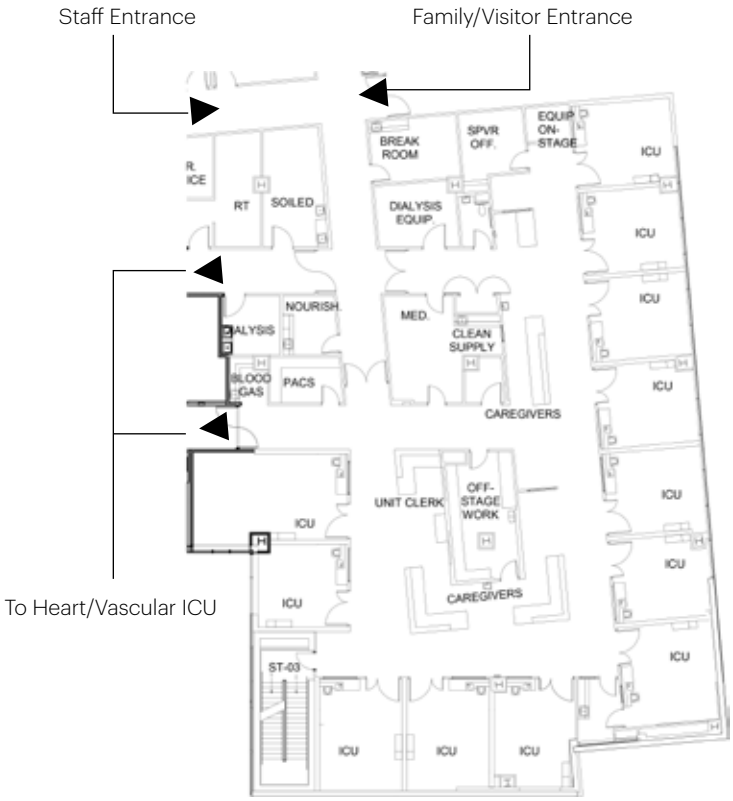
# DESIGN DIAGNOSTIC

A systematic current state analysis that studies the relationship between facility design, human experience and organizational efficiency, in order to inform future state design

**DD002: HEALTHCARE WORKPLACE**
A DESIGN DIAGNOSTIC OF THE SICU

Creating places that enhance the human experience

# Context




## MIDWEST SURGICAL INTENSIVE CARE UNIT

MIDWEST REGION

12 Bed ICU Unit 1:2 Nurse-Patient Ratio

Total Staffing: 40 RNs, 4 PCS, 4 UC/NA (cross-trained)

**In one shift:**
12 patients
7 Registered Nurses
1 Trauma Nurse (not assigned)
1 Patient Care Supervisor
1 Unit Clerk
1 Nurse Assistant

**Floating staff:**
Physicians (8 - can vary; 4 critical care physicians)
1 Respiratory Therapist
1 Care Navigator
1 Radiologist
1 Dietary
Clinical Affiliates

The SICU in the Midwest tower is a successful unit which meets most KPI targets such as infection rates and fall rates. However, the HCAHP scores and the Rate of Use of Restraints are on the lower side. Additionally staff voiced some concerns with the organization in the HR Survey. This study sought to determine how the facility design may play a role in current performance, and use this insight to enhance the performance in the new tower.

# Contents

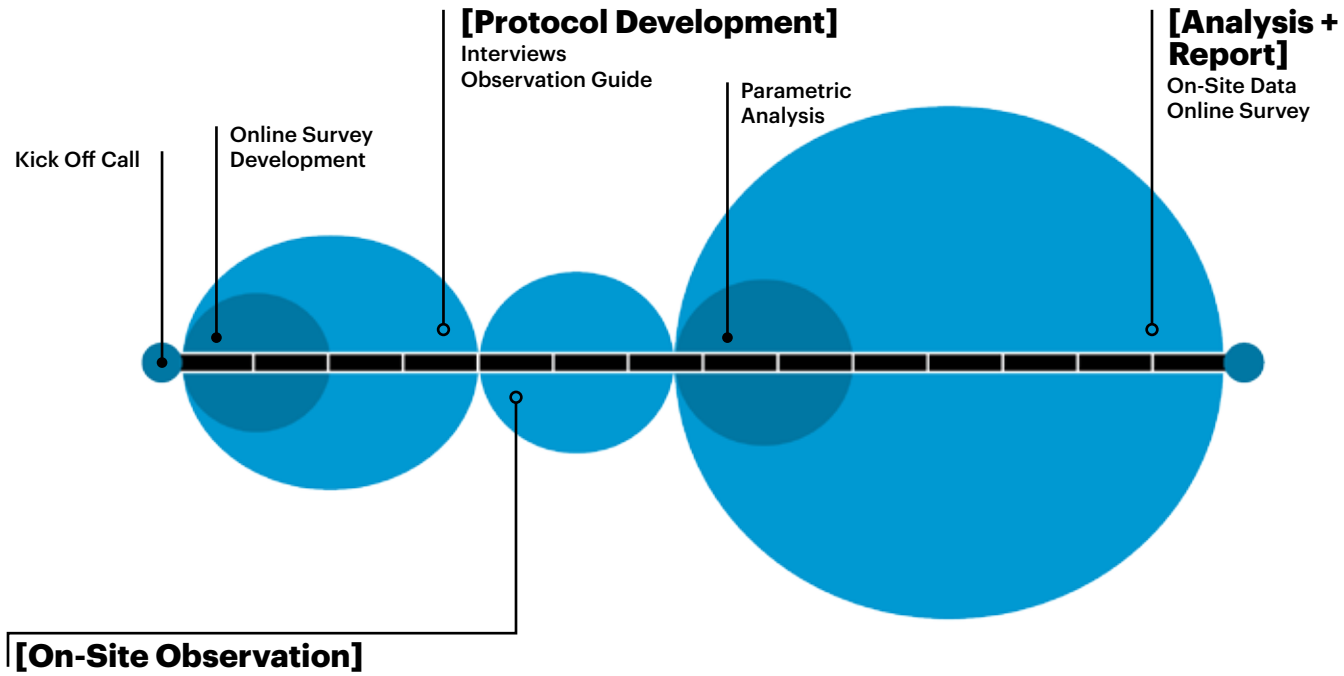
# 1.0 Study Design

## Aim

To study the relationship between facility design, human experience and organizational efficiency, to understand current state, and inform the design of future state in the design of the new medical tower.

## Method

The study method involves a triangulation method using online surveys , on-site observations and interviews, and off-site spatial analysis using parametric modeling tools. Reported data (archival/ surveys/ interviews), observed data (shadows/behavior maps) and spatial data (proximity and visibility analysis) are analyzed together to understand the patterns that emerge. We synthesize user data into a series of user personas to call out the goals and concerns of each stakeholder within the context of the site. A detailed timeline of the study is shown below.




# 2.5 Days on Site

### Day 0

- Online Survey
- Photo-Essay

### Day 0.5

- Site Tour
- Intro
- Pilot Shadow
- Interviews
- Sound readings

### Day 1

- 17-Hour Shadow (3+2+12) 2 RNs
- 8 Staff Interviews
- 12 Behavior Maps
- 52 Sound Readings

### Day 2

- Interviews
- Debrief
- Behavior Maps

## 1.1 Key Findings

Key findings of the study relate to unit design and patient room design, and are summarized as follows:

**1. Communication is Happenstance:** Care team coordination tends to "happen" in the corridors and nurse stations; the stations become communication hubs, and a source for noise. The off-stage area, originally designed for team collaboration is not used for this role.

**2. Access trumps Visibility:** Nurses leave doors open for patient monitoring and immediate access. Often blinds remain closed and the doors are kept open. This combined with the extensive use of the care coordination hubs increases noise levels and perception


**3. Off Stage is "Out of Sight..":** The off-stage area was designed for team huddles; however, the enclosed and opaque space obstructs unit visibility and is used as a hide-away space. Staff complains about the space, and refers to the units as two halves- divided by the off-stage center.

**4. Documentation is excessive and inefficient:** Despite spending a majority of their time in documentation on the computer (see activity analysis) nurses still tend to hand-write their personal notes on patients to share with other care providers. This puts into question the efficacy of the current electronic health record system

**5. Connectivity in the unit is limited:** Currently the unit does not have any technological connectivity between the nurses (no pager/ phone etc). The Unit Clerk is a key human connector. Although it is likely that this creates a "tighter" unit with a stronger personal connection, it is also evident that the lack of technological connectivity can affect timely call responses

**6. Nurse Station is the Nucleus of the Workspace:** All key work related interaction, as well as work that does not require patient interface happens at the nurse station.

Nurses, physicians, and other care team members use the nurse station as touch down spaces, as well as documentation stations. The offstage is under-utilized adding pressure on the nurse station and also making it a noise generator for the unit

**7: More space needed on the bedside:** The number of care team providers in a room can reach up to eight or more in admissions and emergency situations - adequate patient room real estate and point of use supplies are key. Nurses also spend two-thirds of their shift in the patient room and strategies that allow them to monitor patients outside the room must be explored.

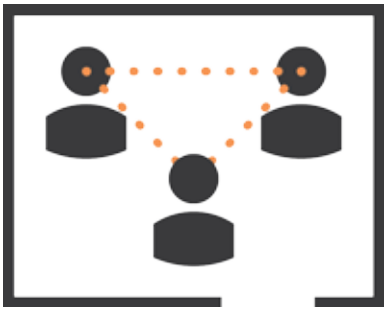
## 1.2 Do Now Recommendations

Do now recommendations are small changes in design that can be made immediately to improve the current state.

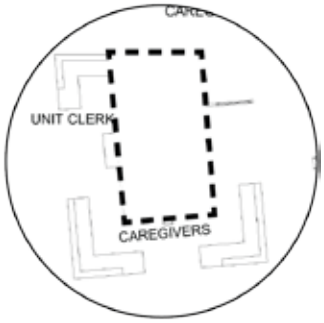
These are summarized as follows:

Provide direct/remote connectivity to staff

Move EKG remote to more accessible location



Allow care coordination spaces away from patient areas




Make off-stage more transparent


Add telemetry unit to off-stage

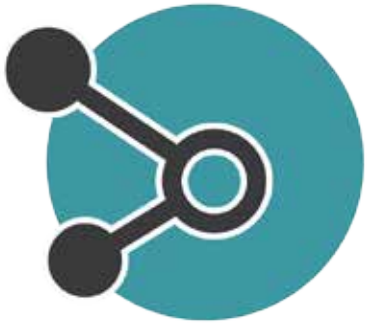
Consider sound sensors to monitor noise

## 1.3 Drivers for Future Design

The Design of an ICU should take into account the complexity of the care delivery team, the advanced equipment and information needs, and timely access to medications and supplies. Key drivers emergent from the study are summarized below:

**Patient Monitoring: Visual, Auditory, and Virtual:** It is important to allow all three levels of connectivity, with auditory and virtual connectivity, arguably, trumping the visual.

**Care Coordination Space** has to provide for "touch down" spaces that encourage happenstance conversations and rapid documentation. Observation shows the nurse station as a team station



**Connectivity:** (nurse-patient; peer-peer; care team; care team-support services) There must be connectivity between patients and care team members without the bottle neck of a single professional such as the UC.


**Access to Medication** must be conveniently situated, as well as secure. It should be possible for the nurses to prepare and administer meds without interruption, while being visible to the unit

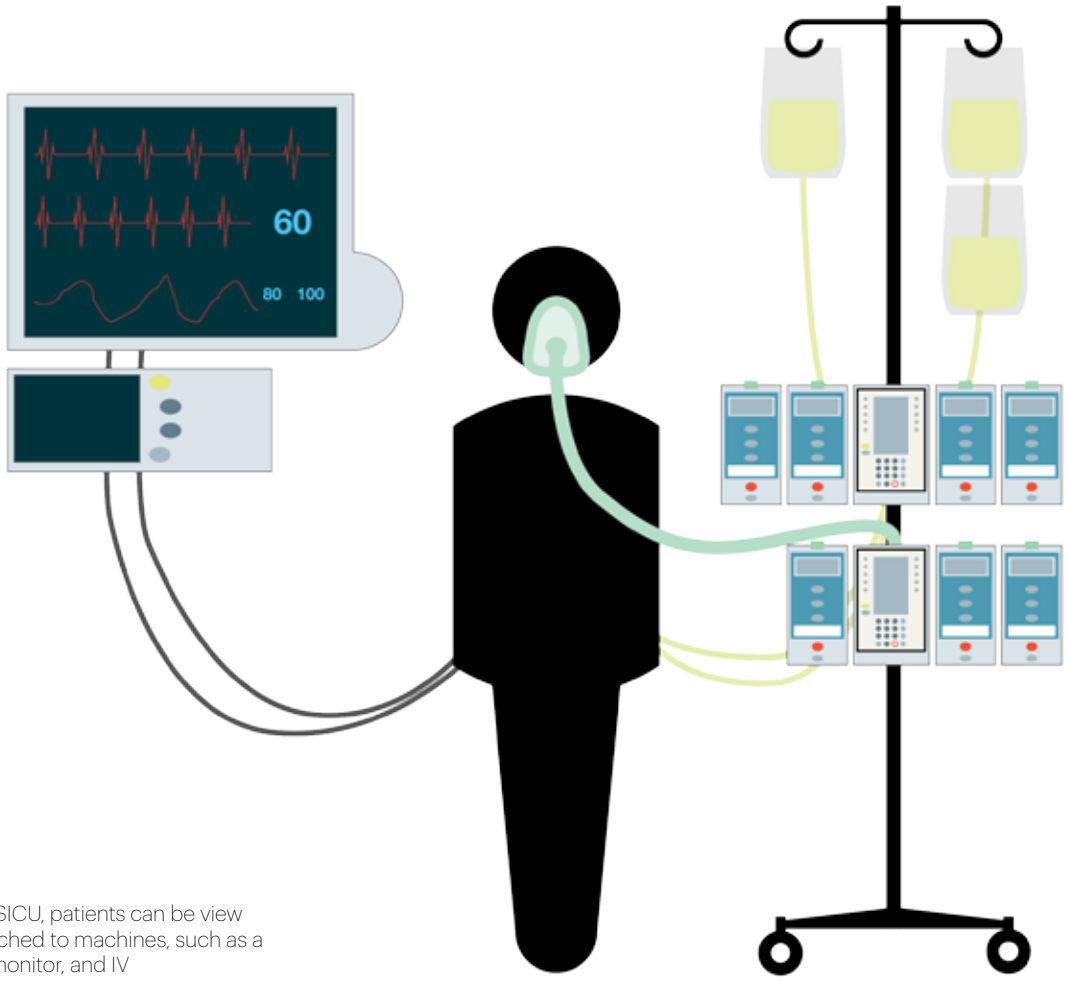
**Security of the unit** is paramount for the SICU which often deals with victims of potentially volatile situations (such as gang wars). Patients and staff must be secure, and "feel" secure as well.

**Care Delivery Space in Patient Room:** The ICU patient is connected to a lot of large equipment and is treated by a large team (up to 8 or more people at the bedside)- often simultaneously. Space and power supply are essential at the bedside.

# USER EXPERIENCE & WORK FLOW

The people define the place in any unit. To understand workflow, we first seek to understand the people - who they are, what they do, and how they spend their time.

## 2.1 PATIENT AND CARE TEAM

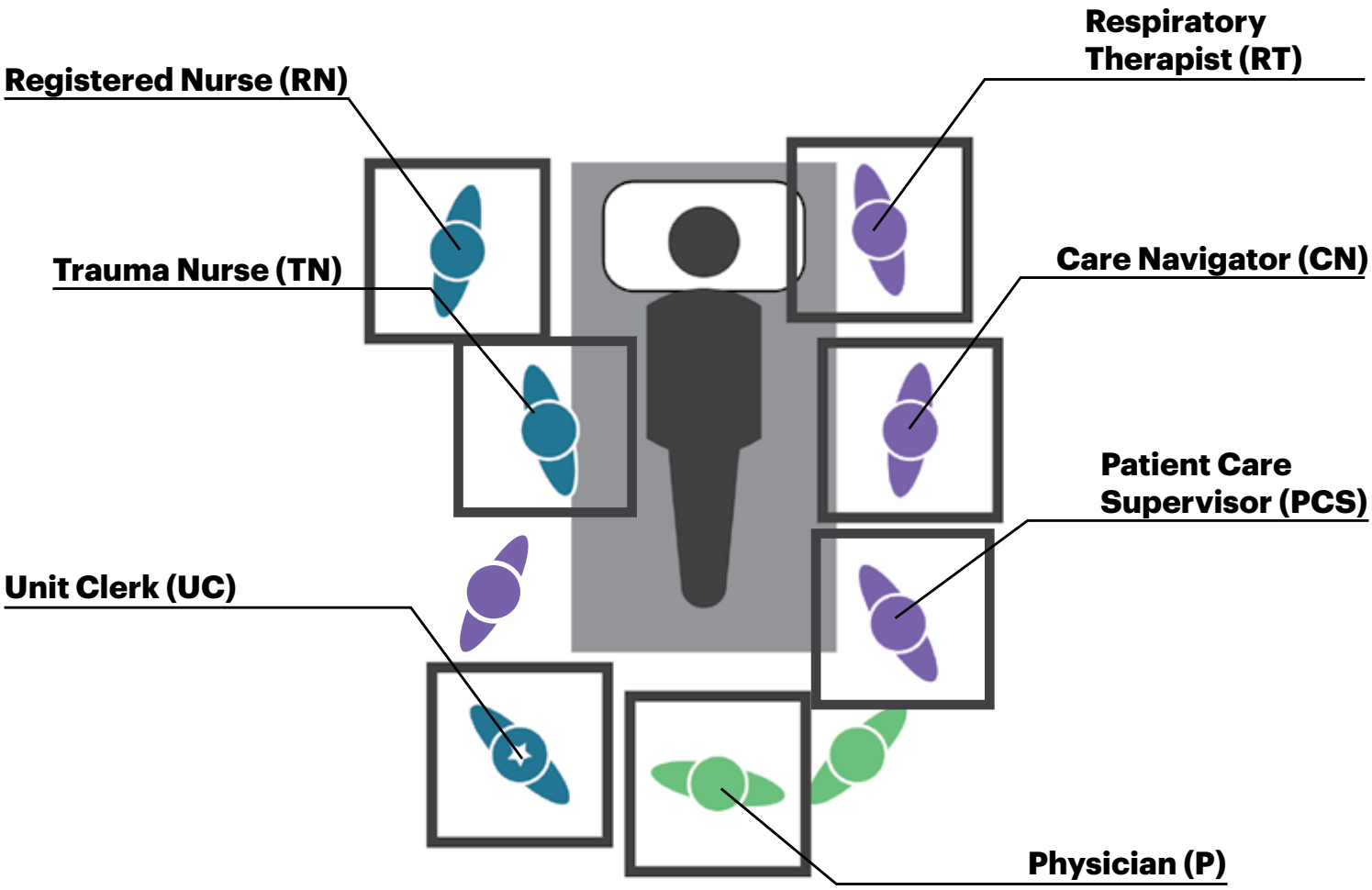



**ABOVE:** In the SICU, patients can be view as a person attached to machines, such as a ventilator, EKG monitor, and IV

### PATIENT = PERSON + EQUIPMENT

The key purpose of the ICU is to serve patients who are in critical condition and make them strong enough to move to the acute care unit, or, on rare occasions, be discharged.

To understand the workplace, we must first understand the patient. In an ICU the patient is more than just a person. He/she is constantly connected to and monitored by advanced medical equipment, and this insight is key to designing the ICU, and the workplace for those who care for the ICU patient




**CARE TEAM CONFIGURATION**

Another unique characteristic of the ICU is the complexity and diversity of the care team that cares for the patient. In addition to the RN who is the person most directly responsible for the patients ICU stay (and thus cares for only 2 ICU patients in her/his shift), the care team includes the physicians (critical care physician plus specialists as needed), the anesthesiologist, the trauma nurse, the respiratory therapist, and the unit clerk. Additionally non clinical support is provided by the care navigator, dietary services and other support staff. The care team configuration demonstrates the need for space at the patient bedside. Our observations show that up to 8 people may be around the patient at the time of an admission (more in a code blue). Thus space around the patient, and especially in the entrance to the room, is critical.

# REGISTERED NURSE (RN)

> *"I need visual assurance between myself and the patient, therefore I usually don't break far from the patients."*

Of the 13 nurses surveyed, the average years of service and experience level were between one and five years (Refer appendix 1 for detailed demographic).

In observing the unit and speaking to the staff, it was evident that the RNs are the key care givers for the patient. They are responsible for monitoring vitals, preparing and administering meds, taking labs, coordinating treatment plans with the rest of the care team, providing the patient with as needed pain relief and comfort, and being the key point of contact for the patient and the family.

Overall, the RNs were satisfied with their unit, especially their team members. However, the lack of visibility and connectivity was a recurring issue that was reported.

In observing the nurse in detail, the research team found that the ICU nurse rarely sat or took any time to rest. The demand for documentation was excessive and there was a constant back and forth within the room (between supply cart, computer, IV, ventilator and EKG monitor). The poor placement of the remote for vitals decreased efficiency (see space utilization section).

**KEY DUTIES:**

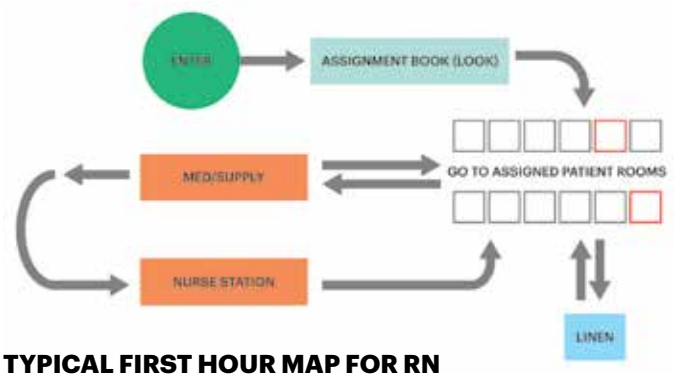
Patient Care
Care Coordination
Medication Prep & Administration
Labs and Diagnostic Coordination
Call Response
Patient Monitoring
Liaison between patient, family and care team

Overall, a certain amount of waste was observed in small tasks such as looking for the assignment book, looking for team mates, waiting for phone calls and computer availability etc.

The RN likes to be near their patient, and this makes taking a break (shown by other research to be beneficial) a challenge.

The RN user persona is as the patient advocate, care provider, and guardian to the patient. The workplace for the RN has to support the RN's key role in providing for the patient, and being the key contact for care coordination.

Below is a visual illustration of the RN's first hour (simplified by key activity). On the next page, you will see a break down of their key activities, then a more detailed work flow map for the RN based on some key decision points. This is not comprehensive but allows a glimpse into the complex role of the RN and the need to locate spaces close to the patient bedside.




**TYPICAL FIRST HOUR MAP FOR RN**

## 2.2 ACTIVITY ANALYSIS

The activity analysis breaks down a 12-hour shadowing observation of an RN in the clinic. Her actions were categorized into a series of key activities, and measured on time and frequency.

