

Implementation of an Electronic Medication System in a large tertiary hospital: A case of qualitative inquiry

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Abstract

Introduction There is a growing interest in the use of technology in the health sector in Australia. Hospitals across Australia are implementing Clinical Information Systems (CIS) e.g. Electronic Medication Systems (EMS) at a rapid pace to moderate health service delivery. The implementation of an EMS is crucial in a big hospital organisation. The benefits of the EMS depend on the acceptance of the system by the clinicians. The study hospital used a unique patient-centric implementation strategy. This paper aims to study the factors facilitating or hindering the adoption of EMS as viewed by clinicians and the implementation team. **Method** Four focus group, one each for 1) doctors, 2) nurses 3) pharmacists 4) implementation team were conducted. A guide for the focus group was created based on the Unified Theory of Acceptance and Use of Technology (UTAUT). **Results** A total of 23 unique codes were identified and were grouped into five main themes 1) Implementation strategy 2) Organisational outcome of EMS 3) Individual impact of EMS 4) IT product and 5) Organisational culture. Clinicians reported improvement in their workflow efficiency post-EMS implementation. They also reported some challenges in using the EMS that centered around the area of infrastructure, technical and design issues. Additionally, the implementation team highlighted two crucial factors influencing the success of EMS implementation, namely: 1) the patient-centric implementation strategy, and 2) the organisation readiness. **Conclusion** Overall, this study provides substantial evidence of the use of the behavior theory of UTAUT in explaining the implementation process of EMS in a large healthcare facility by using clinicians' and the implementation team's perspectives. A unique implementation strategy with the patient-centric approach and clinical leadership in the implementation team played a crucial role in clinicians' acceptance of the EMS. Perceived and realised benefits helped clinicians to form a positive attitude in the adoption of EMS. On the other hand, general training instead of customised training based on local needs, technical and design issues and lack of availability of computer systems can act as a barrier to the adoption of the system. Promptly resolving these issues can improve the adoption of the EMS.

Introduction

There is a growing interest in the use of technology in the health sector in Australia. Recently, the Australian government framed National Digital Health Strategy in 2017 (1). The strategy acknowledges digital health as a priority for the Australian health care system and outlines seven strategic areas for improving health outcome and service delivery. Some of the strategic areas include providing greater access to healthcare across Australia, supporting the efficient health system, and digitally enabled models of care and centralising patient information (1). As a result, hospitals across Australia are implementing Clinical Information Systems (CIS), e.g. Electronic Medication Systems (EMS) at a rapid pace to moderate health services.

Various benefits of EMS have been reported in previous studies, such as improving organisational efficiency, reducing medication errors, and minimising the cost of medication management processes (1–8). Furthermore, studies suggested that EMS improved the efficiency of medication management

processes by reducing the time between prescription and administration of antibiotics to the patients (9,10).

The benefits of EMS are much dependent on how well clinicians embrace the new system. They are the key stakeholders to influence the success of the transition from the paper system to an electronic system. Earlier research found that nurses and physicians perceived the EMS beneficial as it improved their workflow and efficiency (11,12). On the contrary, other studies suggest that EMS can lead to the introduction of a new type of errors (13,14), increased workload among the clinicians (15), loss of productivity (16) and a clinician burnout (16,17). Previous studies have reported a number of human factors that can affect the adoption of the system including clinician's perceived ease of use and usefulness of the system (18), clinician's knowledge of the system (19), confidence in using the system (19), user involvement (20) and socio-technical aspect of the system design (21).

Furthermore, the role of the implementation team is critical during the implementation of EMS. While most research studies focus on understanding the clinicians' perspective in using the system, little research has focused on understanding the implementation team's perspective (22). Implementation team forms the implementation strategy and oversees the process of implementing the new system (23). Their experiences can provide valuable insight into understanding the implementation process.

Therefore, this research aims to study the factors facilitating or hindering the adoption of the EMS from clinicians' and the implementation team's perspective on the EMS implementation based on patient-centric implementation strategy.

