks into a bar and asks for a glass of water. The bartender points a shotgun at the man. The man says “Thank you,” and walks out.

Nonsolvers


paper bag
remedy
glass of water
friendly
thank you
relieved
pretzels
T. V.
bar
loaded
man
surprise
shotgun
bartender

Nonsolvers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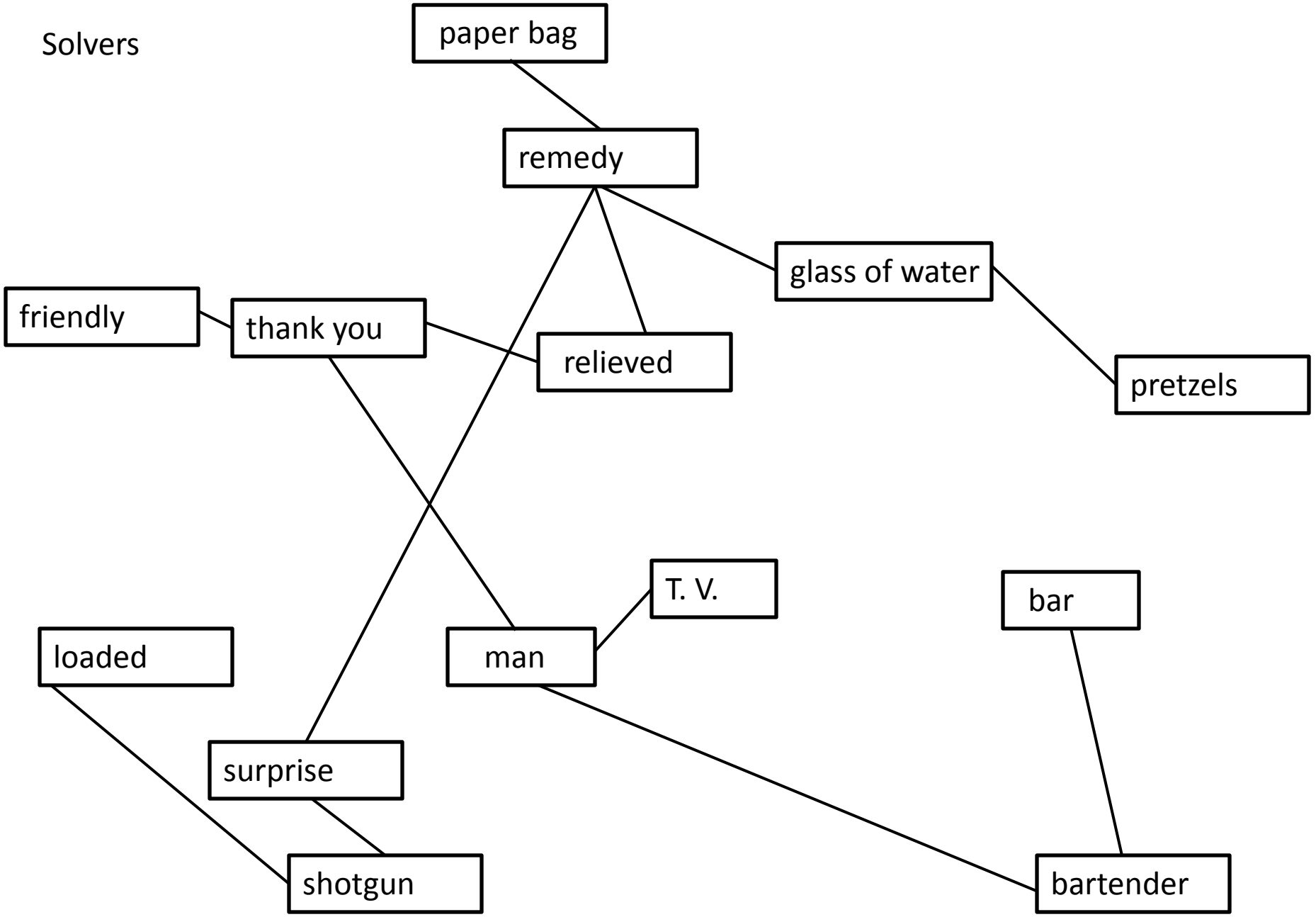