**Care Coordination**
Activities involving care coordination of a patient, team meetings and huddles, work-related conversations with co-workers, educating and mentoring

**Socialization**
Communications with co-workers but not pertaining to patient care or work; socializing

**Documentation**
Charting, scanning, documenting, printing

**Medical Prep**
This activity pertained to the preparation of medications

**Medical Administration**
This pertained to the delivery and administration of medication to the patient

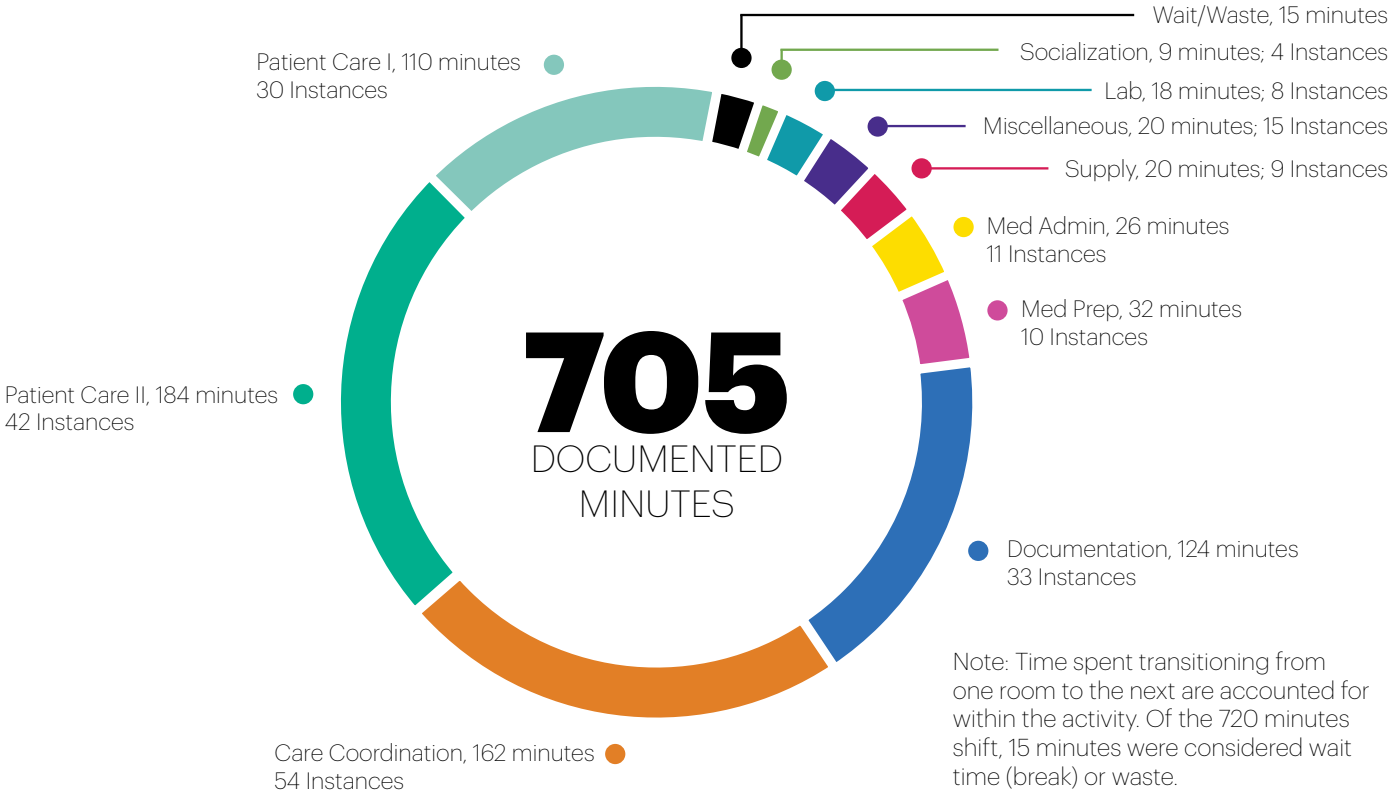
**Patient Care I**
This pertained to any clinical activity involving patient interface

**Patient Care II**
This pertained to any non-clinical activity involving patient interface

**Lab**
Any activity pertained to the unit laboratory; picking up and dropping off samples, labeling samples.

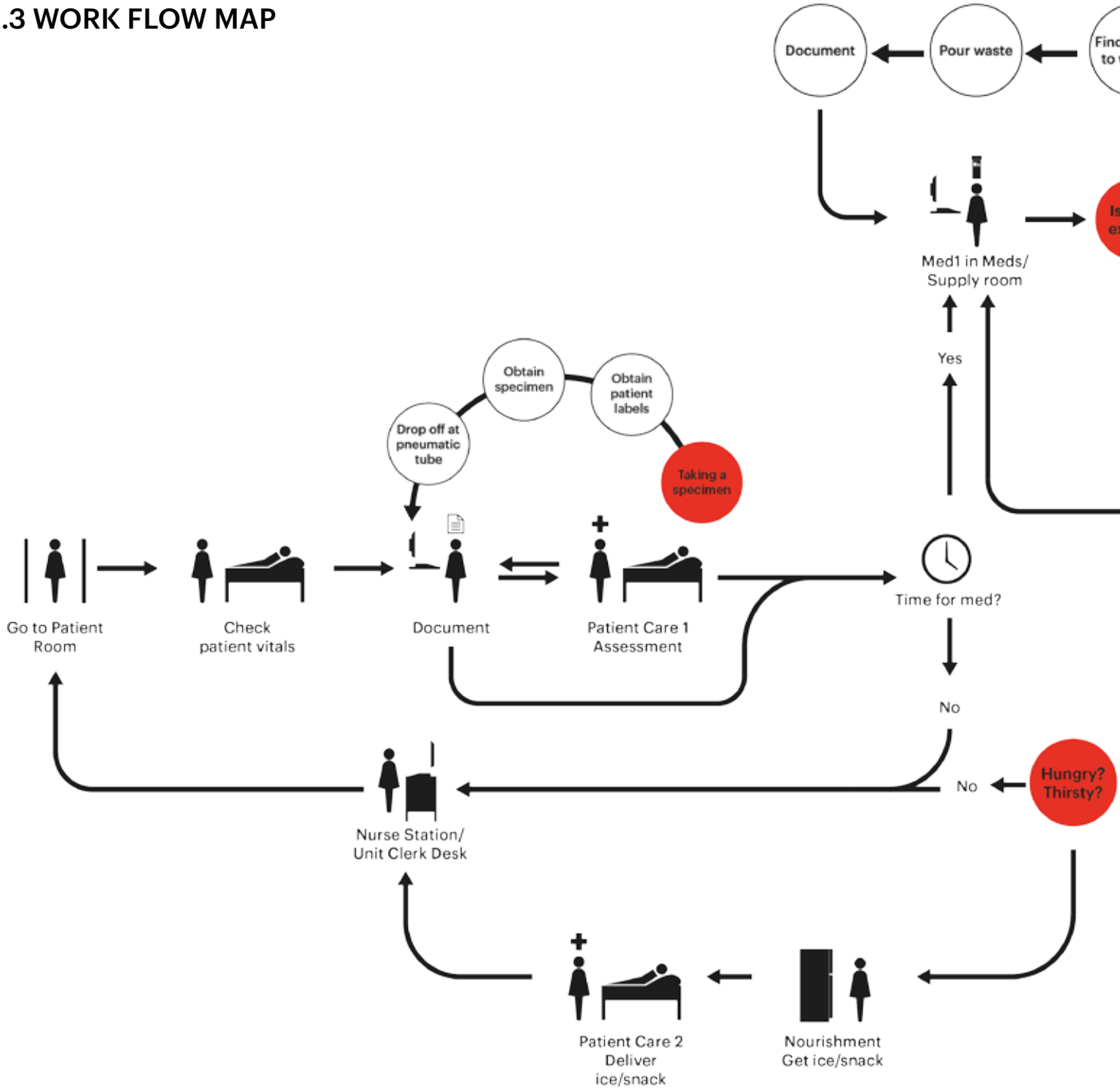
**Supply**
Getting, collecting, or dropping off supplies within the unit

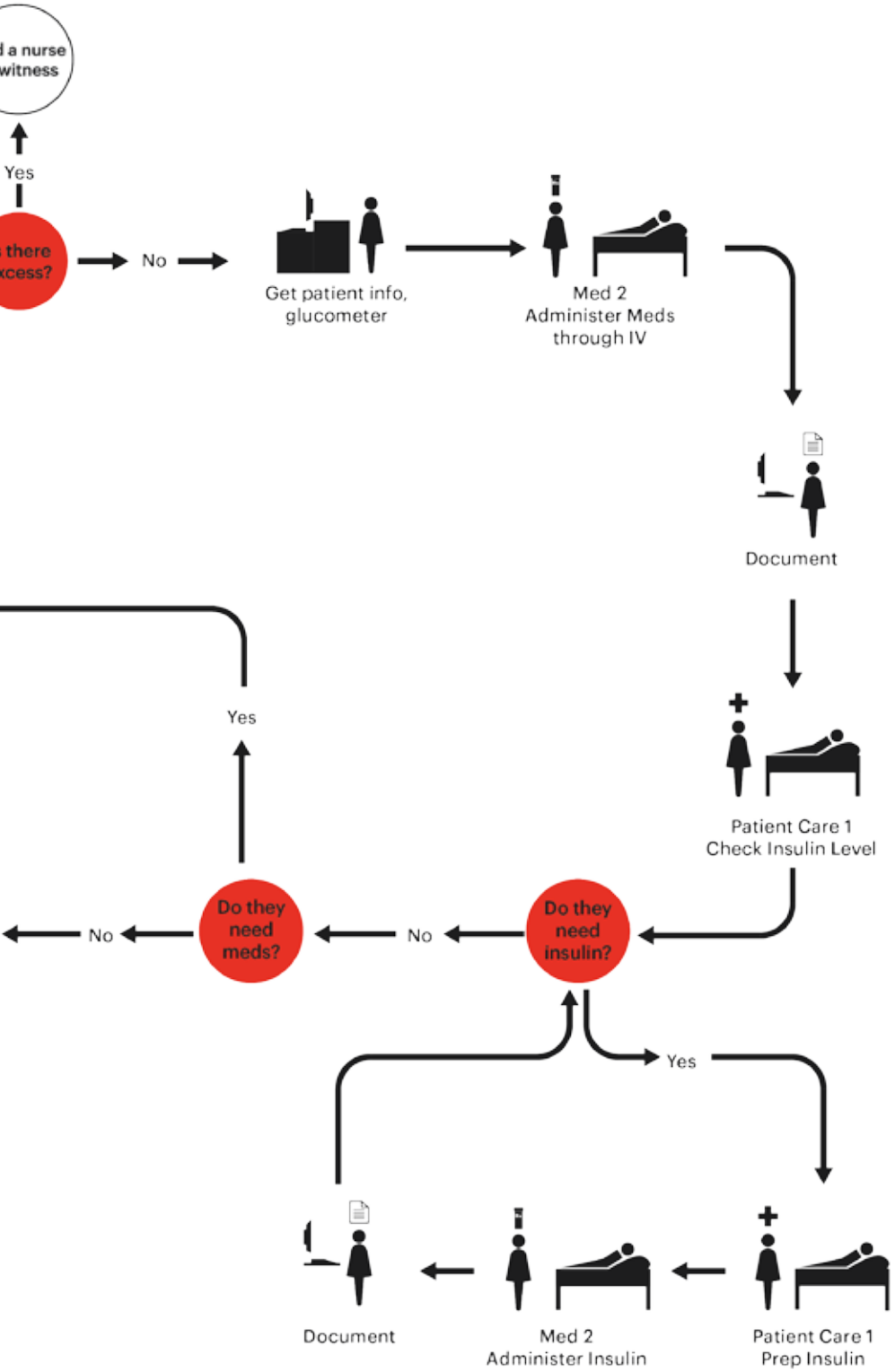
**Miscellaneous**
Any uncategorized activities within the unit




Note: Time spent transitioning from one room to the next are accounted for within the activity. Of the 720 minutes shift, 15 minutes were considered wait time (break) or waste.

## 2.3 WORK FLOW MAP






## WORK FLOW MAP (RN)

Registered Nurses of the Midwest tower follow a process that consists of different decision points when on their patient rounds and this flow map illustrates those decisions. The work flow map is created from observing the RN and organizes their processes into a series of possible decisions they had to make while making their rounds.

The map highlights possible loops in their process which slow the nurses from completing their rounds, such as pouring excess medication and running to the nourishment room to pick up ice. Although this map not comprehensive, as no two patients are alike and nurses often multi-task between their patients, we use it in effort to reduce the number of loops and ultimately streamline the entire rounding process.

Pinch points and loops registered nurses face while on rounds include getting scheduled samples from the patient to send to the lab, fetching a staff member to witness legal wasting of excess medication, scheduled insulin shots, forgetting all medication for the patient, and running to the nourishment room to get snacks and ice for the patient. We cannot solve each of these pinch points, but bringing attention to them gives us an opportunity to streamline the rounding process and reduce excess movement if eliminating the loop is not an option.

## AVERAGE ROUND: 30 MINUTES

## 2.4 USER PERSONAS



### UNIT CLERK (UC)

**KEY DUTIES:**
Call Response; Direction to family/visitors
Stocking (C-Lockers, Linen, Med Supplies, Gloves)
Filing/Chart Maintenance Paging Doctors
Locating care team members

In the absence of direct connectivity between the patient and the care team, as well as between care team members, the Unit Clerk becomes the linchpin in the unit. She is responsible for relaying calls to the nurse/ other staff, finding members of the team as needed, stocking supplies, assisting with nursing care or admin duties as needed. She is also supposed to be the first point of contact on entry into the unit

### CARE NAVIGATOR (CN)

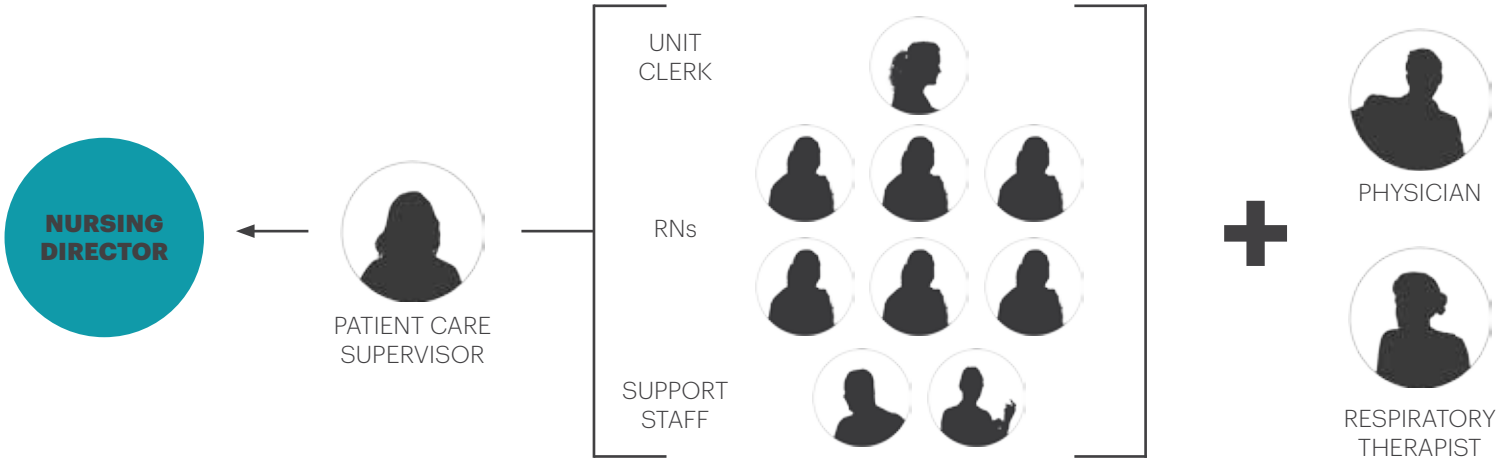
**KEY DUTIES:**
Family Support
Care Planning
Discharge Planning

In an increasingly complex model of healthcare delivery, new roles have emerged to help the patient navigate through the ICU experience. The care navigator works closely with the Patient Care Supervisor and care teams, as well as the patients and their families, to develop a cohesive care plan, and when needed, discharge plan. She also helps families understand the process of patient care and acts as a liaison between the clinical team and patient advocates

### TRAUMA NURSE (TN)

**KEY DUTIES:**
Emergency Care
Assist to all nurses as needed
Unit Wide Resource

Unlike Med-Surg units, the SICU does not have Nursing Assistants. Instead, a majority of the nurses are trauma certified and a trauma nurse is assigned to the unit, who can be a resource to all the nurses on the unit. The trauma nurse moves all around the unit and assists as needed. He/she is also responsible for responding to code blues on other floors



## PHYSICIAN (P)

**KEY DUTIES:**
Patient Care Plan
Diagnosis and Treatment
Care oversight
Care coordination

The Physician, or Doctor, is in charge of the care of a patient. However, unlike other departments, in the ICU, a single patient may be treated by a team of physicians. The critical care physician usually controls the care plan- and the unit is currently moving to a "Captain of the Ship" model. However, depending on the diagnosis of the patient many other attending physicians and specialists may be involved. Additionally residents and physician assistants are also involved in patient care. Care coordination between various physicians becomes a challenged for the nursing team.

In feedback to the researchers physicians prioritized daylight for the patient, and adequate bedside work space.

## PATIENT CARE SUPERVISOR (PCS)

**KEY DUTIES:**
Administration
Clinical Support
Bed Management

For each shift a patient care supervisor works closely with the nursing director on the unit and the nurses on the floor. The PCS is responsible for managing the day to day workings of the ICU unit. He/She also oversees the critical issue of bed management and ensuring that beds are available for new patients and existing patients are transfered to step down or acute care units as soon as they are able.
PCSs round with the director, care navigators and the nurses as needed. Their role is both administrative and clinical.

For PCS a key issue was the coordination with the complex care team and diverse physician mix. Currently information has to be repeated by the nurses many times. Also the patient transfer is an issue due to challenges in the bed management system.

## RESPIRATORY THERAPIST (RT)

**KEY DUTIES:**
Administer Breathing Treatment
Set up Ventilators
Emergency Care

The SICU has an assigned respiratory therapist due to the number of patients who are on ventilators.

Unlike the nurses, unit clerk and PCS, the RT tends to rotate between units. Although there is an assigned RT room, currently RTs tend to use the off-stage area. Because of the opacity of this area, and the lack of a seamless paging system, it is often a challenge to find RTs on the unit.

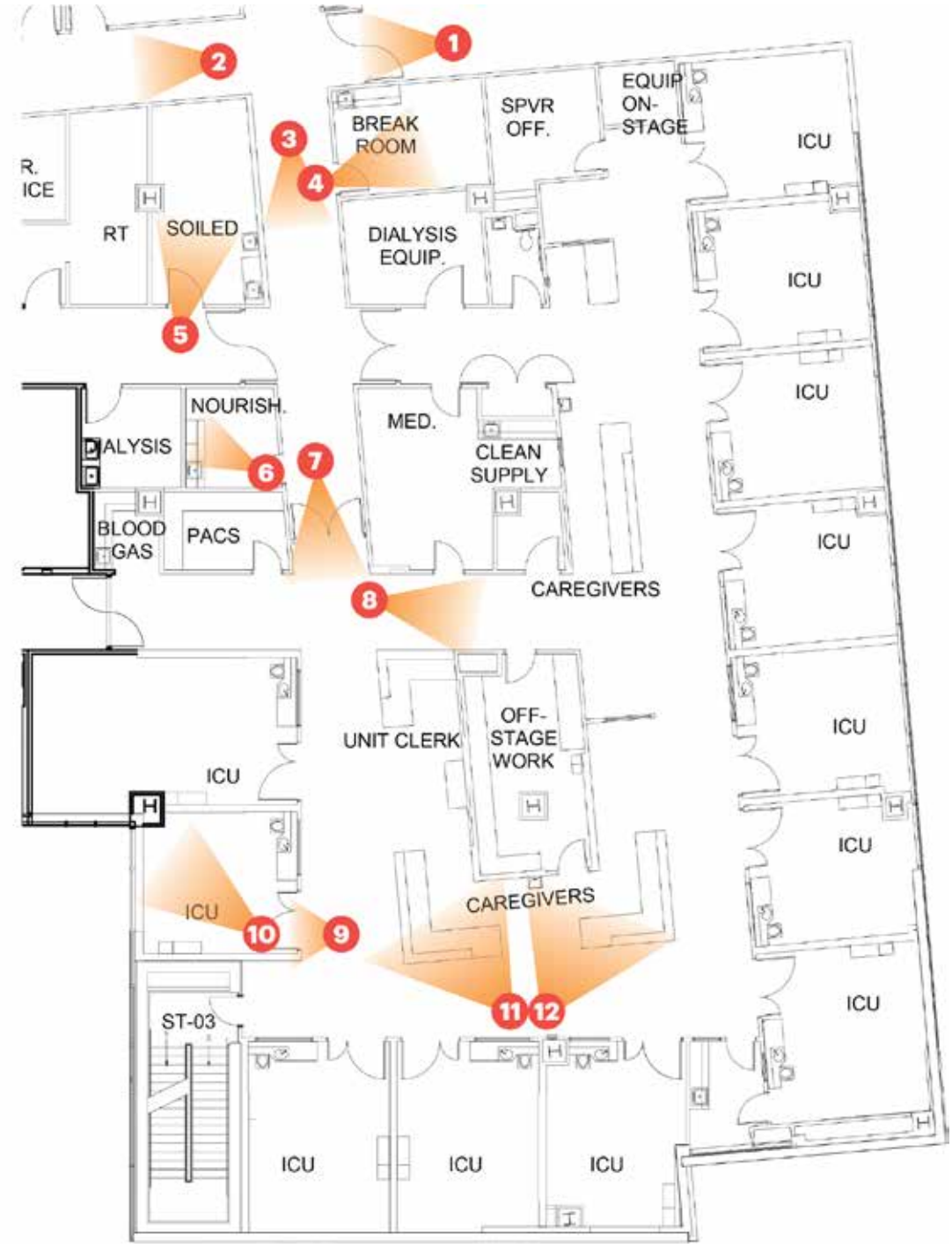
For RTs. the space in the room is adequate, but they would prefer additional space in the front of the unit. Adequate power supply in the headboard is an additional concern.

HKS

HKS

# SPACE UTILIZATION ANALYSIS

Once we have a deeper understanding of the people and their actions and experiences, we focus on how they use the space.



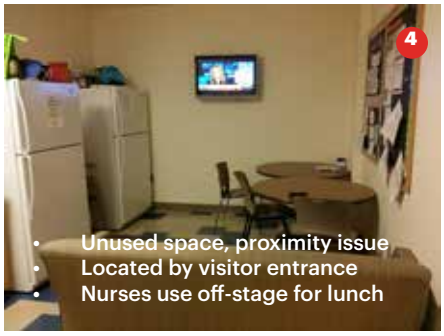

## 3.1 PHOTOESSAY

The Photo Essay is a detailed mapping of the SICU, conducted by the research team to show the various spaces within unit and highlight pinch points. The 34-point essay validates issues the staff has with the unit as well as points out undiscussed habits of the staff - the Off-Stage area becoming an improvised coat room is an example of this. In the photos below, they correlate back to the map to give a sense of location. They are annotated and highlighted with red to emphasize the issue, such as the wayfinding and visibility pinches.