PATIENT-CENTRIC IMPLEMENTATION STRATEGY

Development of a comprehensive implementation strategy plays a vital role in the success of EMS implementation. By and large, healthcare organisations use two prominent methods of EMS implementation: 1) Big Bang approach and 2) Phased (staged) approach (16,24,25). Both of these methods have their challenges. The big bang approach requires rapid change, increased system testing and large support team to help the users during the implementation process (24). On the other hand, the phased approach creates hybrid medication charts (paper and electronic charts), workflow interruptions and prolong time to implement the system (24).

Keeping in mind the limitation of these two implementation approaches, the EMS implementation team at the study hospital introduced "patient-centric implementation" strategy (24). The implementation team had clinicians from various discipline as a part of their team. Moreover, a toxicologist and ED physician was the clinical lead with a keen interest in medication safety. The strategy was based on the guiding principle of "one patient, one chart". Each new patient started on the EMS from day one of the implementation, and existing patients stayed on paper charts (24). This patient-centric approach avoided hybrid medication charts being used for the same patient, thus minimising the risk of medication errors.

CONCEPTUAL FRAMEWORK

Various theories have been used in the literature to explain the users' intention to use and actual use of the IT system in healthcare. The theory of reasoned action (TRA) and the theory of planned behaviour (TPB) has been used to understand behaviour intention and actual behavior (26,27). TPB is an extension of TRA where individuals do not have complete control over their behavior (27). According to this theory, human behaviour is guided by three beliefs: 1) behavioural belief (User's attitude) about likely outcome of the behaviour, 2) normative belief (Subjective Norm) about the normative expectation of others and, 3) control belief (perceived behavior control) about the internal and external factors that can facilitate or impede the performance of the behavior (27). User's Attitude (A), Subjective Norm (SN) and perceived Behavior Control (BC) (27) in using the new system can influence the acceptance of the new system. In a big organisation, many external factors are beyond user's absolute control (e.g. selection of the system, patient-focused implementation strategy, executive support, standards of practice, organisational culture, the training, the support provided to users and so forth) and this might influence user's BC.

Based on TRA, TPB, and six other theoretical models, Venkatesh (2003) suggested the Unified Theory of Acceptance and Use of Technology (UTAUT) to explain technology acceptance. To understand clinicians' attitudes in accepting the EMS implementation, UTAUT (26) was used in this study. UTAUT helps to explain how performance expectancy and effort expectancy (behavioural belief), social influence (normative belief) and facilitating conditions (control belief) affect behaviour intention and user behaviour (Figure 1). The focus group protocol (Appendix 1) adopted the four core constructs of the UTAUT model, namely: 1) Performance Expectancy, 2) Effort Expectancy, 3) Social Influence, 4) Facilitating Conditions.(26)

Figure 1: Unified Theory of Technology Acceptance and Use of Technology (23)

Method

Setting

The EMS was implemented in one of the major tertiary teaching hospitals in Sydney, Australia. The study hospital is part of the local health district, which serves the population of more than 2 million people. The hospital had a capacity of 480 acute inpatient beds and had 50,000 ED presentations annually when EMS was implemented.

The study hospital was the lead site for the Electronic Medical Record (EMR) implementation in New South. It was also the first site to have full EMR utilisation before EMS implementation. The EMS was implemented on 28th February 2017 in all clinical areas except Intensive Care Unit (ICU) (24).

Ethics for this study was obtained from the XXX Local Health District Human Ethics Committee (No. AU RED LNR/16/WMEAD/359).

Participants

Focus group sessions were held in the first few weeks of the implementation. The maximum variation sampling method was used to recruit participants from various clinical areas across the hospital. Staff from various clinical areas including Emergency Department, aged care, surgery, medicine, cardiology, respiratory and cancer units participated in the focus group. Participants consisted of various age groups and with various level of work experience. All participants were given a coffee voucher as an appreciation for their time.

Interviews & Questions

The focus group guide was created based on the UTAUT(26) framework (Appendix 1). Semi-structured questions were asked based on this theme guide. The average duration of the interview was 60 minutes.

Interviews were facilitated by both an academic (SP) and a PhD student (MV). The academic has more than 20 years of experience in the evaluation of health information technology. The academic was assisted by a PhD student in note keeping and recording of the interview. The PhD student worked as a registered nurse for over ten years in the acute facility and with five years of research experience. We felt that it was essential to have a team of academic and a clinician who can complement each other with their respective skills and avoid the bias and possibility of reflexivity in the interview process.

Interview sessions were organised according to staff preference and availability. Participants' consents were obtained before the interviews. The objective of the study, interviewers' role in the study and participants' right to withdraw from the interview were explained to participants at the start of the interviews. Staff were introduced to the researchers and made aware of the recording of the interview for the research purpose while assuring the confidentiality of their views.

Data Processing and Analysis

All interview recordings were stored on a secured computer. Interviews were transcribed by two PhD students and two research students. Each transcript was reviewed by one academic staff to validate the text as well as identify and remove any discrepancies. Three research students developed the codes from the transcripts independently. The research process is outlined in Figure 2.

Figure 2 Research Process

Thematic Analysis (TA) of the transcript was performed using NVivo software (28). TA is widely used in qualitative research. TA is a method to identify and interpret the qualitative data using themes and codes (29). Codes are blocks within the data set with the pattern of meaning with similar underpinning concept. Themes are abstract and represent the meaning within the dataset about the research question (30). A team of seven members consisting of academics, IT students, PhD students and a clinician met weekly

to review the codes and discuss any discrepancies. The differences in the codes were resolved after discussions and consensus, thus establishing inter-rater reliability (31). This diverse group of people fostered multidisciplinary learning and broadened their perspective in the area of Health and Information Technology implementation.

Results

Twenty-three unique codes were identified and were grouped into five main themes: 1) Implementation Strategy 2) Organisational Outcome of EMS 3) Individual impact of EMS 4) IT product 5) Organisation Culture (Table 1). More detailed descriptions of the themes, subthemes and quotes is included in Appendix 2.

Table 1 Themes, Subthemes and Quotes

Theme	Subtheme	Quotes
Implementation Strategy	<ul style="list-style-type: none"> Support during the implementation Training User engagement/ownership/involvement Administrative support Infrastructure Super-users Communication among the support staff Capacity building 	<ul style="list-style-type: none"> "I find the helpline really useful as well. I have called them like five times, I think. They are really helpful." (P7) – Subtheme: Support "I think the big thing is that we had that governance that supported us. We had that leadership from the executive level from the beginning." (IT1) – Subtheme: Administrative support "They (Clinicians) were heavily involved in that build process. There was an endocrinologist to put his hands up to help. He was heavily involved, and some of the nurses were involved as well. They accepted the system even prior to our go-live." (IT1) – Subtheme: User engagement
Organisational Outcome of EMS	<ul style="list-style-type: none"> Legibility and information completeness Alerts and Prompts Access to the system Visibility of information Workflow 	<ul style="list-style-type: none"> "The EMS is useful because the medication orders are a lot clearer and we can read them easily." (N2) – Subtheme: Legibility and information completeness "I know it is quite useful to be anywhere in the hospital, I mean if you are in ED and you would have to come all the way up to level six or seven, it is a big deal. So, it really helps in that sense too." (D2) – Subtheme: Access to the system
Individual impact of EMS	<ul style="list-style-type: none"> Change in the way of working Accountability Self-efficacy 	<ul style="list-style-type: none"> "That is right, you know whom to contact if there is an issue with a dose whereas before when you ring and say "I never charted that", but (now) at least you can read on the top and see who charted it". (P3) – Subtheme: Accountability
IT product	<ul style="list-style-type: none"> Design and Build process (Process Design) Design issues (System Design) Technical Issues Workarounds 	<ul style="list-style-type: none"> "That's the only thing that's a bit confusing if you do not read the full order sentences you would not know if it is paracetamol or paracetamol with codeine." (N2) – Subtheme: Design Issues "Our other barrier is mainly to do with listings of product that do not match with what we have got and having to do

		all these unnecessary steps of having to change the products.” (P3) – Subtheme: Technical Issues
Organisation Culture	<ul style="list-style-type: none"> · Organisational readiness · Communication with colleagues · Cultural factors 	<ul style="list-style-type: none"> · “I think the facility has the right culture, and this is only something this hospital just brings itself to make changes to be innovative, develop and work around the new system and develop strategies.” (IT1) – Subtheme: Organisational readiness

Implementation Strategy

As mentioned earlier, the implementation strategy used was centred around “patient-centric” approach where a patient was commenced on the electronic medication chart upon their arrival to the hospital and stayed on electronic medical chart throughout their journey in the hospital (24).

Overall, clinicians gave positive feedback about the implementation strategy, e.g. the support during the implementation, the training and user engagement.

· Support during the implementation

Support was available in each unit round the clock in the first two weeks during the implementation. Apart from the support staff, the dedicated helpline was made available for the clinical staff if they face any difficulty with the system. Participants perceived the availability of support staff and helpline was useful.

“I find the helpline really useful as well. I have called them like five times, I think. They are really helpful.” (P7)

· Training

The training was provided to all clinicians in two parts. At go-live stage, 79% of doctors, 68% of nurses/midwives, and 90% of pharmacists were trained in the EMS system(24). Although participants found the training was useful and adequate, they suggested more specific scenario-based training and simulation-based training would help them in using the EMS more effectively.

“I would also suggest that some stimulation training sessions on how to use the system before using the real system would be helpful.” (P2)

· User engagement/ownership/involvement

User engagement in adopting the new system is important in the implementation of the system. Implementation team highlighted strong clinical lead, and team member with a strong clinical

background made the stakeholder engagement easy due to their established relationship with their respective disciplines.

"They (Clinicians) were heavily involved in that build process. There was an endocrinologist to put his hands up to help. He was heavily involved, and some of the nurses were involved as well. They accepted the system even prior to our go-live." (IT1)

The implementation team also highlighted the role of administrative support from the top of the organisation made the implementation easy.

"I think the big thing is that we had that governance that supported us. We had that leadership from the executive level from the beginning." (IT1)

· Infrastructure

Participants felt that the infrastructure was not adequate to catch up with their daily tasks in EMS in some areas. Nurses were concerned as there were not enough Workstations on Wheel (WOW) in high activity areas like the Emergency Department.

"The Work Stations on Wheels (WOW) are not always available for us to wheel around, it is just time-consuming sometimes, just because of the one computer that's available there. (N2)

The organisational outcome of EMS

This theme outlines the benefits perceived by the participants with the new system. The perceived benefits that improved user acceptance and reduced their resistance of using EMS include improved legibility, information completeness, alerts and prompts, access to the system from anywhere and improved visibility of medication information.

· Legibility & information completeness

Participants perceived the legibility and information completeness as a key benefit from the new system. Participants perceived the legibility medication orders as the most significant benefit of EMS.

"The EMS is useful because the medication orders are a lot clear and we can read them easily." (N2)

· Alerts and prompts

Participants felt that various features of the EMS, e.g. alerts, prompts and ability to create a folder with most commonly charted medications were helping them to do their task more efficiently.

"Emergency Department has made a folder of the most commonly used medications list (in EMS), and you can choose from there. Each department is trying to make its own list to save time while ordering medications." (D2)

Participants also mentioned that the auto-population of the medication information was helping them in their tasks.

"I felt like after-hours shifts, you know you get four or five times we have to re-chart meds, that is saving it five to ten minutes per chart. I have found my after-hours shifts much, much more manageable as a result." (D4)

- Access to the system

The EMS system was accessible from anywhere in the hospital. Participants mentioned that the new system saves time as they do not need to go to the different parts of the hospital physically.

"I think it does help. I know it is quite useful to be anywhere in the hospital, I mean if you are in ED and you would have to come all the way up to level six or seven, it is a big deal. So, it really helps in that sense too." (D2)

- Visibility of medication information

The new system improved the visibility of the medication information for clinicians. Pharmacy staff felt that they could prioritise their task based on the needs as they have better visibility of the information due to the new system.

Individual Impact of EMS

Two themes of the organisational outcome of EMS and individual impact of EMS were differentiated based on the benefits perceived to organisations and the individual staff, respectively.

Participants felt that the system has made everyone more accountable for their tasks as now there is a trail of the person who has performed specific tasks.

"That is right, you know whom to contact if there is an issue with a dose whereas before when you ring and say "I never charted that", but (now) at least you can read on the top and see who charted it". (P3)

Additionally, pharmacists mentioned the verification of the medication order was challenging in the new system.

"Because of our expanded role in the computerised verification of all the medication orders, for those pharmacists who actually have to go to see the patient and take a history, it becomes the time factor". (P2)

IT Product

This theme outlines the codes related to the design and the build process (Process Design), design issues (System Design), and technical issues in the EMS system.

Implementation team outlined the benefits of having the contents ready from the previously implemented EMS in other sites.

“So we looked at what the other sites had done and made it (the system) better basically.” (I7)

Clinicians mentioned some issues they faced with the design of the system. Nurses mentioned the possibility of errors when prescribing/reviewing the medications with similar names.

“That’s the only thing that’s a bit confusing if you do not read the full order sentences you would not know if it is paracetamol or paracetamol with codeine.”(N2)

Apart from system design issues, participants also faced some technical issues with the EMS. Pharmacist highlighted the issue of the medications that were not listed on their catalogue.

“Our other barrier is mainly to do with listings of product that do not match with what we have got and having to do all these unnecessary steps of having to change the products.” (P3)

Pharmacy staff also mentioned that the view of the medication lists was hindering their efficiency as the list of active medication was mixed with the cancelled and discontinued medications as well as some of the functionality in the system are American practice-based not aligned according to the local practices.

“The system basically is based on the American system, so the functionality is not made for the Australian pharmacists. So many functions inside (the system) are not necessary. It just creates confusion and then duplication.” (P14)

Organisation Culture

Implementation team mentioned the organisational readiness of the hospital being instrumental in the EMS implementation.

“I think the facility has the right culture, and this is only something this hospital just brings itself to make changes to be innovative, develop and work around the new system and develop strategies.” (IT1)

The EMS also had an influence on the way clinicians interact with each other. Nurses mentioned that they do not see the pharmacists a lot in the ward post-EMS implementation, but they felt that the job was still getting done.

Discussion

This study outlines several factors that can facilitate the success of EMR adoption in a large hospital setting. First, the implementation strategy played an essential role as a facilitator in clinicians’ acceptance of the EMS. Patient safety is one of the core focus for clinicians while they provide care to patients. This core belief was embedded in the implementation strategy. The well-thought-out approach of “one patient – one chart” gave ample time to the users to learn and adapt to the new system while

avoiding the hybrid charts as well as workflow interruptions, maximizing users' BC. By avoiding the use of hybrid charts, clinicians felt that patient safety is not compromised during the implementation phase, which is consistent with their core belief thus having a positive attitude towards the adoption of the system.

Second, the support provided during the implementation was a critical factor in clinicians' acceptance of the new system. Although, IS implementation literature explains the relationship of the support in improving user acceptance of the EMS (19), the type of support provided is also important. In the study hospital, comprehensive support structure (e.g., the availability of the support staff 24/7, dedicated helpline and availability of technical staff to resolve any technical issues promptly), during the implementation of the system, impacts on how well supported the users feel. These various efforts taken by implementation team improved the participants' perceived belief of being successful in using the EMS similar to Ajzen's TPB - a person would be more likely to execute the behaviour if he/she is likely to be successful (27).

Third, the presence of clinicians in the implementation team further facilitated user acceptance in using the EMS. The involvement of clinicians in implementation played a critical role in engaging with users as well as hospital executives to bring them on board during the change process. Clinicians felt comfortable to engage with the implementation team as they felt they talked in the same language. This clinical leadership within the implementation team may have influenced the clinicians' Attitude (A) and Social Influence (SI) in the favour of using the EMS.

Fourth, the benefits of EMS highlighted by the participants are multifold, e.g. access to the system from anywhere, prompts and alerts, legibility and information completeness of medication orders and availability of all required information in one place. This perceived usefulness and perceived ease of use helped users to form a positive attitude towards using the system.

Fifth, this study found that organisation culture plays an essential role in the implementation of the EMS. The study hospital took various initiatives in digital health domain previously and thus had the culture of adopting new technology. Positive organisation culture towards embracing the new system may have acted as a Social Influence (SI) in facilitating user's BI to use the system as mentioned by Venkatesh (2003) (26). Furthermore, participants experience a change in the type of interaction with other clinicians due to the new system.

Participants also reported users' negative perception in using the EMS. Doctors, nurses and pharmacists outlined the issue of not having enough computer systems in some clinical areas as one of the main barriers in attending their routine tasks. Infrastructure is critical during the implementation of a new system (7), and inadequate infrastructure can pose as a barrier in the adoption of the EMS.

Furthermore, clinicians also suggested scenario-based training instead of general training to prepare them better in using the EMS in their respective clinical areas. Studies in the past have highlighted the

importance of training (4,14,19,21) but more tailored training according to the local needs can prepare clinicians in adapting to the new system quickly.

A significant number of technical and system design factors also influence the rate of user adoption. Although the literature suggests that some technical issues that arise during the system implementation do get resolved and the perception of the users in using the new system do change over time,(32) these issues can further contribute to the new type of medication errors if they are neglected (14).

Furthermore, some of the issues raised by the clinicians (e.g. filling mandatory fields in the EMS) were due to the change process of the system. This perceived loss of autonomy (33) with the new system contributes to the users feeling frustrated. Although clinicians may not like it, it was helping the organisation to monitor the medication process and generate detail reports to see the improvements in the processes. Earlier research found similar results where the managers were benefiting with the new system, but the users had to do extra tasks to input the data (23). The optimisation of the system to streamline the processes as well as conveying the benefits of completing these extra tasks can help the clinicians to perform the task efficiently (23) and improve the adoption of EMS.

LIMITATION

There were four focus groups organised for each group, e.g. nurses, doctors, pharmacists and implementation team. While we had a good representation of the participants in pharmacy and implementation team's focus group sessions, we could not involve more nurses and doctors focus group, and therefore we could not reach data saturation for these two groups.

During the pharmacy focus group, we were only able to meet with all the pharmacists at once and too many participants in the FG session led to some participants not being able to provide their views, and more vocal participants dominating the session.

CONCLUSION

Overall, this study provides substantial evidence of the use of the behaviour theory in explaining the implementation process of EMS in a large healthcare facility by using clinicians' and the implementation team's perspectives. The unique implementation strategy with the patient-centric approach and clinical leadership in the implementation team played a crucial role in clinicians having a positive attitude towards EMS. One of the facilitating condition, namely, comprehensive support provided by the implementation team, was influential in the adoption of EMS. Perceived and realised benefits, e.g. clarity in medication orders, access to the system from anywhere and information completeness helped clinicians forming a positive attitude in the adoption of EMS. On the other hand, general training instead of customised training based on local needs, technical and design issues and lack of availability of computer systems can act as a barrier to the adoption of the system. Promptly resolving these issues can give the volitional control (27) to the clinicians and can assist in the success of the adoption.

Finally, our research adds a significant piece of knowledge to Health and Information Technology literature that the implementation strategy can influence all three domains (Attitude, Social Norm, Behavioral Control) of Ajzen's TRA and TPB (27) and can contribute hugely to the successful adoption of EMS.

Future Research

Our finding of Implementation Strategy strongly associated with A, SN and BC based on Ajzen's TRA and TPB is based on a qualitative research method (focus group interview data). Future research can combine a mixed method study together with a correlational study to produce richer results in improving the utilization of HIT within the healthcare settings.

Declarations

Conflict of Interest: There was no competing interest to carry out this research study.

Funding: There was no funding sought for this research project, and the study is part of PhD these for MV.

Availability of data and materials:

All major data have been presented in the manuscript and in appendix 2.