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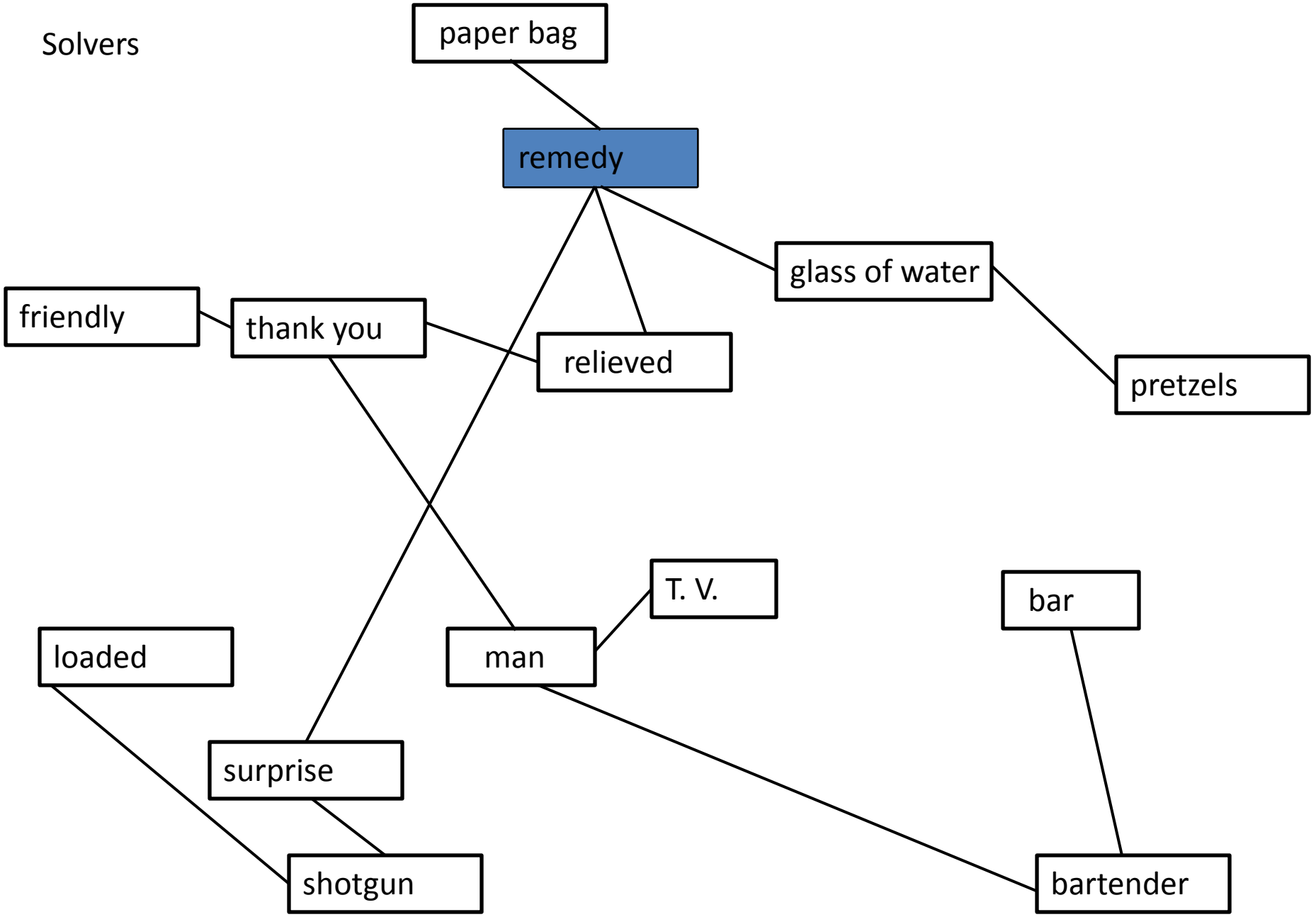
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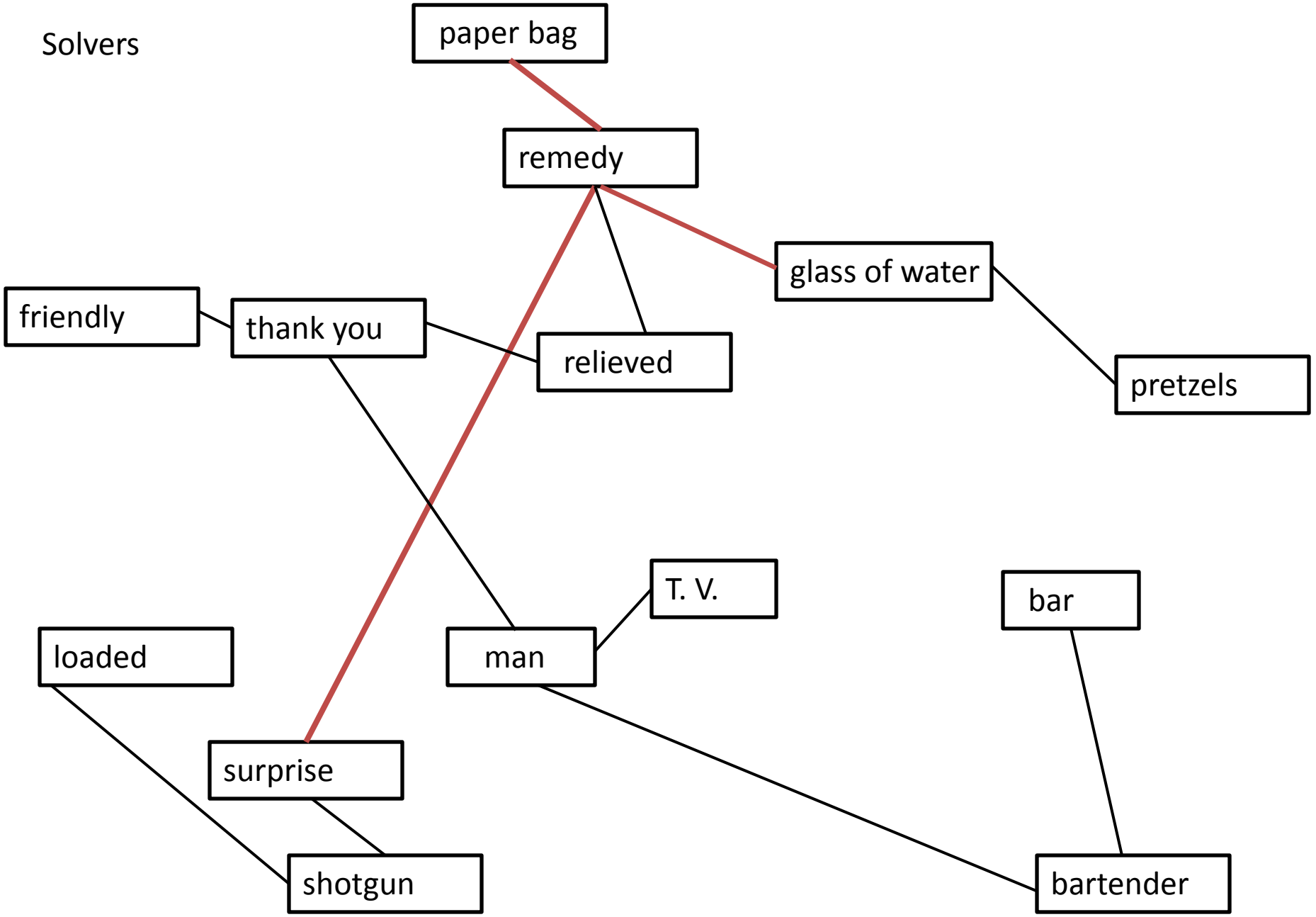
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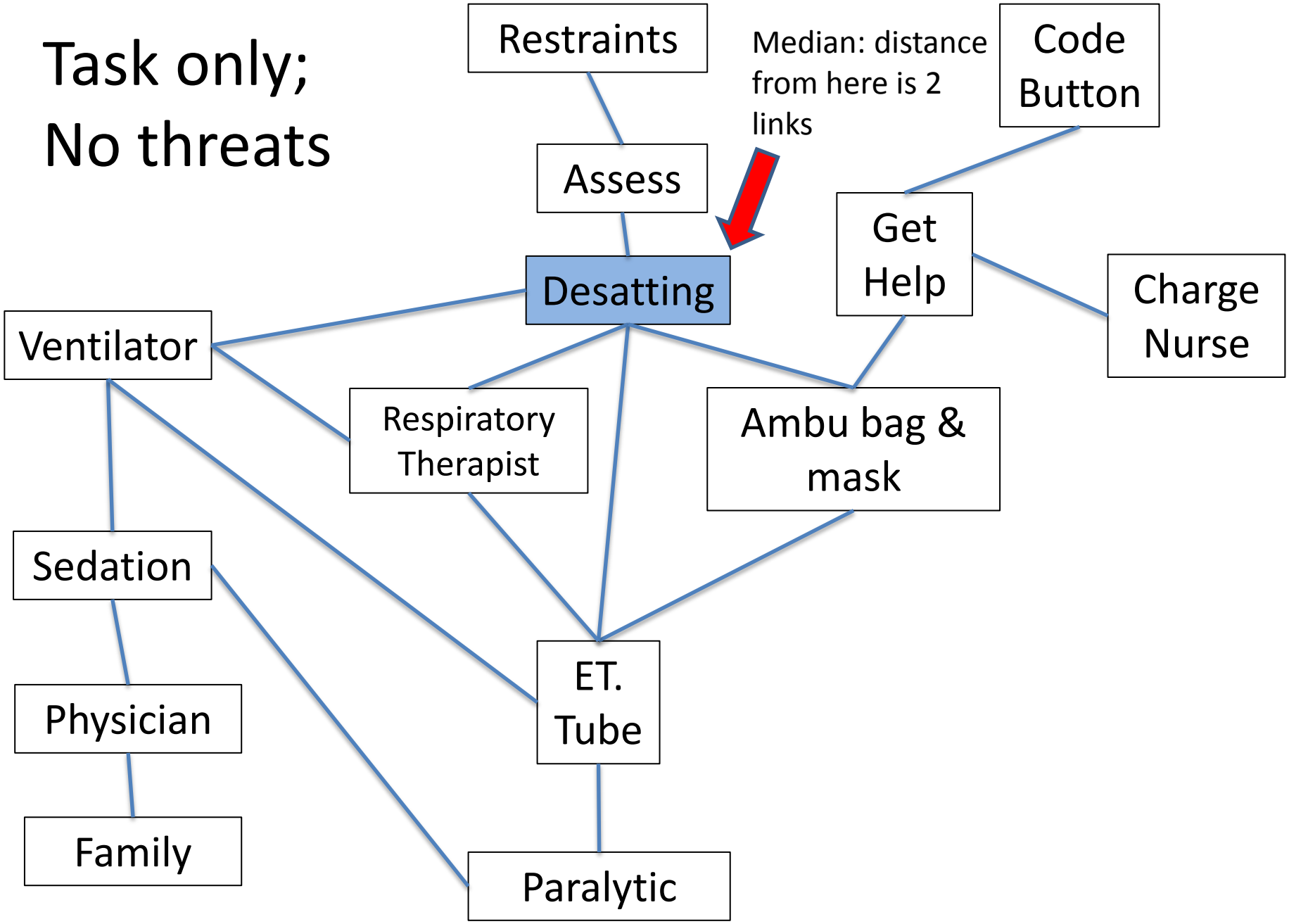
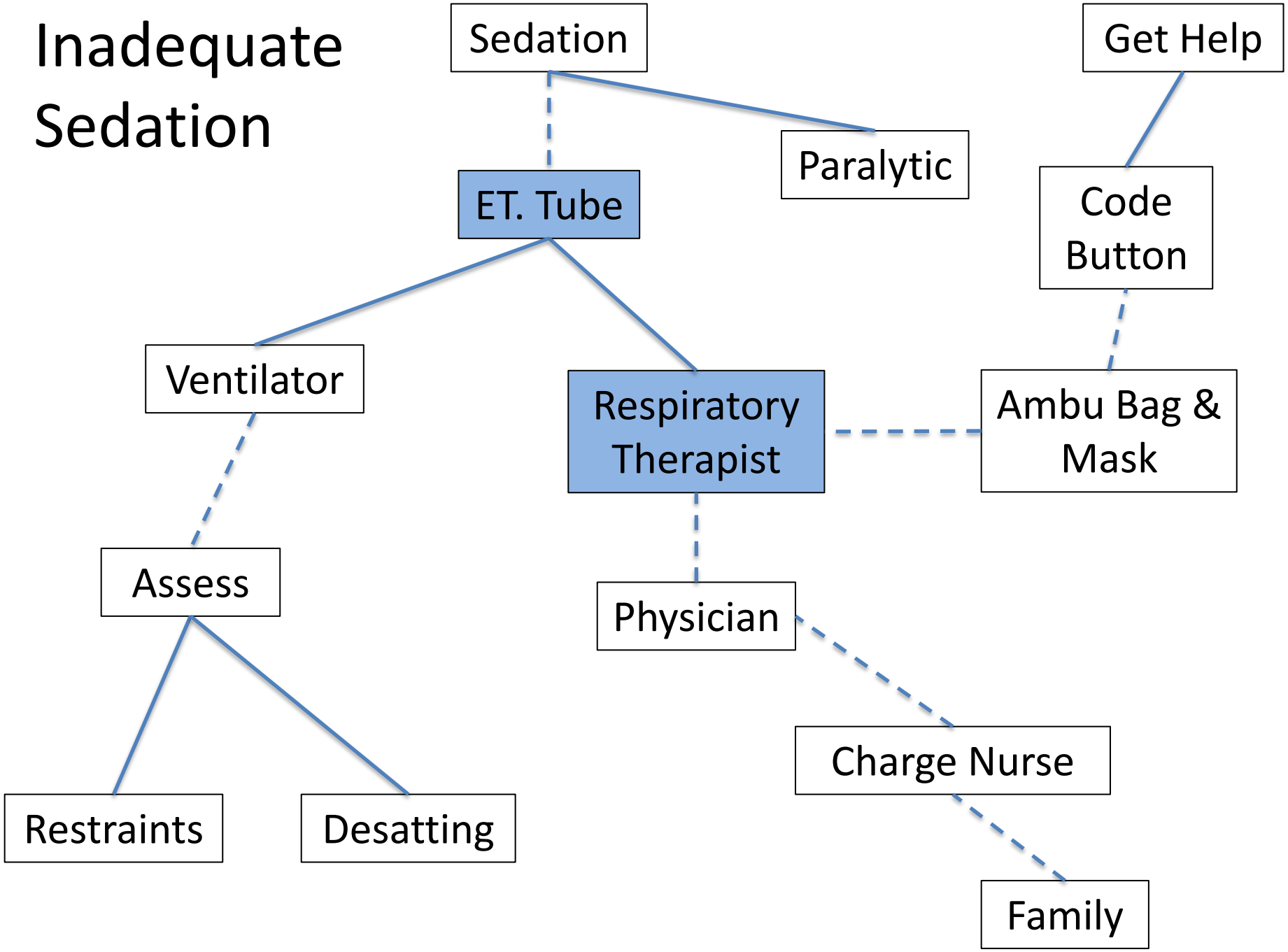

