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Optimizing the Usability of Automated Dispensing Cabinets and the Optimization's Impact on the Nurse Performance and Technology Adoption

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Abstract

Background: Automated dispensing cabinets (ADCs) are used more frequently in skilled nursing facilities than other long-term care facilities because different patients check in daily. Although Omnicell cabinets use barcode and scanning technology to reduce medication errors and track drug inventory, there are still bins having incorrect drug counts. This study aims to understand the interaction between the nurses and the technology and why inventory count is an issue when Omnicell helps improve inventory control and management. Nurses are the end-users for Omnicell. Therefore, it made sense to survey them for their perception and satisfaction with the technology.

Objective: This research study allows the target audience to learn about the usability or easiness of using Omnicell from the nurses' perspective. It will also provide insight into if improving its functionalities or features will help with inventory control, impact medication administration accuracy, and make a more positive experience/performance for nurses who work with this machine.

Methods: This research study combines descriptive, correlational, and evaluation of Omnicell's usability for the study design. The selection of participants for this study was through convenience sampling. A total of ten nurses participated and were required to have access and some Omnicell experience to be eligible for participation. The research study took place in three skilled nursing facilities. The data collected came from the survey questionnaires on Omnicell's usability, visual observation of misplaced drugs, and discrepancy reports on inventory count. Tables, graphs, and pie charts from excel spreadsheets represented the analysis as appropriate for the data type.

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Results: Overall, 90% of the surveyed nurses were satisfied with the usability of Omnicell. Nearly 80% of the nurses had a positive perception of using it, and 80% found it convenient and easy to use to perform their tasks. There were no significant suggestions for improving the technology, but nurses mentioned they needed more training. The observation results showed misplacement of drugs due to the same drug name with a different dosage strength, location inconvenience, and color similarities of drug bins adjacent. A common factor is the simple human error of not looking carefully. The discrepancy reports failed to prove that optimization of Omnicell would decrease errors in inventory count. However, factors such as high nurse turnovers could have influenced the results. Through observation, drug misplacements seemed to lower after optimization took place.

Conclusion: The surveys showed that usability was not a problem for the nurses and that the majority had a positive perception of Omnicell. The machine was not the problem for inventory count discrepancies. Omnicell's usability did not correlate with the issue in inventory count. However, the constant changes in nurses or schedules did not give enough time for the staff to learn or use the machine properly and optimally. Overall, the nurses need more training.

Introduction

Automated Dispensing Cabinets (ADCs) are state-of-the-art machines that store, distribute, and monitor drugs electronically for patient points of care [1]. Nurses are the end-users of this technology. Therefore, using this machine's performance and experience could influence inventory control and medication administration accuracy. Omnicell is the name of the ADC used in this research study. Inventory accuracy is crucial because the pharmacy staff typically only visits each facility once a month to restock/destock drugs in the Omnicell. The drugs that come from Omnicell are for first doses, new medication orders, or emergency medications dispensed without waiting for deliveries to arrive. Therefore, if inventory is not in good standing, it can harm the patient due to the risk of no medication for administration.

ADC is a technology that can be used in hospitals, nursing homes, assisted living facilities, and skilled nursing facilities. This research study sets at three different skilled nursing facilities: Manor Care Rehab Center-Marietta, Manor Care Rehab Center-Decatur, and Anderson Mill Health and Rehab Center. Different patient's check-in daily at skilled nursing facilities and use ADCs a lot. Although Omnicell cabinets (like any other ADCs) use barcode technology and green light indicators to reduce medication errors and track drug inventory, there are still bins having incorrect drug counts. Some nurses struggle with retrieving medications using the screen prompts, which can mess with the drug count if not read or entered correctly.

A study published in 2016 discussed the concerns for medication stockouts in ADCs at hospitals [2]. Although our research is on skilled nursing facilities, this research gave us valuable insight to enhance inventory control by optimizing ADCs. The study discussed optimizing ADCs by adjusting the par inventory levels (the desired amount to have on-hand for each medication), expanding common stock medications (assigned to the ADC inventories), and removing infrequently prescribed drugs from the ADCs [2]. The study concluded that by optimizing the ADCs, there was less labor from the pharmacy having to restock, less stockout percentage, less risk for product expiration, and increased medication available for the patient points of care. We have also noticed that resetting the barcode scanner could help with the inaccuracy in inventory. The nurses often bypass the scan if the barcode is unreadable and can increase their temptation to take out more medications than they are required to take. Thus, this brings us to conclude our target problem. Does optimizing the usability of Omnicell cabinets impact nurse performance with Omnicell inventory control? and how can the optimized usability indirectly affect the administration of medications in skilled nursing facilities?