1
Weak signage
No receptionist

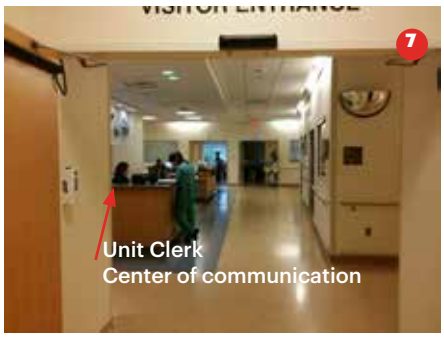

2
First view for visitors

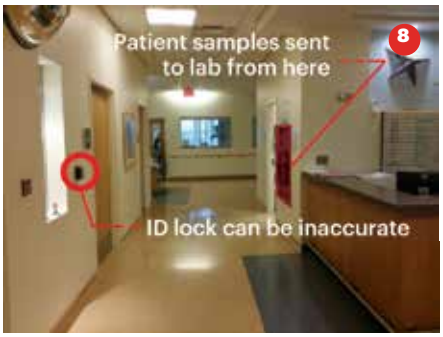

3
No line of sight to Unit Clerk
Cleaning unit halves hallway


4
Unused space, proximity issue
Located by visitor entrance
Nurses use off-stage for lunch


5
No designated space for equipment, controlled clutter


Noise generator
6
Too far for its frequent use


7
Unit Clerk
Center of communication


Patient samples sent to lab from here
8
ID lock can be inaccurate


Open door, but no view of patient...
9
And blinds are closed
Current room signage
Sanitizer beside every door


10


11
Visibility trade off
open door,
closed blinds
Physicians at nurse station


physicians at nurse station
12
No assigned location for patient binders


R.
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RT
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EQUIP
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STAGE
ICU
DIALYSIS
EQUIP.
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23
22
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NOURISH.
MED.
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CLEAN
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PACS
CAREGIVERS
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19
18
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ST-03
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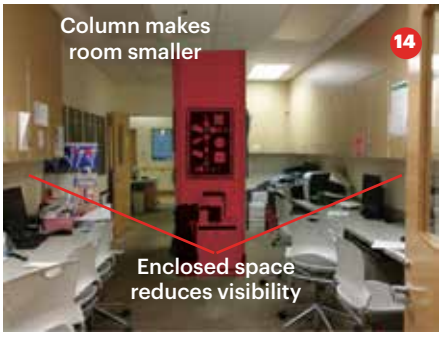
ICU
ICU


13
coat room for nurses


Column makes room smaller
14
Enclosed space reduces visibility


15
Centralized pneumatic chute adds step to care process


16
Impromptu meeting at WoW


17
Nurse's line of sight


18
Opportunity for more interactive bulletin board


19
patient rooms and unit clerk behind wall

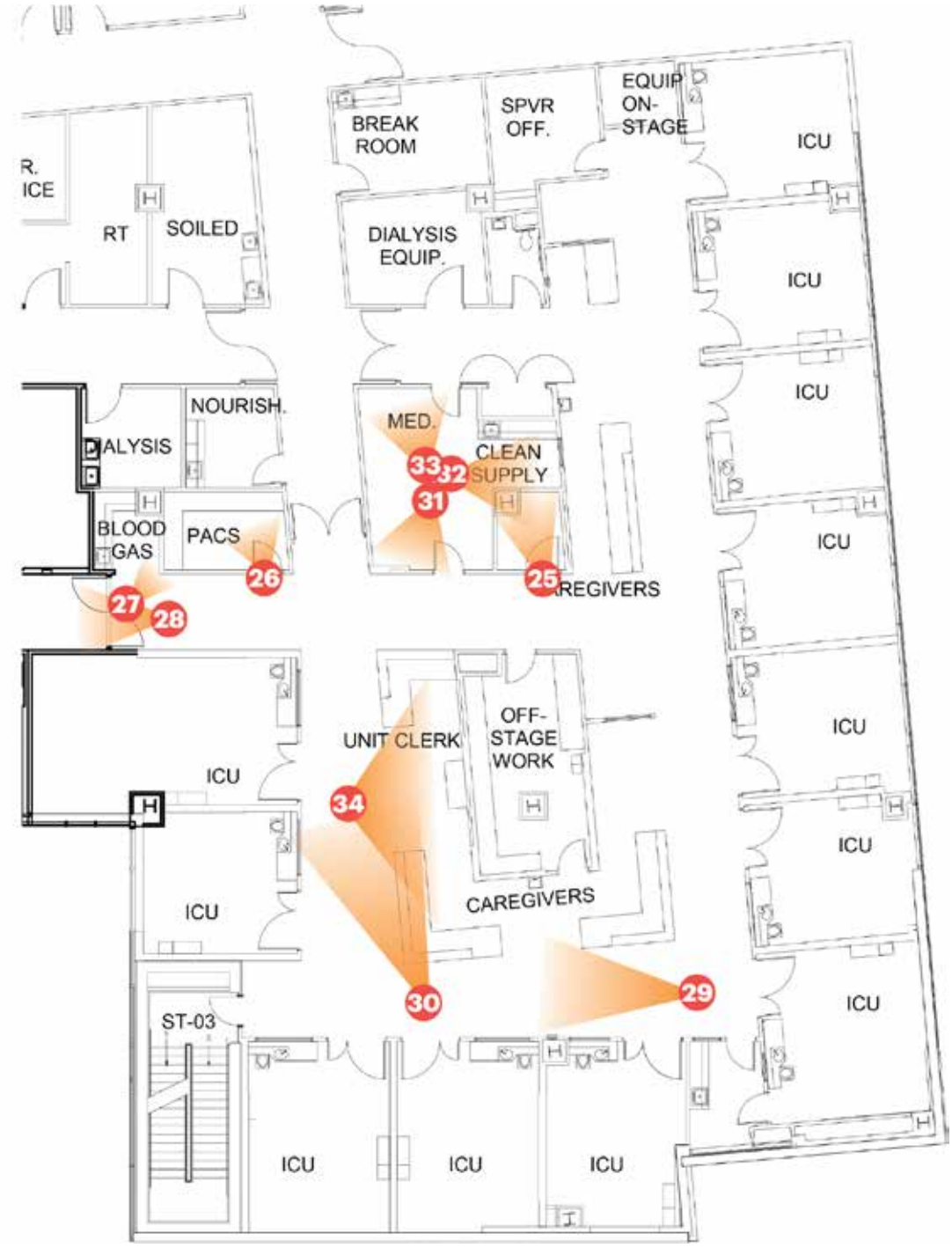

20
Underused nurse station


Enclosed office space
21
impromptu storage


22


23
Controlled Clutter


24
Visibility to Pyxis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PACS
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REGIVERS
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28
ICU
UNIT CLERK
OFF-
STAGE
WORK
34
ICU
ICU
CAREGIVERS
ICU
30
29
ST-03
ICU
ICU
ICU





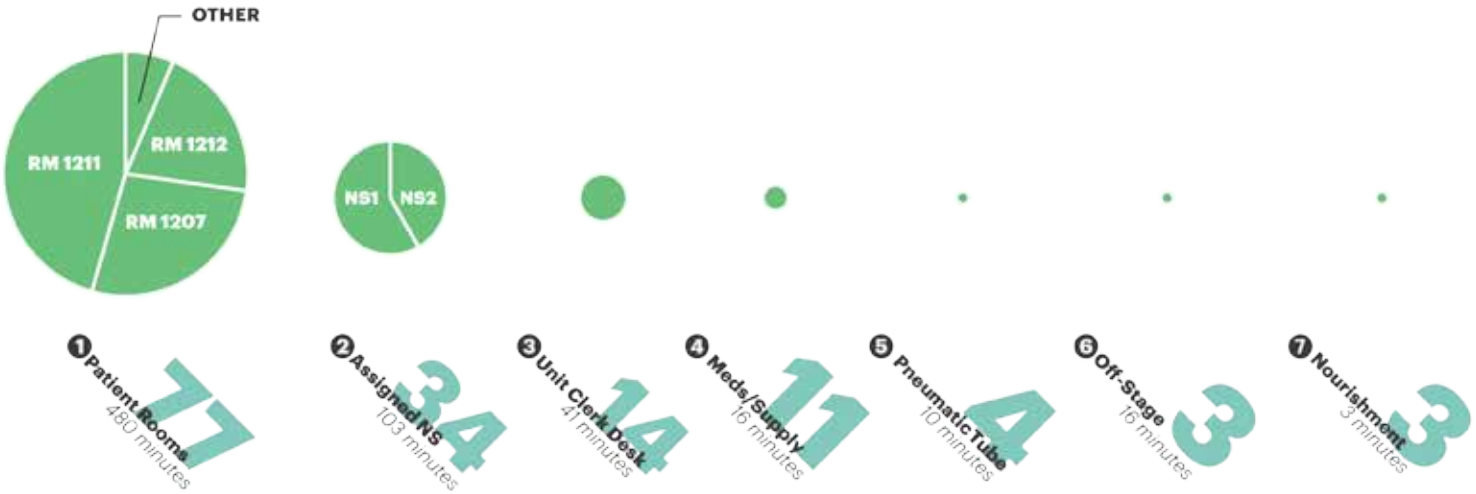





**THE MED ROOM & ACCESS TO THE PYXIS**

Each time a patient needs medication, their RN oft make a trip to the Med/Supply room, a shared space where staff members can pick up patient medication as well as supplies to perhaps administer that medicine. Most of the medicine is held in the Pyxis, an automated medication dispenser which securely stores the medicine until nurses request for it. The Pyxis is tucked away in a tight space within the med room, which can make accessing medicine difficult as the dispenser opens out toward the nurse to deliver medicine. Finding adequate space for the Pyxis and providing adequate, but secure, sight lines can better optimize processes for staff and get medication to patients quicker.

## 3.2 PEOPLE IN SPACE





**ABOVE:** SICU Floor Plan highlighting most utilized spaces as told by shadowing data
**RIGHT:** The table shows which rooms nurses spend the most time in per visit

### ROOM OCCUPANCY

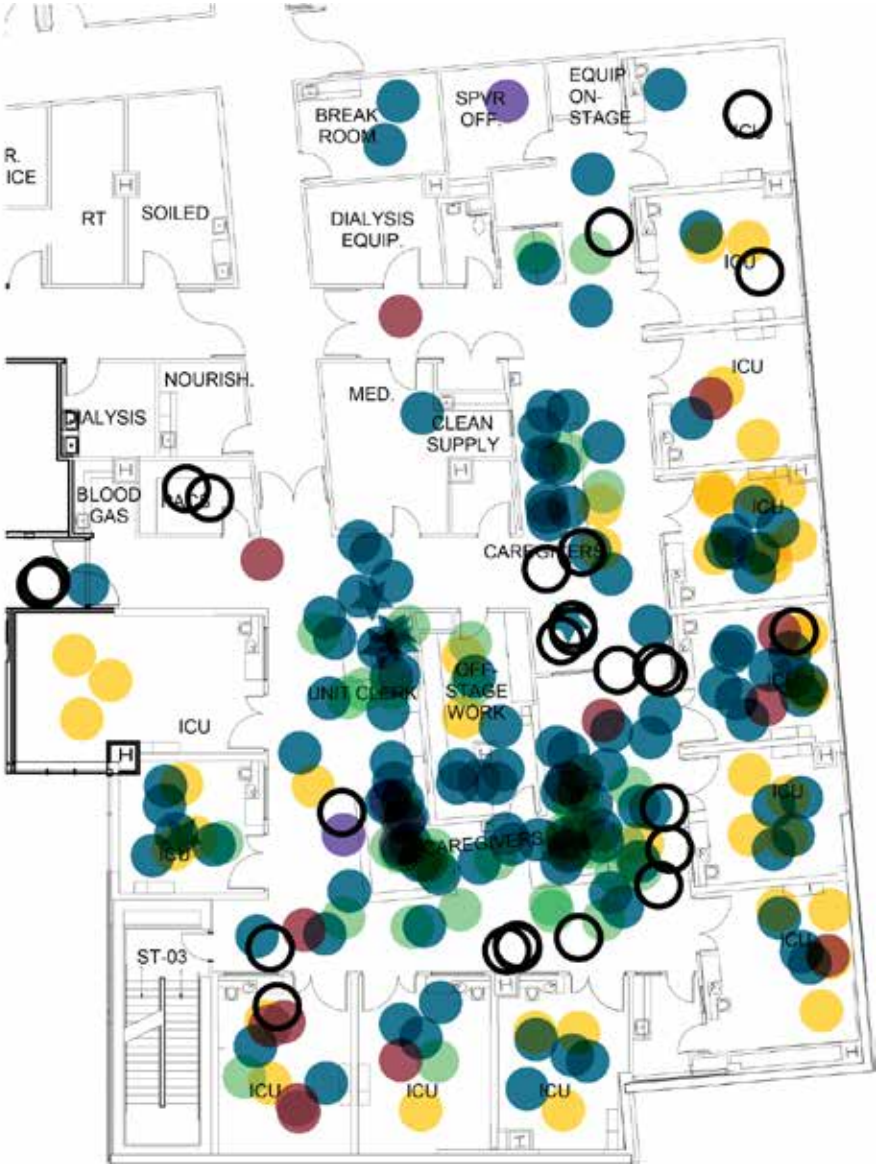
The floor plan of the SICU is a hub-and-spoke model that centers around the nursing stations with patient rooms surrounding that hub. The graphic above shows us a break down of the most frequently visited spaces by nurses within the unit. By shadowing them throughout their day shift, we learn that two-thirds of that twelve hour shift is spent in the patient room, contradicting the flow of the hub-spoke model. The time spent in the patient room is divided between two or three patients, depending on the shift and the patient's acuity. The remaining four hours are divided between the nursing stations and support spaces, like the medication room and pneumatic tube.

The table below shows how much time the nurse spends per visit to a space, giving us insight to which spaces are occupied longer than others.

| LOCATION | ROOM FREQUENCY | TIME SPENT/OCCURRENCE |
|---|---|---|
| Patient Room | 77 | 6.2 minutes |
| Assigned NS | 34 | 2.9 minutes |
| Unit Clerk Desk | 14 | 2.7 minutes |
| Meds/Supply | 11 | 2.0 minutes |
| Pneumatic Shoot | 4 | 2.5 minutes |
| Off-Stage | 3 | 4.0 minutes |
| Nourishment | 3 | 1.3 minutes |

**BEHAVIOR MAPS**

In addition to shadowing nurses throughout their shift, the research team also conducted hourly behavior maps - which mark the location of those within in the unit at any particular time. These are used to present a snapshot of who is in the unit, with whom they are interacting, and where that interaction is occurring. By overlaying the twelve behavior maps recorded, you can see which spaces are used and unused; unit staff prefer to congregate around the front two nurse stations, as well as the Unit Clerk's desk. Unit staff spoke about the Off-Stage area splitting the unit in two - "front-nine" and "back-nine". The "back-nine" rooms have been given their own nursing stations, but since they are away from the central hub, they go underused by staff. This is especially true for the fourth station, located farthest from the central hub.




- Nurse (N)
- Physician (P)
- Other Clinical Staff (C)
- Ancillary Staff (A)
- Family/Visitor (F)
- WOW (W)
- Unit Clerk (UC)

**BELOW:** Two individual behavior maps which show location of staff at a particular time.

Behavior Map No. 1 | 4:30PM

Behavior Map No. 2 | 6:30PM

Behavior Map No. 3 | 7:15AM

Behavior Map No. 4 | 10:00AM

Behavior Map No. 5 | 12:08PM

Behavior Map No. 6 | 1:10PM

Behavior Map No. 7 | 2:25PM

Behavior Map No. 8 | 3:30PM

Behavior Map No. 9 | 4:20PM

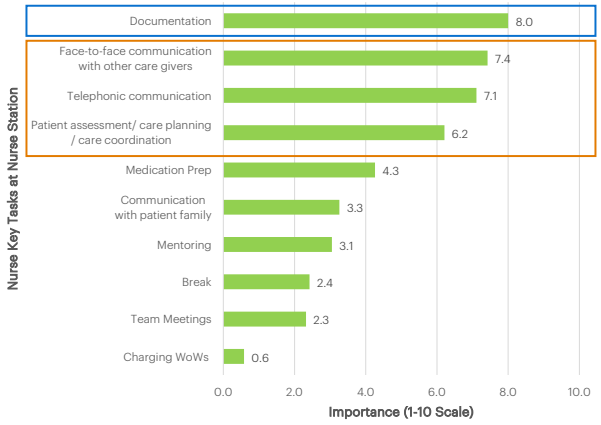
Behavior Map No. 10 | 6:20PM

Behavior Map No. 11 | 8:05PM

Behavior Map No. 12 | 9:30AM

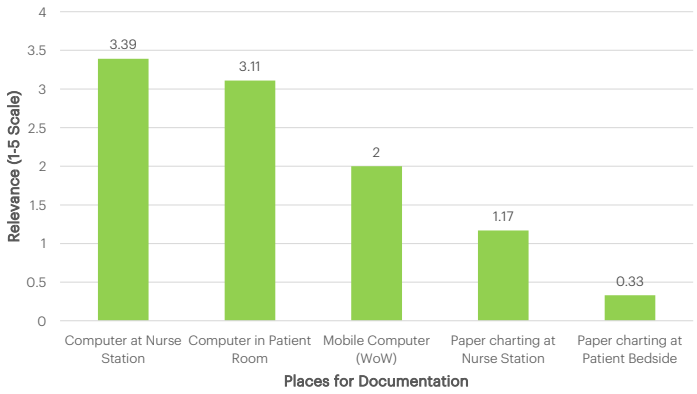
# 3.3 THE NURSE STATION

## NURSE STATION AS THE CORE OF MAIN ACTIVITIES



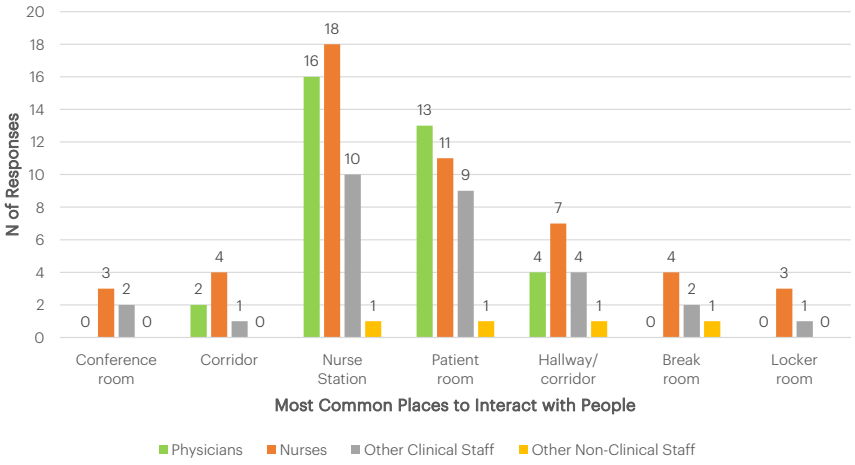

Please rank your key tasks at the nurse station in order of importance

## NURSE STATION AS THE CORE OF DOCUMENTATION




Please rank the following areas based on where you do the most of your charting and documentation

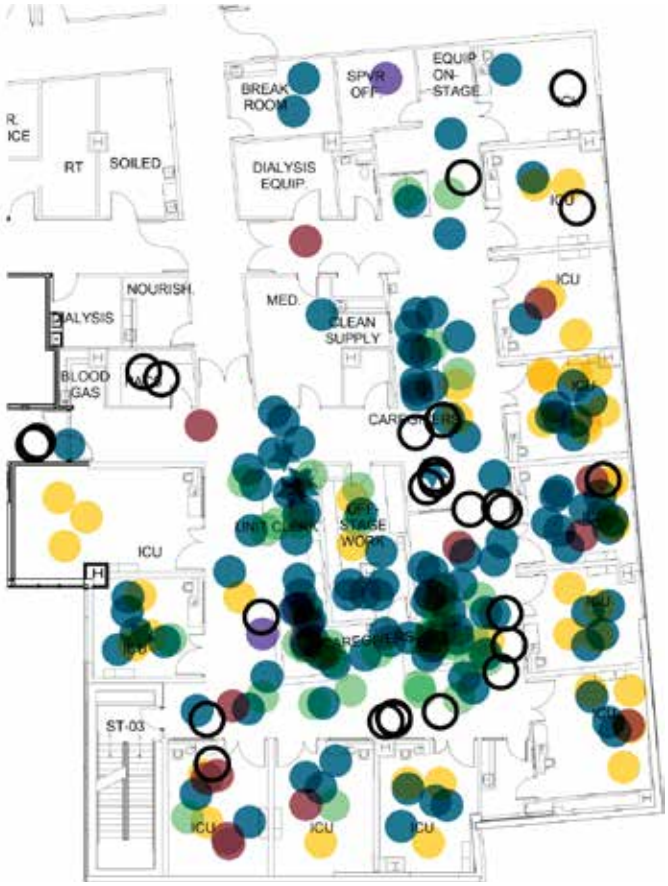
## NURSE STATION AS THE CORE OF INTERACTION

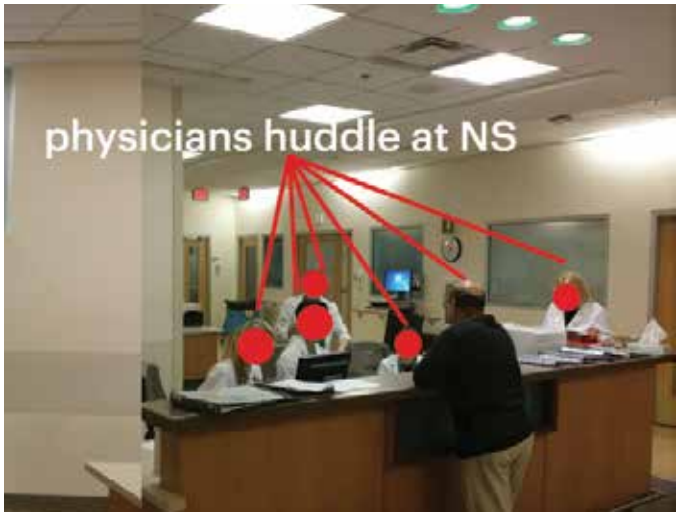



Where do you most interact with staff?

Systematic observations of the unit show the nurse station to be the nucleus of the healthcare workplace.

The Nurse Station is used by nurses, physicians and other ancillary staff to document. Although nurses do a large portion of their documentation in the patient room they still use the nurse stations as well.




**NURSE STATION: THE NUCLEUS**

Systematic observations of the unit show the nurse station to be the nucleus of the healthcare workplace.

The Nurse Station is used by nurses, physicians and other ancillary staff to document. Although nurses do a large portion of their documentation in the patient room they still use the nurse stations as well.

Additionally nurse stations are used as touch down points for the care coordination. Physicians confer with their residents, others attending, and the nurses at the nurse station.

Nurses also connect with other nurses, therapists, supervisors and the care navigators at the station.

The Unit Clerk's station is also used as a nurse station and is a popular hub since the UC is the human connector on the unit.

The Nurse Station is also used for all phone calls- and it is not uncommon to observe multiple parallel conversations in a single nurse station.

Currently the nurse station is not designed for the wide role of functions it served: touch down, documentation, communication, care coordination etc.

As a nucleus, better designed nurse stations are essential for the success of the healthcare workplace.