Task only;
No threats
Restraints
Median: distance from here is 2 links
Code Button
Assess
Get Help
Desatting
Charge Nurse
Ventilator
Respiratory Therapist
Ambu bag & mask
Sedation
ET. Tube
Physician
Family
Paralytic

Inadequate Sedation

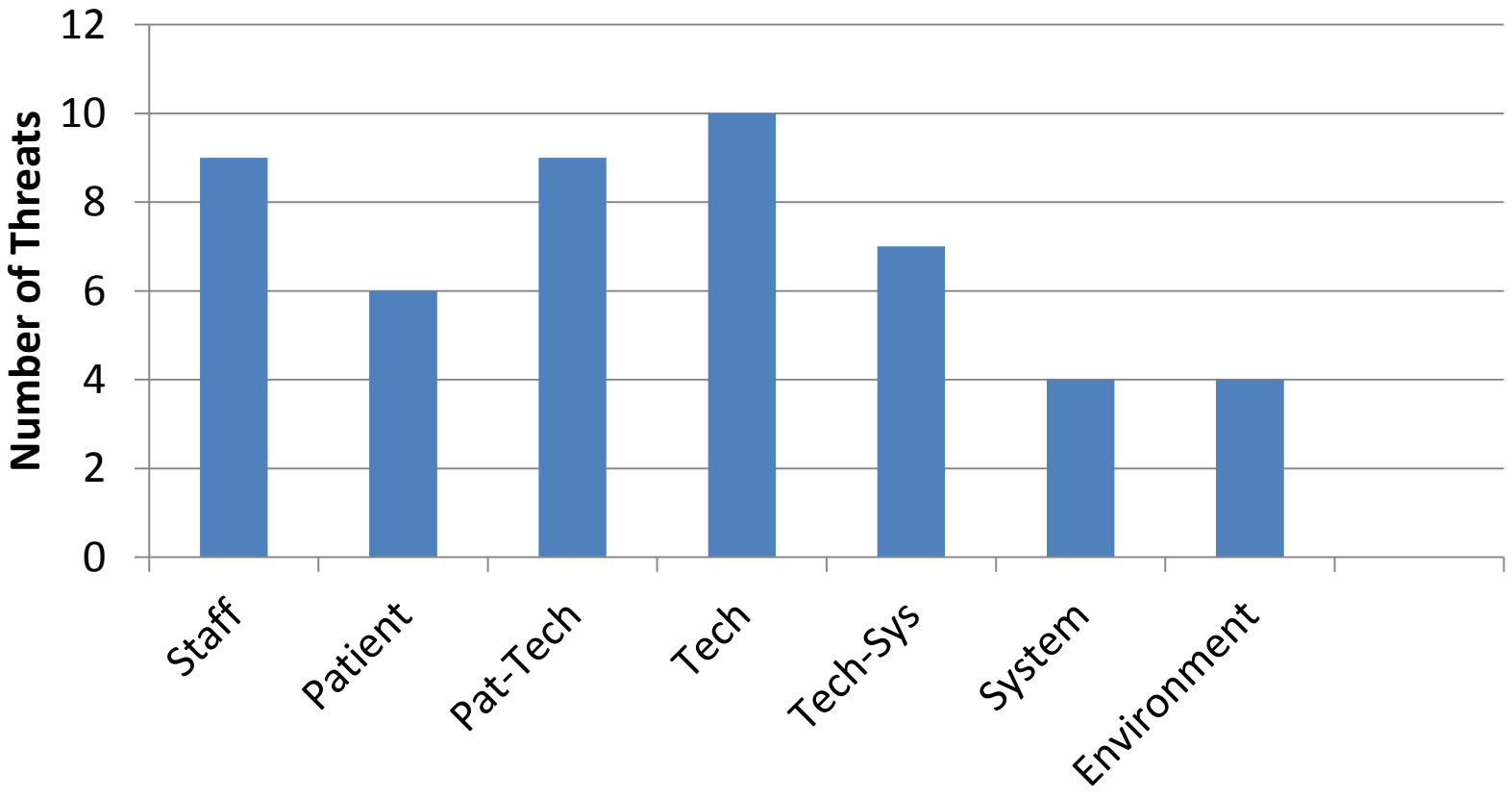


- Threats change the cognitive landscape
- They reorganize thinking; recenter it

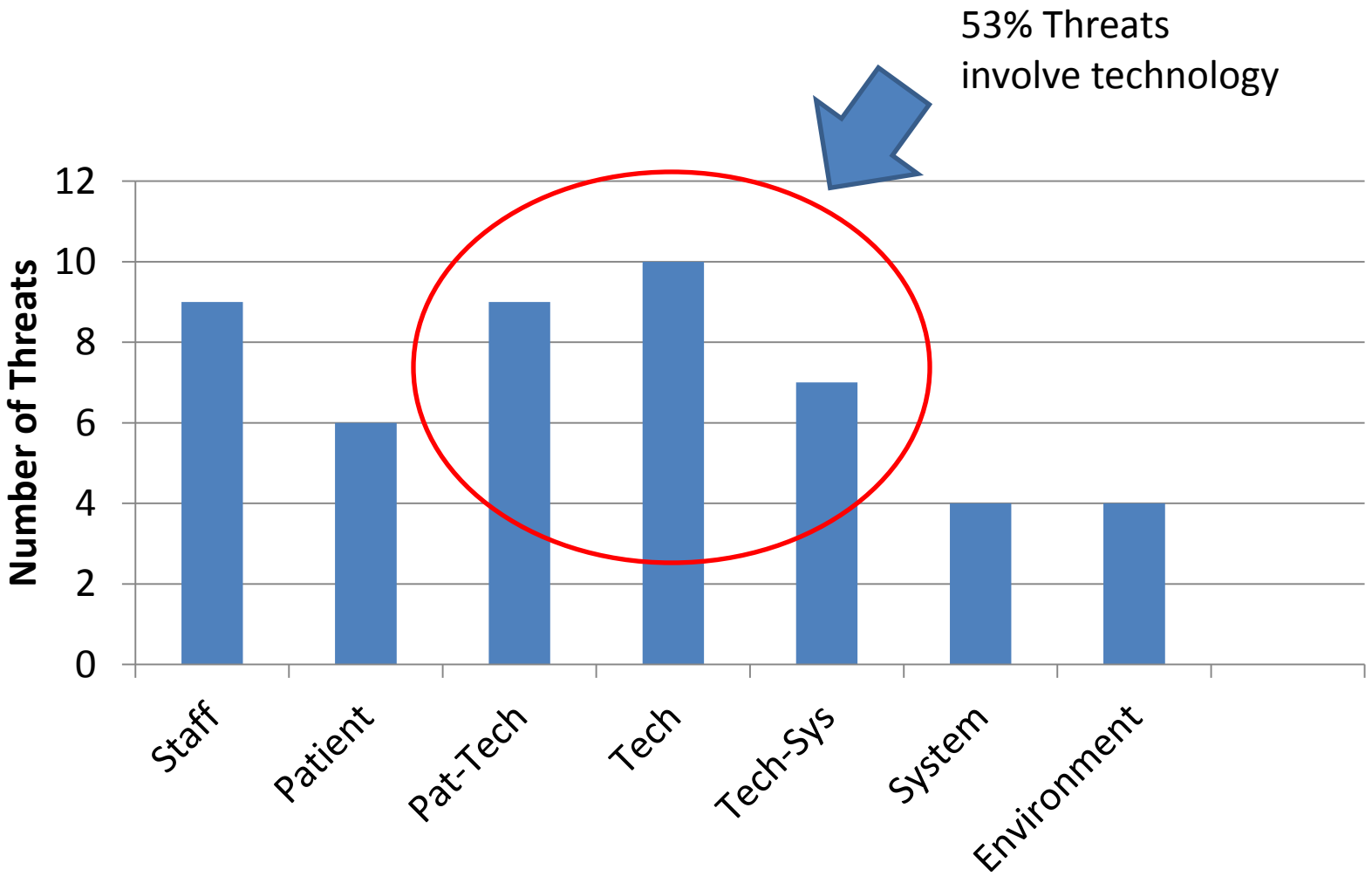
Classifying Threats

- Staffing-related
- Patient-related
- Technology-related
- System-related
- Environment-related
- Patient-Tech
- Tech-System

Threats


Number of Threats
12
10
8
6
4
2
0
Staff
Patient
Pat-Tech
Tech
Tech-Sys
System
Environment

Threats


53% Threats
involve technology
Number of Threats
12
10
8
6
4
2
0
Staff
Patient
Pat-Tech
Tech
Tech-Sys
System
Environment

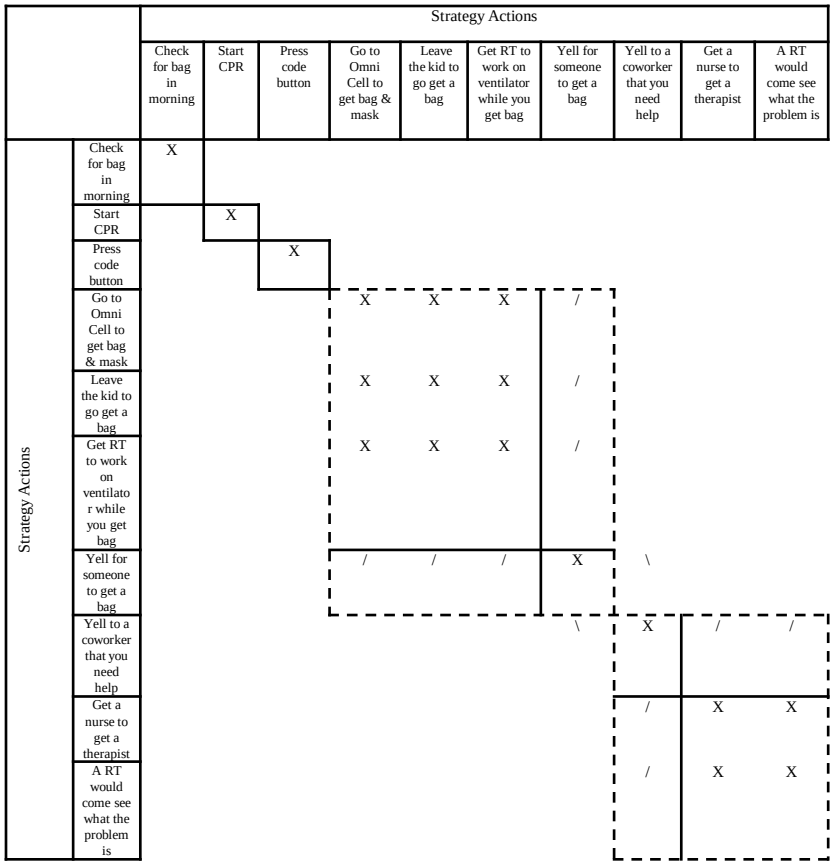
STRATEGIES

Strategies

- A plan or method for achieving a goal
- Cockpit Task management
- Workload management
- Aviate-Navigate-Communicate
  - Airway-Breathing-Circulation
- SOPs

Example Interviewed Threats

- Staff (3): Inadequate support staff
- Patient (5): Inadequate sedation
- Pat-Tech (2): ET tube dislodged
- Tech (5): Ventilator malfunction
- Tech-Sys (1): Ambu bag missing
- System (6): No patient history
- Environment (1): Overstimulation from family



