Failures in Visual Signage System for Disease Transmission Prevention

ENSE624 - Human Factors in Systems Engineering

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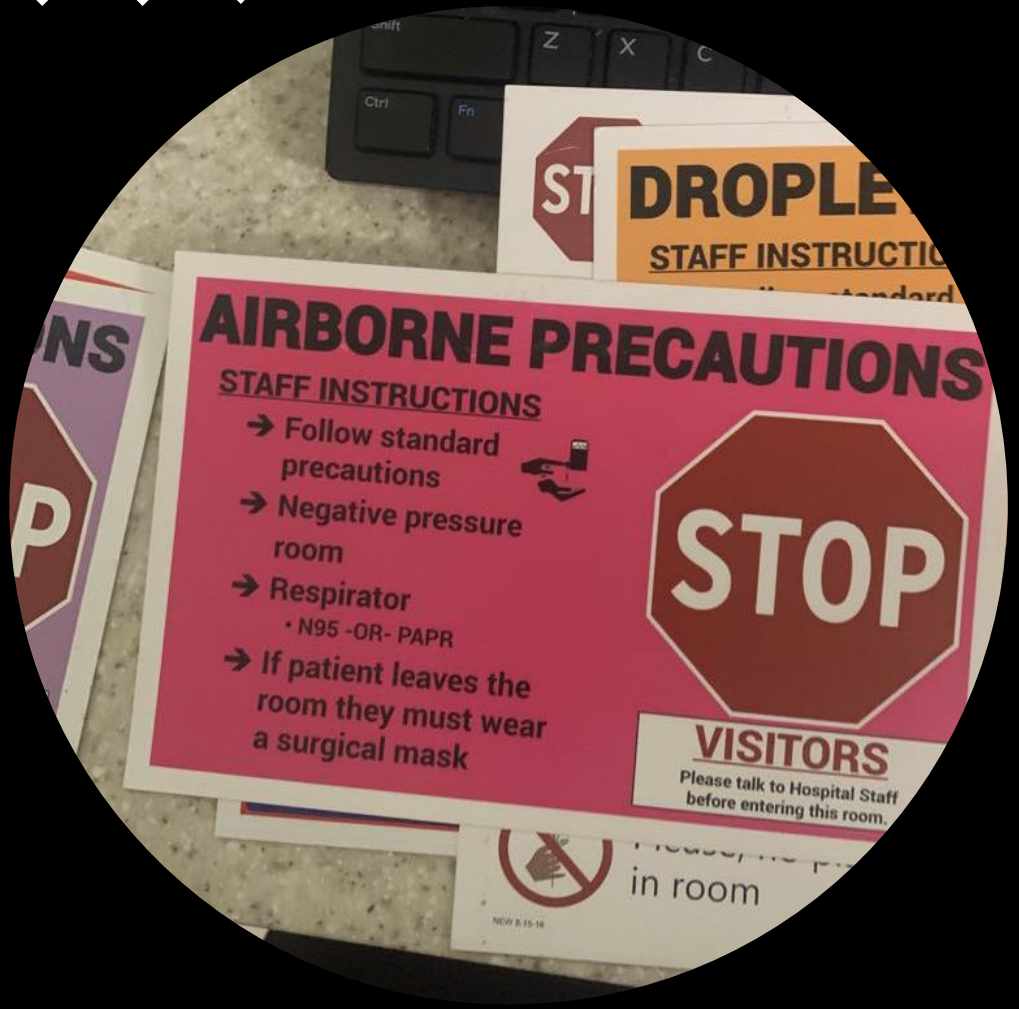
UNIVERSITY OF MARYLAND FEARLESSLY FORWARD

System Under Study

- Large regional hospital caring for ~600 patients
- Main focus was on the Emergency Department, ETCU (extended transitional care unit), and patient wards
- For the purposes of this study, the hospital name has been omitted and no identifiable patient information was collected



The Problem

- Hospital staff utilize a low-fidelity visual signage system to track “patient isolation status”, a metric that indicates what types of PPE (personal protective equipment) should be worn in each patient’s vicinity to prevent the spread of communicable disease
- Prior to the study, it was reported that
  - Signs are often missing when they should be posted
  - Signs are often ignored when they are posted
  - Proper usage of the signs is inconsistent between different areas of the hospital

Definitions

No Isolation Precautions

- Patient has been confirmed to have no communicable disease

Contact Precautions

- Indicates a risk of infective transfer from a patient to another person via touch
- Lowest of the PPE-required precaution levels, necessitating use of gloves and/or a gown to prevent transfer via hands or clothing.