A study published in 2020 was similar to our research topic and methods. However, the difference in their research study surveys nurses to help understand their perception of the technology and increase the acceptance of implementing ADCs [3]. The ADCs are already at the skilled nursing facilities we visited in our research. Our research assumes that improved usability testing will reduce the burden for nurses on Omnicell's functionalities.

This research study allows the target audience to learn about the usability or easiness of using Omnicell from the nurses' perspective. If the nurses can easily use the system correctly, there would be fewer errors in inventory count. Indirectly, this would improve accuracy for medication administration because the drugs are stored and accessed appropriately. This research hypothesis is that optimizing the usability of Omnicell cabinets for nurses will positively affect their performance on inventory control in skilled nursing facilities and improve the accuracy in storage and accessibility for medication administration. Our main study aim is to understand the interaction between the nurses and the technology and to assess why inventory count is an issue when the ADCs help improve inventory control and management. The study goal is to provide insight into if improving ADC functionalities or features will help with inventory control, affect medication administration accuracy, and make a more positive experience/performance for nurses who work with this machine.

Methodology

Study design

This research study combines descriptive, correlational, and usability evaluation for the study design. The intention of selecting these study designs was to help with identifying barriers or associated factors that hinder optimal usability in the automated dispensing cabinet technology for nurse satisfaction and performance in inventory control. It would also give insight into improvements needed for Omnicell's usability and identify if nurse satisfaction in usability can influence the accuracy of medication administration.

The methodology for this research study uses applied research to attempt to identify and solve the issue with inventory control using Omnicell technology. The collected data include quantitative, qualitative, primary, and secondary sources. The survey questionnaire was distributed to nurses in Georgia located at Manor Care Rehab Center-Marietta, Manor Care Rehab Center -Decatur, and Anderson Mill Health and Rehab Center, approximately on the week of October 25, 2021.

Participants

The selection of participants for this study was through convenience sampling. This type of sampling was more suitable be-

cause of the limitations in the availability of the nurses or the time that we could collect the data. We initially emailed the Director of Nursing (DON) of each facility studied in this research to inform them of our purpose in this study. However, we had more responses when asking for their signature in-person on a permission form since they receive so many different emails each day. After the Director of Nursing approved and signed the permission form, the primary investigator physically handed the surveys to the nurses interested or were available to participate in this study. There was a total of ten nurses that participated.

Before the participants could answer the survey questions, they were to fill out an informed consent form to ensure the participants agreed with the purpose of the study, how their answers would play a role in the study, and what information would be collected. It also explained how all the answers would remain confidential and anonymous. The nurses were aware that their participation was voluntary before taking it. They received the primary investigator's contact information for any questions.

Data collection

The tools used for this study are the discrepancy/inventory reports auto-generated to the pharmacy, the System Usability Scale (SUS), and the Usability Metric for User Experience - Lite (UMUX-Lite) questions. The SUS and UMUX-Lite use a five-point Likert scale (options start from Strongly Disagree, Disagree, Neutral, Agree, to Strongly Agree). However, we started the option from Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree on the survey questionnaire. The scoring is still the same where Strongly Disagree = 1, Disagree = 2, Neutral = 3, Agree = 4, and Strongly Agree = 5 [4].

SUS is a ten-item questionnaire that tests usability and learning with scores ranging from zero to a hundred (but is not a percentage) in 2.5 increments. The average SUS score is 68, and anything under 68 would mean the usability of the technology may need improvements. SUS does not require a large sample size to get reliable and valid results [4]. UMUX-Lite is a two-item questionnaire that tests perceived usability with scores ranging from zero to a hundred. UMUX-Lite uses a regression equation to calculate a score and compare it to a SUS score. Some findings showed that UMUX-Lite has similar reliability to SUS [5]. Therefore, it seemed suitable to use these two tools for this research study.