## 3.4 SPACE UTILIZATION

**ACTIVITY ANALYSIS**

By observing the nurse's activities throughout the day, the most frequently visited rooms can be broken down by activity – revealing which spaces are highly prioritized by activity to better optimize the layout of the unit. Clearly, there is a large disparity in the number of times the nurse visited the patient room versus another other room.

- Care Coordination
- Medical Prep
- Socialization
- Medical Admin
- Clinical Care
- Lab
- Non-Clinical Care
- Supply
- Documentation
- Miscellaneous

1 PATIENT ROOM

2 NURSE STATION

3 UNIT CLERK DESK

4 MED/SUPPLY ROOM

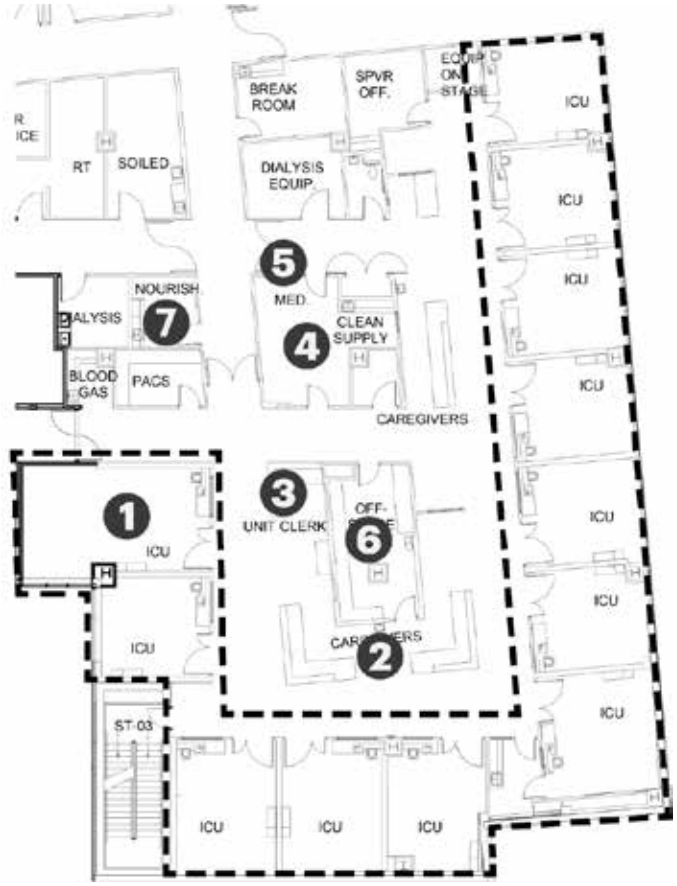
5 PNEUMATIC TUBE

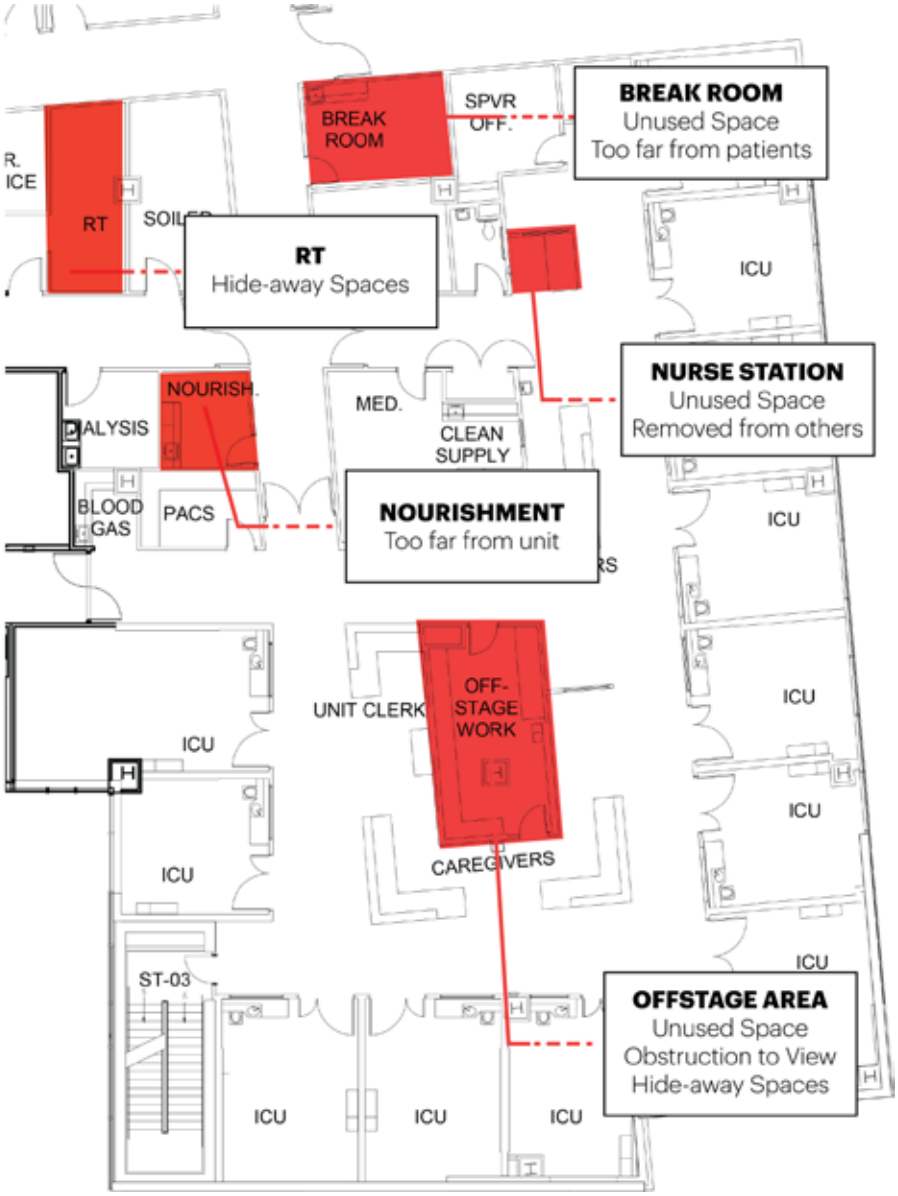


6 OFF-STAGE AREA



7 NOURISHMENT






**LEFT:** SICU Floor Plan highlighting several under-utilized spaces as told by the staff

## UNDER-UTILIZED SPACES

An ICU unit holds a complex set of functions. However, not all spaces are utilized to their best ability.

Currently the nourishment room is too far- not due to the distance as much as the effort of going through two keyed entryways to get to ice.

Nurses in the ICU need ice frequently for labs or to give patients ice chips.

The placement of the nourishment room may cause delay in patient care.

The space assigned for the RT is not used (probably because it is to one end of the unit). The RT tends to camp in the off stage unit which makes it difficult for nurses to find them.

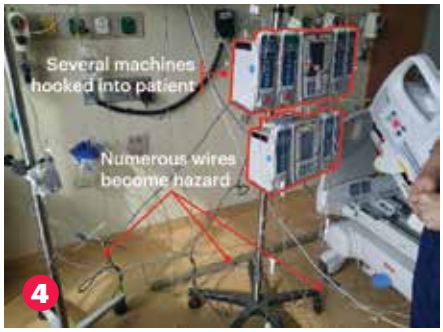
The off stage area is under utilized and used as a hide away space because of its opacity. Physicians, and other members of the team tend to connect in the corridor and by the nursing station.

The break room is located on a far end of the unit; without daylight and limited amenities, it is rarely used.

The Nurse Station in front of room 1 & 2 is unused due to the lack of telemetry unit and distance from the hubs





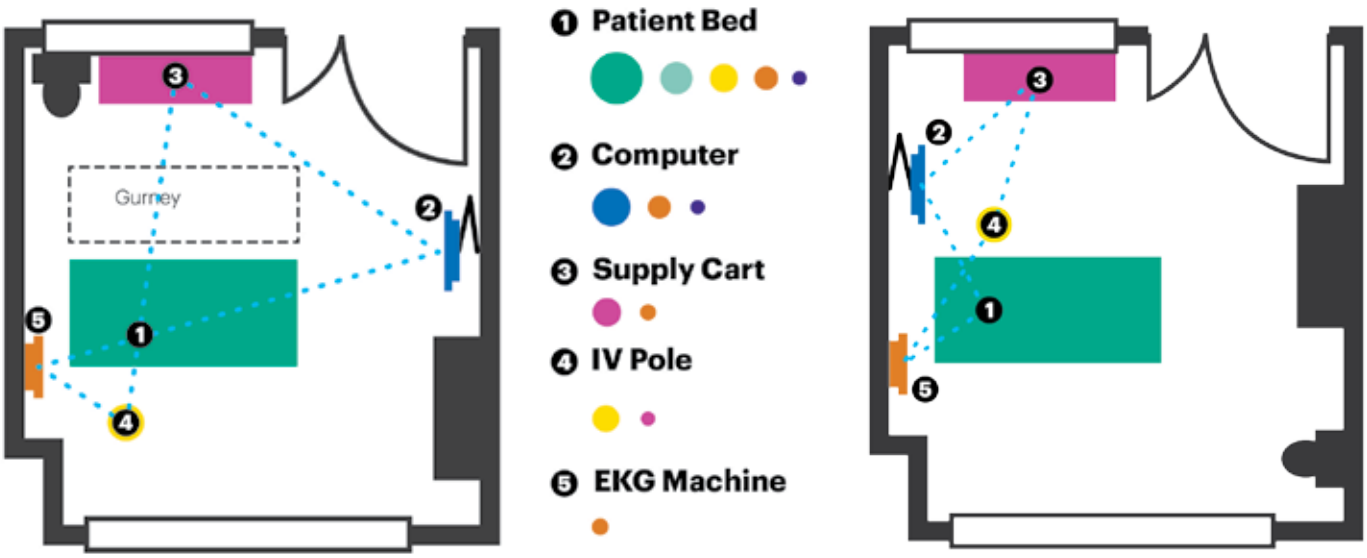





**PATIENT ROOM CONCERNS**

The Photo Essay can be applied at a macro level with the unit and also at a micro-level with the patient room, the room nurses spend a majority of their time. Within the room, nurses have to go back and forth between several touch points. This portion of the photo essay highlights hazards, bottlenecks, and general information in the patient room to gain insight into which issues need immediate attention. We found that the excessive number of wires attached to the user proves to be a hazard for all parties.

## 3.5 PATIENT ROOM CONFIGURATION
Current versus Optimal




Current Configuration

Example of Optimizing

**PATIENT ROOM UTILIZATION**

Currently, based on shadowing the nurses, there is a lot of moving around within the patient room. One key takeaway involves the amount of time the nurse spends documenting on the room's computer, resulting in their back to the patient. Rearranging the tools in the room - which can be as simple as moving the documentation computer to the headwall - can reduce movement around room and encourages more frequent interaction with the patient.

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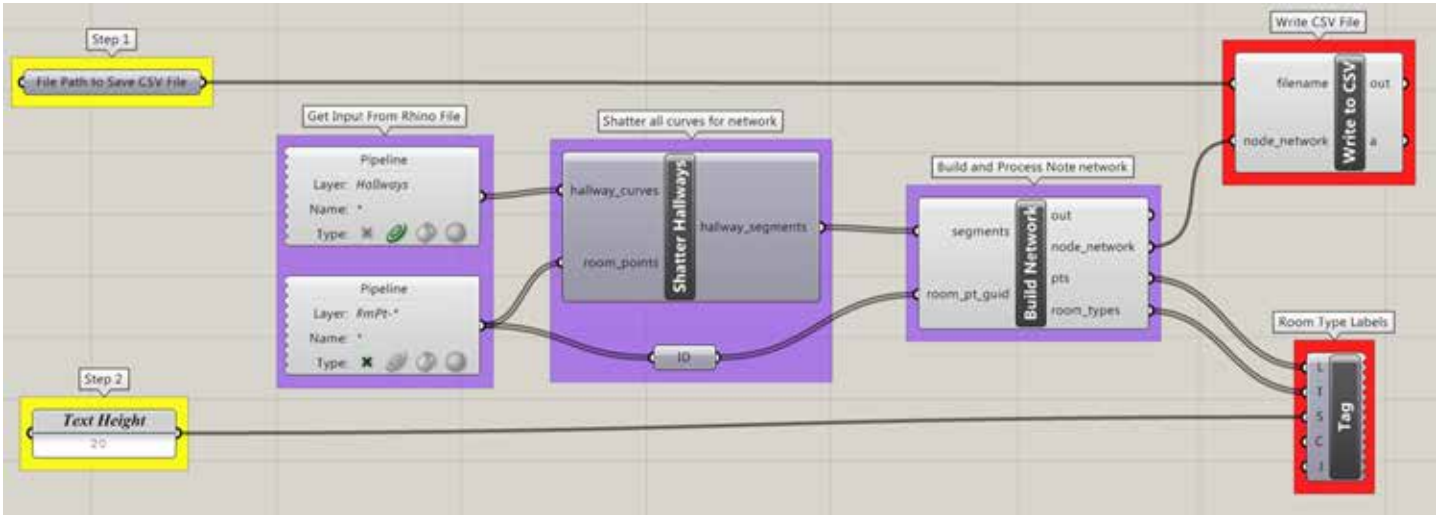
# WALKING ANALYSIS

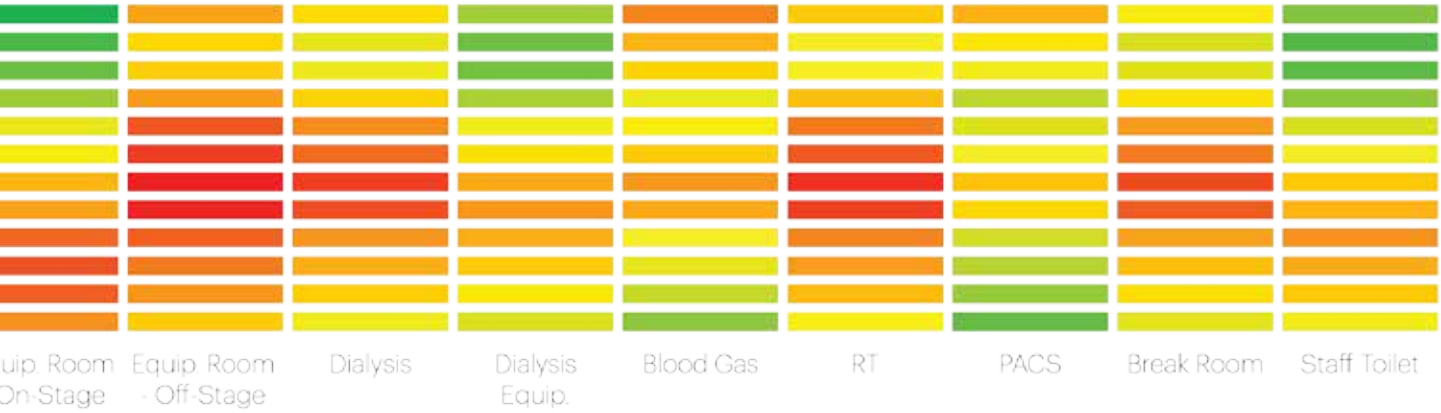
In a unit a nurse, and other support staff, typically works 12 hour shifts. They are on their feet most of this time. After understanding who they are, what they do, where and how they spend their time, we now look at how they move, and how proximities and adjacencies between areas effect walking distances and work flow.

## 4.1 WALKING DISTANCES

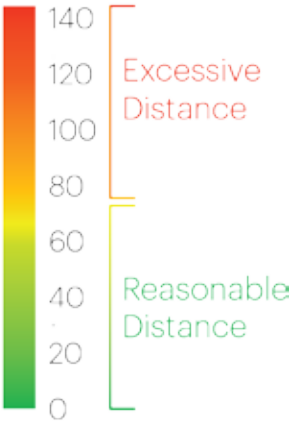




**1336**
STEPS RECORDED
0.6325 miles

Steps were recorded from point to point and do not reflect steps within a room





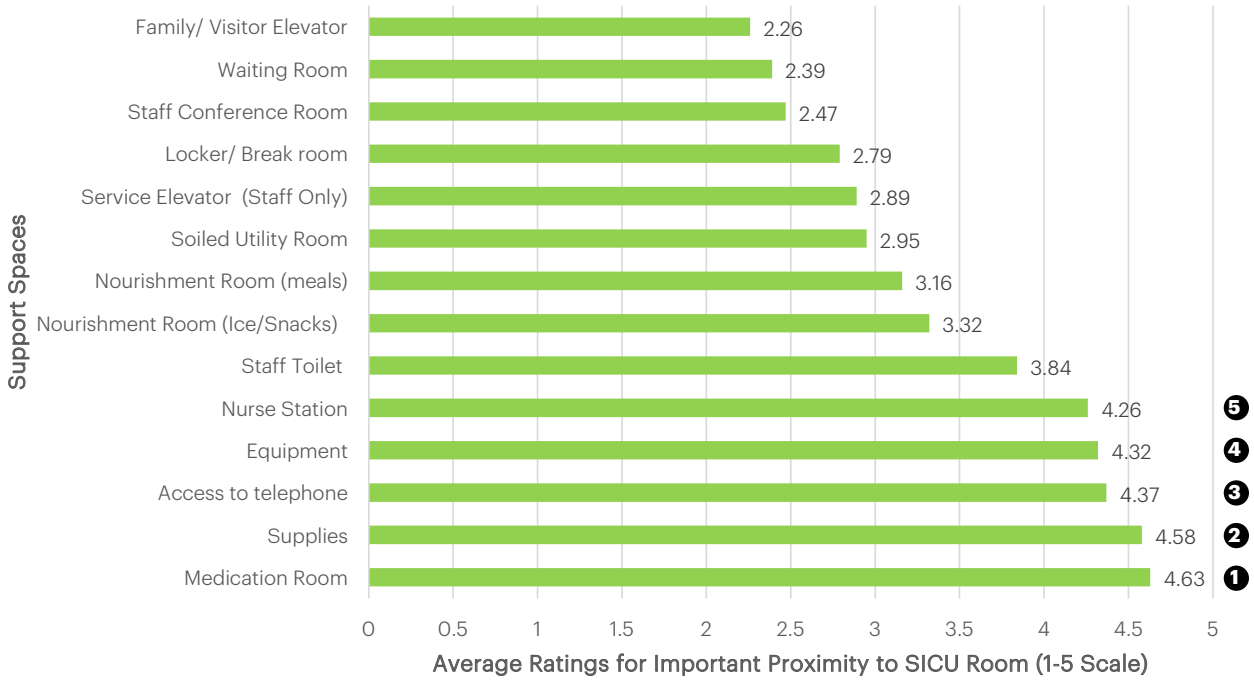


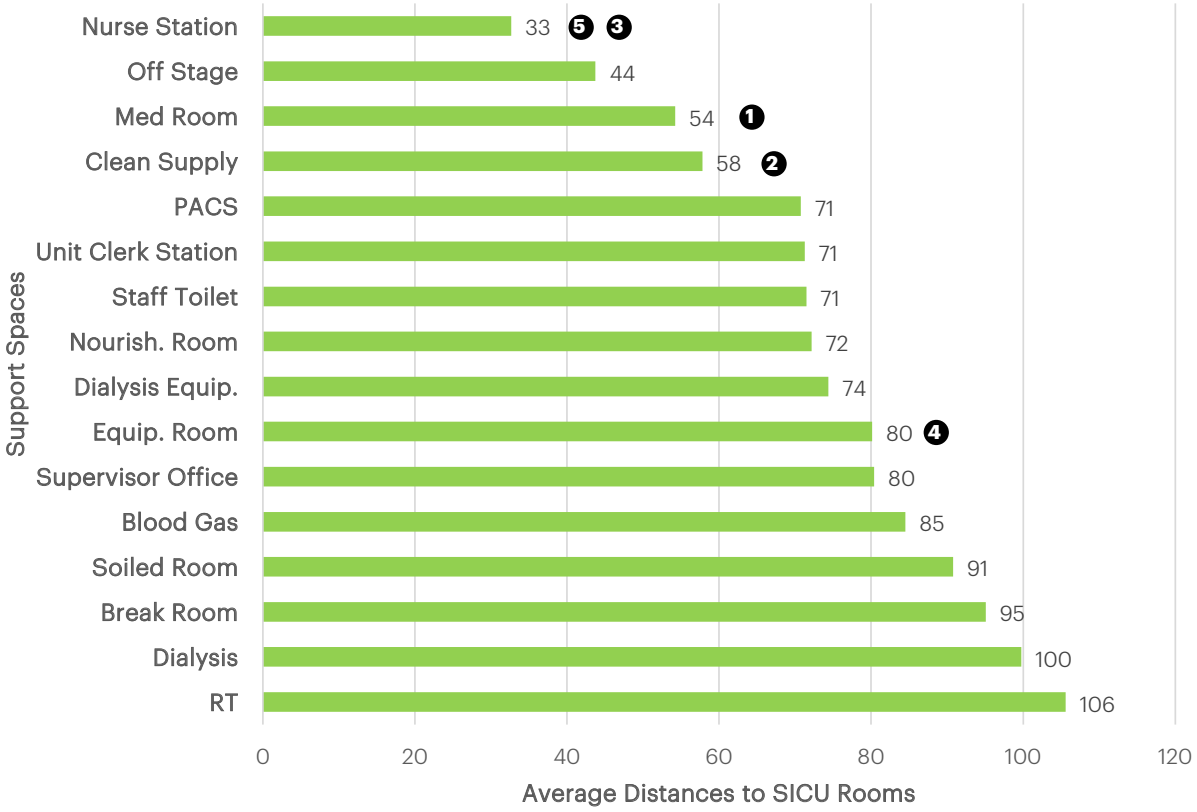

**NURSE WALKING ANALYSIS**

Proximity analysis, a research tool we use at HKS, uses Rhino and Grasshopper to rapidly analyze the distances between patient rooms and support spaces. The application of this tool to a plan generates a spreadsheet of distance between key locations which in turn is converted to a heat map which graphically illustrates the distances that are reasonable vs excessive.

Based on the observations on site, walking distances are extrapolated (we know the number of times a nurse typically goes to a room and sequence in which she moves from space to space.

This information that layers spatial and observed data is used to analyze walking distances (for a nurse in this case) on a unit.


Support Spaces
Family/ Visitor Elevator 2.26
Waiting Room 2.39
Staff Conference Room 2.47
Locker/ Break room 2.79
Service Elevator (Staff Only) 2.89
Soiled Utility Room 2.95
Nourishment Room (meals) 3.16
Nourishment Room (Ice/Snacks) 3.32
Staff Toilet 3.84
Nurse Station 4.26 5
Equipment 4.32 4
Access to telephone 4.37 3
Supplies 4.58 2
Medication Room 4.63 1
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5
Average Ratings for Important Proximity to SICU Room (1-5 Scale)


Support Spaces
Nurse Station 33 5 3
Off Stage 44
Med Room 54 1
Clean Supply 58 2
PACS 71
Unit Clerk Station 71
Staff Toilet 71
Nourish. Room 72
Dialysis Equip. 74
Equip. Room 80 4
Supervisor Office 80
Blood Gas 85
Soiled Room 91
Break Room 95
Dialysis 100
RT 106
0 20 40 60 80 100 120
Average Distances to SICU Rooms

## 4.2 SPACE RANKED BY STAFF VERSUS TRAVEL DISTANCE

1


**Medication Room:** Ranks most important among nurses in terms of proximity to patient rooms. Nurses must only travel an average of 54 feet to reach there, making it one of the most accessible areas in the SICU

2

**Supply Room:** Immediate access to clinic supplies makes the supply room, currently split with the medication room, the second most important space. Since it is also the med room, travel distance remains 54 feet on average.

