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Real-Time Monitoring in Radiology

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In healthcare today control is mainly based on retrospective analysis of business data, usually financial key performance indicators (KPIs) or performance KPIs such as utilisation or number of examinations. Control is often misinterpreted as an instrument of scrutiny, a misconception that is particularly common in the german-speaking world. However, control should be more than just that; it should rather be a management tool that considers all aspects of business needs and gives a push in the right direction. In service-oriented business there are four relevant aspects: customer, finance, employees and process (gocke et al. 2002).

This article focuses on a processoriented approach to workflow control. According to Zapp and Oswald (2010), efficient processes are the foundation of customers' (and even employees') satisfaction and thus also of economic success. How can efficiency and effectiveness of typical radiologic processes be defined and measured? While processes are dynamic, static and retrospective analysis of data is still possible and oftentimes helpful. However, the extraction and analysis of data in real time as it is implemented in the Department of Radiology at University Hospital Basel seems even more interesting. This approach allows in-time intervention instead of delayed damage control. The aim is to actively visualise the status quo of workflow, and to recognise possible hazards or even unexpected cessation, eg it is preferable to recognise a patient waiting for more than an hour than to realise that the average waiting time increased five minutes over the last month.

The solution for effective process control is real-time monitoring. This has been successfully applied to other non-medical industries for a long time. Especially in manufacturing industries such as automotive production or chemistry, real-time monitoring is essential. No chemical manufacturing process will run properly without permanently measuring process KPIs such as pressure, flow or temperature. Unfortunately, medical procedures are less predictable than those in other sectors. Additionally, there may also be downsides to measuring outcome and processes in healthcare (Lilford et al. 2004). However, there is also evidence that processes can be optimised by defining process KPIs (Halsted and Froehle 2008). Diagnostic radiology in particular is suitable for this kind of process optimisation. Radiology workflows are characterised by a high degree of standardisation (Teichgraeber et al. 2003). Nowadays most processes are computerbased, utilising Radiology Information Systems (RIS), Hospital Information Systems (HIS) and Picture Archiving and Communication Systems (PACS). This allows extraction of a huge variety of data for use in process control.

Process and KPI Definition

Main processes in diagnostic radiology are highly structured. In the beginning an examination is ordered by a referring physician; the final report of the process usually represents the end. Figure 1 shows the simplified overall process. Of note only part of all these process steps are visible for the referring physician. In regards to a high level of service quality, it is therefore important to remember that customer satisfaction is mainly determined by these visible process steps. While other process steps are relevant only within the radiology department, these steps still have a substantial impact on processing times of the overall process, and thus also affect customer satisfaction.

According to this process definition, the following internal KPIs are derived:

- Ti1: time period from order entry to defining the examination protocol

- Ti2: time period from protocolling to scheduling the examination

- Ti3: time period from the end of the examination to signing-off the finalised report

At least for these KPIs, process control should be implemented in a radiologic department. Depending on the specific reporting workflow (eg additional read-out of the resident/ fellow by the attending in teaching hospitals) it might be appropriate to split T i3 in two separate steps.

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Before implementing a measurement system of KPIs and processing times, specific targets need to be defined. What are the mean goals, what is the 95% confidence interval, eg what is the maximum permissible time between order-entry and protocolling by the radiologist; what is the maximum permissible report turnaround time? Without defining specific goals it will be impossible to assess whether the desired service quality (ie these goals) has been achieved.

In order to control this process, it is essential to collect these KPIs in real time and visualise them permanently. A simple example for real-time monitoring is the visualisation of all pending results, their status and the time remaining until the predefined goal occurs. This information should be displayed and be clearly visible to all radiologists involved in these specific examinations (see Figure 2). An additional colour-coded alarm system of time-critical reports is also deemed helpful. This type of monitoring allows not only the identification of potential problems, but also to take action in a timely fashion.

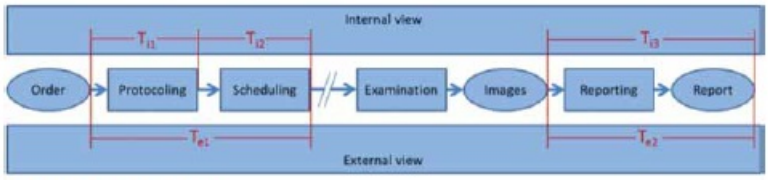

Figure 1. Simplified Main Process of Radiology

The internal KPIs within the main process listed above can and should be complemented by external KPIs that also determine service quality. As shown in

Figure 1 the following KPIs are defined as:

-Te1: time period from order entry to receiving the date/time of the examination

-Te2: time period from the end of the examination to signing-off the finalised report

These KPIs mainly determine customer satisfaction, and may be included in contracted Service Level Agreements. However, a retrospective survey of these KPIs seems acceptable as long as these processes are controlled by the internal KPIs as defined above.

Benefits of Real-Time Monitoring

What are the benefits of real-time monitoring? First, it helps to coordinate processes within the radiology department. Nowadays staff requirements are so complex that it is difficult for the individual employee to keep on track. A common reason for delayed turnaround times simply is that pending reports or important process steps will not progress, and nobody is aware of this problem. Oftentimes reports are forwarded for cosignature to a staff radiologist, who will be out of office the next few days. This is avoidable by implementing a monitoring system that indicates time-critical issues, based on a departmental/sectional rather than personal perspective. Following the implementation of real-time monitoring in the Department of Radiology the median report turnaround time improved from 7 hours 50 minutes to 3 hours 14 minutes, with more than 90% of all reports being finalised within 24 hours.