Along with the SUS and UMUX-Lite questions, there are three open-ended and four multiple-choice questions for the survey. The survey questionnaire was self-administered for the nurses. There were 19 questions total on the survey, and it took approximately five minutes to complete. The four multiple-choice questions were demographic information such as the participant's position, years of experience as a nurse, years employed at the current facility, and years of experience with the Omnicell machine. Personal information such as email, name, or birth date that could identify the participant were not asked in the survey to maintain confidentiality. The three open-ended questions were to gain more personal feedback from nurses on what they like about Omnicell, what could improve, and why they think inventory is off balance. Also, when we were destocking or restocking medications at the facilities, we observed how often the drugs are misplaced and why they may be displaced in the incorrect bin to assess accuracy for medication administration.

Statistical analysis

The results for the data are displayed using tables, graphs, and pie charts from excel spreadsheets as appropriate for the data type. The quantitative data came from the primary sources: SUS, UMUX-Lite, and multiple-choice questions that the nurses self-complete about Omnicell's usability and the nurse demographic. It also came from the secondary source at the pharmacy that auto-generates the discrepancy/inventory reports. The qualitative data came from the open-ended survey questions distributed to the nurses. It would also include any observations regarding misplaced drugs at different location bins. Those observations were recorded manually and then transferred electronically for documentation.

Results

Observation Study

The results of the observation study came from what the primary investigator physically saw at the three skilled nursing facilities on misplaced drugs in the Omnicell. Since the primary investigator scheduled visit for each facility is on different days, she recorded her observations in writing from the week of October 4, 2021, to the week of November 15, 2021, and transcribed the data electronically afterward. The results showed misplacements due to the same drug name with a different dosage strength, location inconvenience (ex: a drug is located too far below eye level), and bin adjacent to the selected drug bin has a drug that looks similar in color. A common factor is the simple human error of not looking carefully. **Figure 1** shows some of the findings in more detail.

Observation of misplaced Drugs
Found 6 capsules of an antibiotiv drug misplaced in the bin beside it. However, the inventory count was correct I cycle counted. Drug was probably misplaced in to wrong bin after entering the quantity on the screen promt and taking out the required amount of that drug for the patient. Also same color as the drug inside the adjacent bin.
Found on two different associations where an IV drug was misplaced in a different IV bin while I was restocking medications. The IV drugs are typically located on the very bottom cabinet of the Omnicell. I previously saw a nurse put back on IV drug without bending to see where the green indicator light was. This could be the cause of why IV drugs can be misplaced in the bin beside it's designated location.
Found tablet of a medication with the same drug name but different drug strength in one bin. Could not figure out why it was in the wrong bin because I checked to make sure both drugs were not assigned to the same drawer. Each drawer generally contains many bins with a different medications assigned in each bin. And most of the time, a drug with the same name but different drug strength would be assigned in a different bin in a different drawer to minimize misplacements.

Figure 1: The Observation Findings of the Misplaced Drugs.

Survey questionnaire results

Ten nurses completed the survey with their demographic information such as their position, years of experience as a nurse, years employed at the current facility, and years of experience with the Omnicell machine presented in **Table 1**. The majority of the nurses were LPNs (80%, 8/10), and the rest were RNs (20%, 2/10). Half of the surveyed nurses had 16 years or more experience in their field (50%, 5/10). The second majority had 1-5 years of experience (30%, 3/10). The rest were 10% (1/10) with 6-10 years of experience and 10% (1/10) with 11-15 years of experience. None of the nurses had less than a year of ex-

perience. Although half of the surveyed nurses had 16 years or more experience in their field, 70% (7/10) of the nurses had only 1-5 years of experience with Omnicell, and 30% (3/10) had less than a year of experience with Omnicell. Half of the surveyed nurses have only been working at their current facility for 1-5 years. The rest are either new, with less than a year of experience (30%, 3/10), or old with 16 years or more of experience (20%, 2/10).

The statement questions consist of ten SUS questions and two UMUX-Lite questions **(see the appendix).** The calculated SUS scores and UMUX-Lite scores are in **Table 2**. The percentages of satisfied and dissatisfied users of Omnicell based on the SUS scores (users had SUS scores ≥ 68 were satisfied, and users had SUS scores < 68 were dissatisfied) showed using a pie chart in **Figure 2**. Overall, 90% of the surveyed nurses were satisfied with the usability of Omnicell, and 10% were dissatisfied.