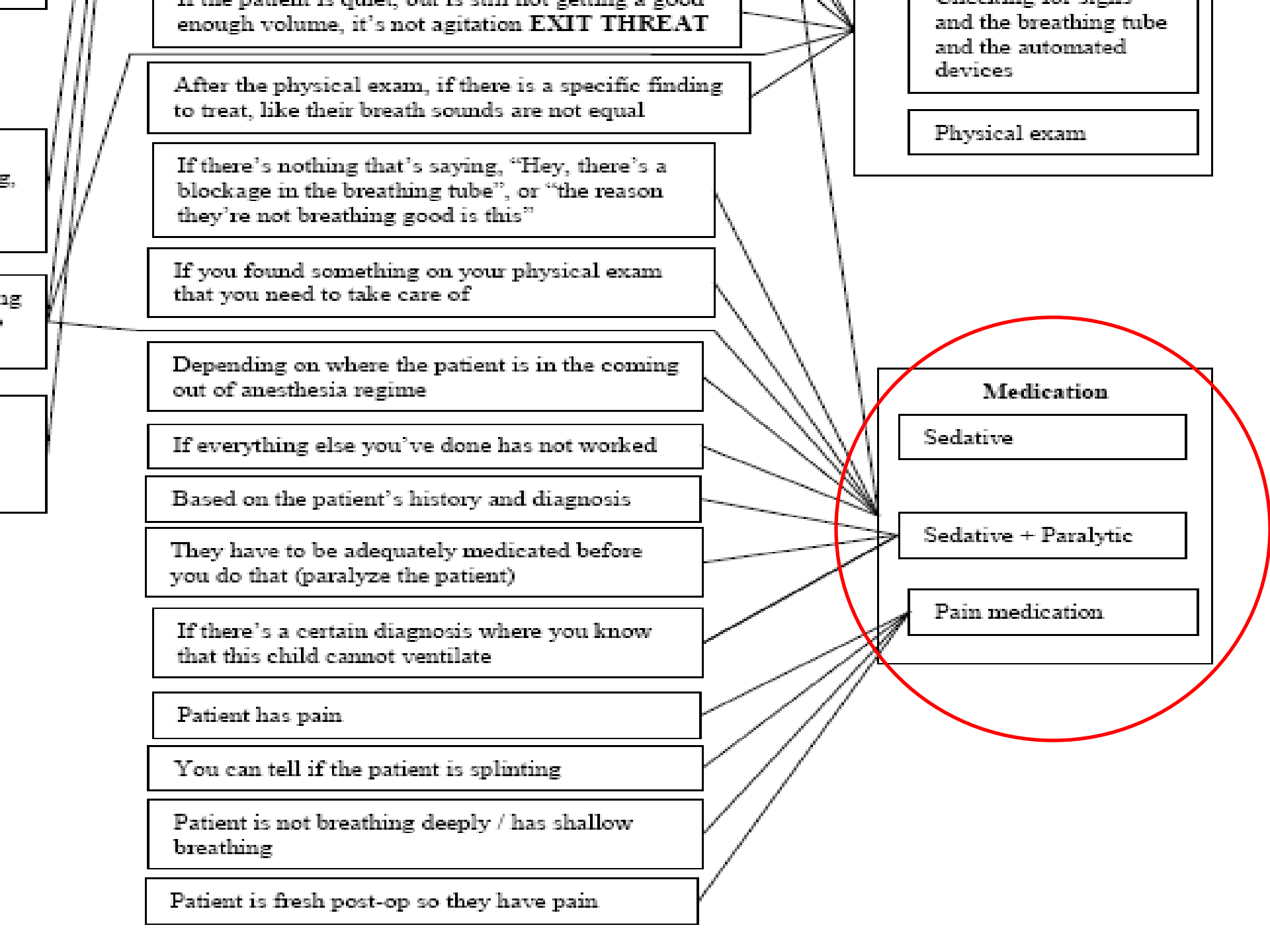
Locate bag at the start of the shift

Perform CPR

Call a code

Get an AMBU bag
- Get the bag yourself
- Get a coworker to get the bag

Yell for help
- Yell for a coworker
- Yell for a respiratory therapist (RT)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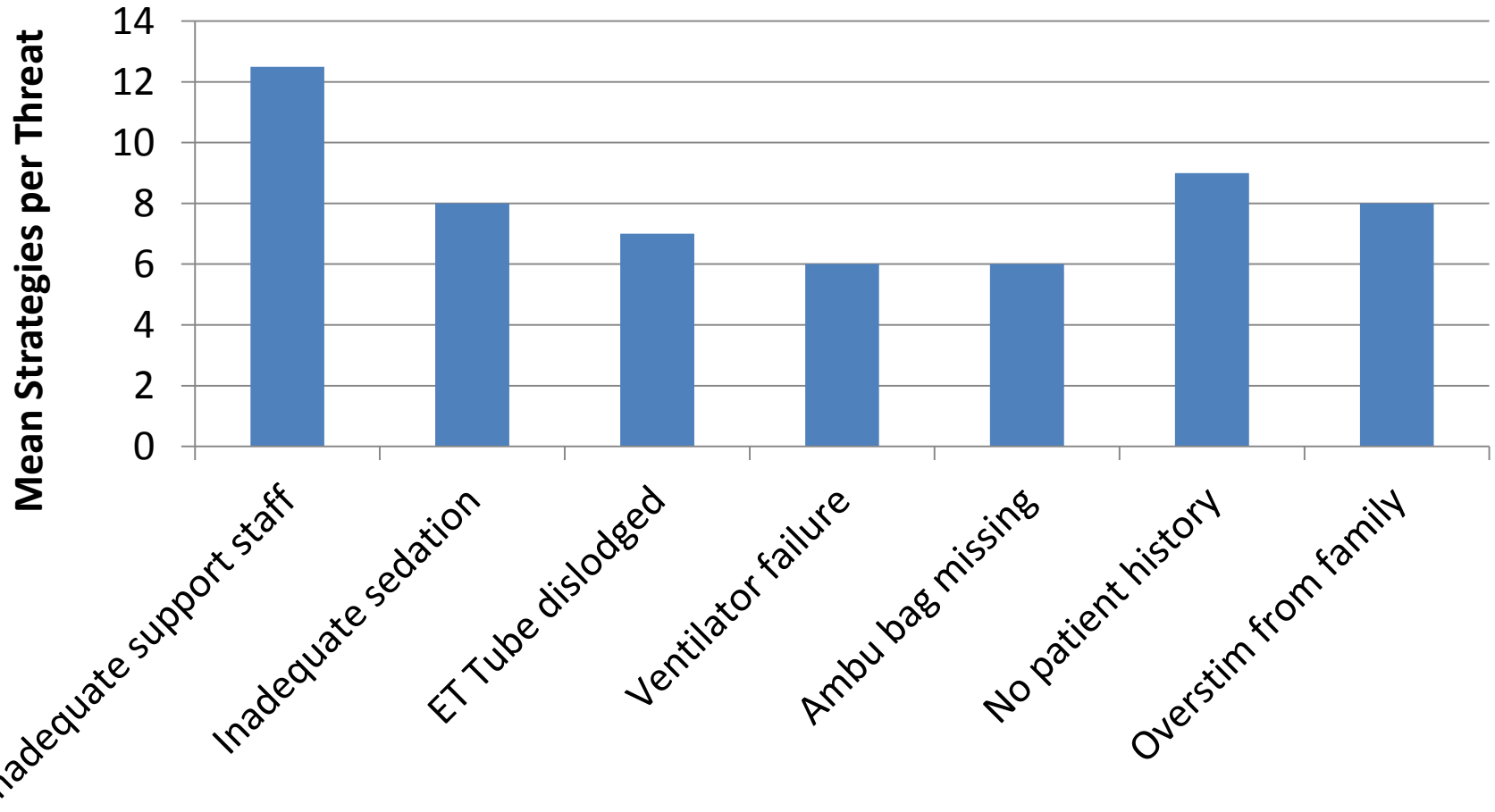
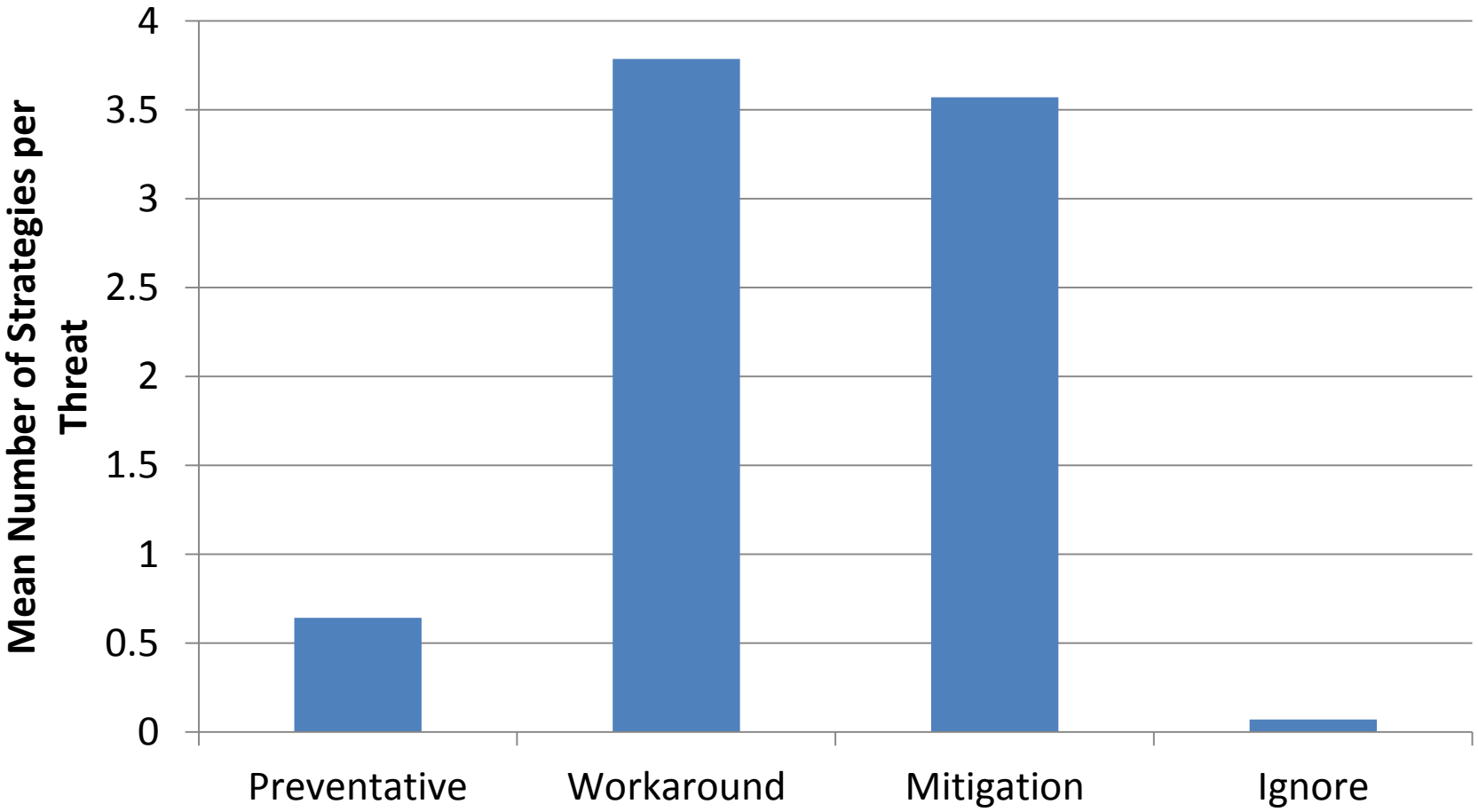
Strategies per Threat



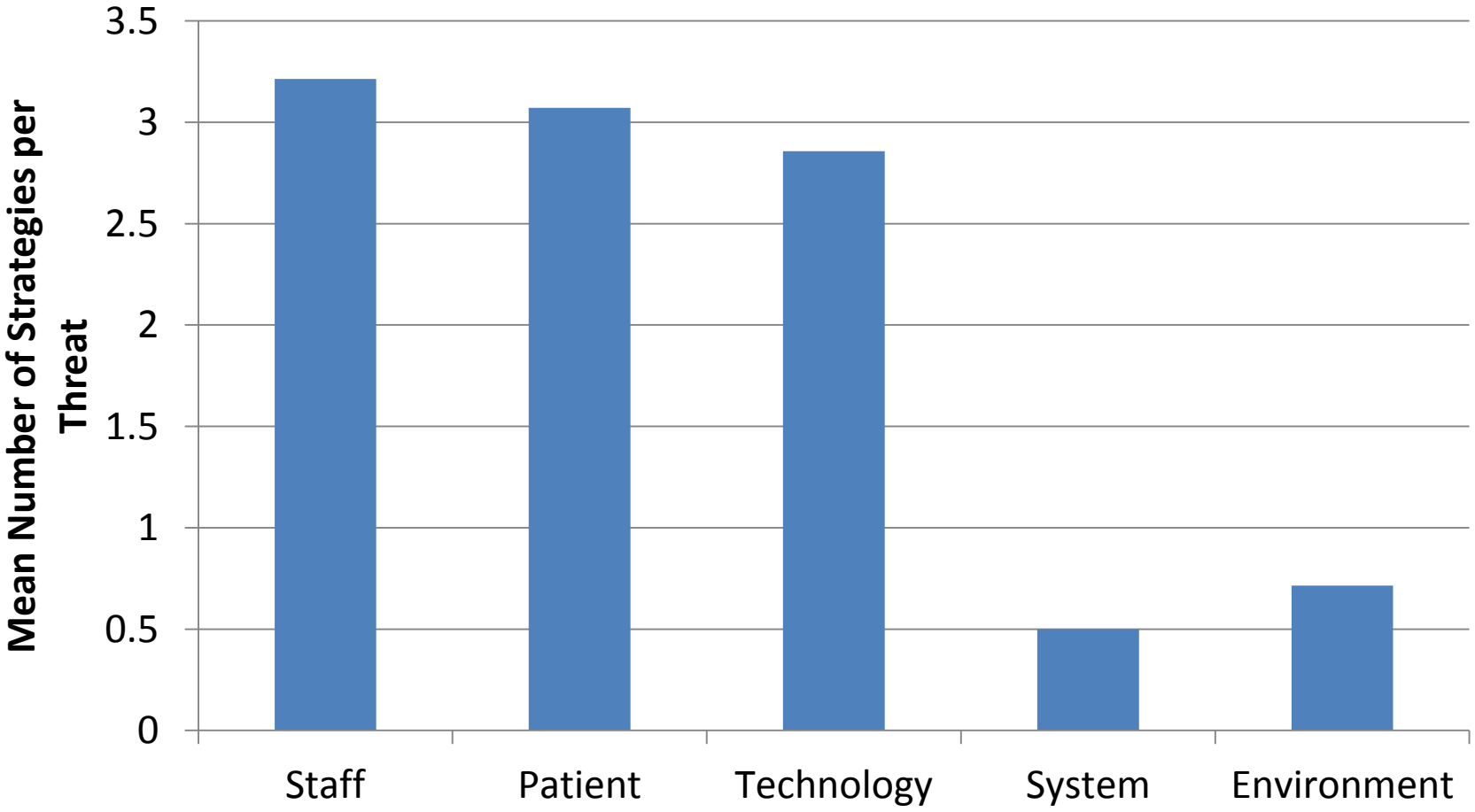
General Strategy Classification

- Preventative strategies—before the threat
- Mitigating strategies—deal directly with the threat
- Ignore threat—continues as if there is no threat
- Work around strategies—not aimed at threat, but takes the threat into account

