Cardiobase

Case Study

Efficiencies from Closed Loop Cardiovascular Information Systems

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EXECUTIVE SUMMARY

This report applies control system concepts to Cardiovascular Information Systems to see it there is an opportunity to improve patient care. By providing background on what open and closed loop systems are the report conceptualizes that some patient care is open loop and more complex care such as Cardiology is closed loop. The background highlights the feedback loop as an important element of system performance and how it can be used to optimize system performance. The report explores case studies of reducing the feedback loops in referrals, studies and reports, inpatient order communications, booking and reporting. The case studies found that in all cases, optimizing the feedback loop improves patient care by increasing the speed to effective treatment, reduced administration, reduced data entry effort, fewer opportunities for error, reduced billing leakage, increased room utilization and reduce bed-time per inpatient. The most profound finding in the report is that when the system is conceptualized as a whole, the optimization benefits compound as the smaller feedback loops affect larger feedback loops. The report concludes that patient care can be improved by applying control system concepts to Cardiovascular Information Systems and as your partner, Cardiobase is here to support you in achieving that vision.

INTRODUCTION

The purpose of this report is to apply control system concepts to Cardiovascular Information Systems and see if there is an opportunity to improve patient care. This report will use intentionally oversimplified scenarios to explore the concepts as the nature of patient care is acknowledged to be complex, stochastic and continually changing. By exploring the theory and analyzing case studies the report will conclude with some opportunities to assist Cardiology departments.

WHAT IS A CLOSED LOOP INFORMATION SYSTEM?

The term closed-loop information system applies control system's theory and expands the concept to cover management of information flow. The most common control system comparison is open loop versus closed loop. Open loop system consists of inputs, outputs, process steps and error. An example of an open loop system is a toaster, the inputs to the system are the piece of bread and timer the output of the system is a piece of toast. The process is started when the lever is pulled down and it is stopped when the timer expires and the output is generated, toast. The error in this system is not known or managed by the system as it is possible to put a frozen, refrigerated or room temperature piece of toast in and get either undercooked, perfect or burnt toast.

An example of a closed-loop system is an elevator, the input to the system is the desired level and the output of the system is the actual level, the elevator then adjusts the direction and speed until such time as the desired level is. According to Shinners (1998), "Closed-loop control systems derive their valuable accurate reproduction of the input from feedback comparison. An error detector derives a signal proportional to the differences between the input and output. The closed-loop control system drives the output until it equals the input and the error is zero. Any differences between the actual and desired output will be automatically corrected in a closed-loop control system."

So, I am sure you are wondering, what does this have to do with patient care? In effect, patient care can be conceptualised as an open or closed loop system depending on the type of care needed. For example, a person with a minor infection goes to the GP, gets antibiotics and the infection goes away and doesn't go back to the GP. This is an open loop and perfectly fine for the type of care needed. Cardiology is much more complex than that, patients generally have many tests, operations, visits and reports throughout their lives and remain ongoing patients. This is a closed loop system as their continual treatment and observation is required as a part of treatment.

An important part of optimizing a control system is the length of the feedback loop. For example, if the feedback loop for the elevator discussed earlier was 30 seconds, the busy business person would not be happy as the elevator will oscillate until it settles at the correct floor. In other words, if you selected floor 10, it may take you up to floor 12, then down to floor 9 and then

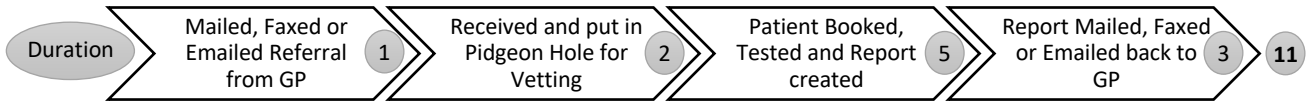
eventually to floor 10. When we apply this oscillation analogy to our patients, we may attempt managing patients when the required information isn't available or delay treatment until information is available.

