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Can Data Driven Digital Medications Dashboards Reduce the Number of Missed Medication Administrations in Haemodialysis Patients?

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1. Introduction

Technology is now engrained in society. So much so, that in the health care industry, seldom can one visit a doctor without them using digital tools to provide care, if only to record simple patient notes. This ability to record large volumes of data in a single digital system is revolutionary and has many benefits. Not only the environmental impact of reducing paper notes, but also by providing the chance to analyse huge data sets and identify patterns, which is invaluable when considered against finding the best treatment for those who are ill. However, retrospective use of this data is one thing, and it has its place in improving treatment options and understanding ailments. But what if the data being captured was available instantly? What if at the point of being captured, the data could be re-extracted and presented back to the clinicians for immediate use? This is where digital dashboards come in!

This project aims to explore how data driven digital medication dashboards can be used in haemodialysis treatment centres to reduce the number of missed medication administrations due to be given to haemodialysis patients during treatment. It explores the concepts of prospective, as opposed to retrospective medication surveillance, how digital can improve patient care in real time and addresses the question:

"Can Data Driven Digital Medications Dashboards Reduce the Number of Missed Medication Administrations in Haemodialysis (HD) Patients?"

The below graphic (figure 1.) represents the problem with retrospective medication surveillance for those people with life long kidney failure, requiring haemodialysis treatment at a treatment centre.

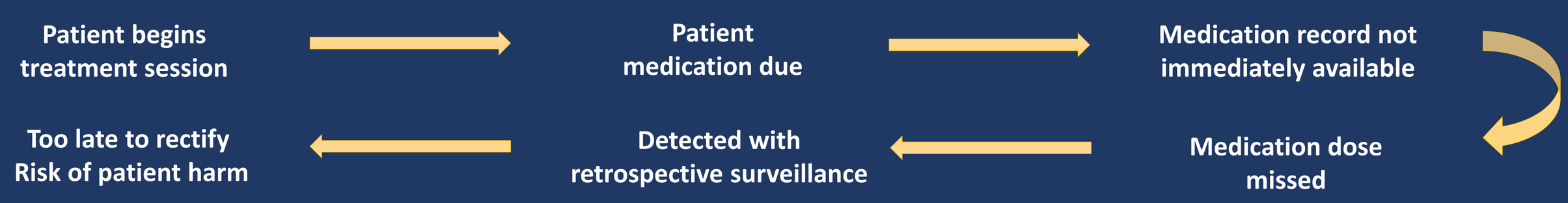

Figure 1. – Flowchart representing HD patient with missed medication dose – retrospective medication surveillance

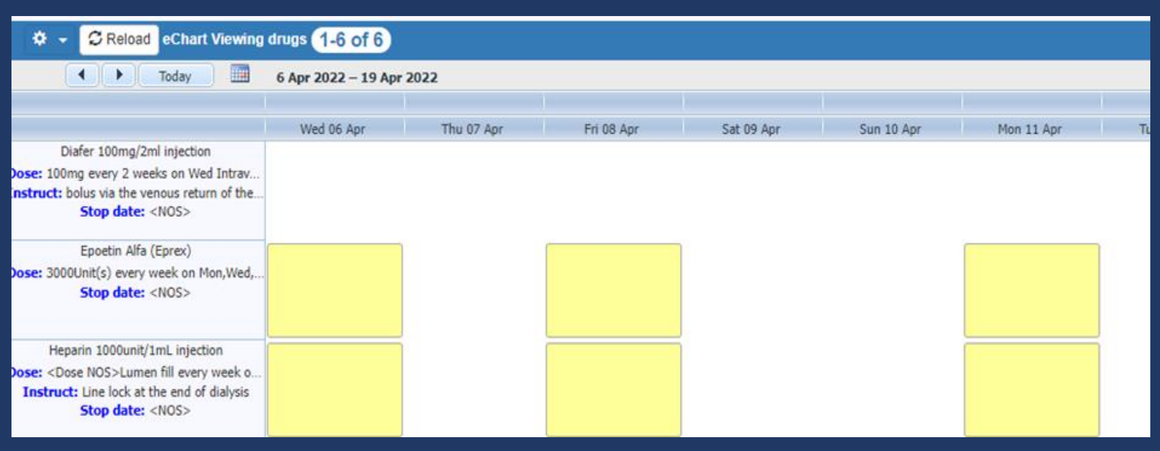

Figure 2. – Example digital prescription chart for HD patient (VitalData: Swansea Bay University Health Board, Renal EHR)