General Strategy Classification



ICU Strategy Classification



MAPPING STRATEGIES TO THREATS

General Strategy per Threat

	Strategies			
	Prevent	Work around	Mitigate	Ignore
Inadequate support staff	1	2.5	9	0
Inadequate sedation	0.5	3	4.5	0
ET tube dislodged	0	4.5	2.5	0
Ventilator failure	0	4	2	0
Ambu bag missing	2	2	2	0
No patient history	0	8	1	0
Overstimulation from family	1	2.5	4	0.5

General Strategy per Threat

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Overstimulation from family	1	2.5	4	0.5

ICU Strategy per Threat

Entires are means per nurse; a strategy could fall into more than one category			Strategies				
			Staff	Patnt	Tech	Sys	Env
	Staff	Inadequate Support Staff	**11**	1	1	.5	.5
Threats	Patient	Inadequate Sedation	1	**6.5**	4.5		
	Pat-Tech	ET tube dislodged	2	**4.5**	4		
	Technology	Ventilator failure	**3**	**3**	2		
	Tech-Sys	AMBU bag missing	2.5	.5	**3.5**	0	
	System	No Patient History	1	**5**	**5**	3	
	Environment	Overstimulation from Family	2	1	.5		5

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	Environment	Overstimulation from Family	2	1	.5		5

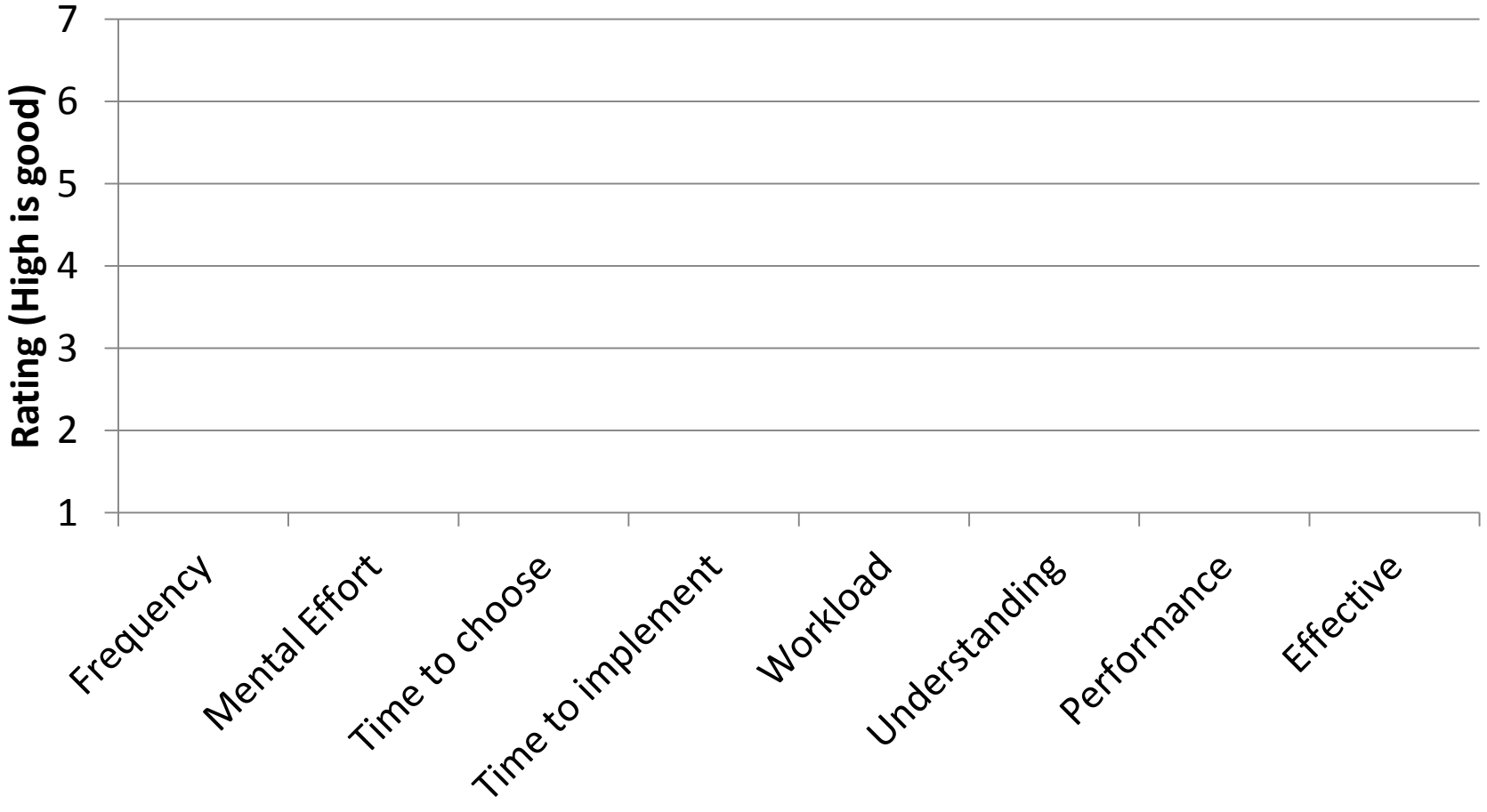
Nurse's Bag of Strategies

- Threats were often dealt with by a variety of strategies; staff, patient, technology strategies were common
- Strategies for managing the system were rare
- Strategies usually managed same resources as those that characterized the threat
- Many strategies dealt directly with the threat
- Nurses "worked around"