REDUCING THE FEEDBACK LOOP

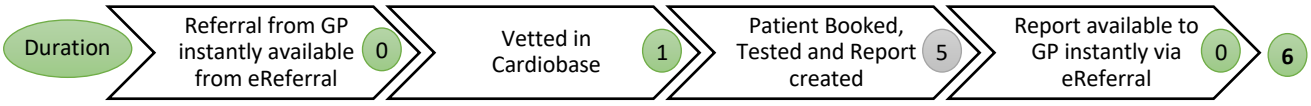
So, how do we minimize the feedback loop? We have been working with our customers in Australia, the UK and New Zealand to solve this very challenge. We have successfully optimized different parts of the patient journey although no one is at the stage of full feedback loop optimization, so there is still more work to do. For this report's sake, we have simplified the patient journey loosely in terms of Admission/Referral, Booking /Arrival, Tests, Reports and Billing. These will be expanded further in the following sections.

REFERRALS

Some of our clients have moved to an electronic referral process from mail, email and fax. The manual workflow with faxing and emailing can be simplified as:



By summing the duration of the steps, the feedback loop to the GP is approximately 11 days. We have worked with some of our clients to integrate their Cardiobase (Via HL7) to electronic referral management systems which are being used in their geographical regions. As a result of this work, we have experienced the following improved workflow:

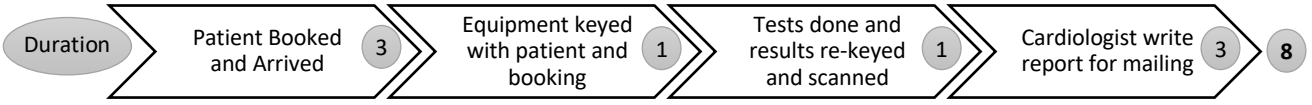


From our observation, this process now takes less time and results in a feedback loop to the GP of approximately 6 days. This is a 5-day improvement in the feedback loop and for critical patient care, this could make a significant difference.

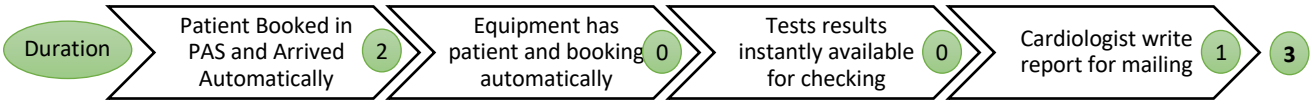
This project not only found improvements in the feedback loop, but it also found reduced administration, data entry effort and opportunities for error.

STUDIES AND REPORTS

Some of our clients have moved to an integrated booking, studies and reports process from manual re-entry with scanning, printing and faxing. At a high level, we have experienced the following workflow:



By summing the duration of the steps, the feedback loop to the clinician is approximately 8 days. We have worked with our clients to integrate their Cardiobase system (Via HL7 and DICOM Worklists) to patient administration systems, electronic medical record systems and equipment. As a result of this work, we have experienced the following improved workflow:

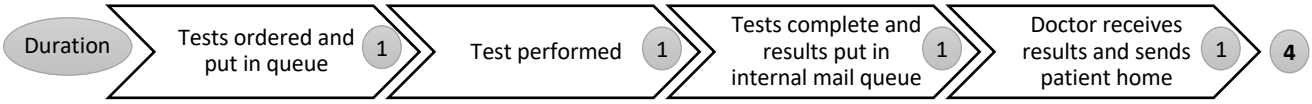


From our observation, this process now takes less time and results in a feedback loop to the clinician of approximately 3 days. This is a 5-day improvement in the feedback loop and for critical patient care, this could make a significant difference.

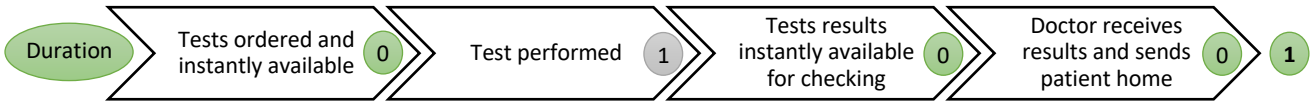
This project not only found improvements in the feedback loop, but it also found reduced administration, data entry effort and opportunities for error.