The majority of the surveyed nurses strongly agreed that they would like to use Omnicell frequently (80%, 8/10). They found it easy to use to perform their tasks (80%, 8/10), found the functions well integrated (80%, 8/10), felt confident using it (80%, 8/10), felt it met their requirements in functionality (80%, 8/10), and found it quick to learn (50% strongly agreed, 50% agreed).

Many of the surveyed nurses did not find that Omnicell was complicated to use (results supported by 50% strongly disagreed, 40% disagree to complications). The majority strongly disagreed that they would need tech support to operate Omnicell (70%, 7/10) and strongly disagreed that it was inconvenient to use (70%, 7/10). They did not find Omnicell inconsistent in its usage (results supported by 50% disagreeing, 30% strongly disagreed to inconsistencies). There was 10% neutrality for statements about Omnicell's complication in use, easiness in performing their task, needing technical support, how well its functions integrated, and how much inconsistency they think the functionalities had.

There were three open-ended questions, and the results are in **Table 3**. The nurses' perception of Omnicell's usability does not seem to support the observations found with the misplacements of drugs inside Omnicell since the majority perceived the usage positively. However, their answers to the open-ended questions showed that the nurses need more training, and the barcodes/scanners need fixing.

Optimization of Omnicell started the week of October 4, 2021 and continued onward. Optimization included removing infrequently prescribed drugs from Omnicell, meeting the par level accordingly to fit the demands of each facility, resetting the scanners to improve accuracy, and assigning new barcode stickers for the bin that were torn off or worn out. The discrepancy/inventory reports auto-generated to the pharmacy from August 23, 2021, to October 3, 2021, showed more discrepancy transactions than the reports generated from October 4, 2021, to November 15, 2021, for Manor Care Rehab Center-Marietta and Manor Care Rehab Center - Decatur. However, Anderson Mill Health and Rehab Center showed more discrepancies from October 4, 2021, to November 15, 2021. The number of discrepancy transactions is in **Figure 3, Figure 4, and Figure 5** for each facility.

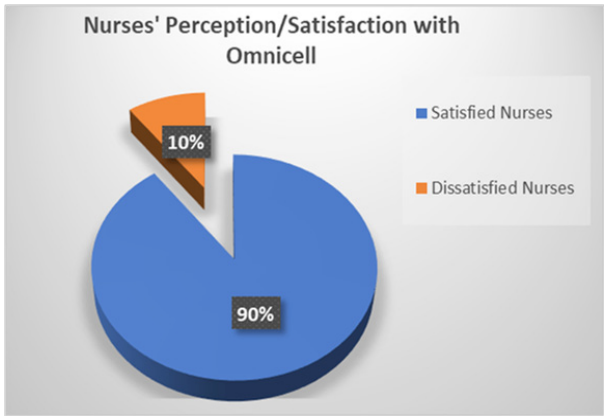

Figure 2: Nurse Perception/Satisfaction Based on SUS.

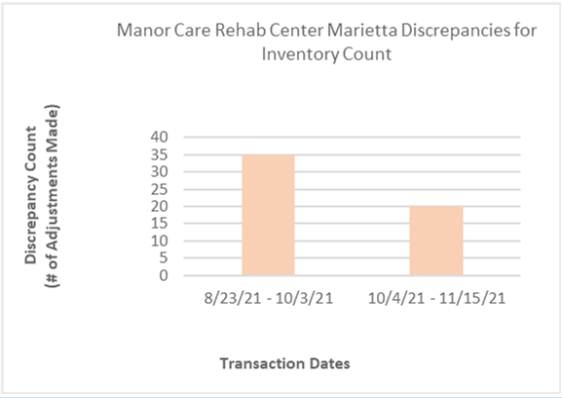

Figure 3: Manor Care-Marietta Discrepancy.