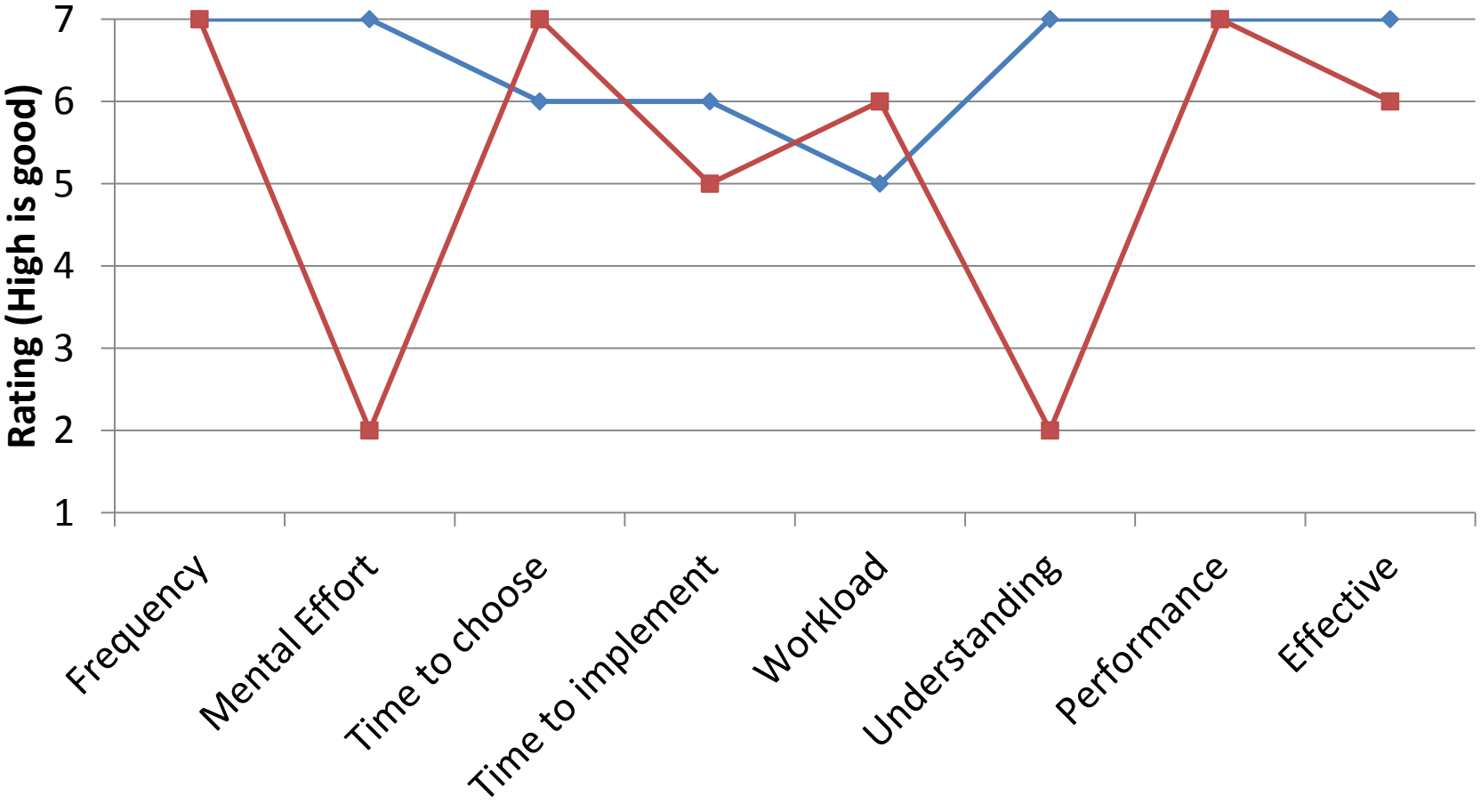
Tech & System threats

EVALUATING STRATEGIC ARSENALS

Evaluating Arsenals



Evaluating Arsenals



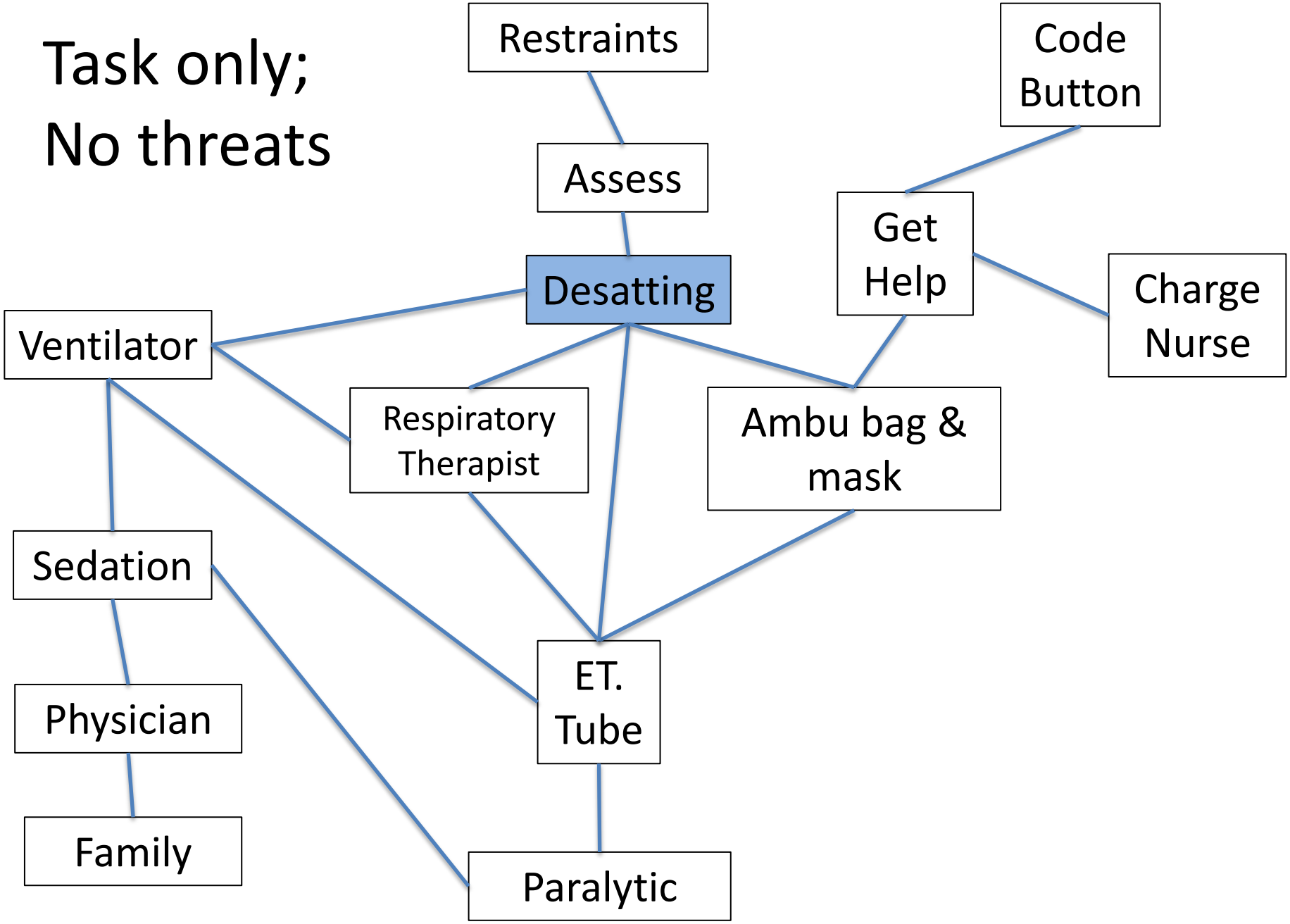
Arsenals

Threat	Type	Mean of all strategies	Mean of best strategies
Paired-patient	Staffing	6.1	6.5
Ventilator malfunction	Technology	5.0	6.0
Ambu bag missing	Tech-System	4.9	5.3
Inadequate sedation	Patient	4.1	5.5
Patient agitation	Patient	4.0	4.0
ET tube dislodged	Tech-Pat	3.8	5.0
Inadequate support staff	Staffing	2.9	5.4
Overstimulation from family	Environment	2.0	4.0
Physician unavailable	Staffing	1.5	3.3

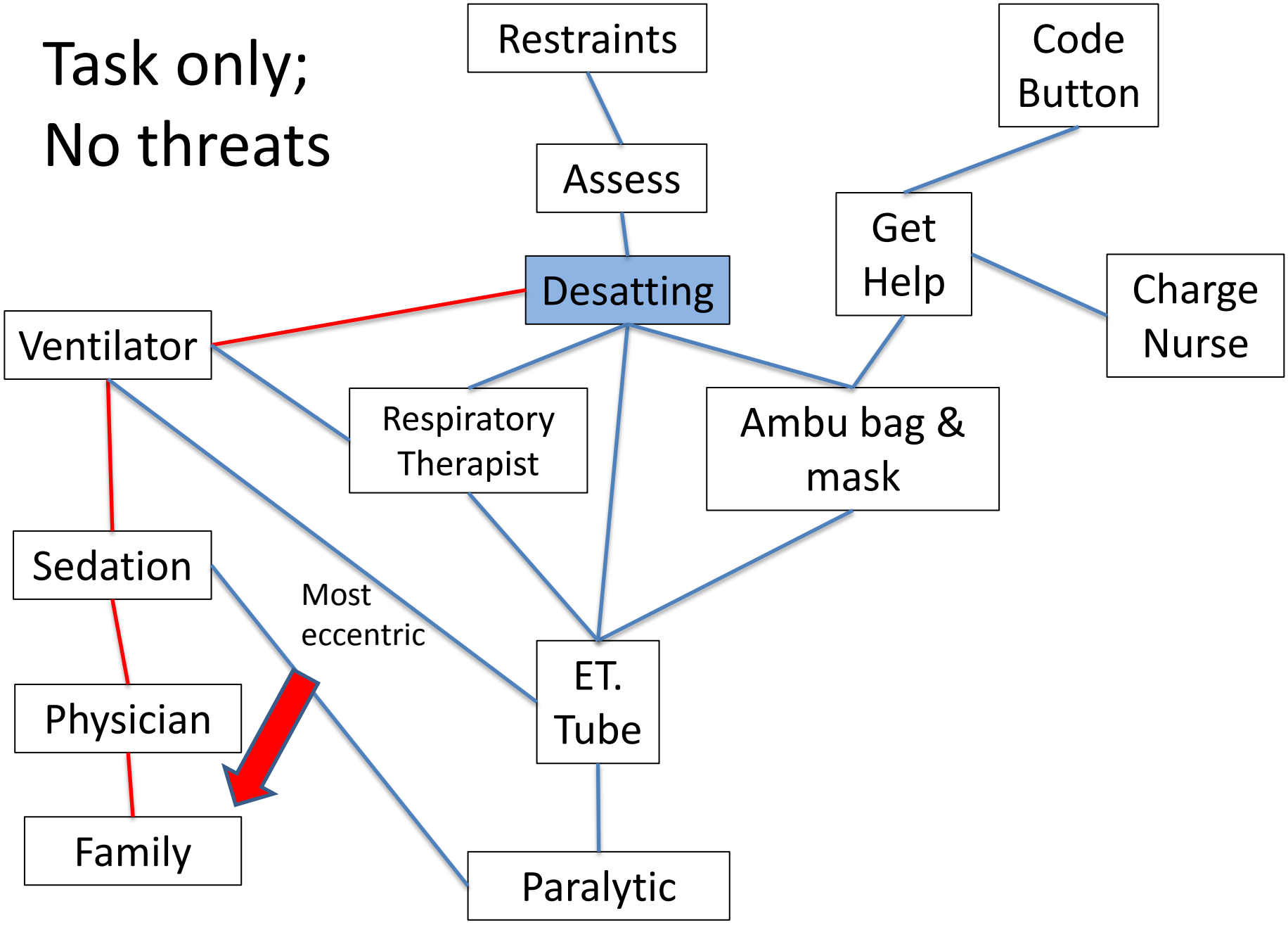
A Gap in the Strategic Arsenal?

