Capturing and Analyzing Injection Processes with Point of Act System for improving quality and productivity of health service administration

Atsushi Koshio[1,2], Masanori Akiyama[1,2]

[1] Todai Policy Alternatives Research Institute, The Univerisity of Tokyo, Tokyo, JAPAN
[2] Sloan School of Management, Masachusettus Institute of Techonology, MA, USA
{koshio, makiyama}@pp.u-tokyo.ac.jp

Abstract. The objective of this paper is to show process data captured with barcode administration system and the results of data analyses and visualizations for improving quality of care and productivity. Hospital Information System named Point-of-Act System that was designed to capture every process of all medical acts was employed to capture data of medical processes. Data of injection process was analyzed based on operative timeliness. The result shows nursing workload didn't be allocated equally through the day and some parts of injections hadn't been administrated at the right time. Improving operative timeliness can contribute to improve quality of care and productivity. This kind of process information has a possibility to provide new research opportunity to analyze outcome with context information including process information.

Keywords: Hospital Information System, Process Management, Electrical Data Capturing, Data Analysis, Visualization

1 Introduction

Utilizing data captured and stored by hospital information systems is quite important issue to make hospital IT systems more effective for improving health care quality and productivity. After the report of medication errors and health care quality by Institute of Medicine, these data have been regarded as significant sources for managing hospital environments [1-2]. The data can be constructed as indicators evaluating health care process and outcome. The movements such as "e-indicators" have been trying to analyze and publish these data for the purpose of health outcome management with bench marking and public disclosure [3-11]. Outcome information has a possibility to affect patient's decision and make health care system more patients centered. In addition to this outcome information, process information is also important to understand reality of health care service provision. Process indicators provide context of outcome indicators and show practices to improve quality and productivity [12-15].

Data captured through daily use of hospital information systems are containing data of medication processes. Utilizing process data for understanding daily medication process is an useful way to plan resource allocation in hospitals to improve operation and management of service delivery. Process information has an ability to provide why differences of outcome are coming from. And this activities capturing process information and managing medical process also have a possibility

to make health care industry more transparent and accountable through publishing the information. Transparency is one of the prioritized areas to be solved to construct better health care systems [16-18].

The objective of this paper is to show process data captured with barcode administration system and the results of analyses and visualizations for achieving the targets described above. This study will emphasize benefits of hospital information system named Point of Act System based on process management and real time data capturing and capturing every activity in the hospitals. In this study, we focus injections and utilize injection process data to analyze medical activities and visualize process in the hospital.

2 Methods

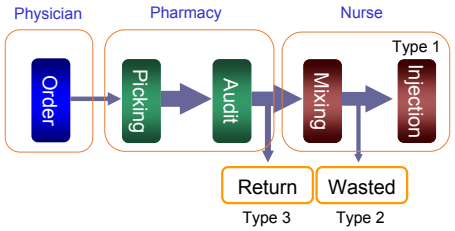
2-1. Things that need to be addressed

Point of Act System (POAS) is a real time bar-code capturing health information system in International Medical Center of Japan (IMCJ) in Tokyo, Japan [19-22]. POAS has a function to prevent medical errors by certifying correctness of medical activities with capturing bar cords on patients, worker and drugs. It ensure not only the correctness of patients, drug, dose but also route and time based on real time information. At the same time, POAS captures implementation records at each process of medical activities including 6W1H information (When, Where What, Why, for what, to whom and How) of the activities. The basic requirement for successful measurement and data capturing, they must be integrated with the routine provision of care and whenever possible should be done using IS and this system satisfied this requirement [6].

There are basic characteristics of POAS captured data. The data is including every activity in the hospital that means it concludes complete data of the administration. This implies the research based on not sampling data but all data of the medications. The second characteristic is process management of administration. The first target of process management is restraining skipping processes that would sometimes be causes of medication errors. The system record the data at each point of action of processes described by figure 1 showing injection process as an example.

By capturing the data routinely at each process of activities, the data provides information on returned and wasted injections as well as normal injections without entering additional information at end points.