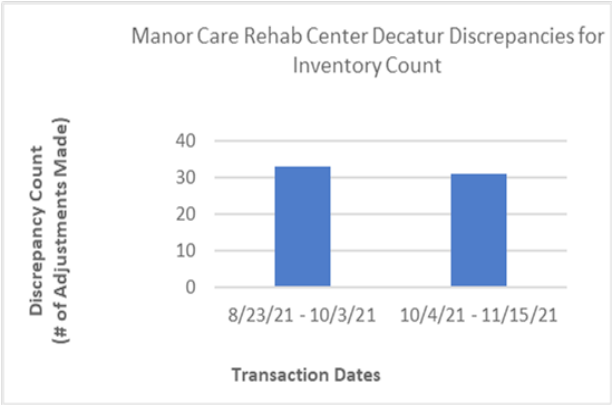

Figure 4: Manor Care-Decatur Discrepancy.

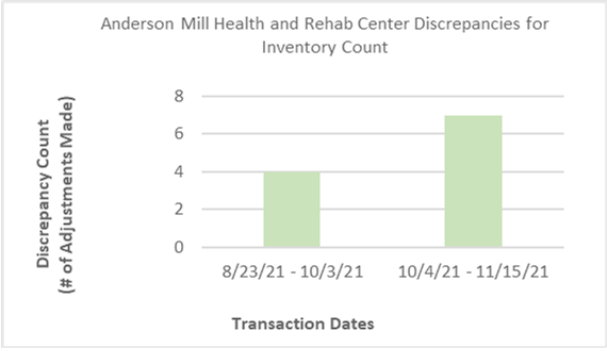

Figure 5: Anderson Mill Discrepancy.

Discussion

Nurse satisfaction

The response rate was 100 percent because we used convenience sampling to collect the surveys. Using SUS scale, all nurses but one seemed to be satisfied with Omnicell's usability as **Table 2 and Figure 2 show**. Looking further into detail, that that nurse was still considered new to their current facility and needed more experience with Omnicell. Half of the surveyed nurses stated that Omnicell was convenient, and the other half liked that it was easy to use. However, due to high turnover in nurses (due to COVID), their experience may not be the best because they need more training, as 20% answered **(Table 3).** Half of the surveyed nurses have 16 or more years of experience as a nurse, but Omnicell is still new to them compared to the other knowledge they have accumulated over the years. The current study results have supported previous studies that concluded that Omnicell is very convenient. Using this technology correctly and after proper training of the Omnicell users has improved patient safety, and it has augmented medical team members' satisfaction and attitude by having the correct medication for the right customer at the right time effectively and efficiently [6-9]. A study showed that the automated cabinet dispensers improved the staff members', nurses', and pharmacists' workload and efficiency [10].

Optimization of omnicell

The results showed many nurses found Omnicell's functions well-made but stated differently in the open-ended questions when asked for suggestions on improving accuracy. However, if speaking specifically on what to optimize for Omnicell, the barcodes and scanners needed fixing or resetting **(Table 3).** When barcodes or scanners do not work, nurses could choose the wrong drug, which could be dangerous for the patient. The current study results supporting the previous studies, which supported the integration of the ADCs with multiple technologies such as effective and stable barcoding technology. This integration has had an improved outcome and has successfully supported the prescription and treatment process [11-17]. Adjusting the par level helped the bins from overflowing with too much of a specific drug to help manage inventory. This result supports the results of a study published in 2016 concluded that efforts to optimize ADCs through par level optimization increased ADCs end-users' efficiency, saved the monetary and labor resources, and maximized the medication mechanism [2].

Figure 3 and Figure 4 support and show that optimization decreased discrepancies for inventory count at Manor Care – Marietta and Manor Care -Decatur. **Figure 5** showed more inventory discrepancies after optimization, but it could be because they hired new nurses, and most of them obtained accessibility and login for Omnicell after optimization took place.

Even though an extensive training was a common suggestion from the surveyed and interviewed nurses to improve the automation medication process, a study published in 2021 finds that training and calls for compliance have limited impact in resolving all the ADC issues and challenges. The same study suggested that the nurses' information needs should be understood and addressed very carefully. The study also recommended that each health facility or department should apply the suitable drug dispensing model that suits its own clinical need [18].