Droplet Precautions

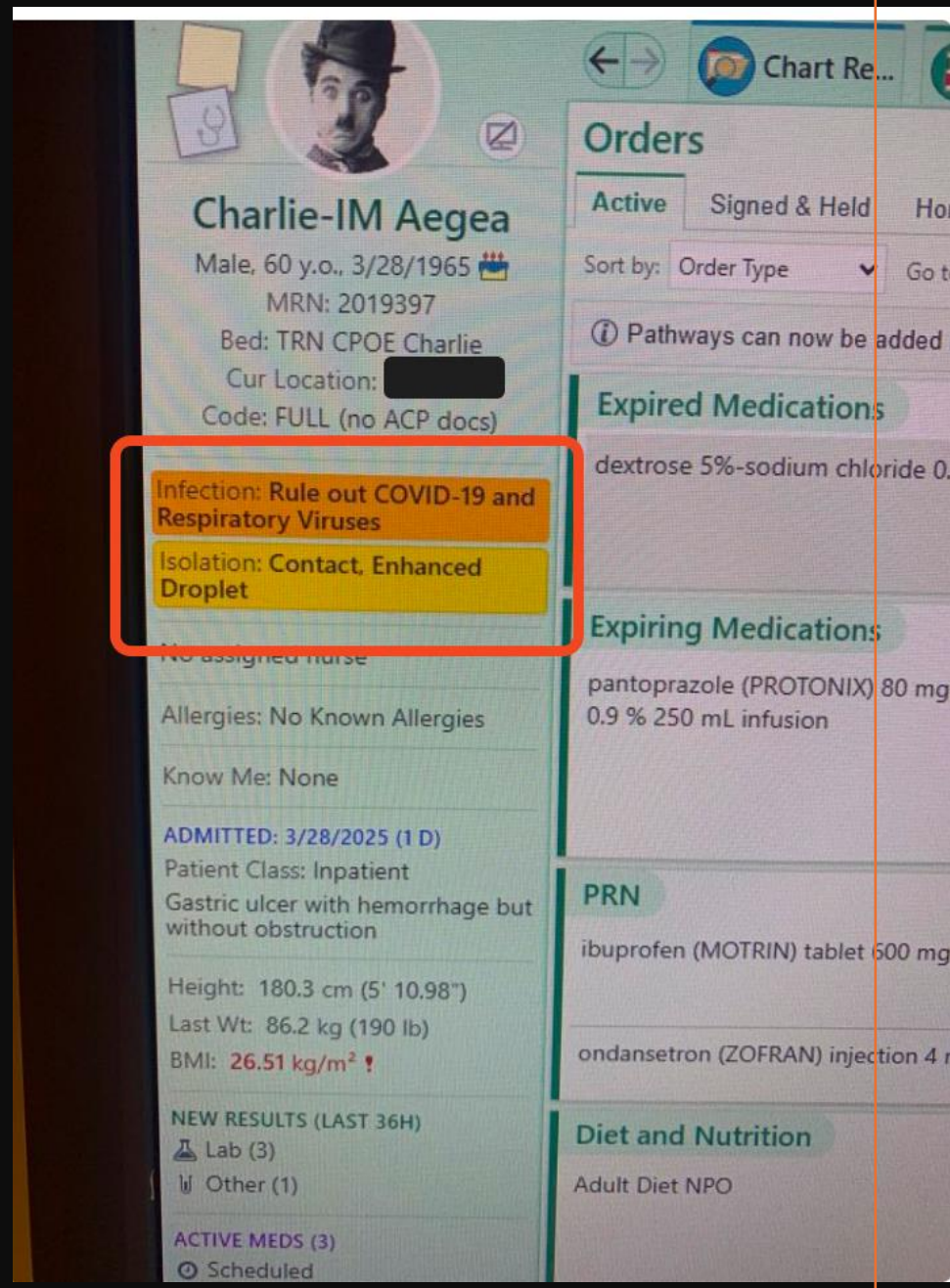
- Risk of infective transfer from a patient to another person via small particles, typically through coughing or sneezing
- Protections include a medical mask and potentially eye protection, in addition to all requirements for contact precautions (gown and gloves)

Airborne Precautions

- Highest risk of infective transfer. Disease can spread through the air via the smallest of particles.
- Effective measures for preventing spread of airborne diseases include N95 masks or a PAPR protective suit, in addition to all requirements for contact and droplet precautions