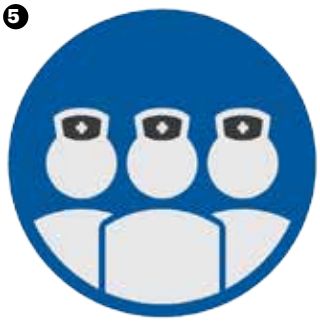
3

**Access to Telephone:** Care coordination is among one of the most common activities done in the SICU, and telephone communication makes up a large part of it. Nurses typically use one of several telephones found at the nurse station, located only 33 feet from a patient room.

4

**Equipment:** The equipment room within the unit holds a variety of tools that monitor and care for patients. Staff value the space, however, must travel up to 130 feet, 80 feet on average, to reach there.

5



**Nurse Station:** The nurse station is vital for staff to communicate with one another and document their work. It is the most accessible space in the unit, staff only travels 33 feet from a patient room.

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# SOUND ANALYSIS

Patients have voiced their disatisfaction with unit noise levels through the HCAHPS survey system. We measure sound levels throughout the unit to determine the root cause, compare those levels to WHO standards, and develop solutions without compromising unit productivity.


**<55 dBA**
10. Empty Patient Room

**56-65 dBA**
2-3. Off-Stage Corridor
4. Break Room
5. Soiled Room
18., 21. Equip Alcoves
23. Dialysis Equip. Room
26. PACS
31-33. Meds/Supply Room

**66-75 dBA**
6. Nourishment
9., 28-30. SICU Corridors
11-12., 24. Nurse Stations
13. Off-Stage Room
15. Pneumatic Tube

**76-85 dBA**
34. Unit Clerk Station

**>85 dBA**
N/A

## 5.1 SOUND ANALYSIS

One of the key issues patients have had with the SICU are noise levels in the unit. As part of our field work, we performed a series of sound readings throughout the unit, using a smart phone app, to gain insight on what noises are causing dissatisfaction to patients and where those noises are generated. After performing 35 readings and laying them over the floor plan, we learned that the nosiest part of the unit is the nurse station - the center of staff interaction. In order to positively impact the unit for both the patients and the staff, it is imperative to enclose the staff, so they may actively collaborate, without compromising visibility and access to the patient.


**The recommended sound level limits for hospital patient rooms as defined by different organizations compared to the Midwest SICU average**

http://www.accenet.org/downloads/Noise_in_hospital_icu-critical_review_of_a_critical_topic_Oct2012.pdf

### WHO Standards

The World Health Organization has developed a series of guidelines on a global scale to "ensure appropiate use of evidence" is applied to positively impact health policies. Their standards for ICU sound levels are stated on the left, with daytime sound levels maxing at 35 dBA (weighted sound decibel) and nighttime levels at 30 dBA. However, the SICU never came close to these levels, with the quietest recording at 55 dBA coming from an empty patient room. Noise levels peaked at 87 dBA during a patient procedure at night.

| Quietness of hospital environment | | | | | |
|---|---|---|---|---|---|
| Never | 1 | 2.7 | | | 2.2 |
| Sometimes | 5 | 13.5 | | | 8.0 |
| Usually | 6 | 16.2 | | | 28.9 |
| Always | 25 | 67.6 | 61.3 | | 60.4 |
| **Total** | 37 | | | Top Box | |
| Solution: Sound Control Measures | | | | %ile Rank | 55 |

### HCAHPS & Noise Levels

The HCAHPS survey system allows patients to score the hospital based on 21 patient perspectives, making internal improvements easier. With quietness being one of those metrics, Midwest patients ranked it lowest among all categories. Our research team investigated the cause of these low scores and determined that noise levels in the nurse station and within the patient room must be controlled first.

### ICU Sights and Sounds

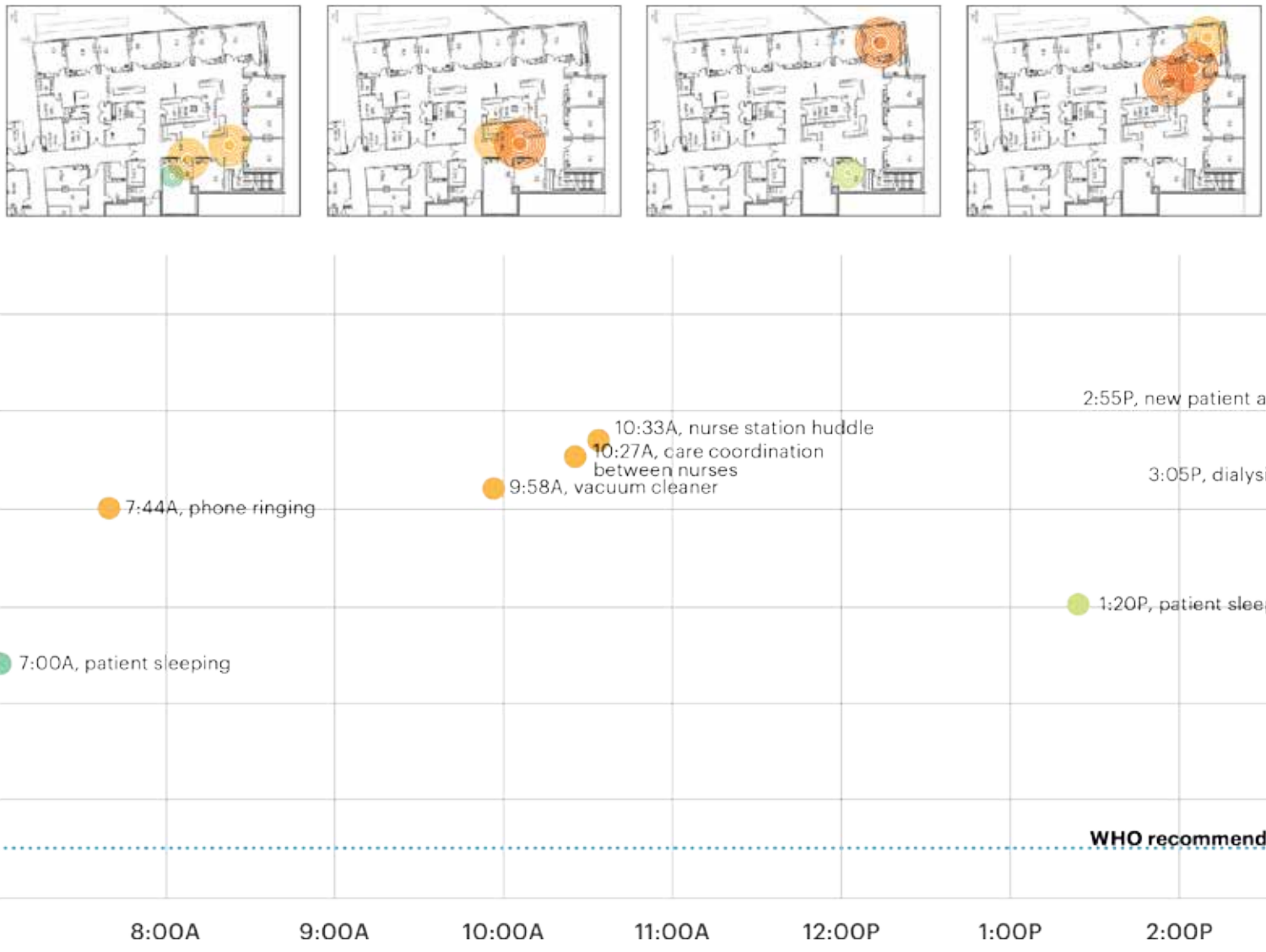
Within the SICU, there are several high level noise experienced that are necessary for the both the staff and patient. Many of these noisy machines and equipment are, in fact, found in the patient room, and include ventilators, EKG monitors, and IV. Each of these come equipped with an alarm, and give staff members alarms when there are any changes in the status of their patients.

We can still effectively design a quieter SICU, but must design around what we can control. Based on the culture of the unit, staff gains the most visibility and access through leaving the patient door open. The nurse station serves as a communication hub and, therefore, generates a lot of noise that carries into the patient rooms, up to 85 dBA. Though patients may still have to deal with equipment alarms for their safety, we can significantly reduce noise perception by providing staff with enclosed collaborative spaces.

**Noises recorded in the intensive care unit**

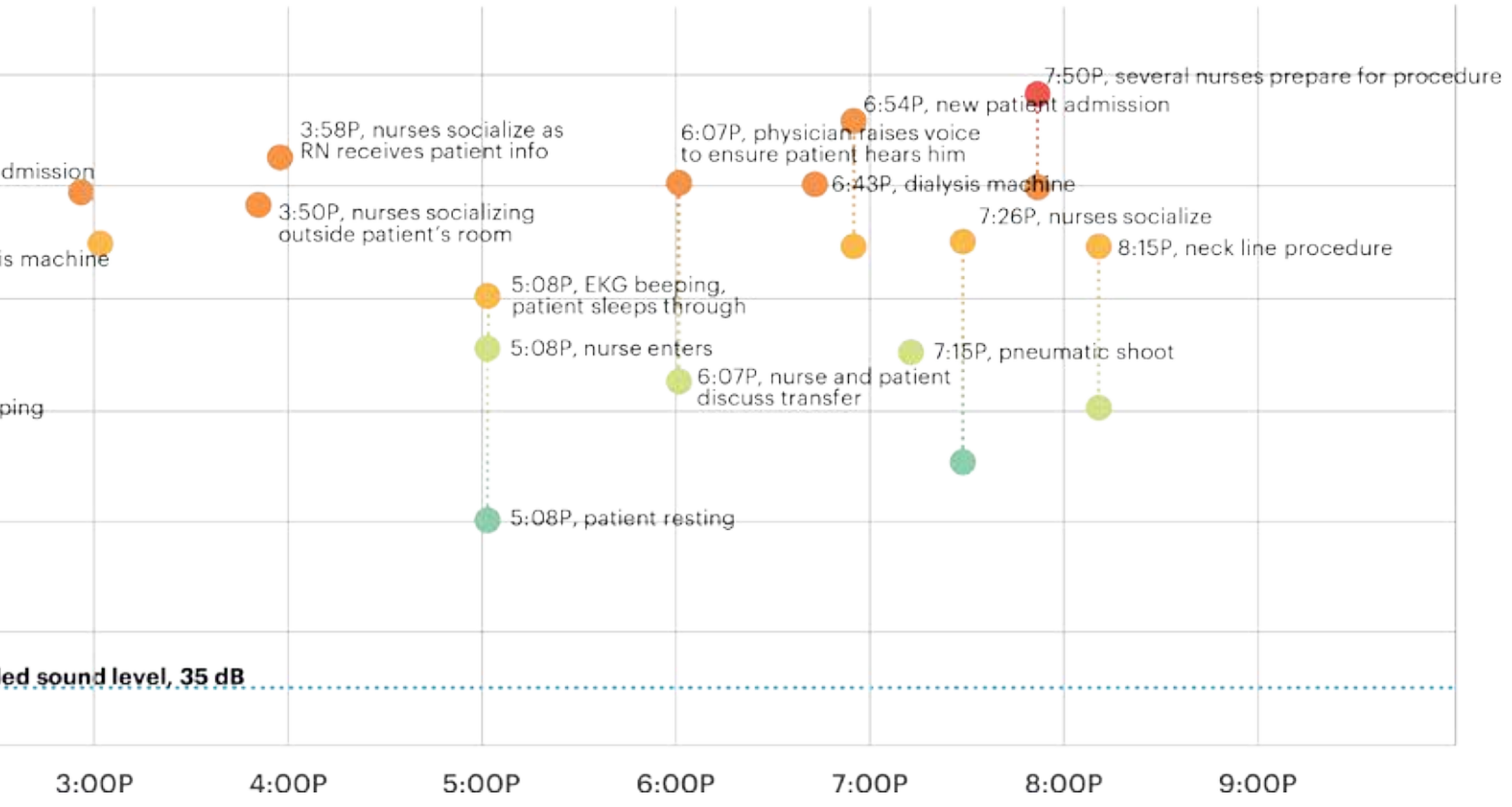
| Source of noise | |
|---|---|
| Items falling onto the floor | Up to 92 dB(A) |
| Equipment movement (e.g. bed) | 90 dB(A) |
| Connection of gas supply | 88 dB(A) |
| Door closure | 85 dB(A) |
| Pager | 84 dB(A) |
| Talking | 75- 85 dB(A) |
| Ventilator alarm | 70- 85 dB(A) |
| Nebuliser | 80 dB(A) |
| Telephone | 70- 80 dB(A) |
| Television | 79 dB(A) |
| Oximeter | 60- 80 dB(A) |
| Monitor Alarm | 79 dB(A) |
| Ventilator | 60- 78 dB(A) |
| IV infusion alarm | 65- 77 dB(A) |
| Endotracheal aspiration unit | 50- 75 dB(A) |

http://ihe-online.com/fileadmin/artimg/the-impact-of-noise-in-the-intensive-care-unit.pdf




**Sound Analysis: Throughout the Day**

The graph above illustrates the sound levels experienced at different times throughout the shadowing process. It does NOT serve as a comprehensive timeline correlating sound levels to time of day; however, it does provide insight into what kinds of sounds are heard within the SICU. Sound levels range from 55 dBA, in an empty patient room, to almost 90 dBA in preparation for a patient procedure. The equipment used by or in the unit can become distracting, especially for a sleeping patient, but are necessary in for the recovery of the patient. These included the dialysis machine, recorded at 75 and 80 dBA, the nurse station telephone, recorded at 70 dBA, and the EKG machine, often providing false positives as loud as 70 dBA. The EKG, in particular, is an annoyance to the staff, who likely dismiss or turn off the alarm when it goes off.


7:50P, several nurses prepare for procedure
6:54P, new patient admission
3:58P, nurses socialize as RN receives patient info
6:07P, physician raises voice to ensure patient hears him
6:43P, dialysis machine
3:50P, nurses socializing outside patient's room
7:26P, nurses socialize
8:15P, neck line procedure
5:08P, EKG beeping, patient sleeps through
5:08P, nurse enters
7:15P, pneumatic shoot
6:07P, nurse and patient discuss transfer
5:08P, patient resting
3:00P
4:00P
5:00P
6:00P
7:00P
8:00P
9:00P

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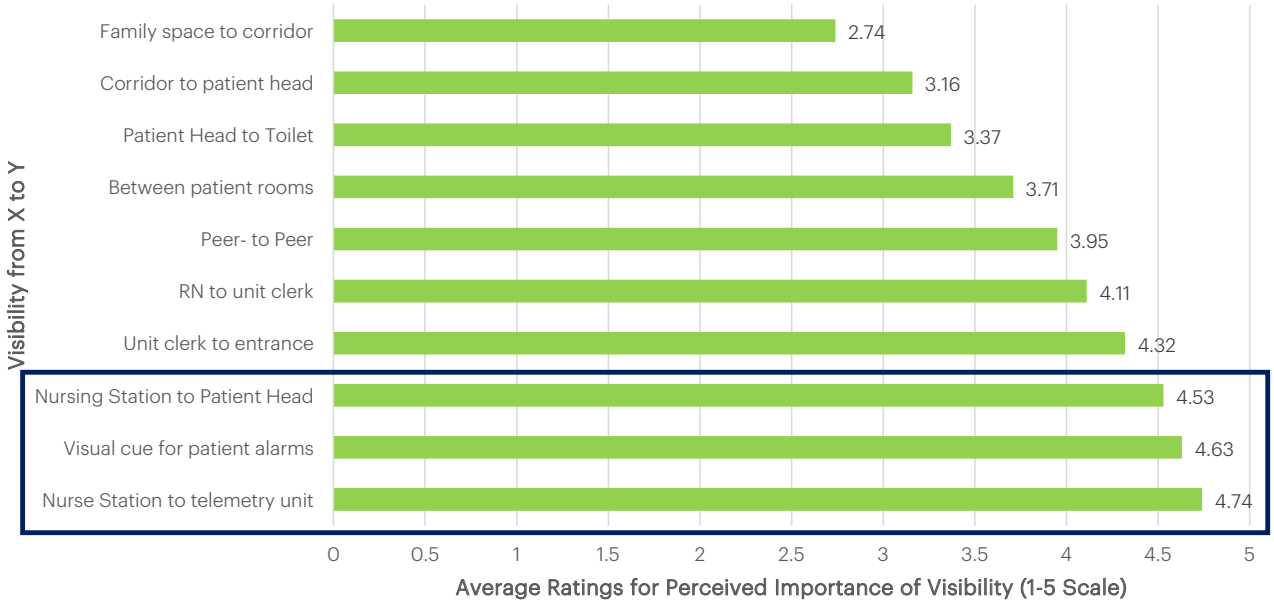
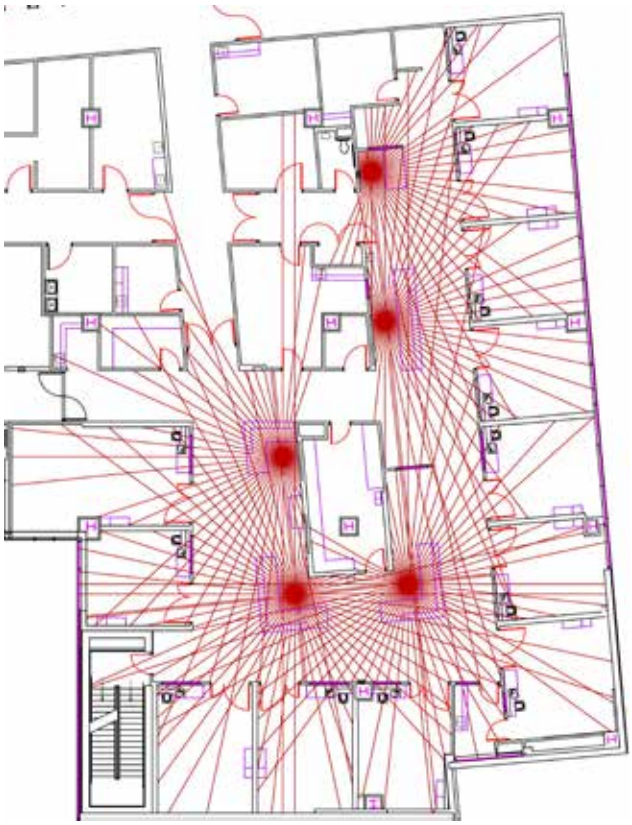
# PATIENT MONITORING

Patient visibility is an integral component of caring for them, from physically seeing them to telemetry devices showcasing vitals to staff. It is all important to understand how the SICU says they choose to monitor their patient and compare it to how they actually monitor them

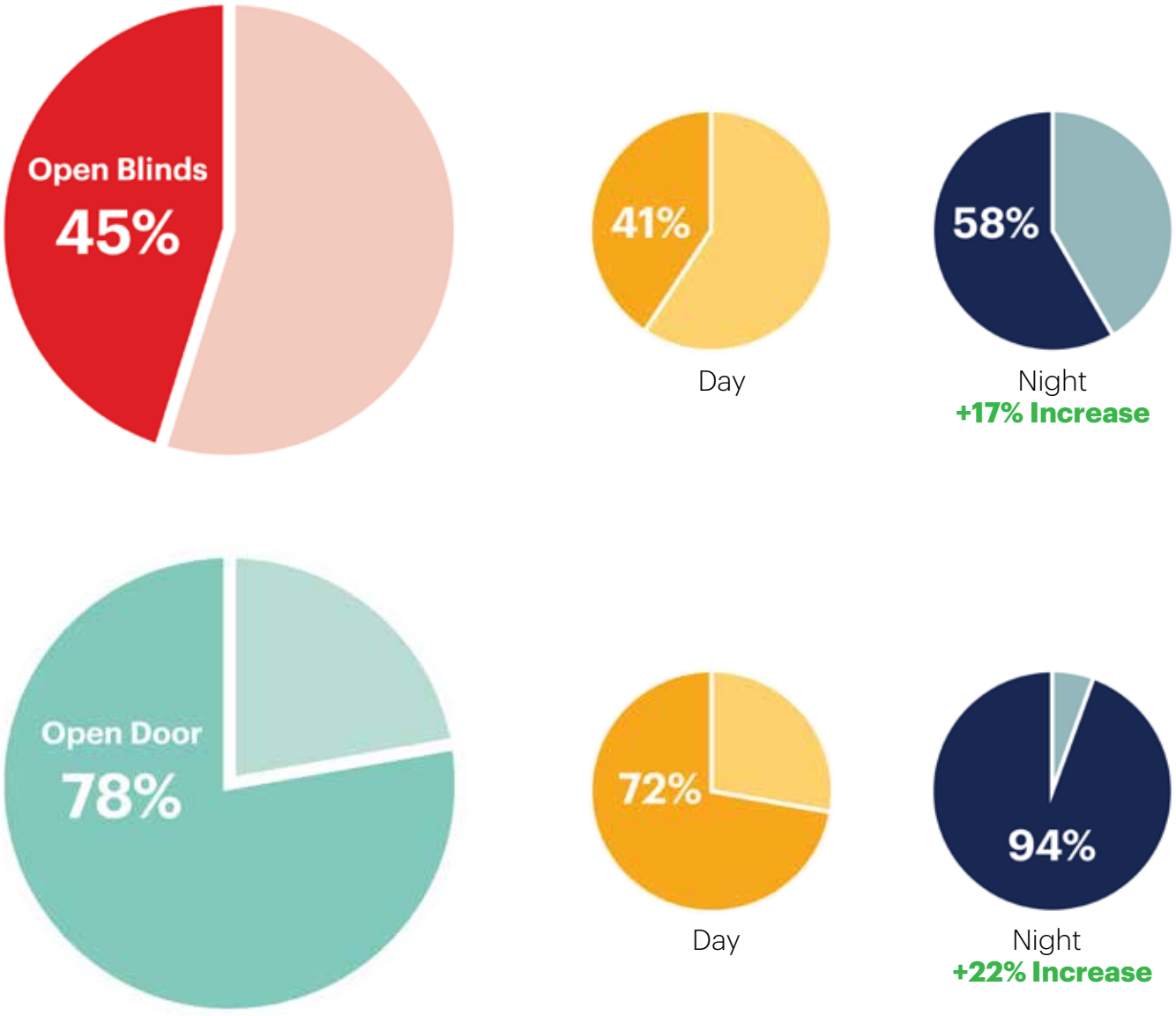
## 6.1 IMPORTANCE OF VISIBILITY



**Patient Room Visibility**
Visibility in the SICU can be measured through isovist programming, made possible through Grasshopper. This is done by defining the space of the floorplan and selecting points for optimal visibility. The resultant graphic provides insight into how space can restrict staff visibility into patient rooms. Specifically, the Off-Stage space splits the unit in two visually.

The design of the new SICU needs to focus on unit-wide visibility of the patient room without compromising the need of defined spaces. According to our survey findings, staff ranked views of a telemetry unit, patient alarms, and the patient's head as the most important points of visibility.