INPATIENT ORDER COMMUNICATIONS

Like studies and reports, some of our clients have moved to an integrated booking, studies and reports process from manual re-entry with scanning, printing and faxing. At a high level, we have experienced the following workflow for inpatients:



By summing the duration of the steps, the feedback loop to the clinician is approximately 4 days. We have worked with our clients to integrate their Cardiobase system (Via HL7) to patient administration systems and electronic medical record systems. As a result of this work, we have experienced the following improved workflow:

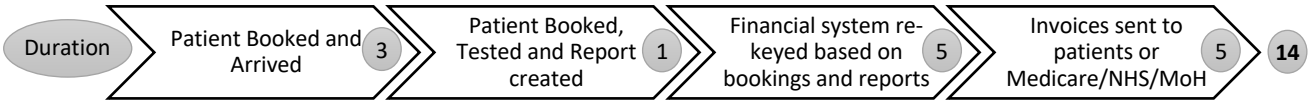


From our observation, this process now takes less time and results in a feedback loop to the clinician of under a day. This is a 3-day improvement in the feedback loop and for inpatients, this is vitally important as the delay in paper queues and internal mail result in an increase in bed stay duration, which is a major challenge for hospitals.

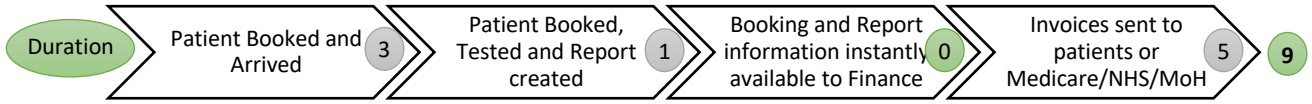
This project not only found improvements in the feedback loop, but it also found reduced administration, data entry effort and opportunities for error.

BOOKING AND REPORTING

Some of our clients have moved to an integrated booking, and billing process from manual re-entry and faxing. At a high level, we have experienced the following workflow:



By summing the duration of the steps, the feedback loop to finance and management is approximately 14 days. We have worked with our clients to integrate their Cardiobase system (Via HL7) to patient administration systems and billing systems. As a part of this, we have experienced the following workflow:

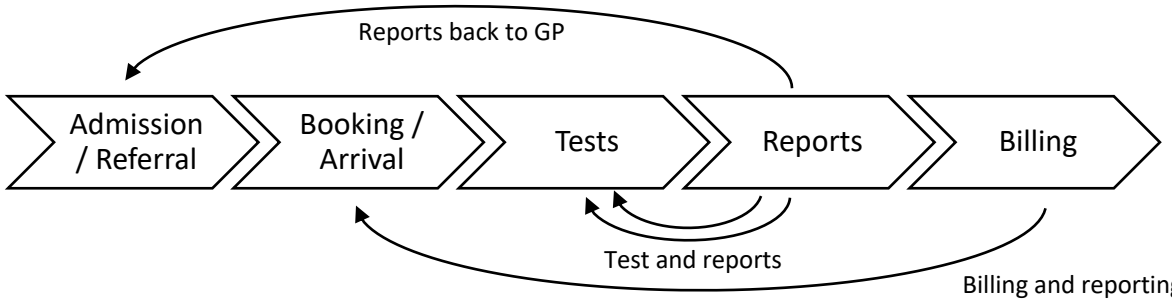


From our observation, this process now takes less time and results in a feedback loop to finance and management of approximately 9 days. This is a 5-day improvement in the feedback loop and can assist in accurately capturing the financial position and justification for departments.

This project not only found improvements in the feedback loop, but it also found reduced administration, data entry effort and opportunities for error. Error in this context results in leakage where incomplete or incorrect data was available when processing. For example, we have observed that billing is often not expanded to capture how difficult the procedure was, resulting in underbilling. In practice, this meant that many billing entries were now correctly keyed and missed billing was now captured, increasing budget available for the department to improve patient care.

ONE COMBINED SYSTEM

If we take the concepts of referrals, studies and reports, inpatient order communications, booking and billing we can see the overall closed-loop system and its interaction within the patient journey. Here is a conceptual representation:



When this is shown as an overall system, we can see that each of the feedback loops have an impact on the others. E.g. if it takes a long time to complete the tests and reports, this will affect how long it takes to get the reports back to clinicians and the GP.