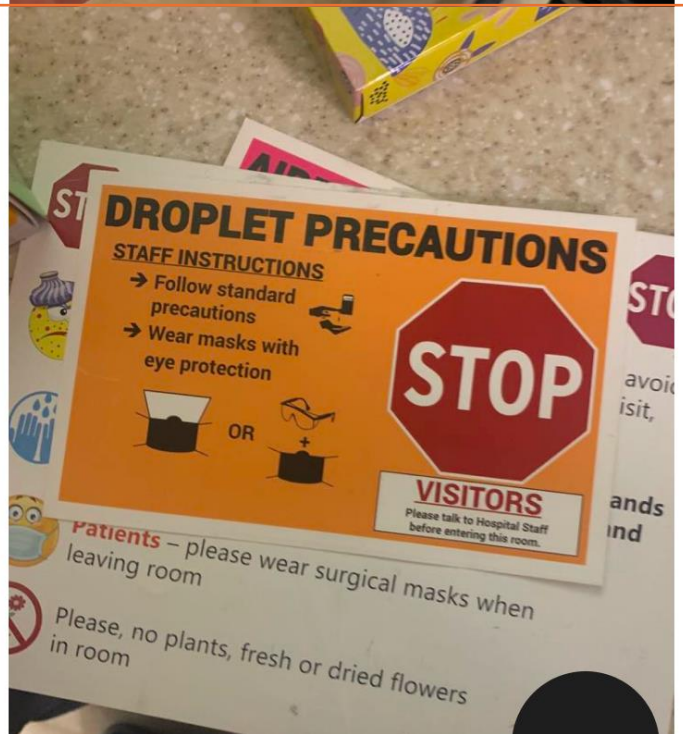
Intended Process

- Patient isolation precaution status is generated automatically through the centralized Epic electronic record system
- When a healthcare provider enters a record indicating a patient may have a communicable disease, the “Infection” property is coded as a “Rule out”
- Based on the Infection diagnosis, Epic changes the “Isolation” property to “Rule out” for one of the three precautions categories



Physical Signage

- After evaluation, any time a patient is on Rule Out precautions, a nurse is supposed to post a physical sign outside the patient's room / holding area
- Indicates that anyone entering the patient's proximity should be using the relevant PPE



Key Human Factors Questions

What inputs does the signage process require to function properly?

What factors contribute most to failed efficacy of the signage process?

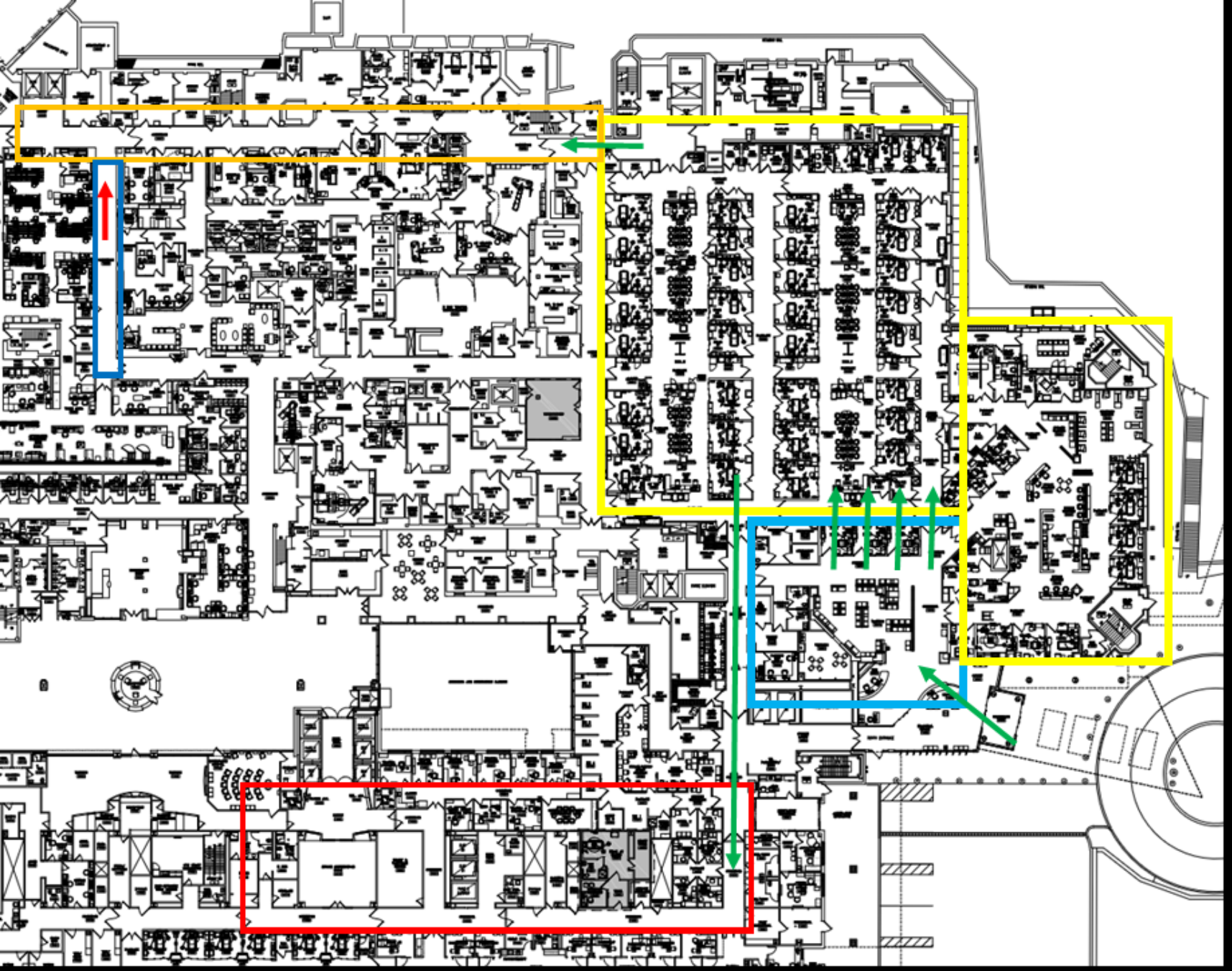
How does Epic generate precaution statuses, and how is that information transmitted between points of use?