Figure 1. Data capturing points of Injection processes



2-2. Data and Analysis Methods

Injection process was chose as a target of this study to analyze process data and visualize processes of medical activities. As a standard injection process physicians order for patients and pharmacists pick up and audit the order. These drugs deliver to nurse stations and nurses mix and inject them to patients. 6W1H information have been captured at each point of action; Order, Picking, Audit, Mixing and Injection. In addition to these data, data on order is including "scheduled order time" that shows the scheduled time to inject to patients. These data were liked by serialized ID on each drug and order. Data from July to September 2007 that is including 306768 drugs taken in all injections during the term at every ward in IMCJ was used to analyze. The data was merged from different partial information system such as physician order entry system, pharmacy system and risk management system. Data from other term was also referred if necessary. Basic descriptive analyses and some visualization techniques are applied for analyzing injection process. Especially we described frequency of injection processes minutes by minutes to analyze business of the hospital and time differences including scheduled time and actual administration time to assess time precision of the administration processes to scheduled plan.

3 Results

Figure 2 shows the distribution of scheduled injection order time by physicians. Enormous portion of orders were scheduled on 6AM, 10AM and 6PM. Figure 3 shows actual number of activities including mixing of drugs for injections and injections of drugs by minutes. As the peak of order by physicians was 6AM, the time of peak of actual injections is around 6AM. The orders scheduled 6AM were injected from around 4AM to 7AM, because the number of orders surpassed capacity of nurses at the time. Nurses adjusted to variation of number of orders by time by injecting earlier than scheduled time.

Figure 2. Distribution of scheduled time

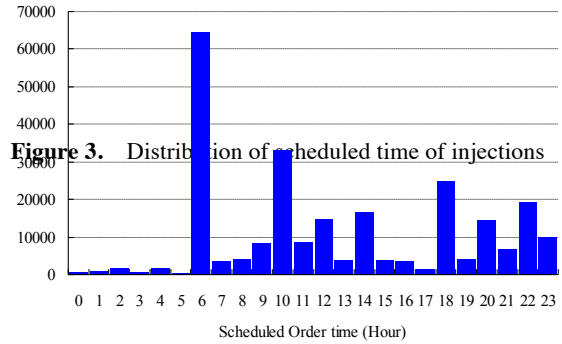


Figure 3. Distribution of scheduled time of injections

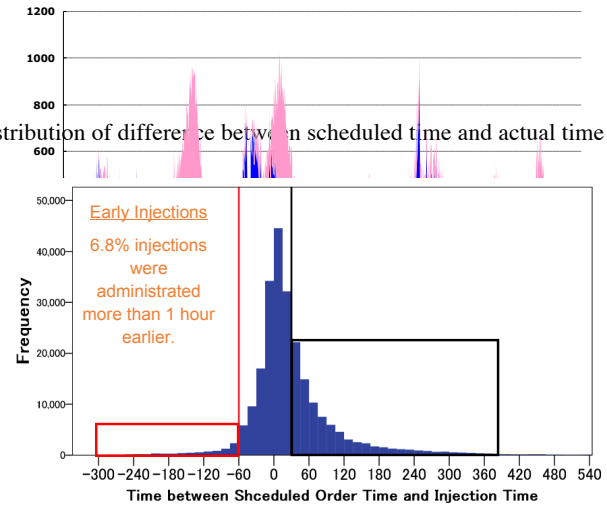


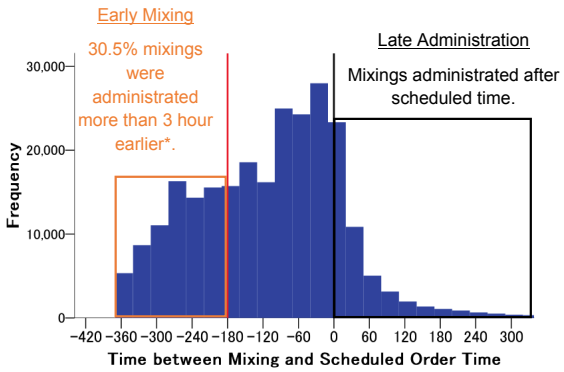
Figure 4. Distribution of difference between scheduled time and actual time of injections

As described above, nurses adjusted to high frequency of scheduled order by injecting earlier or later. Figure 4 shows Distribution of time difference between scheduled order time and injection time. Time between scheduled order time and injection were calculated by the formula and a minute unit.
(Time between scheduled order time and injection) = (Scheduled Order Time) – (Injection Time)

Positive numbers shows early administration of injections, negative number shows lately administration of injections and 0 means right on time. It might be regarded as positive to close to 0 from the point of view of right time administration. Mean of the time is 10.63 minutes. The most frequent category is from 0 to -15 and the second most frequent category is from 15 to 0. Most of injections are around 0. 6.8 % of injections were regarded as early administration that was defined by one hour early administration[33].