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Figures

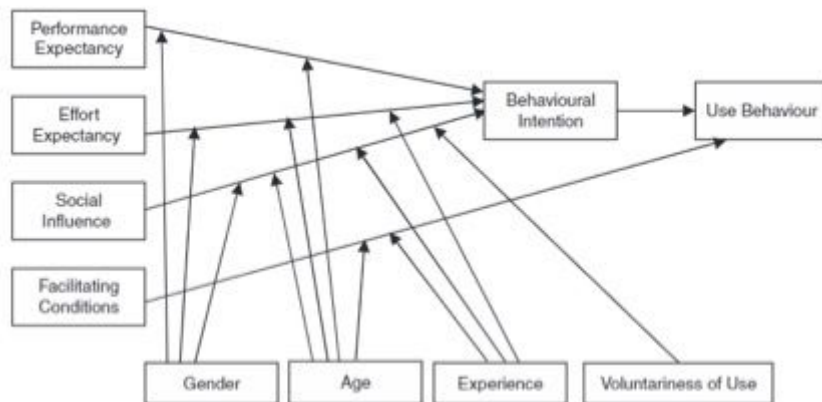


Figure 1

Unified Theory of Technology Acceptance and Use of Technology (23)

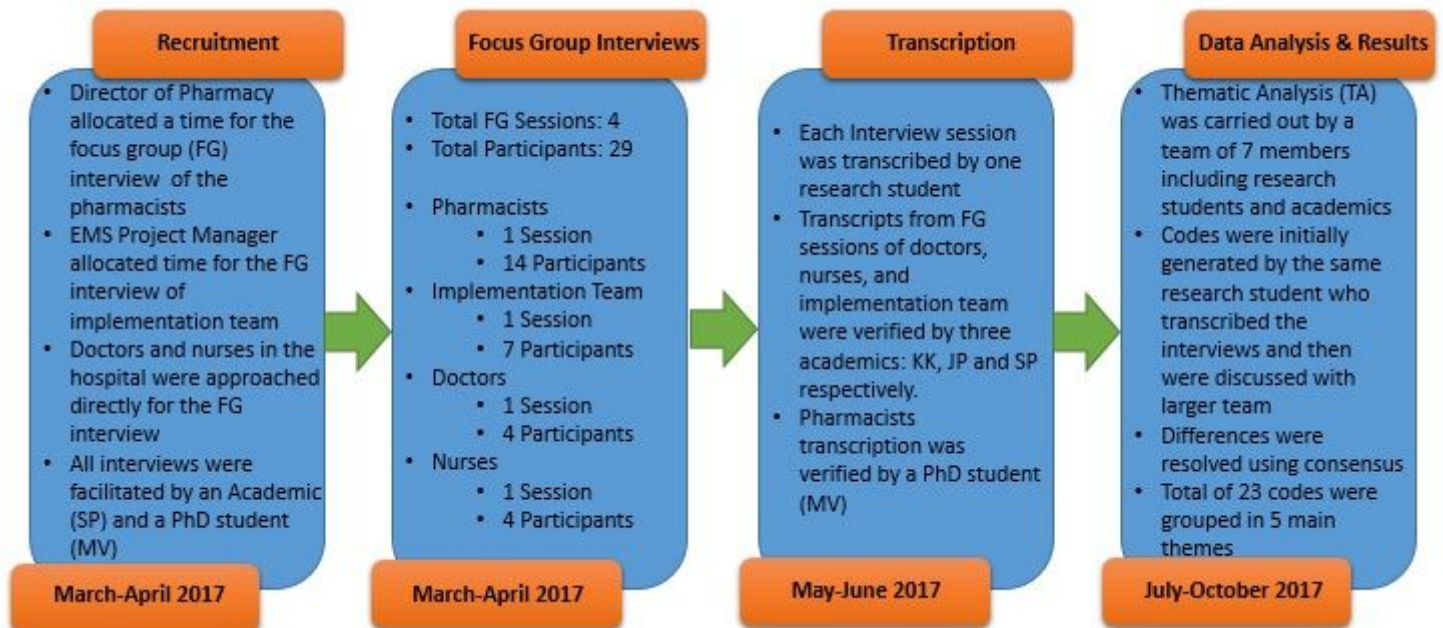


Figure 2

Research Process

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