Let's run through these feedback loops and how they could impact patient care. With the smallest loop, Tests and Reports, if we were to undertake testing because of a suspected diagnosis and the tests showed that the initial hypothesis is not proven, then further testing will be needed. This loop of tests and reports will be continued until there is enough evidence to support the correct diagnosis. If this loop is 11 days and needs to cycle 3 times, this could take more than a month to reach diagnosis and treatment. If this loop is optimized to 6 days and needed to cycle 3 times, this could take just over half a month to reach diagnosis and treatment. This shows that from the patient's perspective, long feedback loops can have a massive impact on them and their treatment. Furthermore, from an inpatient perspective, this could result in several additional days in hospital due to delay in paper flow throughout the hospital, resulting in increased hospital bed usage per patient.

The next loop is the feedback to the GP, having this information available to the GP in a timely manner keeps them in the loop as treatment occurs. If this loop was too long the GP may not have up to date information available to them which could result in clinical risk. This would be amplified by the Test and Reports feedback loop if several iterations were required.

The final loop is billing and reporting, this loop captures information from booking and reports to generate accurate billing or reporting to Medicare, Ministry of Health or NHS. If this feedback loop is too long it could skew the accurate and timely reporting of the income generated by the department which can affect the budget required to purchase new equipment and hire staff to support an ever-increasing workload. If this feedback is too slow, there will be a lag between increased workload and budget availability resulting in increased stress and pressure to departmental staff.

INCREASING INTEGRATION

Increasing digitization is very common in our hospitals today, although digitization just for the sake of going digital should not be the objective of our strategies. Cardiobase is a key proponent of digitizing for the objective of improving patient care and considering the business processes that are to be supported or improved along with digitization.

To codify this closed loop digitization, we can look at this in terms of a maturity model. According to Healthcare Information and Management Systems Society (2017), there is a continuity of care maturity model that has stages of maturity that include closing the loop. The model has stages 0 to 7 that imply greater value as the stages increase. Stage 0 of this model contains isolated data and minimal governance and when we get to stage 6, it becomes "Dynamic intelligent patient record tracks closed loop care delivery" (Healthcare Information and Management Systems Society, 2017). Based on our experience, Cardiobase can help your Cardiology department increase in care maturity. Furthermore, Cardiobase supports the desire to integrate with other

departments and hospitals via EMR systems, Registers and Clinical portals. We have found this to not only be possible but highly beneficial to the Cardiology department and other related departments, hospitals and clinicians.

CONCLUSION

The purpose of this report was to apply control system concepts to Cardiovascular Information Systems and see if there is an opportunity to improve patient care. The report found that conceptually, it is possible to reduce feedback loops through digitization and integration. Through case studies we found reduced feedback loop durations, increased efficiency, reduced administrative burden, reduced opportunities for error and reduction in missed billing. Cardiobase can support you by, undertaking the following:

- Booking / Admission
    - Integrating to PAS systems – Reducing effort by 6% on average
    - Integrating to eReferral systems – Reducing effort by 19% on average
    - Getting information into Cardiobase easily – Reducing effort by 5% on average
    - Increasing appointment attendance – Reducing DNA %
    - Optimizing room utilization - Reducing stay per patient by 20% on average
- Tests / Reports
    - Integrating to equipment - Reducing effort by 9% on average
    - Integrating to electronic report transmittal – Reducing effort by 8% on average
    - Integrating to EMR systems - Reducing effort by 7% on average
    - Sending via eFax, batch printing and PDF generation - Reducing effort by 8% on average
- Billing
    - Integration to billing systems to reflect accurate billing – Reduction in missed billing by 10% on average

REFERENCES

Healthcare Information and Management Systems Society, 2017. *CONTINUITY OF CARE MATURITY MODEL.* [Online]
Available at: https://www.himssanalytics.org/ccmm
[Accessed 17 January 2019].

Shinners, S., 1998. *Modern Control System Theory and Design.* 2nd ed. s.l.:Wiley Interscience.