OVERSTIMULATION FROM FAMILY

Task only; No threats



Task only; No threats



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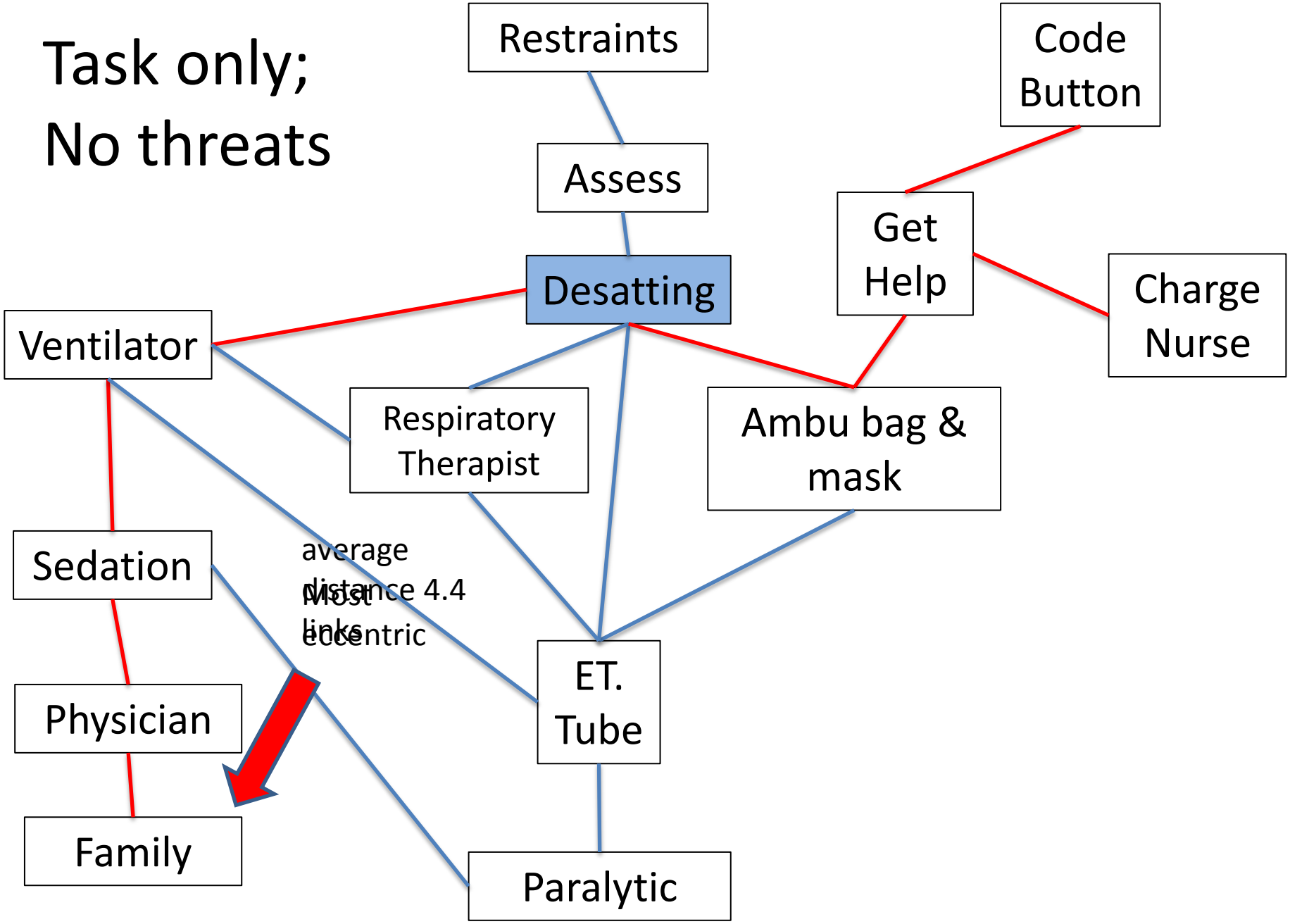
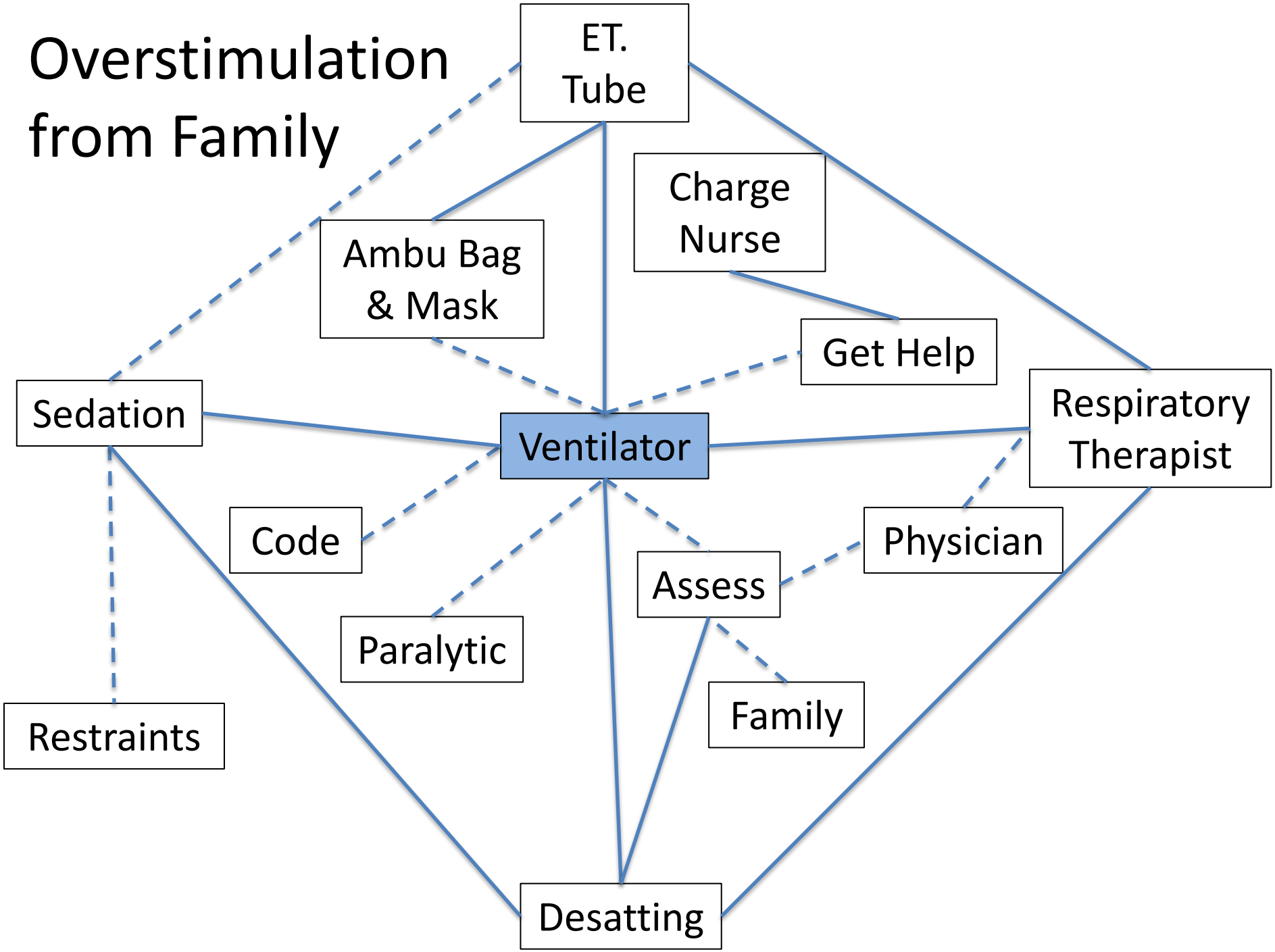
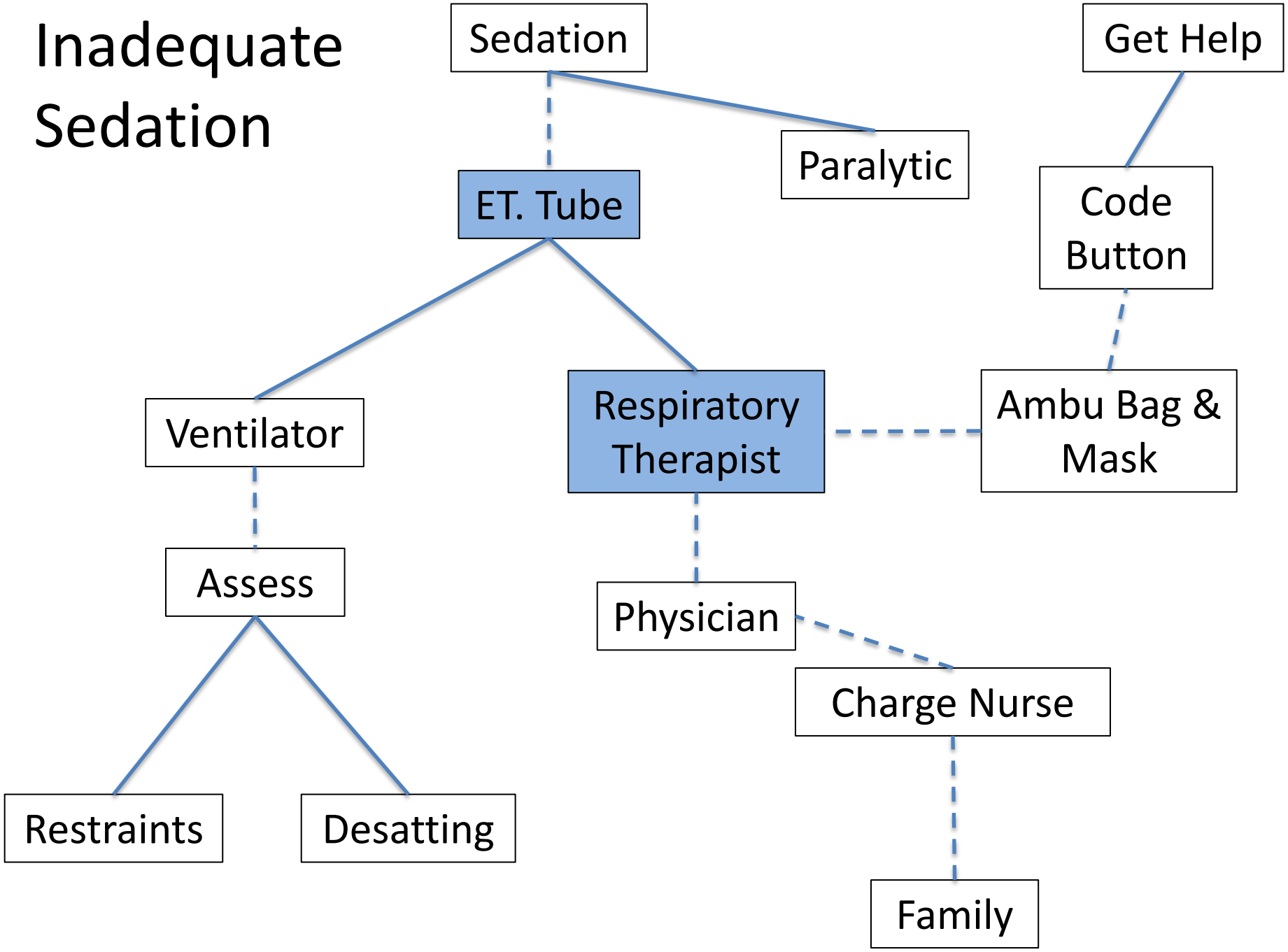


Overstimulation from Family



Inadequate Sedation



The *Family* Concept

Overstimulation from family

- FAMILY now part of the graph
  - 2 links from median
  - 2.8 on average
  - 4 max (charge nurse, restraints)

Inadequate sedation

- FAMILY again eccentric
  - 4 links from median
  - 4.7 links on average
  - 7 max (diameter w/desatting & restraints)

r = -- .12

Overstimulation from Family

- 60 strategies across 10 expert PICU nurses

Overstimulation from Family

Call a physician

Sedation

Let parents assist in patient care

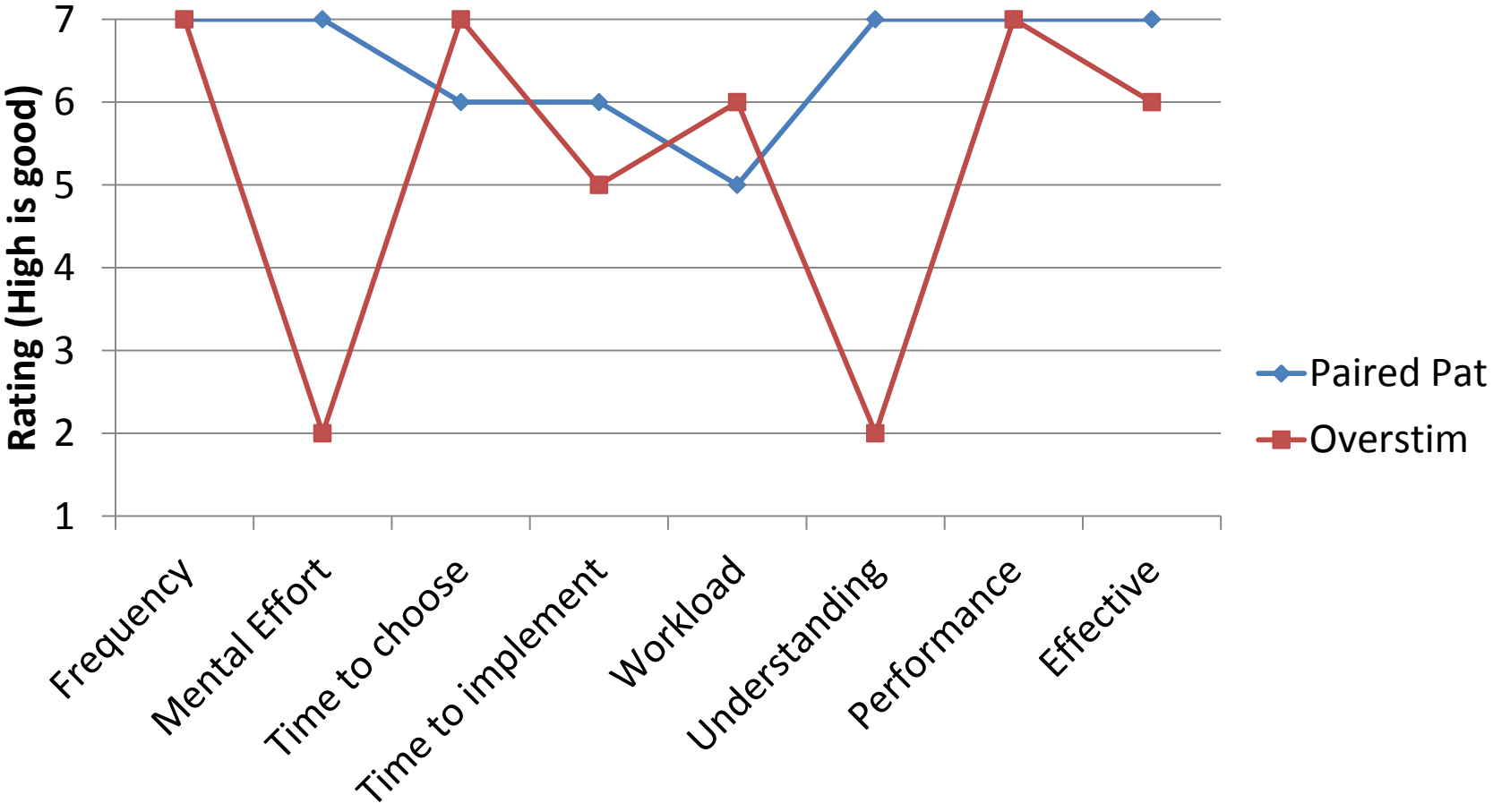
Use your colleagues to back you up

Communicate with the family
- Discuss with the family
- Set goals with the family

Get the respiratory therapist (RT) and physician

- 19 ineffective
- 27 were effective but required high effort
- 5 were effective but required moderate effort
- Only 9 both effective and low effort

Best strategies—Nurse 8



“Good” strategies

Nurse	Effective & Low work	2nd	3rd
1	None		
2	Partnership (3)		
3	Explain (5)	Ask not to touch (4)	Ask to sit down (1)
4	None		
5	Get director (5)		
6	Sedate (5)		
7	None		
8	None		
9	None		
10	Assess patient (5)	Get superior (4)	Communicate w/parent (3)

- Only 5 nurses had any “good” strategy
- Only 2 nurses had more than 1 “good” strategy
- Experience and quality of strategy were uncorrelated (r = .03)