How do digital HMI layouts communicate precaution status, and how might they be improved?

How does the design of the physical precautionary signs contribute to their effectiveness?

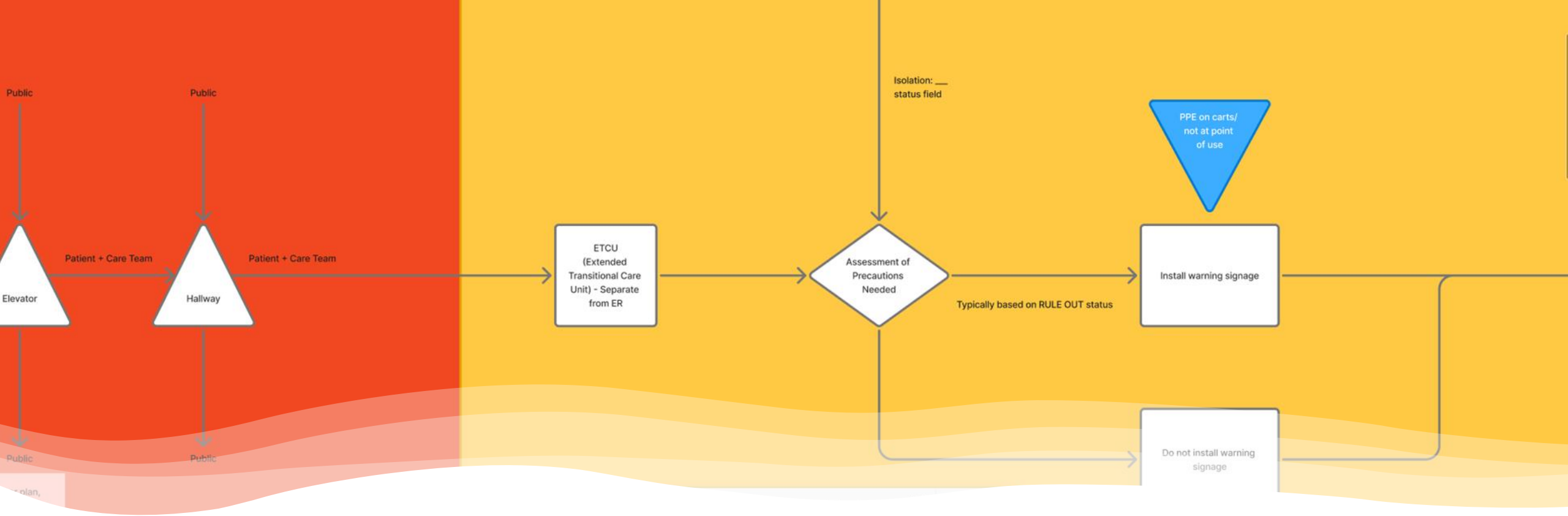
How does the layout of the hospital help or exacerbate potential exposures resulting from failures of the precautionary signage system? What areas are a greater exposure risk?