Figure 5 shows time between mixing and scheduled order time. Time between mixing and scheduled order time was calculated by the formula and a minute unit.
(Time between mixing and scheduled order time)= (Mixing time) – (Scheduled Order time)

Figure 5. Distribution of difference between drug mixings and injections



For example, 180 minutes means mixing before 3 hour. Mean of the time is 108.5 minutes. The highest frequency is from 0 to 30 minutes. According the guideline for safe medication in the hospital, drug mixing shouldn't be implemented 3 hours before injection. However, 30.5 % of injections were regarded as early mixing and this information hadn't informed by the nurses.

4 Discussion

We captured data by POAS that was designed by the concept of process analysis and management. This concept provided the system a structure to capture the data. According to the survey of system use, the system covered more than 99.9% mixing drugs and injections. Process management prohibits workers from skipping each activity on the process and that contribute to ensure the correctness of medical activities through the process.

Secondly these process data suggests the importance of process indicator related to outcome indicators. Outcome data and process indicator have been used as measurement indicators of performance. The advantage of outcome indicators is that it explain the achievements of targets itself. Outcome measurement will reflect all aspect of the processes of care and not simply those that are measurable or not [24-28]. However, as Mant said, difference in outcome might sometimes be due to case mix, how the data were collected, chance, quality of care or other factors such as nutrition, life style. Outcome indicators can be improved if efforts are made to standardize data collection and case mix adjustment systems are developed and validated [7]. Process data can be redeeming indicators to understand meanings of outcome indicators. Process data is providing context information to understand the setting for the case [29-36].

This is the example of research linking process data to some outcome indicators. In this example, we set wasted rate of drugs. If physicians change their order after nurse's mixing drugs, these drugs must be wasted. It is of course necessary to inject right drugs based on up data decisions of physicians, but drug wasting would cause inefficacy of hospital management.

Figure 6. Time difference between drug mixings and injections and drug wasted rate

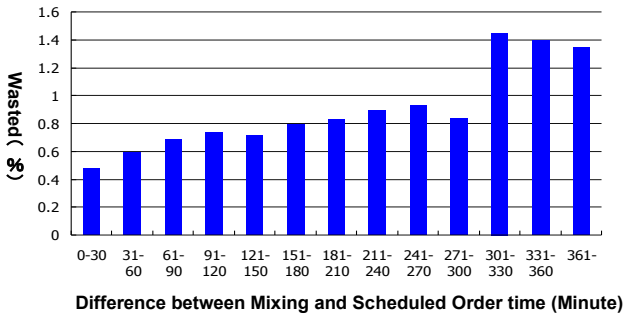
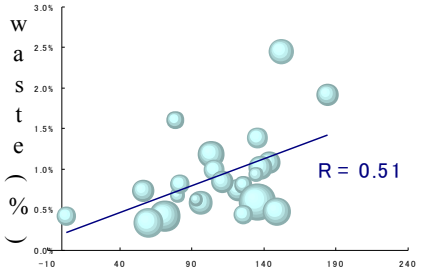


Figure 6 shows the result of analysis that beforehand mixings for laborsaving whose intervals are relatively longer have tend to be wasted by order changes. Analysis on data in unit of wards also shows wards whose intervals between mixing and injection are longer tend to waste more.

Just measuring drug wasted rate is not enough to analyze the cause of high drug wasted rate. By linking process information to outcome information and capturing process routinely, the data make us possible to investigate the reason of some outcomes.

Figure 7. Relationship between intervals and drug wasted rate



5 Conclusion

In this study, we show clearly that data captured by hospital information system provide us new research opportunities to improve quality of care and productivities. Many hospitals have been introducing hospital information system to improve operational efficiency. Secondly use of data captured by HIS hasn't become widely yet, though it has a possibility to improve quality and safety of care as well as productivity. The important thing to spread utilization of bust amount of data is providing evidences that secondly use of data can improve them.

Concern on performance measurement has been increasing rapidly and many organization including government and hospital associations and researches have been trying to set indictors for performance measurement [2]. As discussion of process and outcome indicators, both indicators have useful meanings for patients to chose hospitals and acquire healthcare information. This study will help to understand the benefits of process data and contribute to measure quality of care and improve hospital management on health care quality and safety.

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