Study limitations

The observation period is questionable because the primary investigator not at each facility a fair amount. So, the things she saw may happen by chance when she was visiting. There could be more misplacements on days that she did not visit. However, the primary investigator have seen fewer drug misplacements after optimizing the barcodes, scanners, par level, and removing/deleting infrequently prescribed medications from Omnicell. Although our study cannot represent the whole nurse population who use Omnicell, optimization has shown fewer medication errors in the accuracy of drug administration in skilled nursing facilities. It was tough to get more detailed opinions from the nurses because of the lack of staff, increased turnovers, increased new hires, and increased demands for patient care. The primary investigator tried to interview them verbally after the survey when she saw the detail of the answers. Nurses did not have enough time to complete their work and therefore did not spend time adequately completing the surveys. With all these factors in place, more training seems to be the most feasible thing to do to help with inventory count caused by human error. But without enough staff, this would take time away from the limited nurses at the facility to train others when they could be doing more patient care work. Maybe Omnicell vendors can invest in a talking automated dispensing cabinet for the future. It could guide new users through each step to help them learn by themselves. And, if a user forgets to scan or misreads the screen prompts, the machine would talk and say the quantity aloud without disclosing patient information.

Conclusion

Omnicell provided flexibility for nurses. They found it convenient to access drugs when they needed them, and it was easy to use. Although optimization did help with accuracy for medication administration, it was difficult to determine if it had majorly impacted inventory control. The surveys showed that usability was not a problem for the nurses and that the majority had a positive perception of Omnicell. The machine was not the problem for inventory count discrepancies. From the survey results, Omnicell's usability did not correlate with the issue in inventory count. However, the constant changes in nurses or schedules did not give enough time for the staff to learn or use the machine properly and optimally. Overall, the nurses need more training, and it would be more efficient if Omnicell could invest in a feature that talks to the nurses when using it. This upgrade could prevent more errors from screen prompts and save nurses time training others. As a result, it can provide more time for patient care and less time wasted by the pharmacy to fix discrepancies at each visit.

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Conflicts of interest: None declared.

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Appendix
Optimizing the Usability of Automated Dispensing Cabinets and the Optimization Impact on the Nurse Performance and Technology Adoption: The Survey Questions
1. Current position in facility
a. LPN
b. RN
c. Other form of specialized nurse (specify: _____)
2. Years of experience as a nurse
a. Less than 1 year
b. 1 – 5 years
c. 6 – 10 years
d. 11 – 15 years
e. 16 or more
3. Years employed at current facility
a. Less than 1 year
b. 1 – 5 years
c. 6 – 10 years
d. 11 – 15 years
e. 16 or more
4. Years of experience with Omnicell machine (automated dispensing cabinet)
a. Less than 1 year
b. 1 – 5 years
c. 6 – 10 years
d. 11 – 15 years

e. 16 or more
(Please answer to the best of your ability for the following questions below)
5. I think that I would like to use Omnicell (the automated dispensing cabinet) frequently
□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree
6. I found the Omnicell unnecessarily complicated to use.
□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree
7. I thought the Omnicell was easy to use to perform my task.
□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree
8. I think that I would need the support of a technical person to be able to use the Omnicell.
□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree
9. I found the various functions in the Omnicell were well integrated. (Ex: screen prompts, barcode/QR scanning, inventory monitoring, green light indicator, lidded compartments, etc.)
□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree
10. I thought there was too much inconsistency in the Omnicell. (Ex: screen prompts, barcode/QR scanning, inventory monitoring, green light indicator, lidded compartments, etc.)
□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree
11. I would imagine that most people would learn to use the Omnicell very quickly.
□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree
12. I found the Omnicell very inconvenient to use.
□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree
13. I felt very confident using the Omnicell.
□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree
14. I needed to learn a lot of things before I could get going with this system.
□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree
15. Omnicell's capabilities/functions meet my requirements.
□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree
16. Omnicell is easy to use.
□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree
17. If you found the use of Omnicell inconvenient, please explain why or suggest what can be improved to help with your experience/performance.
.....
18. What do you like about the use of Omnicell or its functions?
.....
19. With the functions/safeguards integrated into Omnicell, why do you think there are still drugs misplaced/miscounted using Omnicell, and what do you suggest can help improve the accuracy? (Ex: limited staff, need more training, scanner/barcode issue, non-ideal assigned location of a drug, other.
.....