Methodology



Step 1. Route Tracing

- 3 field visits to tour the facility and follow the physical path that patients would take from the ED to the ETCU to the ward rooms



2. Digital Mapping

Using a Miro board, I created a digital graphic of the entire patient journey, creating distinct sections to represent each area of the hospital

Data Collection

Epic captures time stamps for many elements of the patient's journey, including

Time patient enters the emergency department

Time of each medical evaluation

Time precautions are added to or removed from the chart

Time patient enters the ETCU, if applicable

Time patient enters a ward room, if admitted

Through manual observation of rooms from a safe distance, I could observe and record:

Whether signage was present on a door

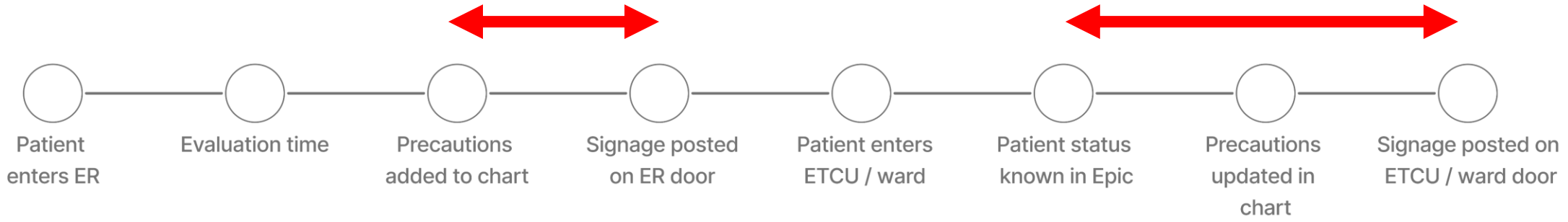
Observation time

Using Epic, I could identify each patient's

Isolation status

Final diagnostic result (positive or negative for the given isolation type)

Data Collection



How long does it take from the time when precautions are added to the chart to the time when the physical sign goes up?

How often does the sign get posted at all?

Data Gathered

- De-identified patients as numbers and tracked timing of care, isolation status, and movement using Epic and physical surveys
  - Time from “identified as needing precautions for rule out” to “time appropriate signage posted”
  - Movement from ED to ETCU to Wards
  - Time to final testing and diagnosis as contagious or not
  - Appropriate signage posted and when