**Visibility: Doors versus Windows**
Staff culture within the Midwest SICU shows that they prefer opening doors to opening blinds to view their patients. They do this to quickly access them in the event of an emergency. The behavior maps conducted by the research team also showed when windows and doors are opened and closed throughout the day. The findings showed the staff tends to keep doors and window blinds open through the night as the patient sleeps.

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# METRICS THAT MATTER

In order to implement effective solutions for the Midwest SICU, we need to know the issues related only to the unit. The following metrics assisted in defining the parameters in which to investigate. Targeting these issues make future design for the unit unique to their culture.

| Call button help as soon as I wanted it | | | | | |
|---|---|---|---|---|---|
| Never | 1 | 3.1 | | | 1.2 |
| Sometimes | 2 | 6.3 | | | 7.3 |
| Usually | 5 | 15.6 | | | 26.1 |
| Always | 24 | 75.0 | 70.3 | | 65 |
| **Total** | 32 | | | Top Box | |
| Solution: Better Technological Connectivity | | | | %ile Rank | 74 |

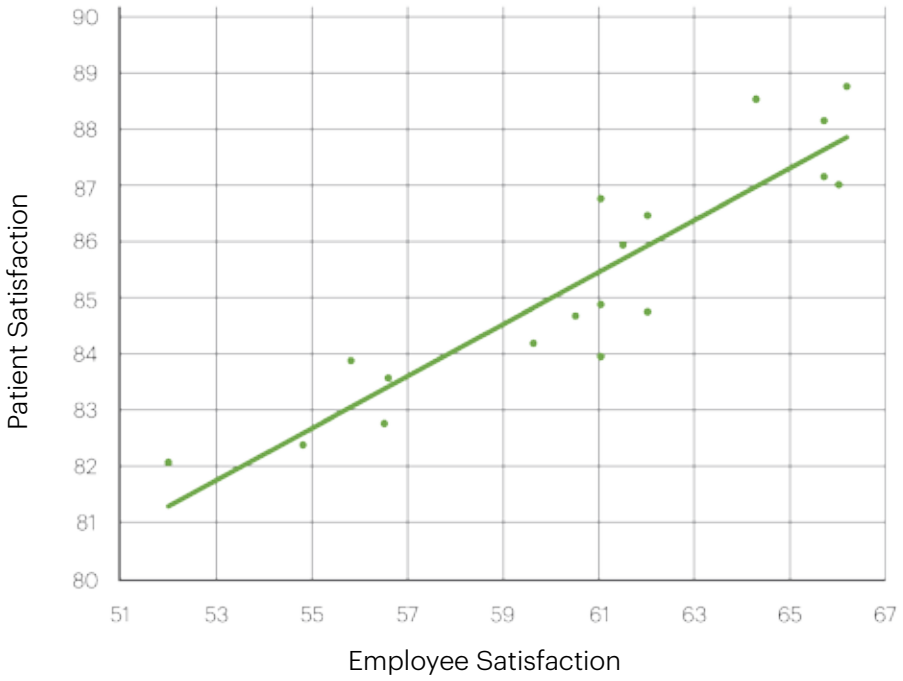
| Cleanliness of hospital environment | | | | | |
|---|---|---|---|---|---|
| Never | 1 | 2.8 | | | 1.7 |
| Sometimes | 1 | 2.8 | | | 6.0 |
| Usually | 4 | 11.1 | | | 18.1 |
| Always | 30 | 83.3 | 77.8 | | 73.7 |
| **Total** | 36 | | | Top Box | |
| Solution: Environment Services Staffing | | | | %ile Rank | 71 |

| Quietness of hospital environment | | | | | |
|---|---|---|---|---|---|
| Never | 1 | 2.7 | | | 2.2 |
| Sometimes | 5 | 13.5 | | | 8.0 |
| Usually | 6 | 16.2 | | | 28.9 |
| Always | 25 | 67.6 | 61.3 | | 60.4 |
| **Total** | 37 | | | Top Box | |
| Solution: Sound Control Measures | | | | %ile Rank | 55 |

**HCAHPS SCORES**

The Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) is a result of the shift in healthcare to give consumers more power in choosing their health care. Patients rate their care providers on 21 different perspectives, including care quality, cleanliness, and accessibility to amenities. Patients of the Midwest SICU ranked the unit well; however, they agree that the unit was too noisy, giving it low scores on the level of quietness. HCAHPS gives the research team valuable insight as to which issues, specific to Midwest, hinder quality performance and helps in developing goals to achieve in field reaserch and design.

Patient Satisfaction vs. Employee Satisfaction




**PATIENT SATISFACTION**

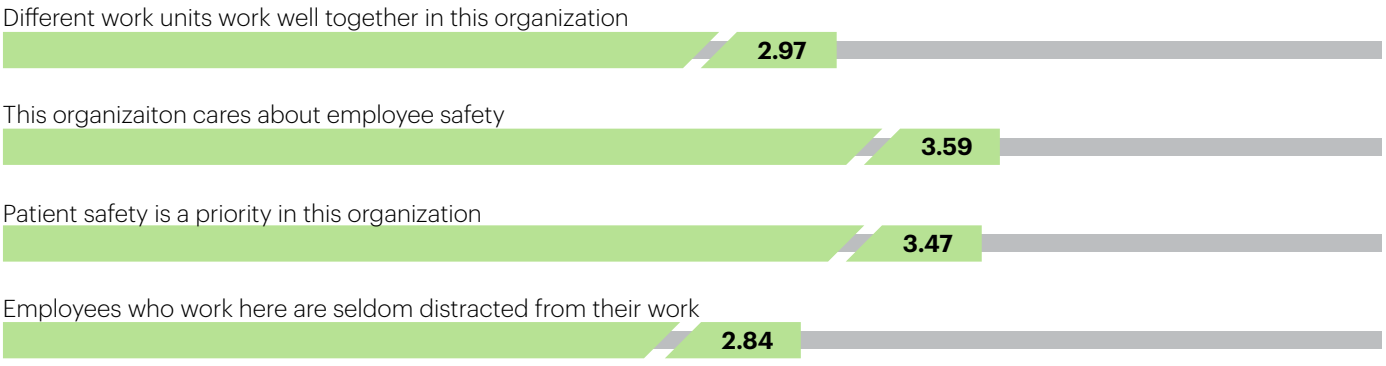
A Press Ganey 18-hospital study has shown that patient satisfaction is directly impacted by employee satisfaction. As employee satisfaction increases, patient satisfaction increased at a .89 coefficient. The study also shed light on other factors correlated to patient satisfaction which included a sensitivity to patient needs, cheerfulness of practice, and care received during visit.

Factors Correlated to Patient Satsfaction


Source: Press Ganey

## HR Survey, 2013

Organization beliefs ranked on a scale of five



# 7.2 CONCLUSION

## User Experience & Work Flow

The SICU consists of a diverse care team that must communicate with one another to effectively care for their patients. Registered nurses within the unit are primary caregivers to the patients, performing several activities throughout the day that require them to walk up and down the unit, which can become excessive at times, especially when grabbing equipment and nourishments.

## Space Utilization

The 12-room unit is centered around an open nurse station, where most staff communication takes place. Although the nurse station acts a the nucleus for the unit, two-thirds of the RN's day is spent in the patient room, caring for them, as we observed in our Activity Analysis.

## Walking Analysis

We shadowed RNs and determined they spend most of their day standing, or walking within the unit. By counting steps and comparing them to computer generated walking models, we learn of the rooms they travel to most and develop scenarios which minimize their travel to optimal levels.

## Sound Analysis

As part of our 2-day field research, we took sound levels within the unit, as a snapshot and throughout the day to determine whether they comply to WHO standards (35dB). We learned that the unit is almost never in compliance, even in an empty patient room, but the source of a lot of noise generation comes from the central nurse station. Decentralization of these communication hubs, as well as enclosing them, are recommended to help reduce noise levels and perceptions to patients.

## Patient Monitoring

Patient visibility is of most importance in any ICU, by either physically seeing and accessing the patient or monitoring their vitals via telemetry devices. Culture in the unit suggests they prefer leaving doors open versus opening window blinds to monitor their patients, which goes against what staff said in interviews of wanting more windows.

## Metrics that Matter

To effectively design for any client, an understanding of their work culture is required. Access to information, in the form of public and HR surveys, helps to determine which issues most affect care quality. In the case of the Midwest hospital, communication between different units and unit distracitons ranked low amongst staff member, and solving those specific issues could benefit the quality of care given to patients. Patients, on the other hand, scored the quality of care they received, using HCAHPS, and ranked the quietness of the unit lowest.

HKS

# APPENDICES

## Behavior Maps







BM7
Place-centered Observation Legend
Nurse
Physician
Other Clinical Staff
Ancillary Staff
Family/ Visitor
WOW
Task and Activity Legend
Care Coordination
Social Interaction
Documentation
Med Prep/ Admin
Patient Care
Task not listed (describe)
Date:
Time:


BM8
Place-centered Observation Legend
Nurse
Physician
Other Clinical Staff
Ancillary Staff
Family/ Visitor
WOW
Task and Activity Legend
Care Coordination
Social Interaction
Documentation
Med Prep/ Admin
Patient Care
Task not listed (describe)
Date:
Time:

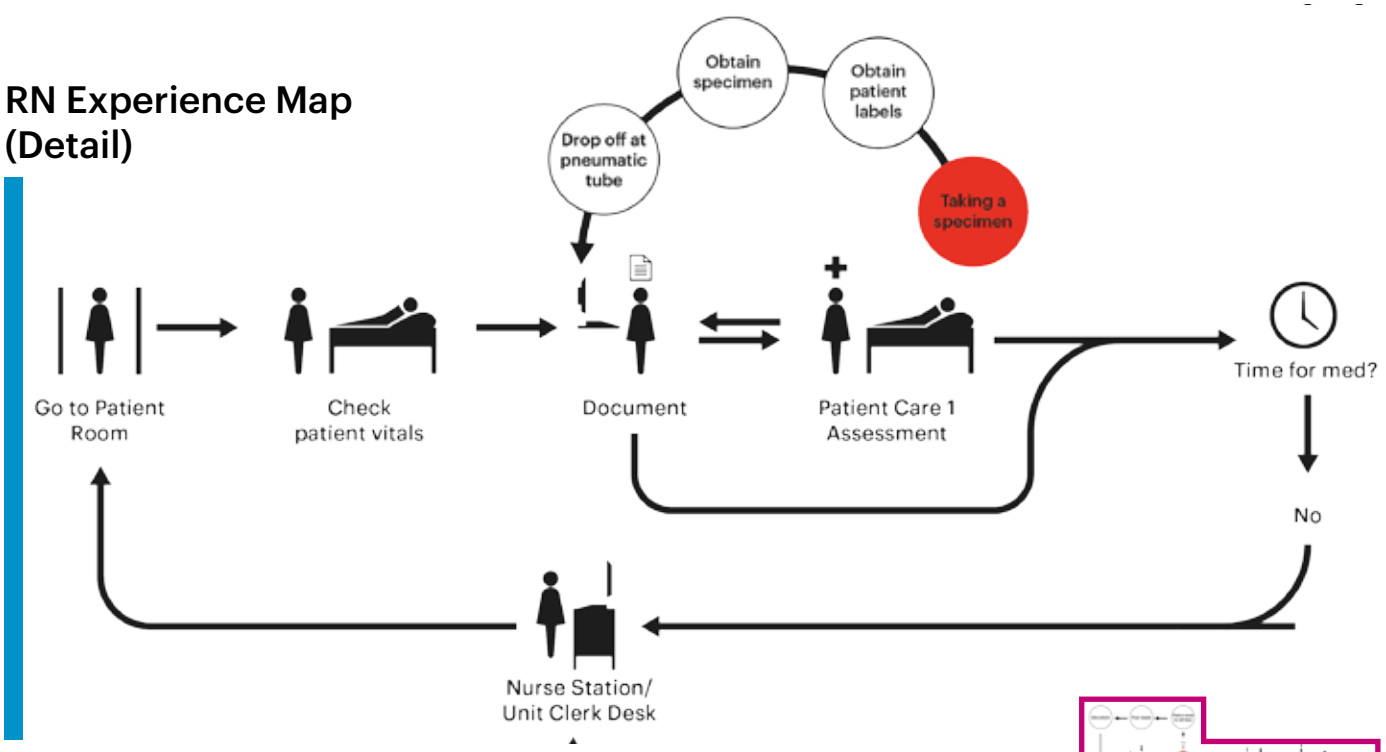

BM9
Place-centered Observation Legend
Nurse
Physician
Other Clinical Staff
Ancillary Staff
Family/ Visitor
WOW
Task and Activity Legend
Care Coordination
Social Interaction
Documentation
Med Prep/ Admin
Patient Care
Task not listed (describe)
Date:
Time:

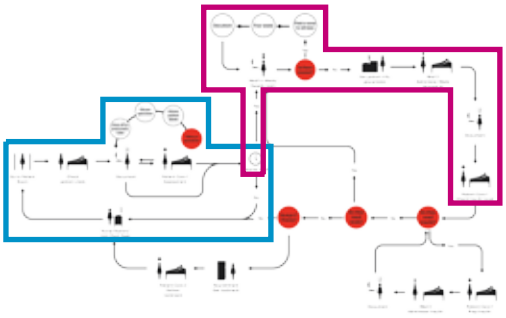

BM10
Place-centered Observation Legend
Nurse
Physician
Other Clinical Staff
Ancillary Staff
Family/ Visitor
WOW
Task and Activity Legend
Care Coordination
Social Interaction
Documentation
Med Prep/ Admin
Patient Care
Task not listed (describe)
Date:
Time:

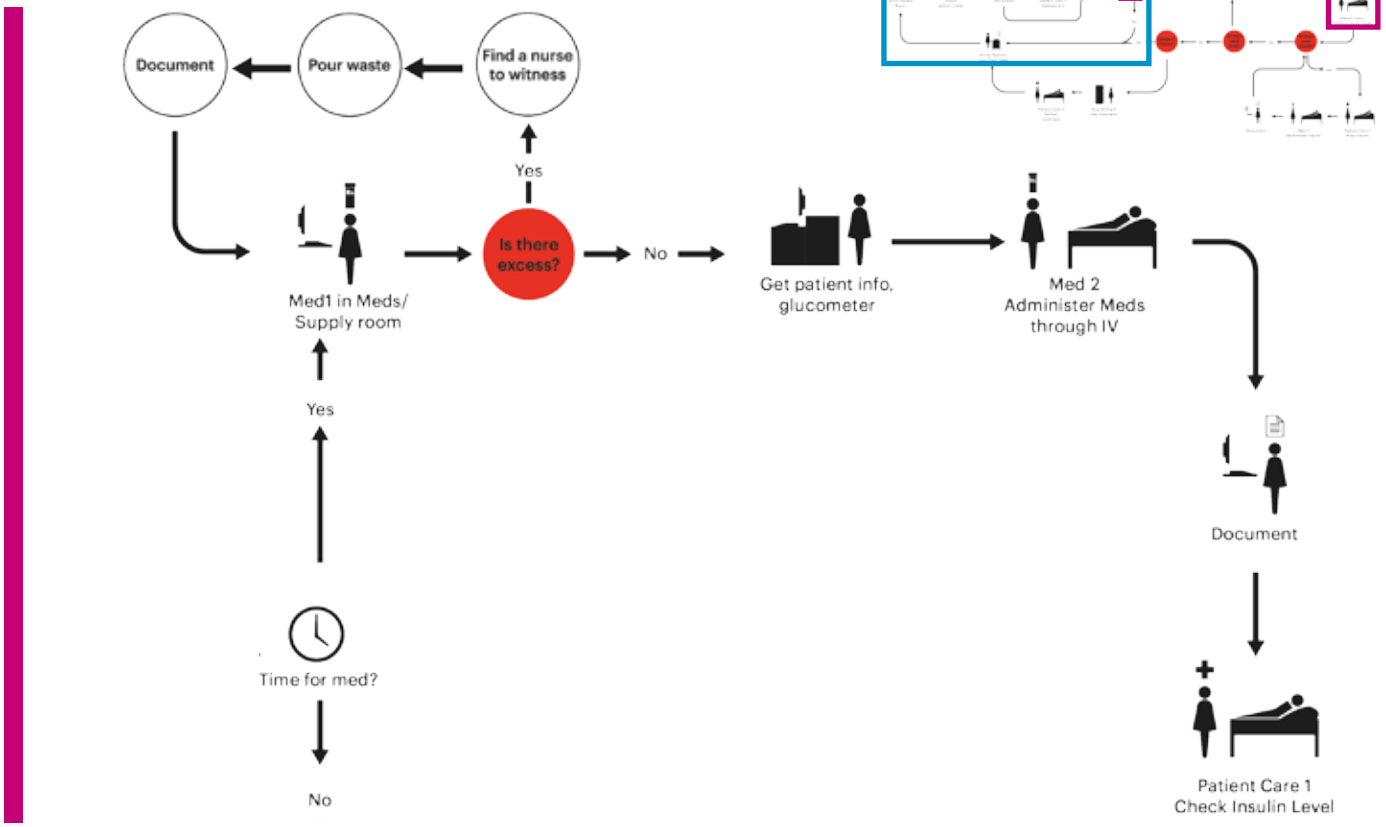

BM11
Place-centered Observation Legend
Nurse
Physician
Other Clinical Staff
Ancillary Staff
Family/ Visitor
WOW
Task and Activity Legend
Care Coordination
Social Interaction
Documentation
Med Prep/ Admin
Patient Care
Task not listed (describe)
Date:
Time:

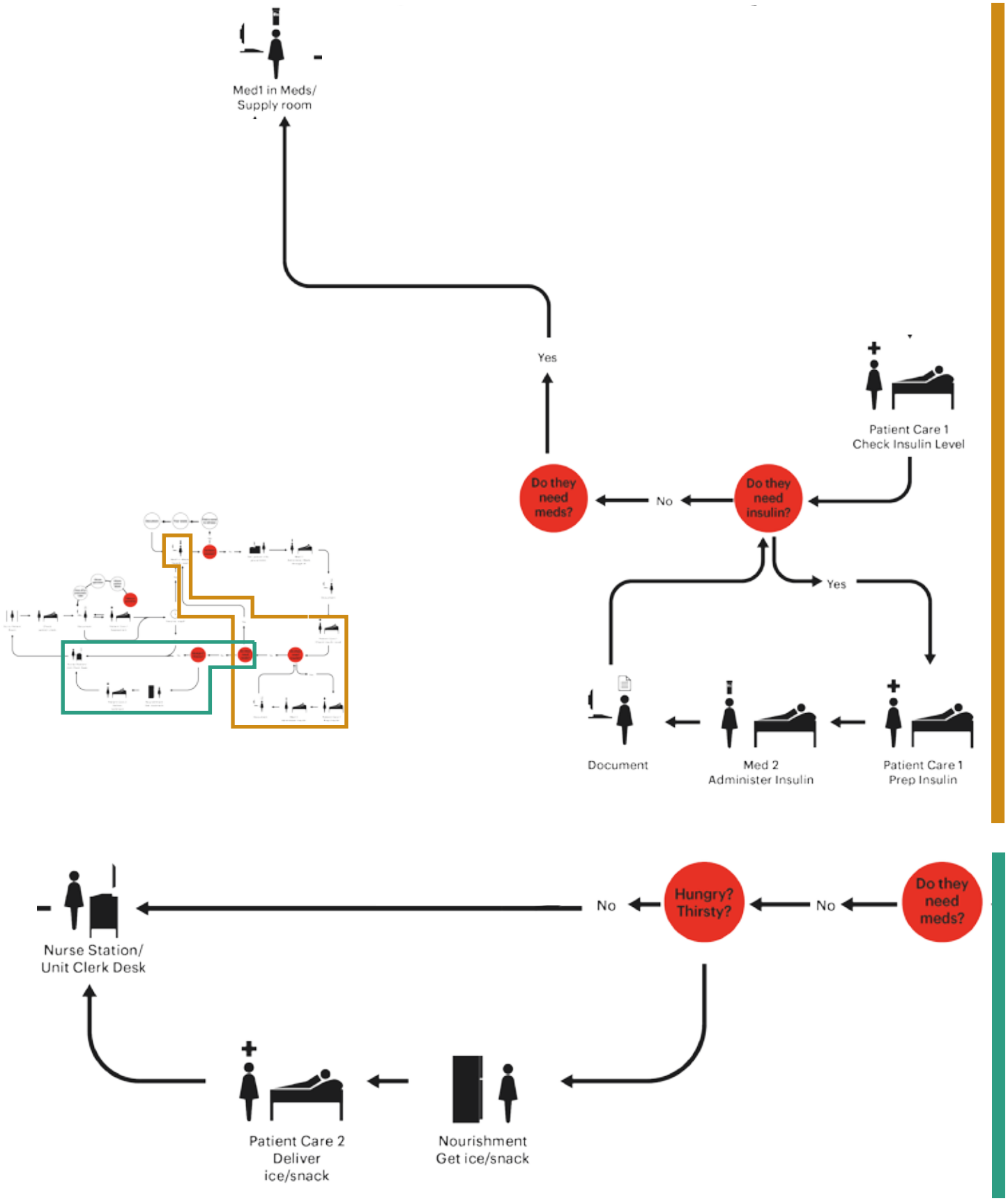

BM12
Place-centered Observation Legend
Nurse
Physician
Other Clinical Staff
Ancillary Staff
Family/ Visitor
WOW
Task and Activity Legend
Care Coordination
Social Interaction
Documentation
Med Prep/ Admin
Patient Care
Task not listed (describe)
Date:
Time:

## RN Experience Map (Detail)





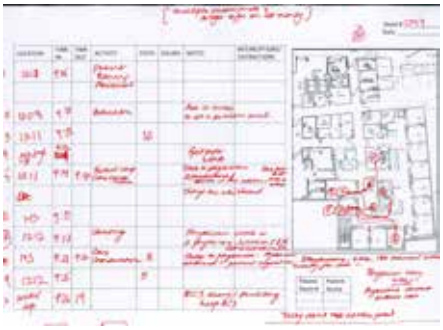

Med1 in Meds/
Supply room
Yes
Patient Care 1
Check Insulin Level
Do they need meds?
No
Do they need insulin?
Yes
Document
Med 2
Administer Insulin
Patient Care 1
Prep Insulin
Nurse Station/
Unit Clerk Desk
No
Hungry? Thirsty?
No
Do they need meds?
Patient Care 2
Deliver
ice/snack
Nourishment
Get ice/snack