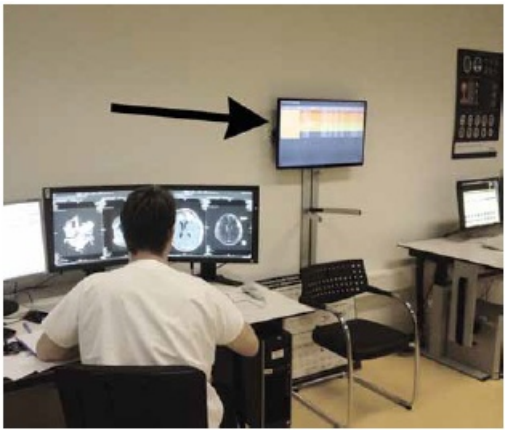
Figure 2: Monitoring Display Installed in a Reading Room

Additionally such a monitoring approach increases transparency. This applies to both internal processes as well as external communication. A similar approach of real-time monitoring is also used to display information about the status of patients from the emergency room (ER) in the radiology department. Thus every ER physician is informed about what is going on with his/her patient. They know when the examination will take place, when the images will be available and when the report is finalised. This can help to increase customer satisfaction simply by avoiding countless status update requests over the phone. This is a benefit for both the ER and radiology department, as these unnecessary phone calls are eliminated.

However, the single most important benefit of real-time monitoring is the fact that it enables management and staff to react to critical issues before “damage” has occurred.

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Challenges and Limitations

Although it may appear rather simple, the implementation of real-time monitoring can be quite challenging. On a level as described above, it is easy to define KPIs for report turnaround times and monitor these constantly. For instance, an overall maximum permissible time of 24 hours for report finalisation is a first step only. Unfortunately, reality is much more complicated. Depending on the clinical context of the examination eg life-threatening motor vehicle accident or follow-up exam on an outpatient basis, 24 hours can be either much too long or unnecessarily short. Thus real-time monitoring reflecting the complexity of medical procedures quickly becomes very complex. The challenge now is to visualise these complex issues in a simple way.

The implementation of effective process monitoring is not possible without substantial effort. It requires human resources with appropriate knowledge of business processes and IT systems. The mapping and documentation of business processes using IT systems is not trivial. Reflecting all processes with corresponding data based KPIs may not always be possible. Data inconsistencies through suboptimal data acquisition can additionally limit the validity of results. Erroneous data will inevitably lead to a low acceptance of such measures. Therefore process control has to be tested properly before deployment. In addition to the human resources (capacity and knowledge), the technical environment has to be implemented. While many core systems such as RIS or HIS provide simple control modules these days, they are often not sufficient to match management requirements. Therefore it may be necessary to add better suited IT solutions.

Another challenge is the acceptance of such a monitoring process by staff. There may be a misconception by some staff members, who conceive the monitoring process as surveillance of their individual performance. It is highly recommended to involve all the various employees early on to achieve broad-based support. This works best if the benefits to the individual employee are highlighted, with the two most important ones being the avoidance of unnecessary interruptions and the optimisation of internal processes. Nevertheless, the need for a high quality service should also be emphasised. Overall, it is recommended to introduce process control incrementally. It should start with activities that provide tangible and visible results. This leads to a positive association, and promotes acceptance by all coworkers.

Conclusion

Today good clinical quality is no longer the single decisive factor for the success of a radiology department. Rapid availability of examinations, quick delivery of the results and maximum transparency of the current workflow and patient status to the referring physician and the patient are prerequisites for high customer satisfaction and business success. Moreover the economic circumstances, eg rising costs and decreasing reimbursement, provide a demanding environment when striving for a higher efficiency of service. This can only be achieved if a radiology department has control over its internal processes. Well-designed processes are an essential prerequisite. Subsequently these processes must be controlled and monitored continuously. For this purpose, real-time monitoring is essential according to the catchphrase “You cannot manage what you cannot measure.” Even though the introduction of such process control requires effort and may meet initial resistance by staff, it will be essential for continuous economic success.

However, optimisation of the internal processes within a radiologic department may be considered a starting point only. The overall goal is to use such indicators to monitor the entire patient pathway within the hospital. This will not only improve internal processes within radiology, but also increase transparency to customers and patients. It is quite conceivable to show each patient their individual expected waiting time.

Another benefit may be computeraided documentation of the communication of critical findings. The system cannot and must not release the radiologist of his medico-legal responsibility to discuss critical findings directly with the referring physician. However, an electronic system can support the documentation of this communication, eg it can track acknowledgments and remember periodically if no feedback has been received. Finally, subsequent activities such as recommended follow-up examinations can be monitored.

In summary, the benefit of process control is the opportunity to achieve control over increasingly complex processes that are out of the scope of an individual. It creates transparency, security and relieves the employees of frequent interruptions and unpopular activities.

Key Points

• Process control can help optimise workflows in radiology.

• Real-time monitoring enables action before damage has occurred, helps to organise workflows and increases transparency.

• Implementation of real-time monitoring is challenging, requires expertise and resources, but has a measurable effect on service quality.

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