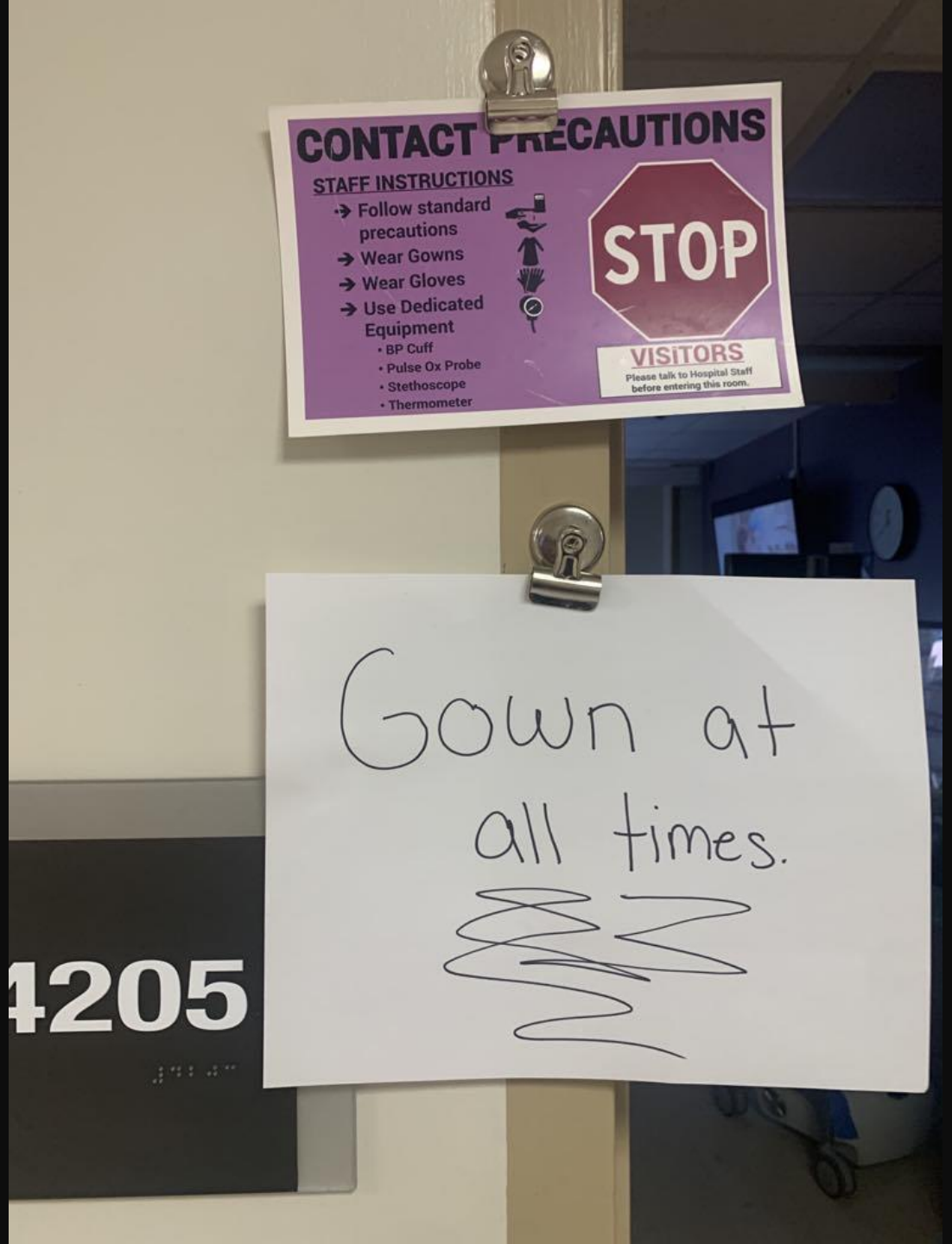
Patient No	Patient Enters ER Room	Evaulation Time	Signage Posted on ER door	Patient enters ETCU room	Signage posted on ETCU door	Discharge time from ETCU	Patient enters ward room	Patient status known in Epic	Precautions Added to Chart	Sign posted on ward room door	Diagnostic result
1	10:13am	10:18am	never	1:01pm		2:40pm		10:13am	10:13am		Positive - contact
2	12:59pm	1:01pm	posted between 2:30-3:30pm	tbd		-		2:58pm	1:03pm		Positive - COVID - airborne
3	12:12pm	12:20pm	never posted	n/a		-		4:04pm	2:30pm		Negative - droplet
4	1:11pm	1:35pm	never posted	n/a		-		3:10pm	1:44pm		Negative - droplet
5	3:27pm	4:00pm	never posted	3:50pm		-		3:27pm	3:27pm		Known positive- contact
6	2:23pm	2:23pm	never posted	n/a		-		5:30pm	3:06pm		Negative - droplet
7	2:50pm	2:51pm	never posted	n/a		-		4:04pm	2:58pm		Negative - droplet

Data Interpretations

- Data converted into time intervals
- Percentage of patients who never had appropriate signage posted
- Average time to signage posted
- For patients who tested positive for a communicable disease, average time without posted signage

Findings and Key Points

- **Most patients in Rule out status never receive posted signage**
  - Patients who test positive are more likely to have signage posted, but always with delay
- **Gaps in time from Epic isolation status to physical signage represent significant intervals of potential exposure**
  - Exposed hospital workers become vehicles of exposure to other patients as they move from room to room
  - Jeopardizes other patients
  - Costs the hospital in employee sick leave and lengthened hospital stays for new in-hospital infections



Additional Observations

- Hospital workers rely on the signage, not Epic, for appropriate PPE
- Even with appropriate signage, level of compliance with recommended PPE is variable
  - Makeshift signs may be added to doors to emphasize importance of precautions on certain more contagious patients

Final Recommendations

- Use a feedforward strategy instead of the current feedback control system
- Digitalize to eliminate human factors causing delays
  - Install electronic indicators (screens, three light andon indicator) outside each patient room, connected to the digital EMR bed board
- Build in additional indicators utilizing non-visual senses
  - Blinking lights, beeping when door opens
- Other suggestions
  - Standardize signs and process across hospital
  - Use better color contrast on signs for low-light environments (lighting is reduced at night)
  - Ensure path of least resistance to appropriate PPE (consistently stage near points of use)