TAKE HOME

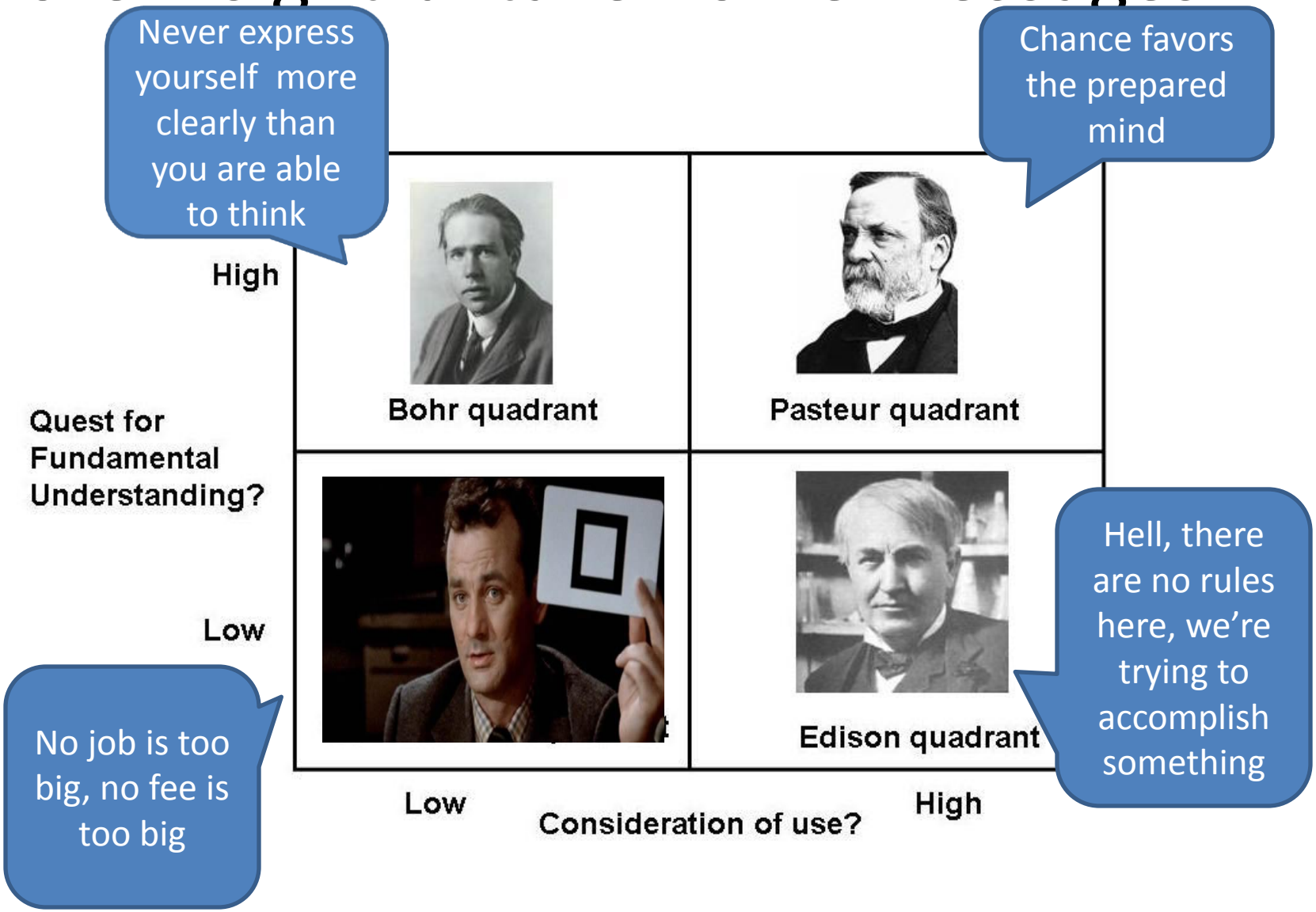
Take home messages

- Nurses manage threats:
  - Threats change the nurses cognitive landscape
- By processing patient oriented, perceptual and memorial cues to . . .
- Select strategies
  - To remove the threat or to
  - Work around system & technology threats

How good are these strategies?

- Nurses are resilient!
- Sometimes forced to choose between quick but ineffective strategies and effective but intensely effortful strategies
- For some nurses, for some threats, like Overstimulation from Family, there are too few good strategies
- Solutions may be in nontechnical training

More insightful take home messages

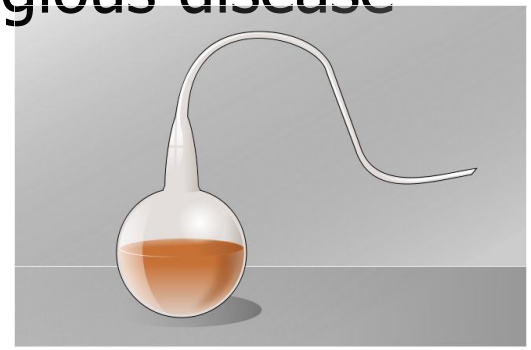


"I was just rubbing sticks together for fun — I didn't realize I was doing basic research."

Thank you

Pasteur in his quadrant

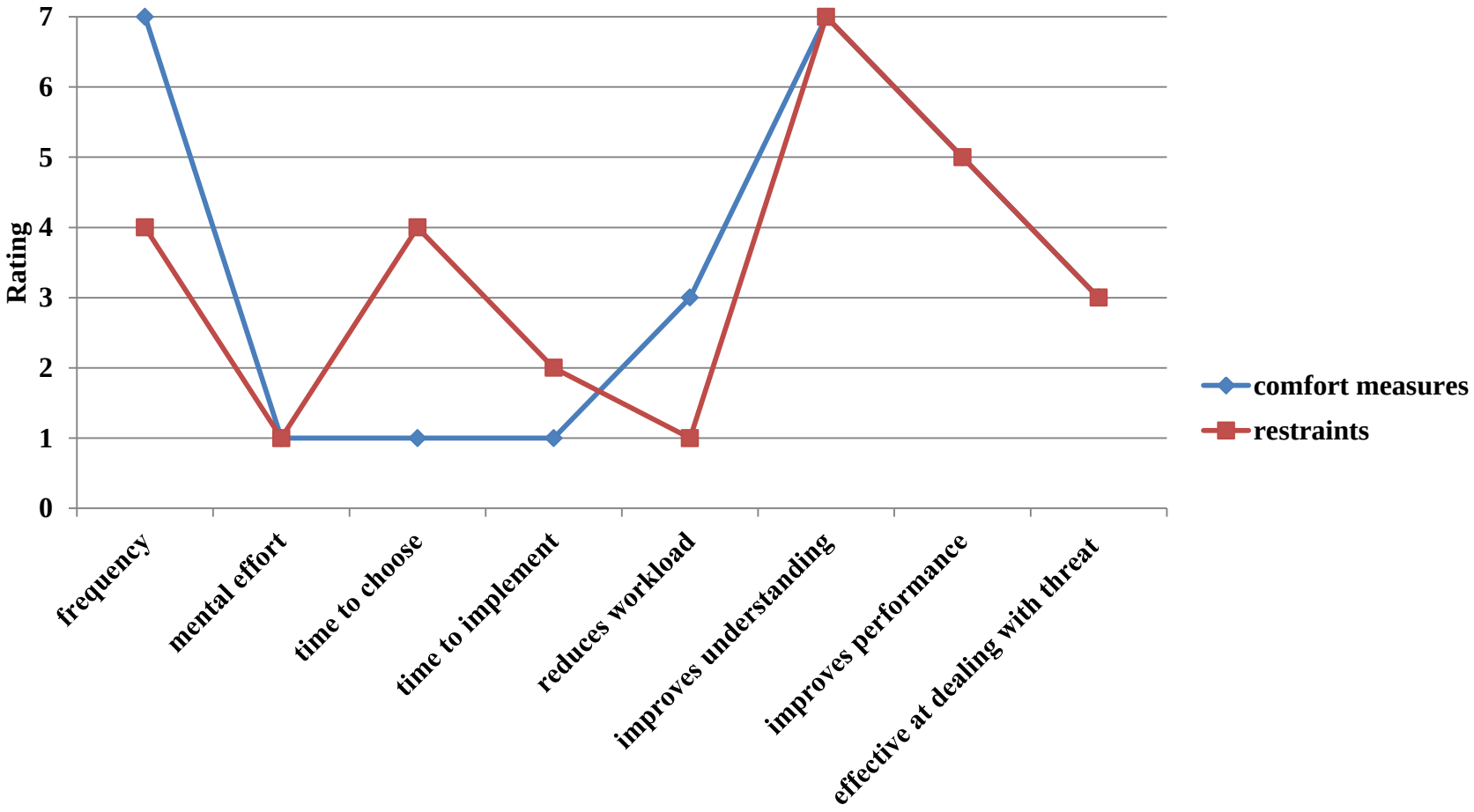
- **Basic:** tartaric vs. paratartaric acid
  - all *organic* crystals rotate light
- **Applied:** Contamination in fermentation
  - Crystals rotate light→ fermentation was organic (Germ theory)
- **Basic**: Germ theory → experiments
  - Swan necks & beef broth
- **Applied**: beer, wine, silkworms, pasteurization, antiseptics
- **Basic (Analogy)**: Fermentation::contagious disease
- **Applied**: Vaccinations



Strategy Profiles

- Assessment of strategy on:
  - Frequency of use
  - Mental effort
  - Time to choose
  - Time to Implement
  - Workload
  - Situation Awareness
  - Performance
  - Effectiveness

Evaluating strategy profiles



How often & how effective?

- Effectiveness & Frequency of use are uncorrelated (.05)
- Workload/effort → frequency
- SA & Performance → Effectiveness

Hospitals

- 5,754 hospitals (941,995 beds; 37M admissions; $751B)
  - 2904 not for profit nongovernment
  - 1013 for profit
  - 1068 state and local government

Nursing

- 5 million nurses and support staff
- 2.5 million RNs
  - 503,000 critical care
  - 230,000 in xICU

- Supply 35% of patient's direct care
- 25%-30% of the nurses' time on direct care
- 45 years old; 20% turnover rate projected
- 1-2 high acuity patients (4-6 patients)

ATC strategies

- Derived from ATC-based taxonomies (Durso & Alexander, 2010; Koros, Della Rocco, Panjwani, Ingurgio, & D'Arcy, 2006; Loft, Sanderson, Neal, & Mooij, 2007)
  - Planning
  - Monitoring
  - Workload management
  - Situation Awareness
  - Coordination
  - Performance enhancement
  - Simplify
  - Precision
  - Problem resolution
  - Information gathering
  - Unclassified

Planning	Risk assessment	Formulating a backup plan	Anticipate pushbacks		
Monitoring	Problem detection	Attend to critical points where problems have occurred/Focus on potential trouble areas			
Workload management	Adding more positions/Decombine	Request a gap in traffic	Anticipate workload peaks		
Explicit SA enhancement/Maintain SA (Loft)	Actively heighten SA	Actively attempt to get the other guy's SA			
Performance enhancement					
Simplify	Amalgamation		Use heuristics that minimize control		
		Group streams		Take the best	Fast and frugal
Precision	Differentiation	Weight dimensions			
Problem resolution					
Nominal strategies	Resolve problems immediately	Rely on past experience	SOPs		
Off-nominal strategies					
Information gathering	Rely on observations	Rely on pilot reports			
Coordinating	More effective communication	Providing others sufficient information	Ground control prepares	Pay special attention to coordination with other controllers	
Unclassified strategies					
Expedite	Slowing down	Eliminate threat	Mitigate threat	Work around threat	Add more frequencies
Maintain control of frequencies	Prioritize	Get a better view			

Predicting frequency estimates

- Performance + Time-to-implement = Frequency