## Shadow Data (RAW & Analyzed)













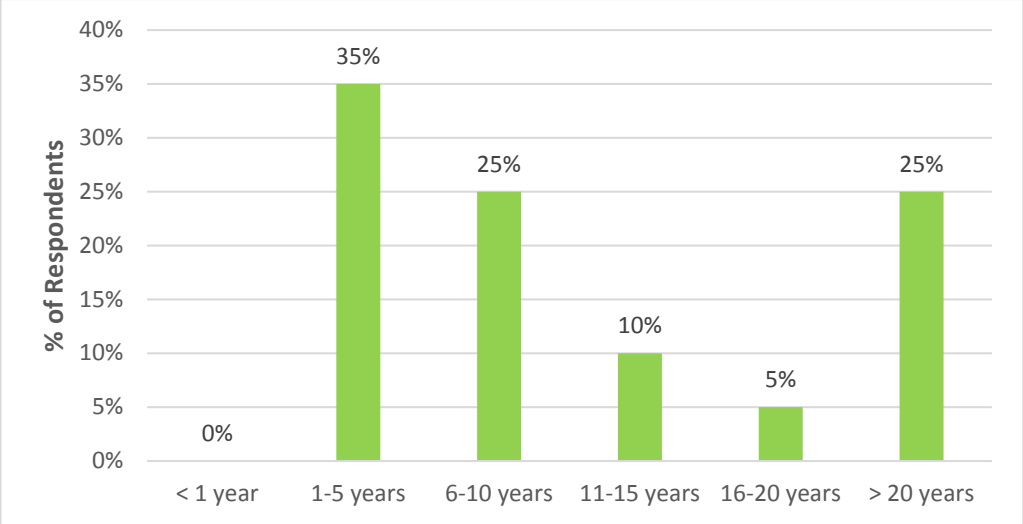




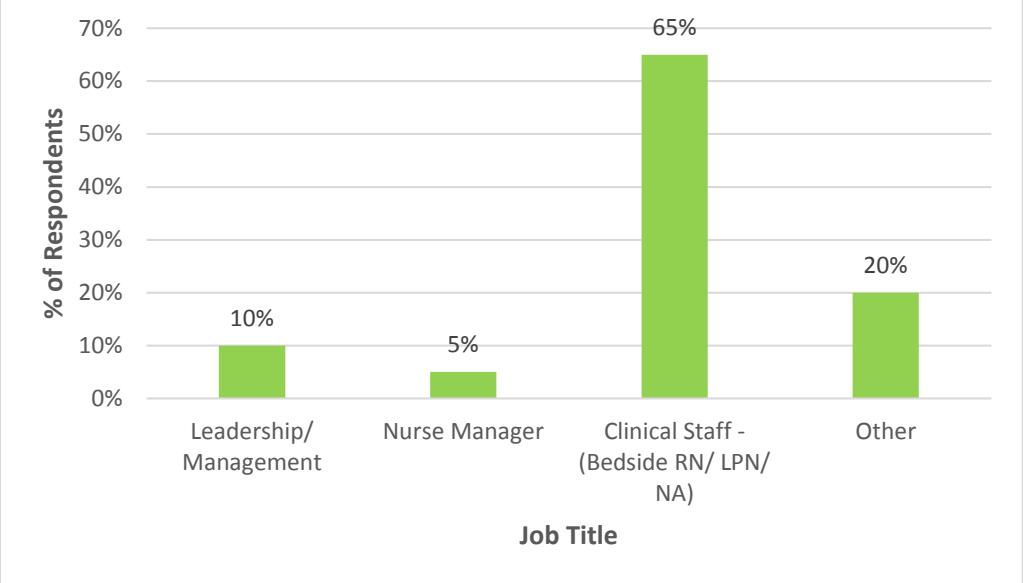



## Survey Results

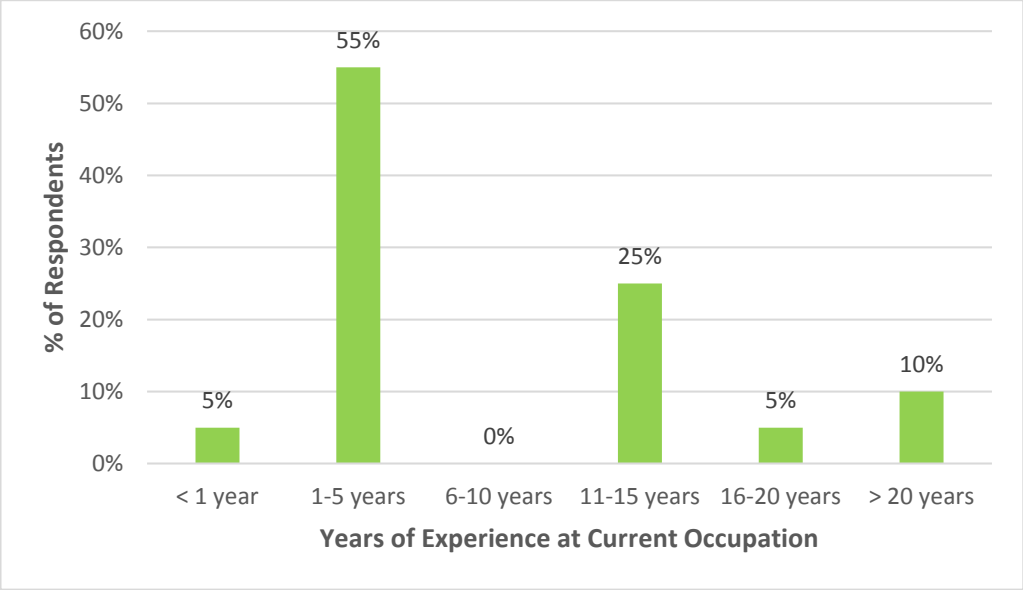
1. How many years have you worked at the hospital?



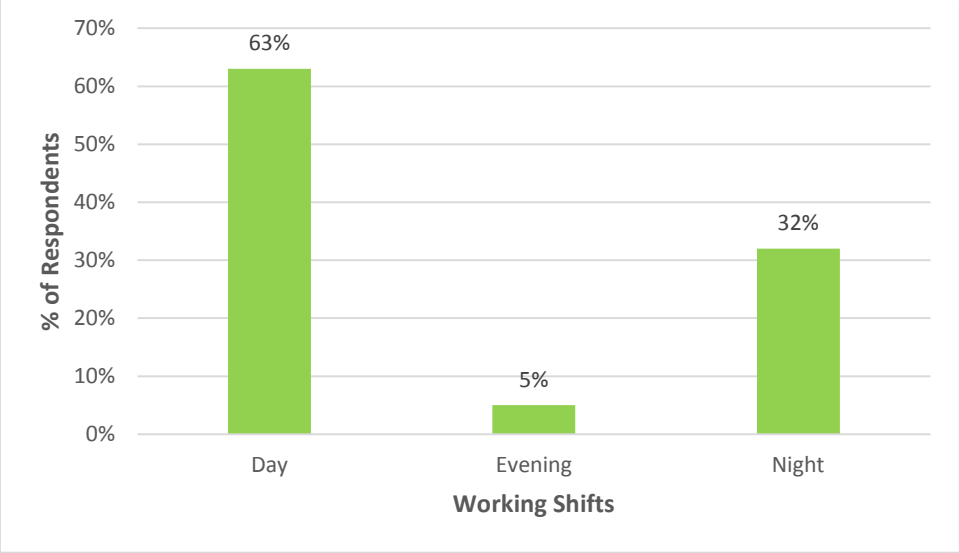

2. Which of the following best describes your current occupation?



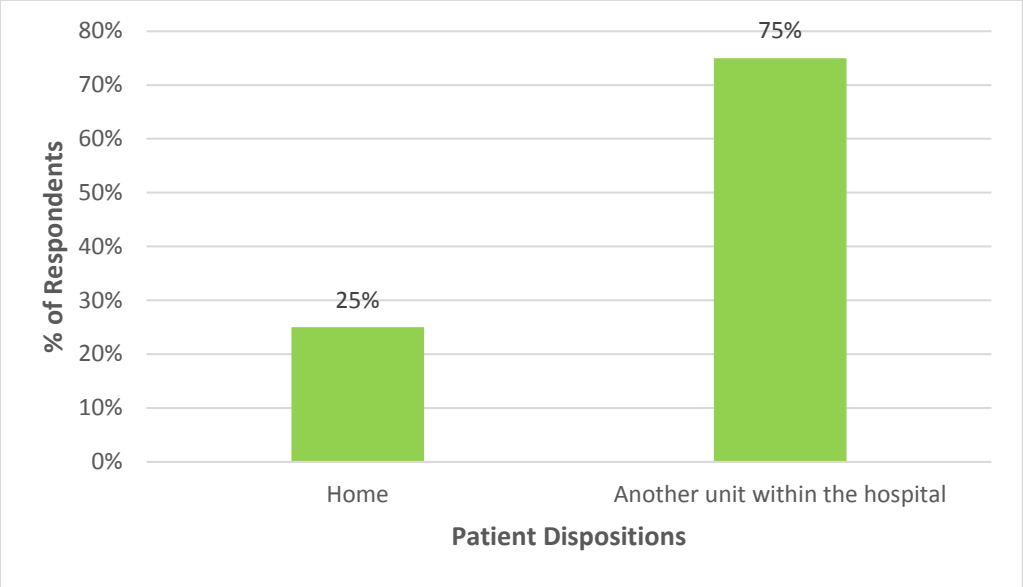
3. How long have you been working in your current occupation?



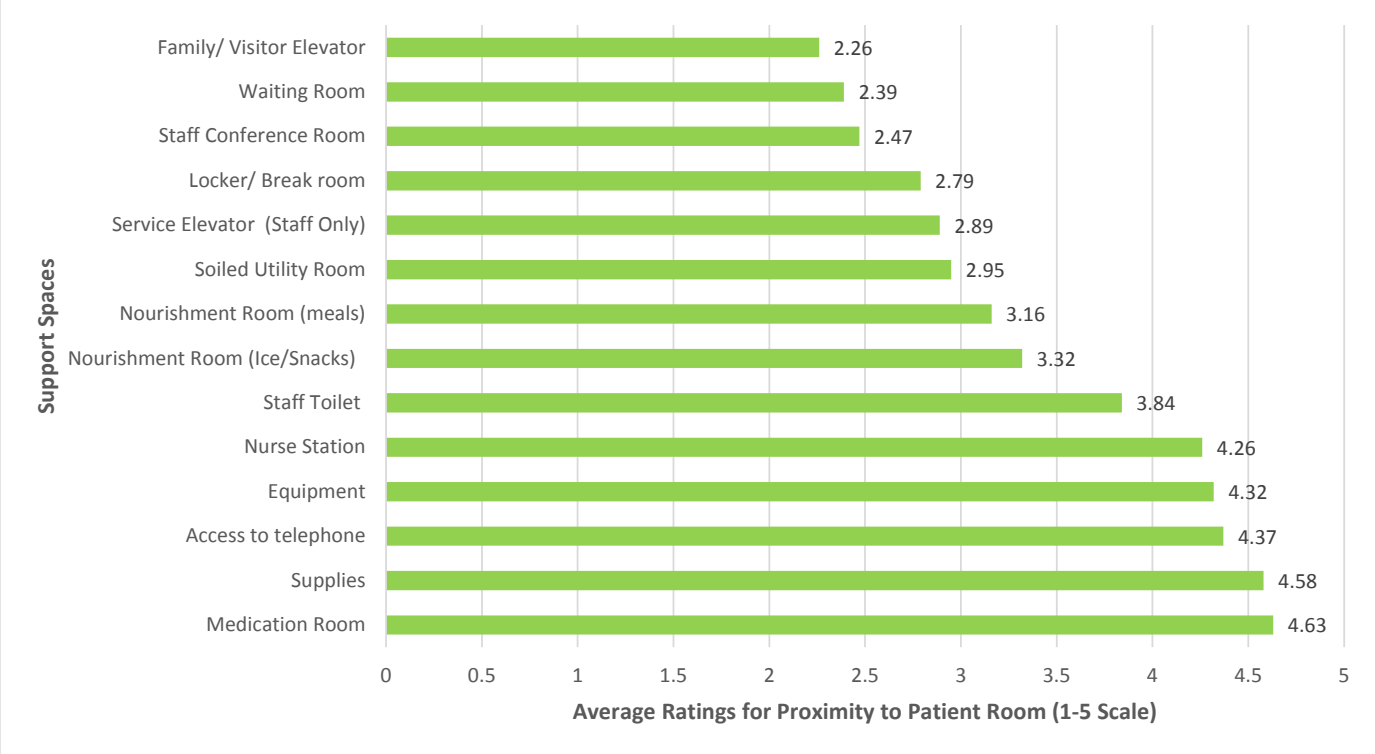

4. What shift are you working today?



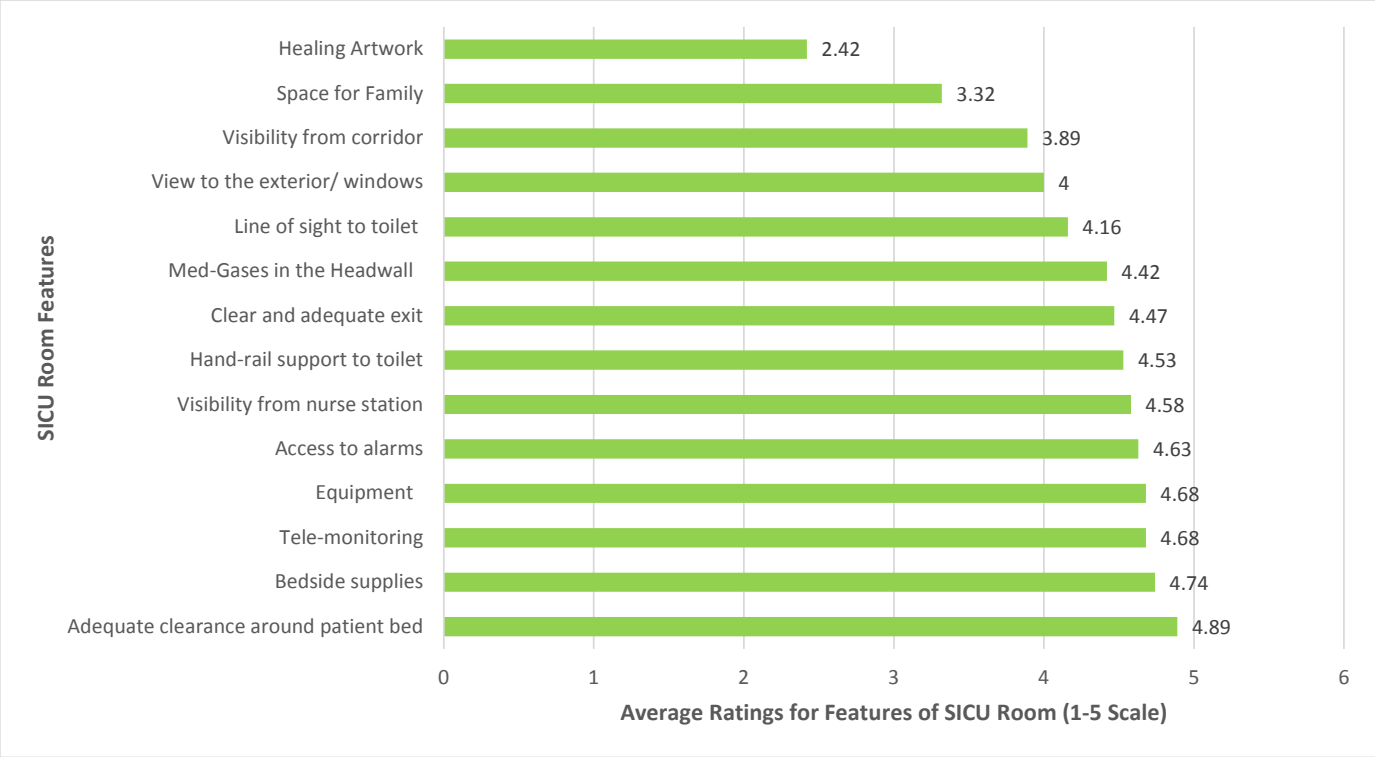
7. Of the patients you are caring for today, note the following expected patient dispositions:



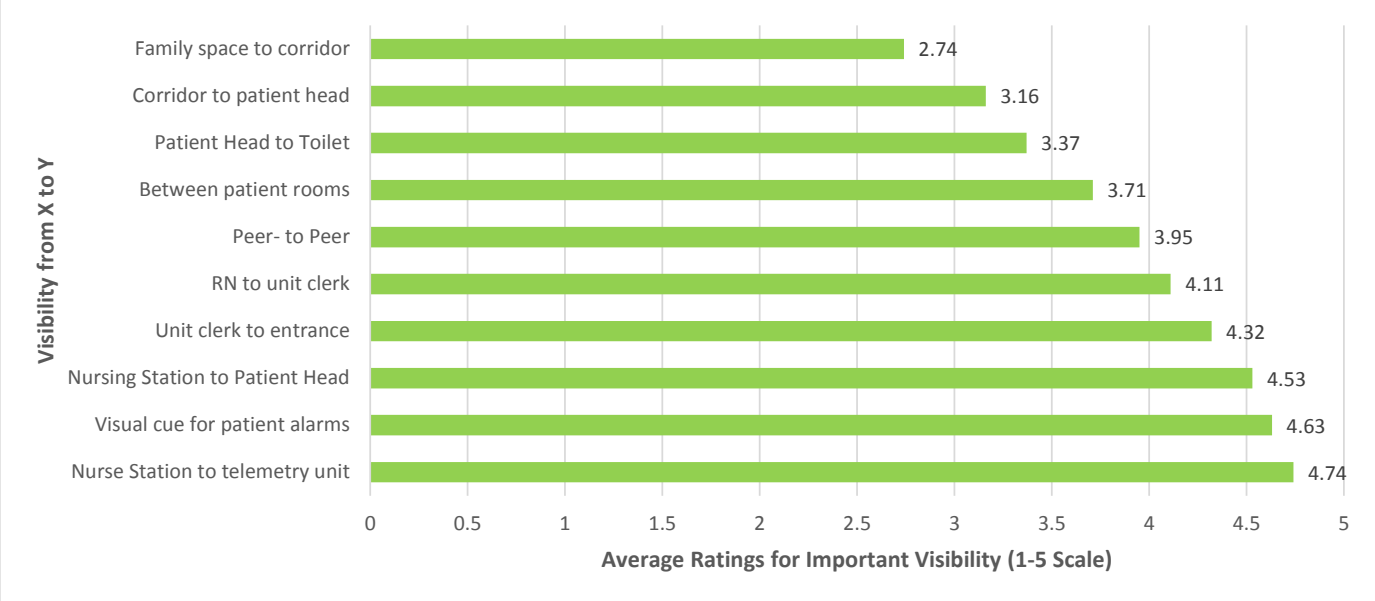

8. Please rate each of the following in terms of importance regarding proximity to the SICU Patient Room, with 5 being the highest:



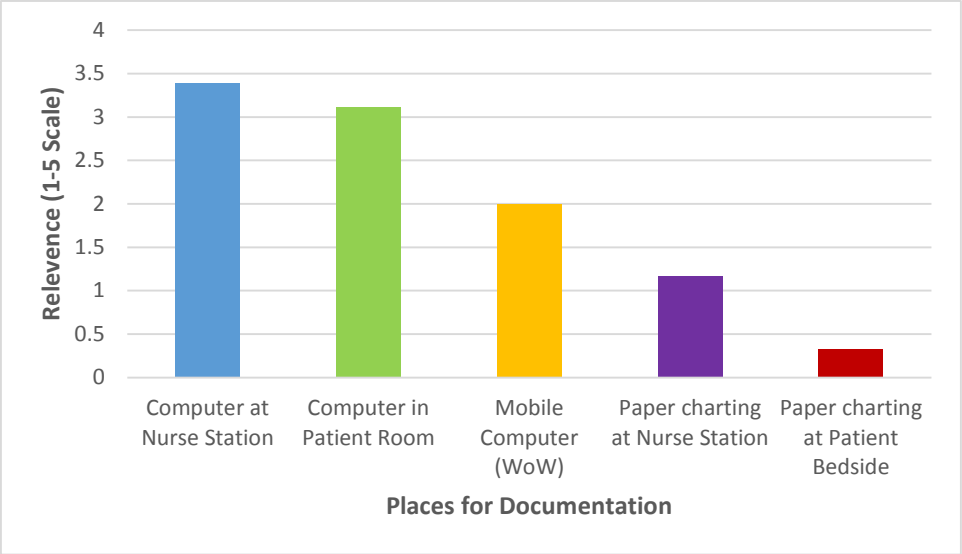
9. Please rate each of the following in terms of importance regarding proximity to the SICU Patient Room, with 5 being the highest:



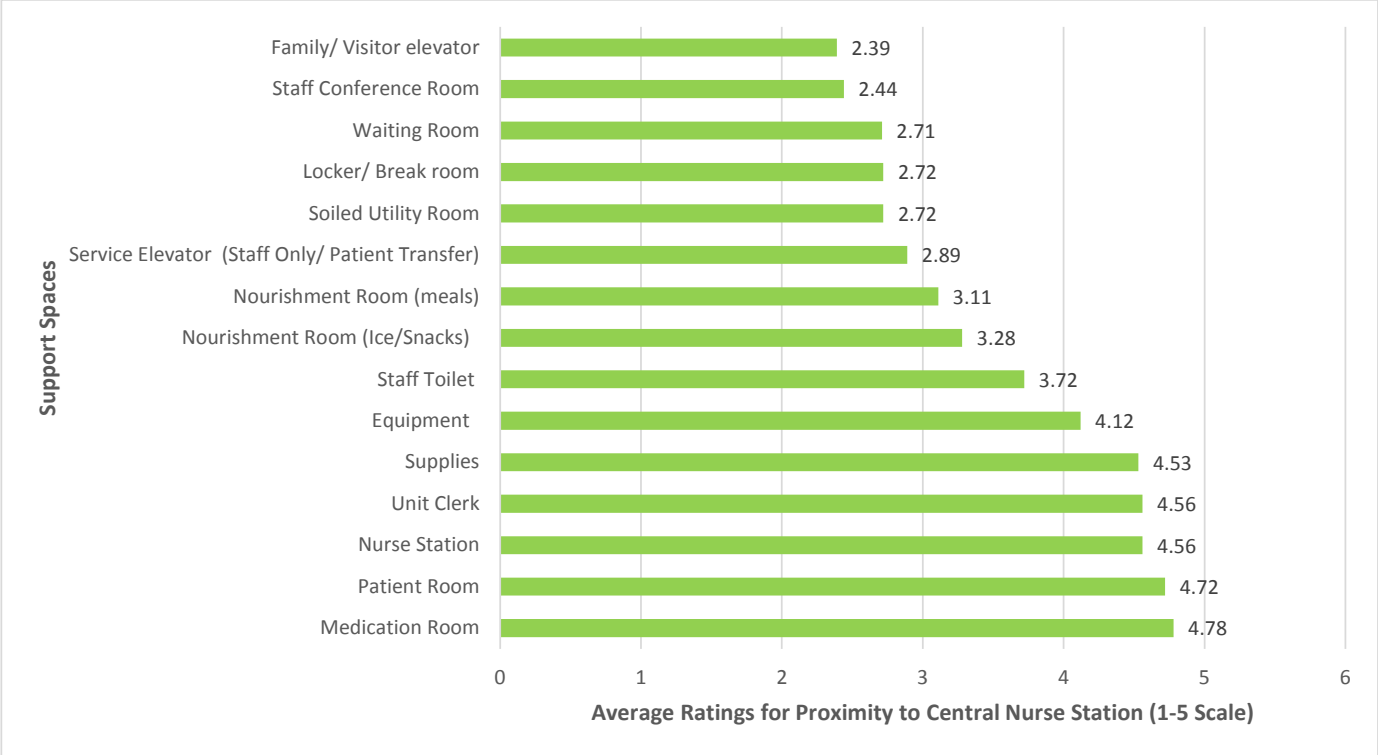

10. Please rate each of the following in terms of importance of Visibility:



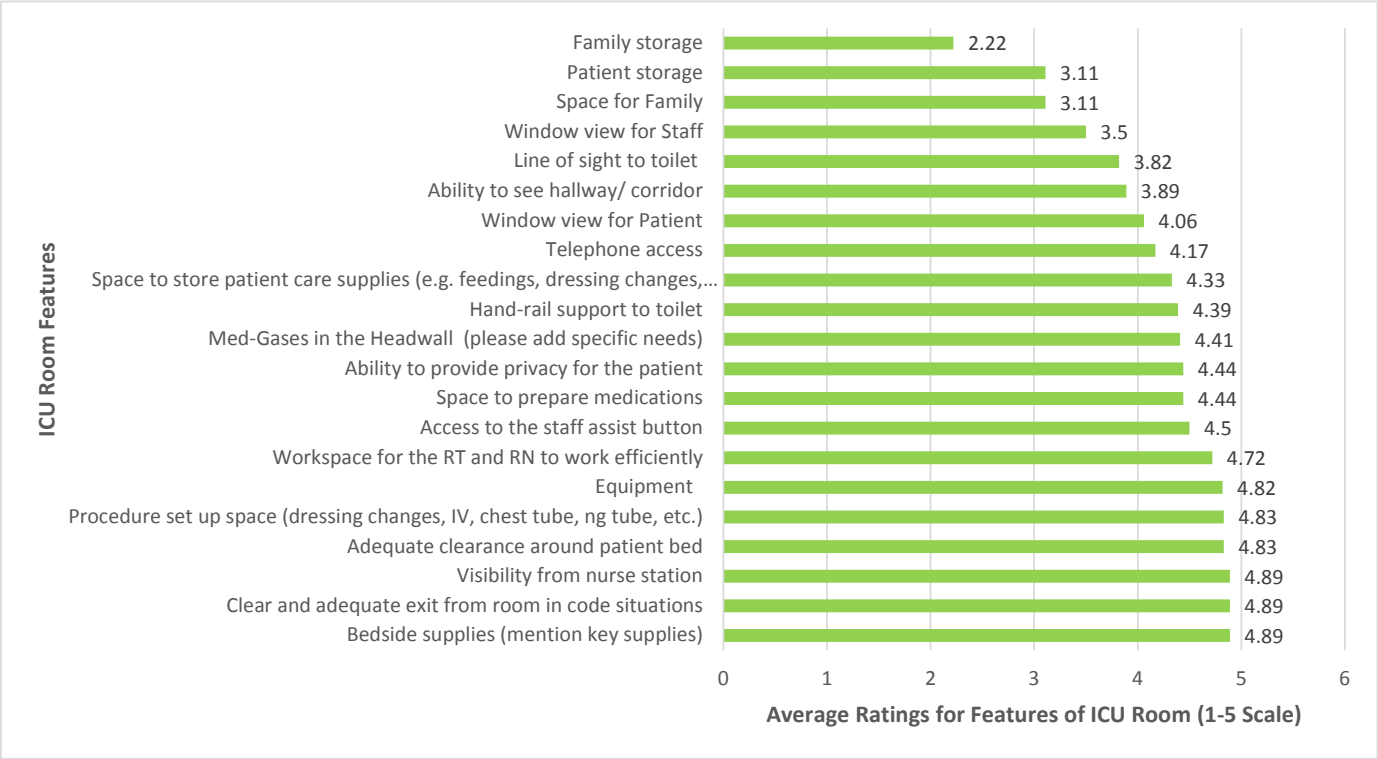
12. Please rank the following areas based on where you do the most of your charting and documentation. (Please drag the choices below to arrange in order of rank)



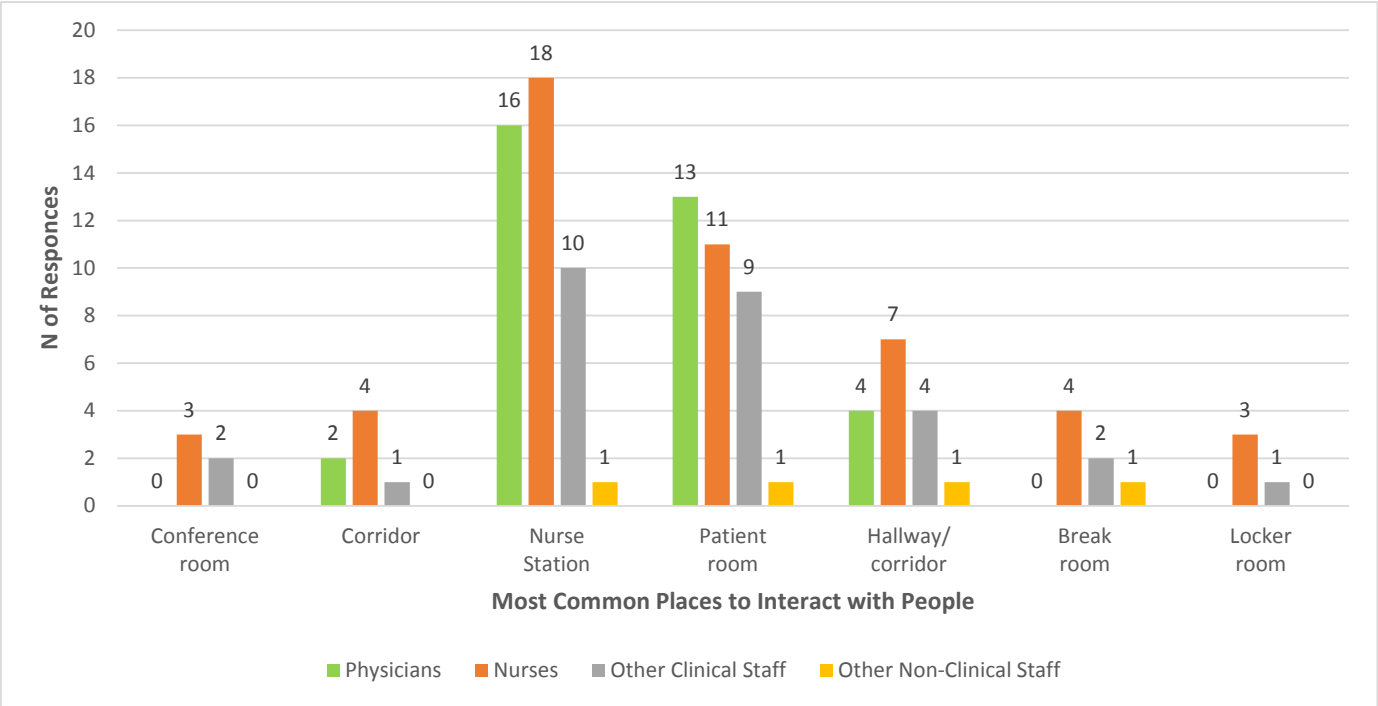

13. Please rate each of the following in terms of importance regarding proximity to the Central Nurse Station, with 5 being the highest:



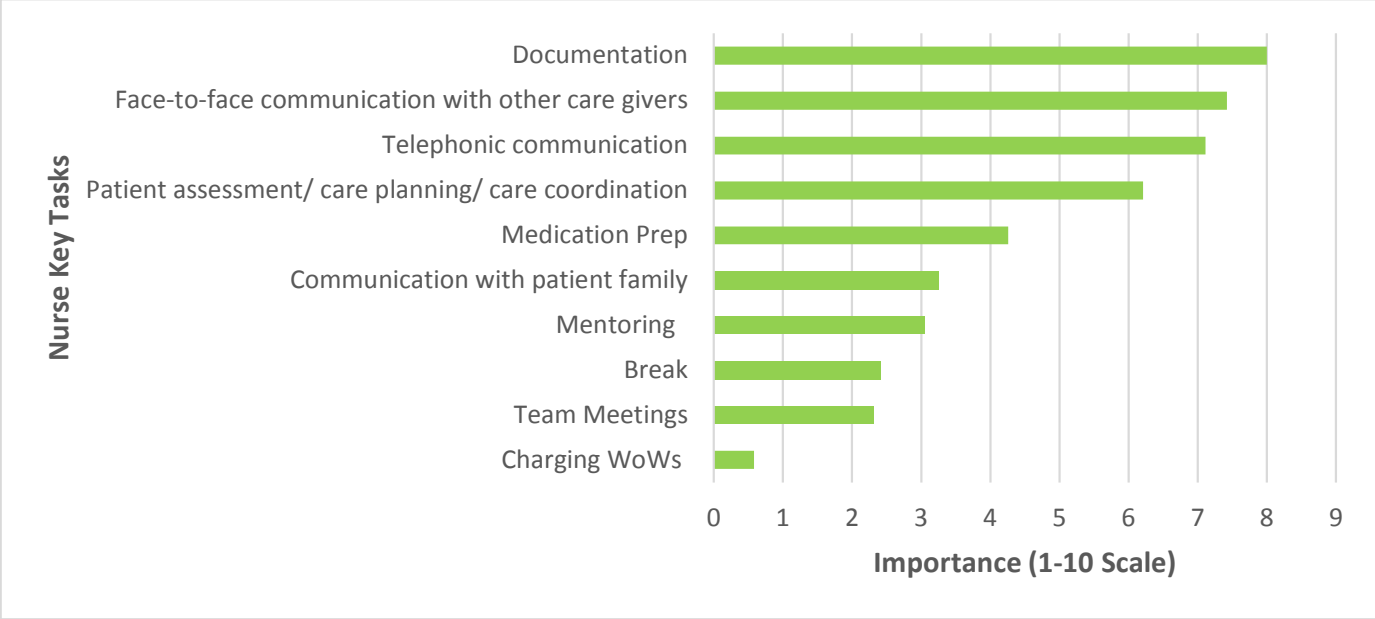
## 14. Within the ICU room, please state the importance of the following:



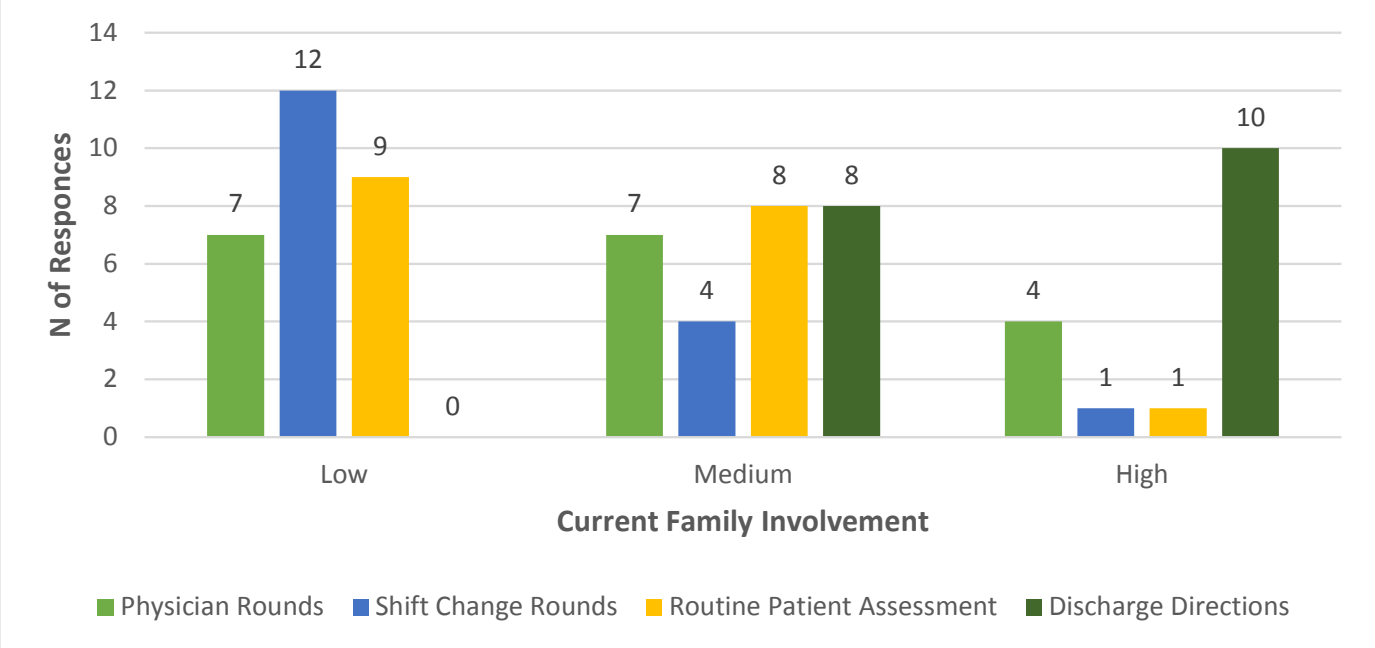

## 15. Where do you interact with staff?



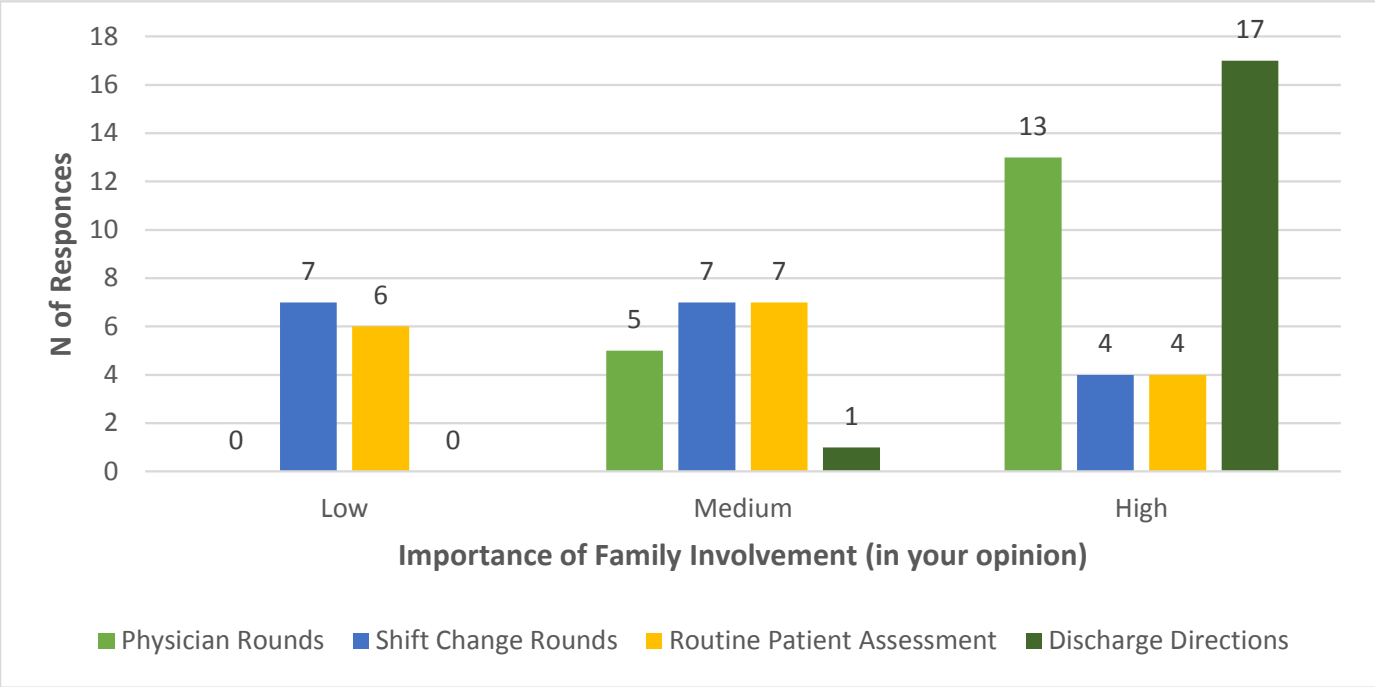
19. Please rank your key tasks at the nurse station in order of importance: (Please drag the choices below to arrange in order of rank)



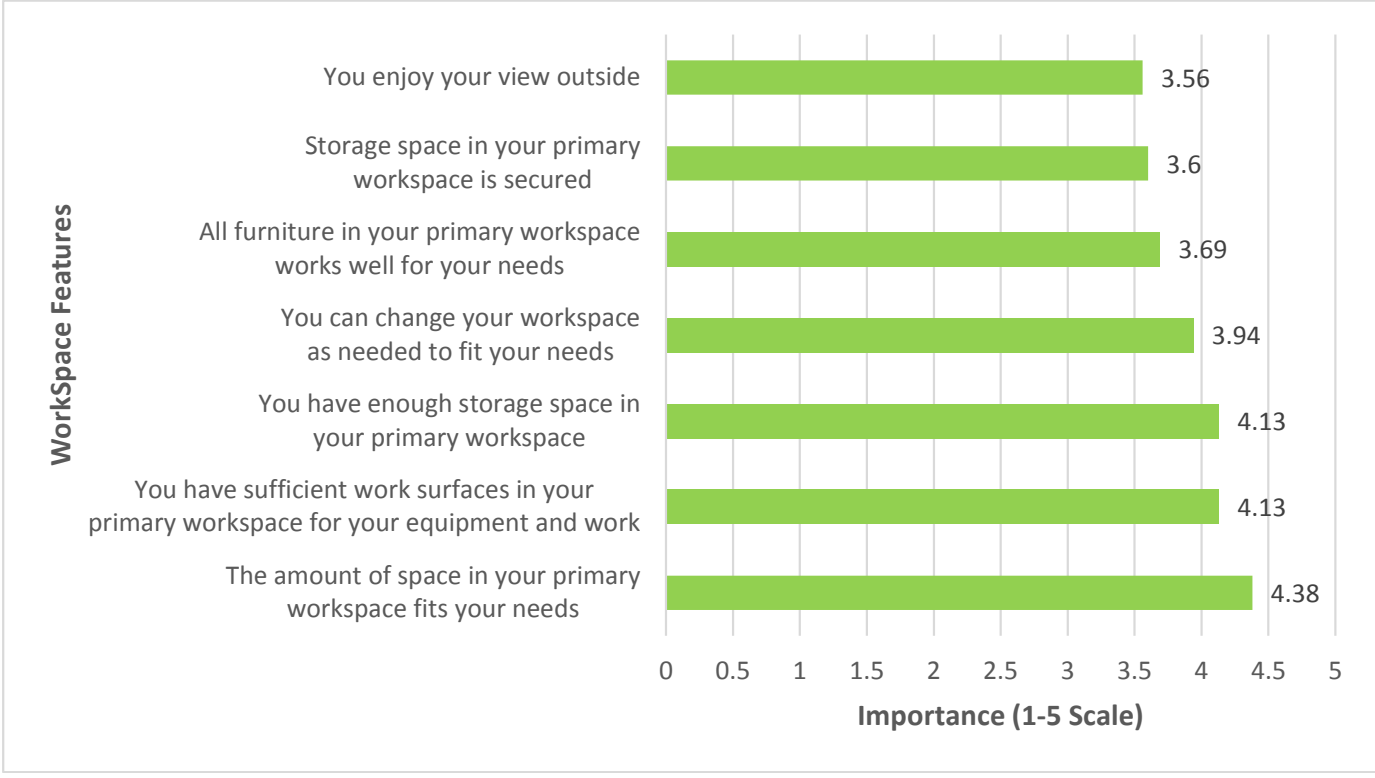

21. How involved are the family in the current care coordination practice?



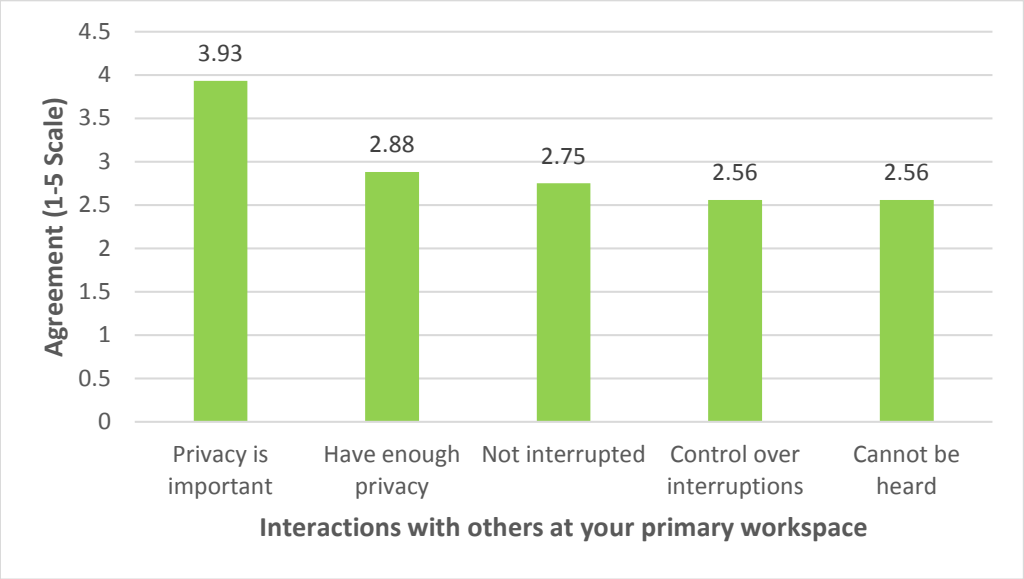
22. In your opinion, how important is this involvement?



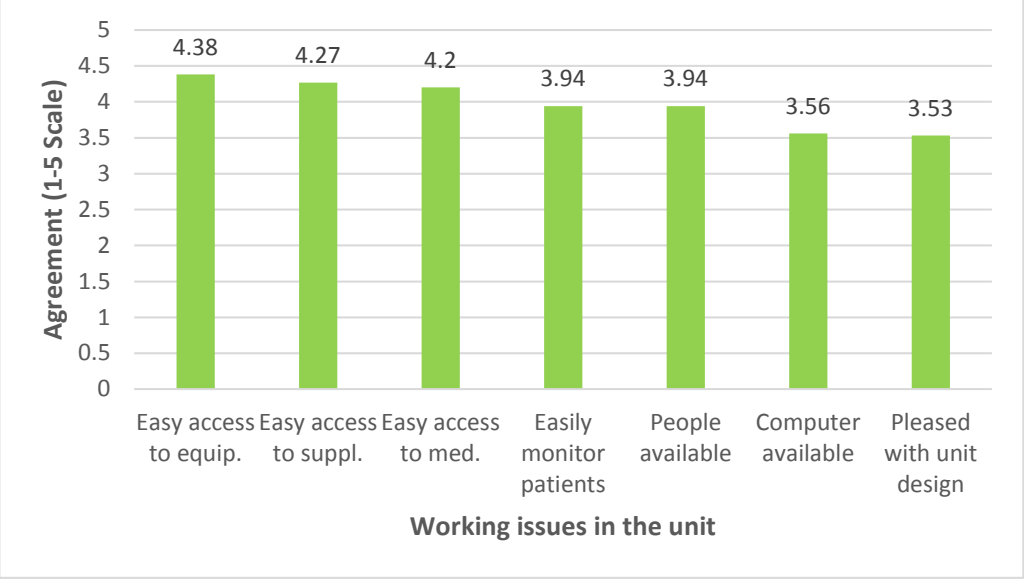

24. Please answer the following questions about your primary workspace other than patient room:



25. Please answer the following questions about interactions with others at your primary workspace other than patient room:




26. Please answer the following questions about your work in the unit:



27. Please give us your opinion about the SICU overall: