Development of Optimized and Efficient Clinical Pathway Software

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***Abstract*—This paper was done due to the need of an optimized and efficient clinical path in healthcare as there need to be a unified clinical pathway to define and taking care upon common diseases. The objectives for this paper is to develop efficient software to manage a good practice and optimized the clinical pathway regardless of different type of hospital capability using the main style of critical pathway for common diseases so that the treatment can be optimized in terms of time and efficiency. it focuses mainly on the different type of clinical pathway developed by various hospital in manual form to create a uniform type of treatment for common diseases and optimized the treatment using the software developed using Visual basic programming language. Graphic User Interface is applied to the system so that it would become more user friendly.**

***Keywords* — *Clinical* pathway, health care, Visual basic, Graphic User Interface (GUI).**

I. INTRODUCTION

Clinical pathway from early years has significantly being improved in order to provide services of better quality as well as reducing time for patient to get their treatment. Clinical pathway has been widely used by hospitals around the world [1]. Clinical pathway are basically a care plans which is carefully designed and structured to be an optimal multidisciplinary care process which later will be used or performed by a team of health care professional for a certain diagnosis only [2].the figure on clinical path is as shown on figure 1. Clinical pathway idea was first being made available by Zander into medical care in early 1980s, its paper based manual implementation has been made into quite numerous number of reports [2]. Though at that time it was considered a breakthrough idea, it does have some disadvantages in terms of recordable data and clinical information and course of treatment regarding certain illness [2].

The function of clinical pathway is to set an acceptable and optimized standard of health care service delivered by a number of medical staff including doctors, nurses, pharmacist and medical staff [3] so that the coordination and communication between those involved can be used to set an improved outcome rather than the traditional method [3]. Before, the patient coming to get treatment for the same illness gets different outcome when they see different physician such as shown in figure 2, this differences is probably due to the experienced gained by each doctor, an experienced doctor may suggest an outcome treatment that is differs to a newly appointed physician that still conduct treatment by following the theory that he learn. So these different outcomes in the end resulted in the creation of an organized critical pathway for health care service.

The terms cost and time do often spark some debacle when clinical pathway was being introduced, but recent studies carried out mostly in the countries such as United States, Canada, Australia and United Kingdom do provide pros and cons on clinical pathway method. Most of the studies had shown a significant decrease on the length of time to stay and the cost involved.

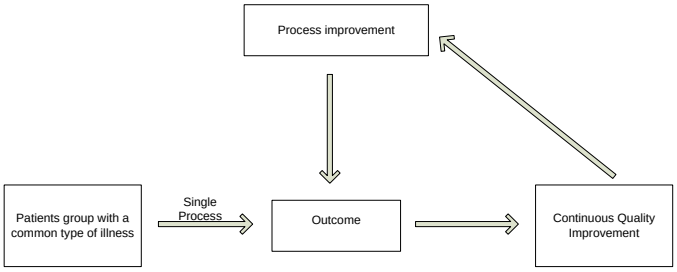

Figure 1: physician care based using clinical pathway

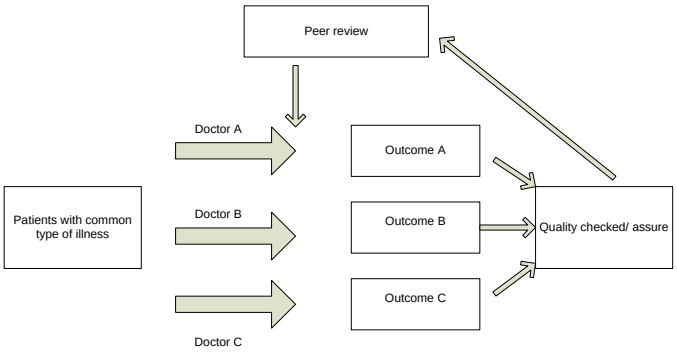

Figure 2: traditional pathway for physician care based

There were also several critical pathway used and developed extensively for certain medical type of procedure

but mostly are done in manual and in not coordinated way resulting in some sort of time being wasted for documentation purposes. Thus the need to implement a new kind of clinical pathway method using newly developed software is needed to ensure the documentation can be done thoroughly and the e-filing system can be implemented. This is all needed in order to ensure the health care field in Malaysia does provide the best and efficient health care service such as those highlighted in National Key Economic Area.

A traditional method on clinical pathway is actually determined by the diagnosis by medical staff based on certain aspect of the disease with pre-organized selective treatment at certain time being subjected. Though the time is reduced, there are certain cons such as the documentation and filing of such a huge amount of data. Some errors might occur due to individual mistake done by medical staff.

In order to improve the efficiency and optimized the data being taken. New method needs to be pioneered. This new method should be able to satisfied the void in terms of reducing time taken to do the documentation, but as well as providing the patient with the necessary document they wanted without any difficulties in trying to find their register using old technique.

The section was organized as follows: Section 1: Introduction, section 2: Methodology, Section 3: Result and Discussion and section 4: Conclusion.

II. METHODOLOGY

In designing good software based on clinical pathway data entry, we need to have rules to follow upon creating our program and tools to be used as a medium to simulate the program that will be written. Therefore to develop efficient software, we will need to follow the rules of Software Development Life Cycle (SDLC). While on the tools part, we will go through from the earlier process of software development.[4]

A. Software Development Life Cycle (SDLC)

Software Development Life Cycle is a string of rules dedicated for those who intended to design a program for certain function. It is being separated into 6 part namely: (1) Problem analysis, (2) Program design, (3) Program coding, (4) Test and Debug, (5) Solution formalization and (6) Maintaining Program [5, 6]. The step by step SDLC when designing a program are as shown in figure 3 [4].

In this paper, a problem being detected revolves in creating a standardized Clinical pathway procedure that can be used by nationwide health care provider. Step (1) will ensure a good session of brainstorming and sketching of idea will take place in order to formulate a rough idea on how to create the solution to the problem.

Step (2) then began to take place where the program is being planned carefully. In this process, a carefully drafted user interface is being put into the plan to execute any proposed instruction being inserted. Graphical User Interface (GUI) is being used for the development of the project.

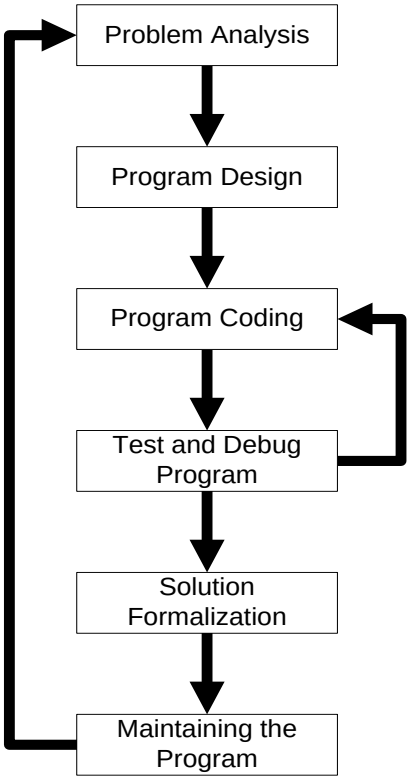

Figure 3: Software Development Life Cycle (SDLC) model [4]

Step (3) involves mainly writing the code for the project. The coding is done so that it can execute the design that is being put into motion; this step needs to be done carefully alongside the designing step so that the program would run accordingly.

After the designing and the coding process had successfully being implemented, the next step (4) is to test the program with the debugging tools embedded inside the program system [4]. This is done prior to formalizing the solution so that any errors that unfold due to coding mistake can be detected and being fixed. After step (3) has been repeated with and tested without any error, the debugging tools can then be disabled [4].

The program can now be formalized as a solution for the problem being analyzed earlier. But before it can be used, it

needs to be tested by a set of user so that the program can be maintained until it reaches its full capability, this process need to be repeated a few times so that we can cover all aspect of the problems that needs to be solved.

B. Clinical Pathway Software

Software development is an important stage in creation of a good software for the purpose of the project. In recognizing the importance step and objective of the software being developed, we will apply the step on making software from top to below based on the objective tree module. From software being developed, we will stress on two main fraction; (1) module system and (2) technique system.

1. Module system

In module system, there lies 3 main categories that define our critical path module, these 3 categories do interact with each other in order to achieve the objective being set for this project that is to be efficient and optimized at the same time. These 3 categories that will be briefly explained is (a) the form category, (b) the stages category and (c) the time category.

i. Form category

in this section, we will go through each form of the software being developed so that we can familiarize ourselves with the function of each form. The first form is the entry form in which an authorized personnel is needed to key in their personal data in order to gain access to the software tools, this to ensure the safety of all the data being stored and at the same time to minimized the risk of being manipulated by person who is not in charge of that area.

The entry form will involve a hierarchy of three stages. The upper hierarchy is for the developer or distributor of the software, they are considered as super administrator. They will decide to key in the numbers of admin available and the list of the admin and their security numbers. This is to limit the numbers of personnel that have direct access to the program.

The second type of user is the admin. They are the selected few that were given a direct access to the main control so that they can validate the data and sending back the feedback to the developer amid any anomaly should it appear. These admin maybe selected based on their position in each department like the head of department for example. It is to ensure high integrity in managing the data being stored.

The third type of user is the medical personnel. They are the personnel who work under the admin jurisdiction. It involved all the medical staff such as the doctor, nurse, or any medical staff subjected to run the treatment upon patients. The full map description is as shown in figure 4.

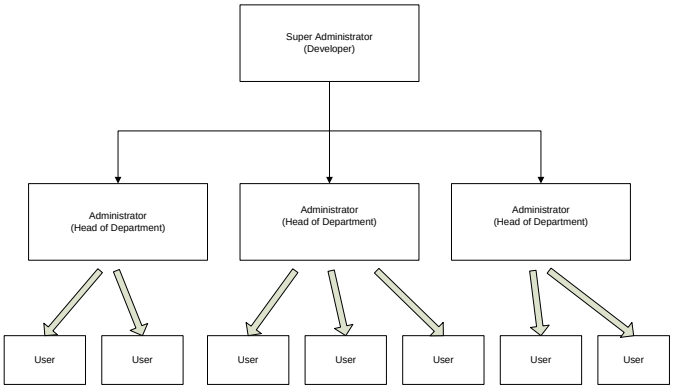

Figure 4: Hierarchy of administrator

Next is the registration form, user can choose to either opt for new patient data entry or they can choose from the patient register if the patient they treated have a history of being registered before for the same illness. For new patient, they will have to provide basic info about themselves like their name and their Identification Card number before being added with an MRN number just like shown in figure 5 below. After that they will began their treatment accordingly to stages and time frame that will be explained henceforth.

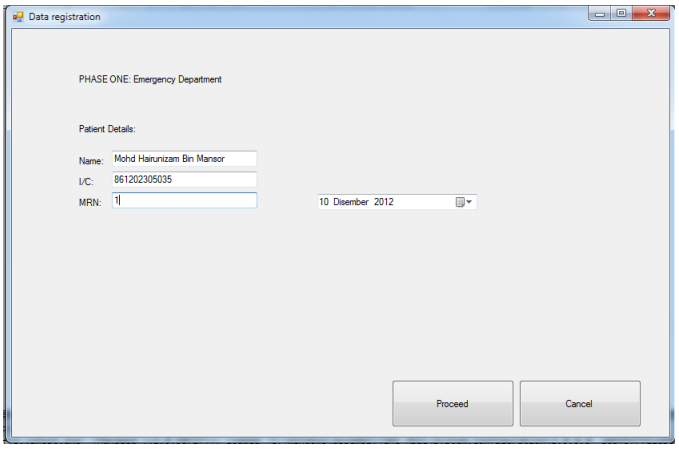

Figure 5: Data registration form

ii. Stages category

In the software that we are trying to develop, they will be 10 stages critical to organize an efficient pathway for clinical use. These stages is to ensure a water flow like procedure is being followed without the need to restart all over again when some stages have been misconduct or being left out due to personal error.

These 10 stages are also used to separate each procedure so that it can all be abide without any difficulties from both parties. The list of all 10 stage are as shown in figure [] in following order.

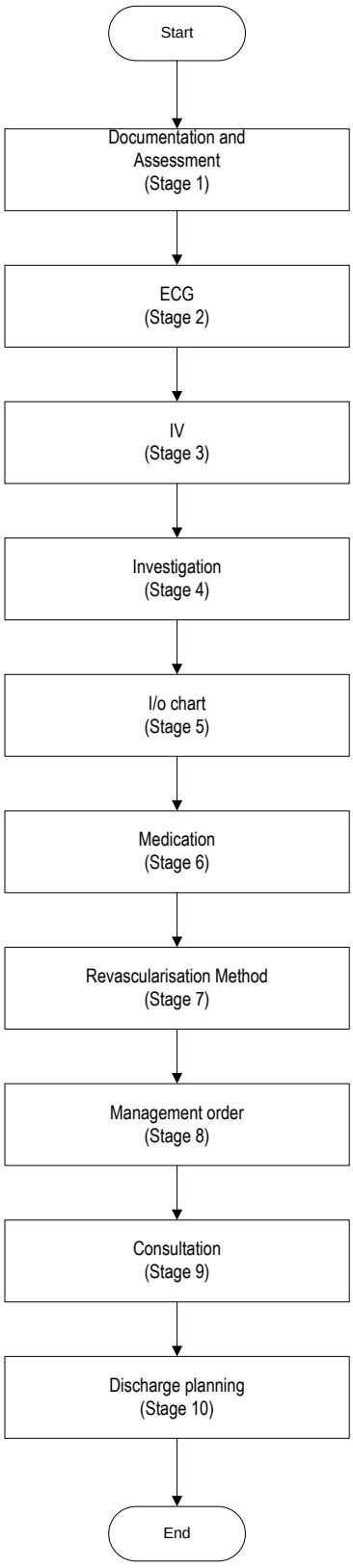

Figure 6: Stages procedure

In order to differentiate the kind of procedure being taken at any time given, these stages will need to be separated by a time frame. This is to ensure the quality of the treatment is being held highly regardless of specified time constraint being subjected.

iii. Time category

Time category is being used to differentiate the treatment in which a patient needs to undergo under certain time constraint. A longer time period means that a patient needs extra care and treatment so as to determine the actual condition the patient are in at the exact moment.

Time frame for the software that we are developing consists of 3 main time frames being set in a time constraint of 1 hour. For time period 1 and 2, the time period stretch for about 15 minutes while for time period 3, the time period is exactly 30 minutes.

This time frame is crucial in determining the optimized and efficient ways to treat a patient. At the same time patient can also be treated in a whole length of the 1 hour period or as short as 15 minutes period. Patient who undergo treatment also need not to worry on having to register a new entry when time taken to be treated has extended the time frame being subjected on them since the user will be subjected to the next time frame with the suitable treatment being proposed for that time period.

2. Technique system

Technique system involve in using what tools in creating the software. There are quite a number of tools being made available but we need to imply on the use of a tools that is easy to conduct and highly reliable in terms of delivering the result. So in this section, we will be explaining on the tools needed in order to create the software. There are basically 4 main aspects in creating our software, each with its own function. the aspect involved are; (a)Visual basic, (b)Graphic interface, (c) Object Oriented Programming (OOP) and (d) SQlite

i. Visual Basic

Visual basic or VB is a visual and object oriented programming language that can be used to develop various applications in the windows environment [7]. It is highly reliable in constructing a data pathway so that an efficient data management table can be created and optimized along the construction phase.

Since VB is reliable in creating a coordinated data path which corresponds to the data being subjected to, it is highly recommended to develop software based on existed critical pathway but in a slightly more advanced feature being implemented.

ii. Graphic User Interface (GUI)

Graphical User Interface (GUI) is like an image portrayal of a program. It can help ease up the use of a program by

anyone involved by providing a recognizable and consistent appearance throughout the program so that user can adapt quite easily. The GUI should have a predictable manner so that the user can expect what lies next. Figure 7 shows a Graphical user interface.

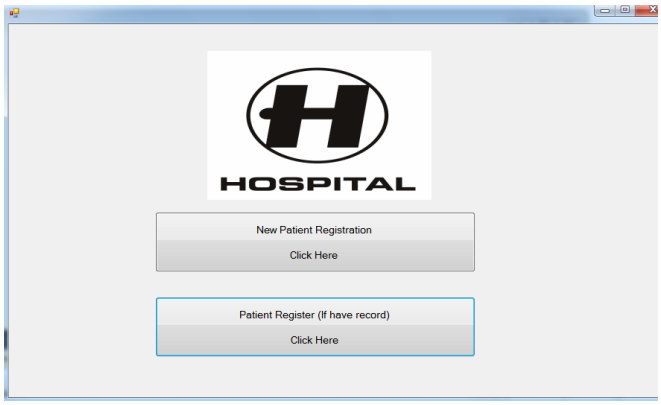

Figure 7: Graphic User Interface

iii. Object Oriented Programming (OOP)

Object Oriented Programming or OOP uses a different set of programming language compared to the old type of coding language such as C and Pascal. In OOP, everything is grouped together as a self sustainable "objects".

iv. SQLite

SQLite is an embedded SQL database engine. It is serverless so the access to disk is done directly. In this project, it is mainly used to be a main database so that all the data that is being inserted will be rearranged perfectly for future search. The reason why SQLite is being chosen as the database administrator is because it doesn't have any known or fixed configuration so it is flexible to be configured to our needs. It is also portable to use and it is deemed as public domain where everyone can use it without breaking the law of intellectual properties. SQLite database are as shown below in figure 8.

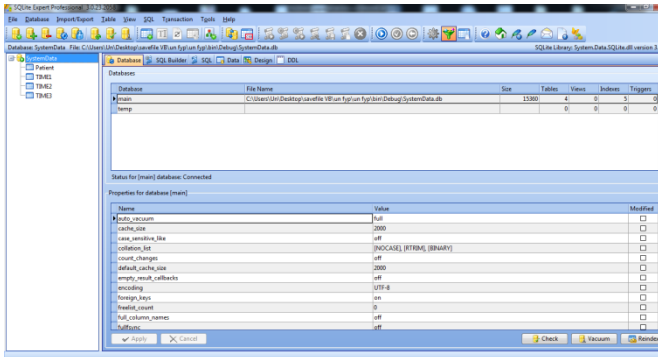

Figure 8: SQLite database

III. Result and Discussion

Based on the result obtained from the simulation of the program, we have successfully develop a computer based software that can be used in health care field nationwide for better efficiency and help in achieving the NKEA aspiration. There are a few comparison that can be made between the result achieved using the software compared with the result obtained from the manual implementation and we have also conduct a cost benefit analysis to evaluate the key area in which the software have contributed significantly towards improving the outcomes.

A. Simulation Results

An extensive run on software simulation had been made to test and configure the ability of the program to work according to the clinical pathway designed by the physician. A test run had been made so that the simulation would involve a 1 hour time of treatment on a test subject. This is to ensure that data being stored will show no error in the end so that it can be saved in the database or printed according to the patient's need.

Figure 9 below shows the flowchart on how the simulation works. First, the patient data is being inserted along with its MRN number while the time and data will be initiated automatically. The treatment will began at the first period of time (time 0). When the time limit has been reached, user needs to proceed to the next time frame with a new set of treatment or otherwise the process I is deemed finish.

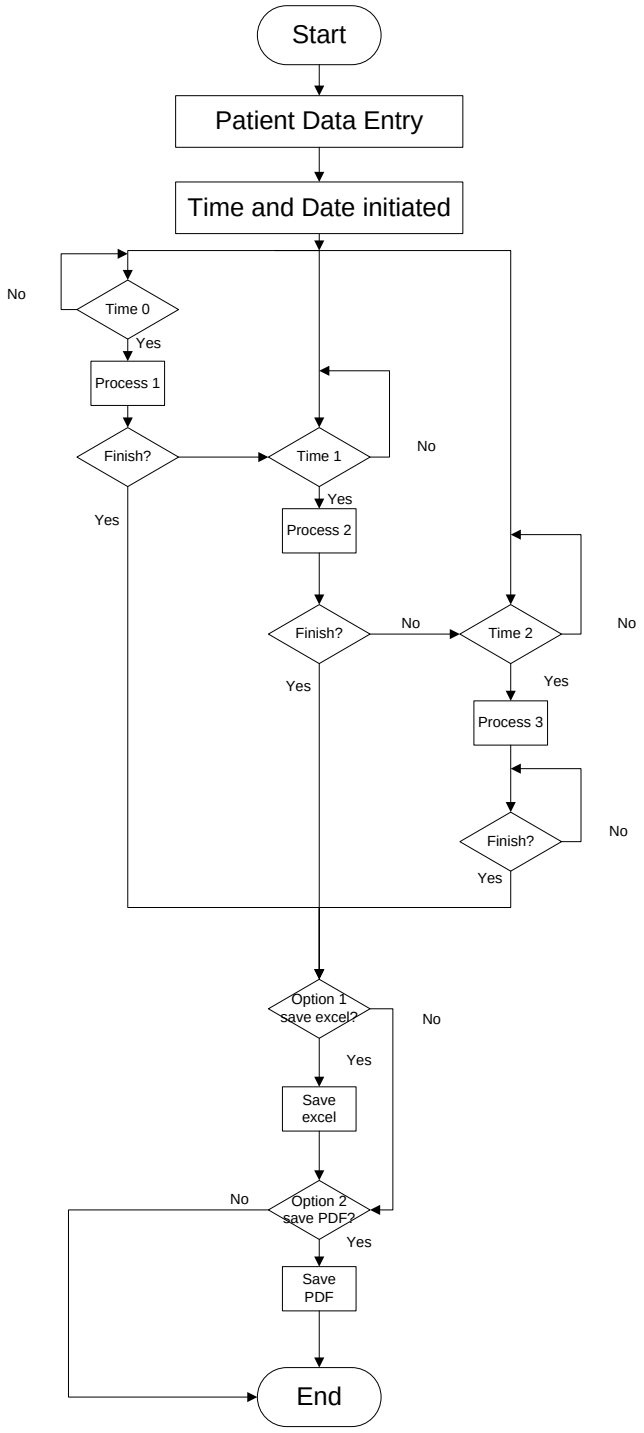

Figure 9: Flowchart on simulation process

The same goes for the time frame 1, user will continue the treatment until it is finish but if time taken is longer, then user will have to proceed to the last time frame (time 2). The form on which the patient will be diagnosed is as shown in figure 10.

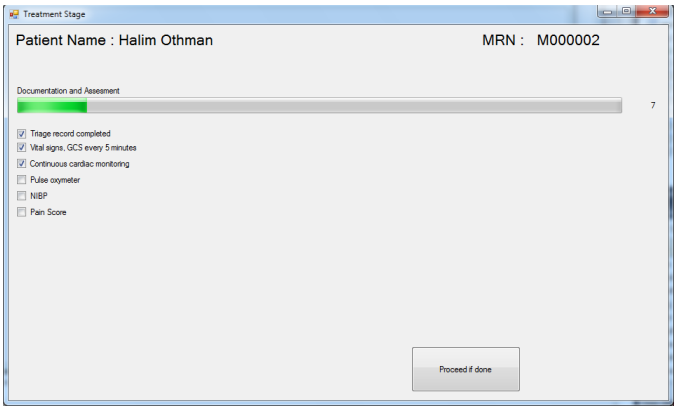

Figure 10: Treatment stage form

After finishing up all the process involved, the user will be notified with a text message saying "procedure is completed", then a large table comprising of list of treatment being held will be shown for references between the user and the patient as shown in figure 11.

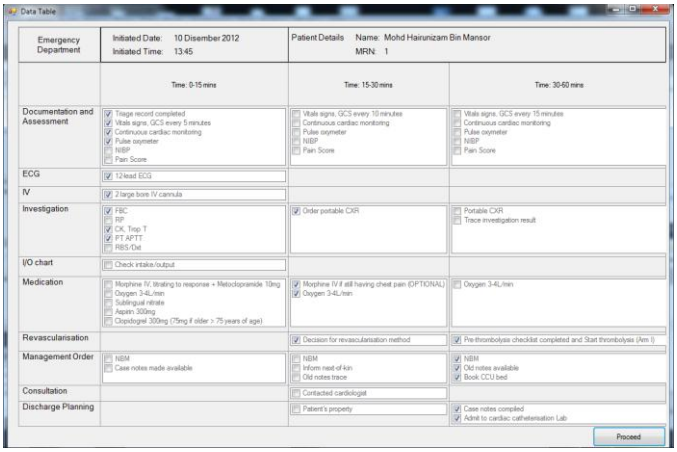

Figure 11: List of treatment

After clicking the button click, a new window form will appear with three options whether the user want to save it in excel form, or print it in PDF form for the patient to see or just exit the program. The example of the excel file being saved are as shown in figure 12.

Emergency Department	Initiated Date: 10 Disember 2012 Initiated Time: 13:45	Patient Details Name: Mohd Hairunizam Bin Mansor	MRN: 1
	Time: 0-15 mins	Time: 15-30 mins	Time: 30-60 mins
Document and Assessment	☑ Triage record completed ☑ Vitals signs, GCS every 5 minutes ☑ Continuous cardiac monitoring ☑ Pulse oxymeter ☐ NIBP ☐ Pain Score	☐ Vitals signs, GCS every 10 minutes ☐ Continuous cardiac monitoring ☐ Pulse oxymeter ☐ NIBP ☐ Pain Score	☐ Vitals signs, GCS every 15 minutes ☐ Continuous cardiac monitoring ☐ Pulse oxymeter ☐ NIBP ☐ Pain Score
ECG	☑ 12-lead ECG		
IV	☑ 2 large bore IV cannula		
Investigation	☑ FBC ☐ RP ☑ CK, Trop T ☑ PT APTT ☐ RBS/Dxt	☑ Order portable CXR	☐ Portable CXR ☐ Trace investigation result
I/O Chart	☐ Check intke/output		
Medication	☐ Morphine IV, titrating to response + Metoclopramide 10mg ☐ Oxygen 3-4L/min ☐ Sublingual nitrate ☐ Aspirin 300mg ☐ Clopidogrel 300mg (75mg if older > 75 years of age)	☑ Morphine IV if still having chest pain (OPTIONAL) ☑ Oxygen 3-4L/min	☐ Oxygen 3-4L/min
Revascularisation		☐ Decision for revascularisation method	☑ Pre-thrombolysis checklist completed and Start thrombolysis (Arm I)
Management Order	☐ NBM ☐ Case notes made available	☐ NBM ☐ Inform next-of-kin ☐ Old notes trace	☑ NBM ☑ Old notes available ☑ Book CCU bed
Consultation		☐ Contacted cardiologist	
Discharge Planning		☐ Patient's property	☑ Case notes complited ☑ Admit to Cardiac Catheterisation Lab

Figure 12: Excel documentation

B. Comparison

A comparison between the computer based clinical pathway software with the existing manual implementation of clinical pathway had been conducted, there are a few key area which can be used as comparison namely; (1) cost (2) efficiency, and (3) time.

1. Cost

The cost of developing the software and testing it is not as expensive as doing it manually since the data being stored will always remain and can be trace back via search function introduced earlier in the simulation and its paperless. Compared to manual documentation, it would required a large number of paper and this add up to more cost whenever error in filling the data occurred. Using the software, any error that resulted from human can be traced and being re-corrected by the admin.

2. Efficiency

The comparison in terms of efficiency between the manually implementation method and the computer based software do show some significant outcomes. Computer based software do have a large advantages in terms of structural database that it use to store all the data being inserted, while the manually implemented critical pathway data needs to be done and sorted accordingly via filing system. This could resulted in such a tedious job to do for the staff responsible

3. Time

Time is the essence in providing the best health care system to the patient in need. In terms of time, computer based software do provide a time watching system so that the physician in charge of a patient can have a look at the time he provided for his patient. This in long terms can ensure that time punctuality is being kept while maintaining the high standard of medical service. Traditional ways do waste a lot of time especially during examination time since the doctor need to rely on the nurse to inform them upon the time, the time taken to fill the patient treatment form manually do indeed contributed to the lack of time management among medical staff before the introduction of the computer based critical pathway software.

IV. CONCLUSION

The development of this software is expected to help in preventing unnecessary problems resulting from human error, minimizing the cost in maintaining the database of patient and reducing the fatality caused by human factor and mismanagement. Considering that Malaysia will soon achieve the status of developing country by the year 2020, there should be a massive overhaul regarding the health care fields so that we will not only rely on manually encrypted data but eventually move forward into the era of systematic computerized data in every sort of ways imaginable. By comparison and by simulation, it is proved that computer based critical pathway analysis system is by far achieved its goal to be efficient and optimized and hopefully revolutionized the health care fields in Malaysia.

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