Evaluation of Clinical Process in Clinical Information Systems using Lean method

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Abstract

Background
There are various applications of Health Information Systems (HIS) that support specific tasks in clinical workflow. To achieve best possible performance, the evaluation of HIS is crucial to ensure that maximum benefits are gained. Lean method has been increasingly used to optimize clinical workflow by removing waste and shortening delivery cycle time of the process. It is very important to make sure about adaption of clinical information system to the clinical process to get the appropriate result. This paper presents the evaluation findings of clinical process related to a clinical care information system known as (Intellivue Clinical Information Portfolio (ICIP)) to pursue redesign.

Methods
We conducted a case study in actual clinical setting to investigate how Lean method can be used in improving clinical process. We used observation, interview and analysis of the workflow to achieve the stated goal. We also applied two tools in Lean, namely the value stream mapping and A3 problem solving method. We used eVSM software to map the value stream map and A3.

Results
We identified a number of problems related to inefficiency and waste in the clinical process and proposed an improved process model.

Conclusions
The case study findings show that the Value Stream Mapping can be used as a tool to identify waste and integrate process steps more tightly. We also proposed a standardized and improved clinical process model. The assessment and redesign of the automated workflow, which includes database, software application and user interface has done based on integrity rules.
Background

The application of information technology in healthcare has significant potential and benefits, particularly with regards to innovations in improving both clinical and administrative processes. Health Information Systems (HIS) support specific tasks in clinical workflow including order entry, resource planning and accounting, and scheduling [1].

The evaluation of HIS is crucial to ensure that maximum benefits are gained as well as assessing the achievement of its objectives in supporting the services of healthcare delivery [2].

Evaluation reports of HIS stated that a range of factors may determine the effectiveness of HIS, such as change management, diffusion of innovation, and workflow, along with other human and cognitive factors [2].

Many studies on clinical process are more likely to show misfit instead of fit between the system and clinical practices. User refuse to use a system if it is not adapted to their routine tasks as implementation of information system in healthcare is a process of mutual transformation [3]. A study reported that 45% of computerized information systems failed due to user resistance [4-6].

It has been reported that clinical workflow support is the highest ranked indicator in the assessment process of IT in hospitals [7-8]. HIS implementation affects clinical workflow, which is also a parameter of the organizational changes. It is essential to evaluate and redesign the clinical process and workflow to ensure its fit with HIS as workflow redesign is needed in order to achieve success in HIS implementation [9]. The extent of redesign is dependent on how much the clinical workflow becomes automated.

Since the 1980’s, quality management methods have been introduced to healthcare organizations. In the last decade, these methods have been used particularly to improve the quality of healthcare including the processes. The selection of these techniques depends on multiple factors such as organizational requirement, objectives and environment as well as available resources and knowledge.
In process redesigning, we can apply a number of methods such as Lean to adapt HIS to a specific clinical setting. [10]. Taiichi Ohno (1988) was the creator of Toyota Production System (TPS), aimed to improve efficiency by eliminating non-value added activities known as waste in the process [11]. This method, which is also known as Lean, is a good option for optimizing clinical workflow as it focuses in detail the process components including workflow and problems as well as it redesign the processes by removing waste [25].

The Lean method eliminates unnecessary intermediate steps, time, and people and retains only those that have added value [12]. Value will be created when wasteful activities are removed or reduced. On the other hand, value would be increased by adding services and features based on customer needs. This aim could be achieved by reducing delivery cycle or shortening delivery batches without incurring additional costs [13].

There are tools and techniques available to enhance Lean concept such as Value Stream Mapping (VSM) and A3 [13-19]. They are clear and objective communication tools that include the knowledge of all workers pertaining to the work process in the value stream. When value stream maps are drawn and A3 documents are written, all specialists and staff can review them. This allows cross-departmental sharing of process changes and generates even more problem-solving ideas.

In VSM, the key people, resources, activities and information flows that are involved in delivering a product or service are graphically drawn. VSM provides a deep understanding of how the work happens now and where the work is not reliable and consistent. VSM is a key tool for identifying opportunities to reduce waste and to integrate process steps more tightly to improve process efficiency [19].

VSM does not only focuses on one single process but also creates a holistic schema of all the process and workflows in order to understand the interdependency of functions, departments and even the whole unit over one another [14]. While VSM is used as a way to see and understand work from a high level view, A3 problem solving uses the same logic but focuses on specific problems with the detail of a microscope [20]. The A3 problem solving method, like VSM, is borrowed from the Toyota Motor Company and adapted to manufacturing
companies in the United States and elsewhere. In order to remove workarounds and reworks, A3 problem solving method was used to improve the value stream [21].

Designing the map solely does not work to identify waste. Once we designed the VSM as a starting point, problems (such as long waiting time between steps or high amount of reworks) can be easily identified and improved. If most of the work done does not add any value to the process, especially to the customers. It should be removed from the process before implementation of HIS, instead of through automation. Hence, identifying all value added and non-value added activities and assessing their impact on the process is essential.

Once the improvements in VSM are identified, the future state of the VSM should be created to show how the process should work if they are redesigned. In redesigning VSM, a smaller number of steps and also a shorter waiting time between steps could be achieved [21]. Hence, applying Lean method during clinical process evaluation related to HIS helps us to have a more accurate view about the process and find errors and waste. We applied Lean method and related tools in actual clinical setting to reduce cycle time and remove waste.

**Methods**

**Research Methodology**
We conducted a case study in order to have a better understanding of the clinical process related to the clinical care information system.

**Data Collection**
We use a number of data collection methods, namely interview, and observation, and data analysis. Site observation of the process allowed us to validate flow of data from the beginning of the process to the end. Over sixteen working days, observation for the pre-anaesthesia process was done after 3 pm as the anaesthetist collects the operation list for the following day to do a physical check of the patient. Therefore, approximately four hours per day during observation spent for semi-structured or unstructured individual interviews and observation.
Study Location
The case study was carried out in an actual clinical setting in the Anaesthesia Department at National Heart Institute (IJN) of Malaysia. A letter to seek permission to conduct the study was granted.

Study Subject and Respondent
We investigated use of the ICIP during pre-anaesthesia process, in particular during pre-anaesthesia physical check. The ten participants were selected among those who involved in the selected workflow; consist of four consultant anaesthetists, two anaesthetists, three clinical specialists and one fellow who was selected based on purposive sampling method.

Data Analysis and Analysis Framework
The collected data were used to design VSM and investigate the application of ICIP in clinical process. We used eVSM to map the stated clinical process. eVSM is a software tool designed to support maps and other visuals commonly leveraged in Lean implementations, including value stream maps. We adapted A3 tool to eliminate waste from the automated clinical workflow to reach to the stated outcome. eVSM also supports A3 tool to design and map the to-be process.

Validity and reliability of the research
In order to ensure the validity and reliability of the research, we collected data from multiple sources as well as multiple respondents. Furthermore, we verified the designed process with the process owner.

Results
The pre-anaesthesia process focuses on activity related to anaesthesia that should be done before the day of patient operation. The anaesthetist records all necessary information during the physical check of a patient. This process includes the following steps: Operating theatre list preparation, Pre-medication process, Patient education, Anaesthesia consent, Anaesthesia planning and documentation.
In this process, the anaesthetists meet each patient who is on the operation list a day before surgery. During the patient visit, an anaesthetist performs a physical check on the patient, as well as reviews of the lab and echo report to provide accurate medication to the patient. All anaesthetists who range from consultant to attachment doctors have access to the ICIP. We can tracked down the system usage according to user log history.

Each anaesthetist has either completed or passed short-term training to use ICIP, or has learned how to use the system by working with another anaesthetists. All anaesthetists mentioned that the level of training was sufficient to work with the system, and that the system is user-friendly enough to work with.

The process starts with a request to visit the patient. It is the responsibility of the anaesthetist to collect the operation list for the following day. After the anaesthetist has collected the operation form, he/she then goes to the ward to visit the patient. Availability of the patient, lab report, room in the ward and PC, need to be considered during the process.

The operation list should be ready by 2 pm before the operation day. However, surgeons are usually too busy to confirm the operation list for the following day, so usually the available time is after 3pm or 4pm. If the list is not ready before 5 pm, the on-call anaesthetist will visit the patient to do a physical check and prescribe accurate medication.

The anaesthetist collects the operation list from a nurse at the ward counter before they go to visit the patient at the ward. A PC installed with ICIP is located in the room within the ward for the anaesthetist to log-in and enter their comments and medication into the system.

Sometimes the PCs are being used by nurses as the number of PCs in the nurse station is not enough to support them in their work. So, when a PC in the room is free, nurses go to the room to use the system. These situations caused a delay for the anaesthetist to visit patient. Sometimes the anaesthetists are not able to use the ICIP due to technical problem in the PC or in the system itself. Usually, when problems occur, there are no technical staffs to solve them. Anaesthetists are already too tired to wait for the system to resume since most of the physical checks are done after 3 pm. So; they prefer to use paper instead of ICIP.
In terms of data completeness, about forty per cent incidents patient demographic data were not entered into the system. So, the doctor has to complete the information himself.

According to anaesthetists, the system is user-friendly enough and does not have any unidentified errors. Information that should be entered onto the form includes the lab report, echo report, pre-operative history, physical and airway examination, anaesthetic plan and risk, pre-operation medication and orders. This information should be available during the time when anaesthetist wants to visit the patient. Most of the time it is ready, but sometimes it is not. All anaesthetists questioned the need for entering data from the lab and echo report into the system as this process is time consuming and anaesthetists have other responsibilities. They argued that somebody else can enter this information. This is the reason why anaesthetist refuses to use ICIP during the pre-anaesthetist process. In general, it is the responsibility of the anaesthetist to verify the accuracy of entered information pertaining to the anaesthesia process. However, they prefer to see verified data when they log-in to the system.

Next, when anaesthetist completes the pre-anaesthesia assessment form, pre-operation medication and orders should be complied by nurse in the ward. The medication and its directions for use are written by the anaesthetist on the paper for the nurse to follow them. In that case the anaesthetist uses ICIP instead of paper, all directions and medication are given to the nurse verbally as the nurse does not have any access to ICIP.

Furthermore, the review of the pre-anaesthesia form is easy as there are only two mandatory fields that must be completed by the anaesthetist.

The outcome of this process is to ensure that patient is physically ready for the operation and followi anaesthetist’s instructions on a day before operation.

In practice, anaesthetists do not follow a standard flow to complete their work. Only one out of ten anaesthetists used ICIP in doing their process, while the rest prefer to use a paper-based system. Some of the anaesthetists complete the hard copy of the pre-anaesthetist form, while the other uses ICIP to write their reports. Also, in ten per cent cases, when the anaesthetist asked about the availability of a patient, the patient was not ready. When the anaesthetist
returned back to check the patient at another time, he found that another anaesthetist came and finished the physical check and nobody notified him about it.

The anaesthesia department performed an assessment on anaesthetist use of ICIP by checking the documents completion, particularly the pre-anaesthesia form. The assessment shows that in 2011, ICIP pre-anaesthesia forms were filled up for 44% in January, 45% in February, 34.6% in March and 69.4% in April.

The information regarding completion of the pre-anaesthesia form refers to after the operation. They just assess the availability of the printed form in the patient file, and not at the time of completion. Many anaesthetists complete the form but they did not print it out to put in the patient file. It means that maybe the anaesthetist completes the form during the operation, and not the day before the operation. So, the assessment result was not accurate enough as the most important thing is that the pre-anaesthesia form in ICIP should be completed on a day before operation.

Furthermore, another reason which helps to explain the evaluation result is that in the Paediatric department, the system is not available to complete the pre-anaesthesia form while visiting the patient.

To better understand of problems and proposed solution, we organized the paper as follows: value stream map of pre-anaesthesia process, problem analysis, fishbone diagram and A3 method to find the root cause of the problem.

**VSM of Pre-Anaesthesia Process**

The as-is VSM of pre-anaesthesia process is depicted in Figure 1. When we consider the time taken by each step to complete as well as the delay between them, we can identify waste in the as-is process. The table in Figure 1 shows the percentage of both value and non-value added time for the whole process. The total non-value added is 83.27%, which is quite high. If we look at the VSM in detail, we can see wasteful areas that caused process delay.
The highest delay occurred at the start of the “pre-operation registration” step, with average time delay of 70 minutes. Furthermore, the average delay between “pre-operation registration” and “pre-anaesthesia check-up” is 10 minutes, which caused total non-value added time to increase.

Next, the average delay between “pre-anaesthesia check-up” and “fill pre-anaesthesia form” is 3.5 minutes, which is due to duplicate data entry or the unavailability of ICIP in terms of technical problem. However, the total percentage of all value added steps is 16.73 %, which is too low for this process. The root causes of problems and waste which increased the total non-value added time in the process is discussed in detail in following sub section.

**Analysis of the problem**

To evaluate the existing process related to ICIP, we identified problems and classified them to find their root causes. We classified the problems in two categories: ‘information technology’, and ‘people’ or ‘human’. Information technology is also classified into two parts; ‘information’ and ‘technology’. To explain clearly, we can state that each part that is related to hardware and software is ‘technology’, and the rest which is related to data is ‘information’.

We explained each problem in detail based on these categories. In the ‘information’ part, we classified problems into ‘collecting’, ‘maintaining’ and ‘organizing’. In ‘collecting’, the identified problems are as follows: Fragmented information, late reporting, incomplete data entry, and delay of lab report.

In ‘maintaining’, the identified problem was repetitive information, such as general information of the patient like name, age. In ‘organizing’, the identified problem was that the information and database between different platforms are not integrated and linked. For example, information from the lab report should be entered into different software and then printed. The printed report should be entered into ICIP manually.

In ‘technology’, we identified two categories of problems which are lack of equipment and technical problems. Lack of ICIP in the Paediatric department is one of the reasons for the anaesthetist ignoring the role of ICIP as a clinical information system in their process. Technical problems are including hardware or software problems.
In ‘people’ or ‘human’, we can classify problems into four categories including lack of integration, standard work procedure, culture and lack of computer knowledge/experience. In details lack of integration between people, lack of technical staff availability in the right time, availability of the patient, availability of the room for pre-anaesthesia check, and a delay in the process is a reason for a lack of integration between people in the process. Furthermore, every person does not work in the same way, which means there is no standardized method of work in the process. Also, it would be difficult to change the way people manage their work with the help of new technology as anaesthetists prefer to use paper in the pre-anaesthesia process as it is faster. The last category was lack of computer knowledge. For example, their speed in typing is too slow. If the PC or software has even a small error which means that the system needs to be restarted, they don’t get involved in that.

After identifying problems and classifying them, we designed a fishbone diagram, which is shown in Figure 2. These problems cause the people who are involved in the process to ignore the role of ICIP in their work. Furthermore, when the information is not integrated between different related departments, it increases human error in data entry. When the activities that are included in one process are not standardized, it increases verbal direction for medication and reduces use of ICIP as all the information is not entered into the system. Furthermore, it causes more delay in the process, as well as increasing waste. As our focus in this research is to apply the Lean method on clinical processes that are related to HIS, we focused more on the workflow to identify waste and remove waste from the process. The next part discusses the existing clinical process and related activities to reduce waste and increase value added activities.

**Discussion**

**Analysis of current state map**
We tried to simplify the processes using as few steps as possible. In examining the steps, the number of connections between people is a clear indication of the complexity of the process. Ideally, all connections should be as direct as possible, with few steps and few people involved in relaying the process request.
Based on Figure 1, the non value-added activities are represented by the deltas. A value stream map illustrates the way (or many ways) the actual work happened and highlights clearly when delays occur. The delay enables us to determine how much of the total time spent in the process is value-added as opposed to non-value-added to the patient. The lowest number in each box reflects the shortest amount of time required to complete the step being measured. Conversely, the highest number in each box shows the most time used for the activities in the box, highlighting an unusually complex set of activities or one in which many interruptions or work-around may have occurred. Again, the lowest number under the delta demonstrates the shortest delay between essential steps and the highest number points to the longest wait.

Once the first view of the problem is seen, we analyze the problems further. In order to find the root cause of the problem, we adopted a root cause analysis to find out the reasons for the problems using the A3 problem solving method.

Problems Identification in Pre-anaesthesia Process

In the as-is process of the pre-anaesthesia, different waste and problems were identified. One of them is waiting waste labelled as ‘number 1’ in Figure 1. The root of this waste is caused by the waiting time for surgeon confirmation. Most of the time, surgeons are busy performing their task in the operation room and do not have time to go out and confirm the following surgery for another patient. As mentioned before, the confirmed list should be ready after 2 pm every day, but there it is always delayed for more than two or three hours before anaesthetist receives the confirmed list.

Another identified form of waste is over-processing and unnecessary activities, which are identified as ‘number 2’ in Figure 1. When anaesthetist goes to the ward to visit the patient, he finds that another anaesthetist had already done the physical check up. This is due to a lack of task coordination, which leads to over-processing.

Another form of waste is waiting time for information or equipment, which is identified as ‘number 3’ in Figure 1. When anaesthetist starts the process of the physical check up, it is essential that the lab,
echo and lung function report are ready and that the room and patient are available. But most of the
time at least one (if not all) of the above items are not available to implement the process.

During patient visit, anaesthetist can use two different ways to complete the pre-anaesthesia form
(paper-based and ICIP), indicating non standardization of task implementing. One of the important
objectives of the Lean method is to standardize work; a condition denoted by problem ‘number 5’in
Figure 1.

One of the reasons why anaesthetists are not eager to use ICIP to complete the pre-anaesthesia form is
the unavailability of the system due to the lack of a PC in the paediatric ward and technical problems
occurred in the PC and the system itself. This problem is highlighted as ‘number 4’ in Figure 1.

The other problem identified in Figure 1 is labelled as 6 (‘searching for the nurse to translate’) refers
to communication problem. Some of the anaesthetists are from different countries and cannot speak in
Malay, the native language, and as most of the patients are Malaysian (where some of them are not
able to speak English).

We also identified duplicate task problem, labelled as 7 (‘verbal medication direction to the nurse’)(
Figure 1). When anaesthetist writes directions and medication on the pre-anaesthesia form in ICIP, the
completed form was not printed to be attached in the patient history file. Since the nurse does not have
any access to the ICIP, this situation resulted in verbal instructions and increased the risk of
medication error. Another duplication was identified in the data entry process. Multiple reports such
as lab, echo and lung function are entered onto different software and particular information from
those reports were entered again in the ICIP, resulting in data redundancy due to the lack of an
integrated information system.

**Problem Identification using A3**

An A3 report is a storyboard that visualizes how a current process happens, what is wrong with it, and
why it happens that way. They are illustrated on the left side of a paper. The right side illustrates a
better way to work, what needs to be changed, and a plan for changing it.
We identified seven problems for the pre-anaesthesia process. When we analyzed the root cause of the problems, we found that some of them have similarities. So, we developed four A3 reports which covers the aforementioned problems, namely Delay in Start Pre-anaesthesia Process, Delay in Patient Visit, Non Standardized Way of Working, and Interaction Problem. For each problems, we developed the A3 report to perform root cause analysis and design improved process (see Figure 3, 4, 5, 6).

Pre-AAnaesthesia Future State Map
We removed waste and problems in the pre-anaesthesia process and subsequently developed future state map using the A3 problem solving method. The future state map (Figure 7) suggests the hospital to have a pre-anaesthesia clinic where one anaesthetist is responsible to visit the patients and prepare for the pre-anaesthesia report. The future state map and its suggested changes to the existing process to remove waste from the current state map is shown in Figure 8.

Instead of anaesthetist, nurse should enter patient general information in the pre-anaesthesia form in the ICIP. So when anaesthetist goes to the clinic, he can simply find the name of the patient in ICIP without having to enter it and prolong the patient waiting time. This small change removes waiting waste from the process and reduces the process complexity.

The optimum proposed solution for resolving duplicate data entry is to develop an integrated information system. So, the process that require anaesthetist to enter lab, echo or lung function report will be eliminated and duplicate data entry will be reduced.

Furthermore, the nurse in the ward can check the availability of all reports that are required for anaesthetist to review from an integrated HIS. So when the anaesthetist comes to the clinic, he can log in to ICIP and read the reports from ICIP. Hence it can reduce patient waiting time as opposed to the as-is process where the anaesthetist completes the form in ICIP himself and keeps the patient waiting. Furthermore, it can encourage anaesthetists who are not eager to use ICIP in their processes. As mentioned before, most anaesthetists complaint about data entry in ICIP. They state that it is time consuming for them and their responsibility is to do physical checkups, not to work as a secretary.
The other suggested changes in the future state map is process standardization. In the as-is process, anaesthetists use paper or ICIP to write medications and directions but in the to-be process, all anaesthetists can conveniently use ICIP to complete the form as all necessary data entered into ICIP through integrated an HIS. Report can be the printed and appended in a patient’s file to be referred by nurse. Also in to-be process, when anaesthetist goes to the anaesthesia clinic, the nurse knows when the anaesthetist will come as the time of physical check of the patients starts at 3 pm every day based on standardizing the way of tasks. So, the patient, room and all necessary equipment which is needed by anaesthetist can be arranged by nurse. Hence, in the future state map, waiting waste can be removed and the process flows.

The other problem that was mentioned in the as-is process is communication. As we have suggested in the to-be process, when the anaesthetist goes to the clinic to visit a patient, a nurse should be available in the room to assist anaesthetist who are not from Malaysia. So, waiting waste from the view of the patient will be removed from the process.

Based on all the suggestions which were explained, we calculated total value-added and non-value added time of the process in the designed future state map in Figure 8. As illustrated, the total value added time increased to 97.07 %, and the total non-value added time decreased to 2.93 %.

To reach to the future state map, the implementation plan gives structure to improvement work gauges the necessary dollars, time and effort required to make the advocated improvement. Calculating cost benefit provides fair justification for the cost of the plan. But monetary measures may be reflected in patient safety factors, quality of care, patient satisfaction or workplace appreciation.

**Conclusions**

We found that VSM is an effective tool for identifying opportunities to reduce waste, to integrate process steps more tightly and to standardize work process. We used Lean method to increase collaboration and teamwork across departments in order to minimize the risk of sub-optimization which was demonstrated in the future state map. Also, the assessment and redesign of the automated workflow have been done through integrity rules as we proposed to integrate features, database
consistency and completeness of data of the patients in an integrated clinical information system. We applied the Lean method to analyse the problem by exploring the root cause analysis and identifying value added and non-value added time. Based on the analysis, we recommend improvement in terms of increased collaboration and teamwork as well as work standardization. So, we applied Lean as a tool to help us to improve effectiveness and increase the quality of healthcare delivery by aligning the process, people, and technology to each other.

There are limited comprehensive studies of Lean application and its effects on cost and quality performance indicators in healthcare, particularly those that directly related to the use of HIS.

It is possible to consider applying the Lean method to the other processes and departments to reduce the risk of sub-optimization between different departments. Indicators should be well-defined prior to research and should be monitored for a period of time to realise the effects of Lean application.

**Authors’ contributions**
MMY was research supervisor. AMBM was clinical supervisor. SKH conducted the case study and reported the findings.

**Acknowledgements**
Our sincere appreciation to all the surgeons and anaesthetists, which their knowledge and care to the patients are invaluable.

**References**


**Figures**

Figure 1 - Value stream map of Pre-anesthesia

Figure 2 - Fishbone diagram

Figure 3 - A3 Pre-anaesthesia (delay to start)

Figure 4 - A3 Pre-anaesthesia (delay to visit patient)

Figure 5 - A3 Pre-anaesthesia (no standardized way)

Figure 6 - A3 Pre-anaesthesia (interaction problem)

Figure 7 - To-be Pre-anaesthesia process
<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5</td>
<td>Request for pre--anesthesia form</td>
</tr>
<tr>
<td>2</td>
<td>Write patient name in the form</td>
</tr>
<tr>
<td>3</td>
<td>Write lab and echo report in the form</td>
</tr>
<tr>
<td>4</td>
<td>Write medication in ICIP</td>
</tr>
<tr>
<td>5</td>
<td>Search for nurse to translate</td>
</tr>
<tr>
<td>6</td>
<td>Give verbal direction to the nurse</td>
</tr>
<tr>
<td>7</td>
<td>Another anesthetist did physical check up</td>
</tr>
</tbody>
</table>

(1) Delay: Surgeon didn't confirm patient list
(2) Patient, room, report is not ready
(3) ICIP is not available
(4) Different way of doing task
(5) Duplicate entry

Figure 1
Figure 2
ISSUE:
Pre-anaesthesia process starts with delay

BACKGROUND
Surgeon work form morning until evening
Nurse station should wait confirmation from surgeon to prepare OT list
Most of OT list are ready after 5 pm

CURRENT CONDITION

PROBLEM ANALYSIS
1. Sometimes OT list is not printed
   Why? The OT list is not ready to print
     Why? Some of the patient names is not confirmed yet
     Why? Surgeon does not confirm the patient name for surgery
       Why? Surgeon is still busy in OT
     Why? Nurse also is not available to inform the anesthetist

2. Anesthetist goes more than one time to nurse counter to collect OT list
   Why? Anesthetist is not sure about time approved OT list
      Why? OT list is not ready the time anesthetist come to collect
     Why? Surgeon did not confirm OT list yet
     Why? Surgeon is still busy in OT

3. Another Anesthetist came to do pre anesthesisia
   Why? Anesthetist came one time and the list was not ready then he went to do another work
   Why? Anesthetist did not know another anesthetist came and collected the form
   Why? Nobody notify him that another anesthetist did the physical check up

TARGET CONDITION

COUNTERMEASURES
1. Number of pre-anaesthesia list modifications
2. Number of list cancellation
3. Number of new emergency list

IMPLEMENTATION PLAN

<table>
<thead>
<tr>
<th>what</th>
<th>Who</th>
<th>When</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inform staff about target condition</td>
<td>Anesthetist</td>
<td>July 2011</td>
<td>Reduce transportation waste</td>
</tr>
<tr>
<td>Education of the staff</td>
<td>Anesthetist</td>
<td>July 2011</td>
<td>Learn new process and work with ICIP</td>
</tr>
<tr>
<td>Implementation new workflow</td>
<td>Anesthetist</td>
<td>July 2011</td>
<td>Remove waiting and transportation waste</td>
</tr>
</tbody>
</table>

FOLLOW UP

<table>
<thead>
<tr>
<th>Cost</th>
<th>$$$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Man/hour</td>
<td>$$$</td>
</tr>
<tr>
<td>Benefit</td>
<td>$$$</td>
</tr>
<tr>
<td>Reduced waste time of anesthetic</td>
<td>Intangible benefit</td>
</tr>
<tr>
<td>Improve time to patient care</td>
<td>Intangible benefit</td>
</tr>
</tbody>
</table>

TEST

Monitor attendance of staff in training
Monitor the new workflow and participant in new process which includes anaesthetist, nurse and surgeon
Review the run chart for time, steps and number of list modification, cancellation and emergency list
**ISSUE:**
Delay to visit patient

**BACKGROUND**
Lab, echo and lung function report is essential for pre anaesthesia check up
Anaesthetist goes to the ward after 3 pm to visit the patient
PC is used by nurse to work with other HIS 
Nurses in the ward also uses room

**CURRENT CONDITION**

**PROBLEM ANALYSIS**

1. Room is occupied
   **Why?** The other nurse visit another patient in the room
   **Why?** There is not too much room available for nurse to visit patient
   **Why?** Nurse did not know that anaesthetist comes and needs the room
   **Why?** There is no schedule that when anaesthetist comes

2. Anaesthetist comes more than one time
   **Why?** Patient is not available
   **Why?** Patient is in lab or any other places
   **Why?** It was not arranged with patient to be ready that time anaesthetist comes to the ward

3. PC is engaged
   **Why?** It is engaged by other nurse to access to other HIS
   **Why?** There is not enough PC in nurse counter for nurses
   **Why?** Nurse did not know that when anaesthetist comes to the ward to use ICIP

4. PC or ICIP is not working
   **Why?** PC hanged or ICIP hanged
   **Why?** The previous person used the system and left it
   **Why?** Nobody comes and check that the system is working properly before anaesthetist comes
   **Why?** Nobody in the ward is familiar with computer and ICIP
   **Why?** Technical people check the system periodically not every day

5. Lab, echo or lung function report is not ready
   **Why?** Anaesthetist did not know that the reports are not ready
   **Why?** Nobody notify him

**TARGET CONDITION**

<table>
<thead>
<tr>
<th>TO</th>
<th>Clinical Director</th>
</tr>
</thead>
<tbody>
<tr>
<td>BY</td>
<td>HOD anaesthesia</td>
</tr>
<tr>
<td>DATE</td>
<td>July 2011</td>
</tr>
</tbody>
</table>

**COUNTERMEASURES**

Duration of time for anaesthetist to visit the patient
Number of time patient is ready and anaesthetist not ready
Number of time anaesthetist is ready but the patient or reports/ICIP is not ready

**IMPLEMENTATION PLAN**

<table>
<thead>
<tr>
<th>hat</th>
<th>Who</th>
<th>When</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inform nurses about new process of work</td>
<td></td>
<td></td>
<td>Reduce waiting waste</td>
</tr>
</tbody>
</table>

**FOLLOW UP**

<table>
<thead>
<tr>
<th>Cost</th>
<th>$$$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Man/hour</td>
<td>$$$</td>
</tr>
<tr>
<td>Benefit</td>
<td>$$$</td>
</tr>
<tr>
<td>Reduce waste time of anaesthetist</td>
<td>Intangible benefit</td>
</tr>
<tr>
<td>Improve time to patient care</td>
<td>Intangible benefit</td>
</tr>
</tbody>
</table>

**TEST**

Monitor attendance of staff in training
Monitor the new workflow and participant in new process which includes anaesthetist and nurse
**ISSUE:**
No standardize way to do work

**BACKGROUND**
Anesthetist should write all medication and direction for the patient in pre-anesthesia form
All these information should be in patient file as a history

Some direction gives to nurse verbally

**CURRENT CONDITION**

**PROBLEM ANALYSIS**
1. Most of the time anesthetist use pre-anesthesia paper form to write medication and direction
   Why? It is faster to write data on paper
   Why? There are so many information needed to write by anesthetist
   Why? All reports such as lab, echo and lung function should be written to the form

2. Most of anesthetist are not eager to use ICIP in pre-anesthesia process
   Why? It is time consuming to insert data in ICIP
   Why? There are so many fields that should be filled in ICIP such as lab, echo and lung function report
   Why? They believe that it is necessary to do their work and no matter in which way they do the work
   Why? They are not too much familiar with using PC and it wastes their time especially when they are tired or busy

3. Anesthetist gives medication direction verbally to the nurse
   Why? It is necessary to follow the direction by nurse a day before operation
   Why? If anesthetist write direction in ICIP, should give direction to nurse verbally as nurse does not have any access to ICIP

**TARGET CONDITION**

**COUNTERMEASURES**
Number of pre-anesthesia form that is not complete/ printed prior to the induction of anesthesia

**IMPLEMENTATION PLAN**

<table>
<thead>
<tr>
<th>What</th>
<th>Who</th>
<th>When</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inform nurses about new process of work</td>
<td>xxx</td>
<td>xxx</td>
<td>Reduce waste in time of anesthetist</td>
</tr>
<tr>
<td>Nurse ICIP training</td>
<td>xxx</td>
<td>xxx</td>
<td>Learn how to work with ICIP to begin new process</td>
</tr>
</tbody>
</table>

**FOLLOW UP**

<table>
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</thead>
<tbody>
<tr>
<td>Benefit</td>
<td>$$$</td>
</tr>
<tr>
<td>Reduce waste time of anesthetist</td>
<td>Intangible</td>
</tr>
<tr>
<td>Reduce risk of medication</td>
<td>Intangible</td>
</tr>
<tr>
<td>Standardize way of doing work</td>
<td>Intangible</td>
</tr>
</tbody>
</table>

**TEST**
Monitor the new workflow and participant in new process which includes anaesthetist and nurse
ISSUE:
Interaction language problem

BACKGROUND
Some anesthetists are not from Malaysia
Some of the patients cannot speak English

CURRENT CONDITION

PROBLEM ANALYSIS
1. Anesthetist do not know Malay language
   Why? He or she is not from Malaysia
2. Patient needs translation to understand anesthetist comments
   Why? Patient does not understand English
   Why? The nurse is not available in the room to assist patient
   Why? It is not defined in the process that when anesthetist comes to the room to visit patient, she should be there for assistance

TARGET CONDITION
TO         Clinical Director
BY         HOD anesthesia
DATE       July 2011

COUNTERMEASURES
Number of time patient and anesthetist are ready but nurse is not available

IMPLEMENTATION PLAN

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<td></td>
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</table>

TEST
Monitor the new workflow and participant in new process
Monitor attendance of nurse
Figure 7