2. Background Research

Health care processes rely on **Clinical Decision Support Systems** (CDSS) to provide ever faster and more efficient clinical decision making [1]. Clinical dashboards are one example of a CDSS and offer dynamic visualisations that make it easier to understand large volumes of related data. Using **User Experience** (UX) **Design** to develop digital systems takes a human centred approach to understand and factor in human feelings to the design process i.e. build well functioning systems that people feel happy to use [2]. This understanding of human-system interaction is key to a successful dashboard. If too little information is made available, users may disengage with the system. Likewise, too much detail, or ineffective graphic design may again cause users to disengage. Successful dashboard design is about finding the balance between available information, attractive graphical design and an solid understanding of how users are most likely to engage with the system.

From an analysis of 2140 medications given over 18 HD sessions in Swansea Bay University Health Board (SBU), non-standard medications (those tailored specifically to the patient) made up 80% of deviations from actual prescription, with 50% of those being classed as "never-events", or incidents that should never occur.
A 2009 study by Victor Zaybfudim et al. looked at the "Implementation of a Real-time Compliance Dashboard to Help Reduce SICU Ventilator-Associated Pneumonia (VAP) with the Ventilator Bundle" and found that the introduction of a dashboard resulted in a decrease in the mean VAP infection rates from 15.2 (7.0) to 9.3 (4.9) incidents per 1000 ventilator days. Quarterly VAP rates were reduced significantly for the November 2007 to January 2008 and February 2008 to April 2008 quarters and compliance with ventilators grew from 39% in August 2007 to 89% in July 2008 [3].

3. Requirements & Methodology

It was clear that there was a need to identify medications due for those currently receiving treatment. It was also clear that the data had to be as close to live as possible, so that clinicians could see an up-to-date view of what medications had been given quickly, to help avoid never-events.
The MoSCoW method for prioritisation was used to group requirement initiatives according to how they fell in to the "Must Have", "Should Have", "Could Have" and "Will Not Have" categories. This initiatives were discussed with clinicians and agreed upon formerly, giving structure and meaning to the development of each features. For example:

Must Have: Clear display of relevant medication data
Should Have: Dynamic link to digital medication prescription chart (figure 2.)
Could Have: Function to move administered but **non-witnessed** meds for those having already completed treatment, to separate section
Will Not Have: Direct interaction with patient medication records

To encourage a lean development strategy, the Agile manifesto was employed, in particular, **Feature Driven Design** (FDD). FDD organises developments around making progress on tasks that need to be achieved, known as features. The main ones were:

- See when medication is due for the patient receiving treatment
- See when medication has been administered
- See when it was administered and not witnessed by a senior colleague
- See all medications administered and not witnessed within the last 24 hours

FDD has five key steps that can be applied to the project lifecycle. The first task is to develop an overall model, in this instance, a wireframe diagram to help users visualise the final product. Second, a features list was drawn and thirdly a plan built around the features most important and most likely to be achieved. Following this, the agreed features were designed and then developed. This process was reiterated until the dashboard was ready for full testing.

4. Design & Implementation

For the dashboard to work effectively, a number of related tasks were to take place. To extract the data from the database, a MySQL query was designed for each of the sections (meds due, meds due to be witnessed, and non-witnessed meds in the last 24 hrs) and a crystal report for each developed to output the data automatically, every 5 minutes, to a secure file location, in .XLSX format.

Next, a PowerBI dashboard was developed to target the .XLSX file, use the data from each and display the required information. Figure 3 (test data only) shows a fully developed dashboard example. In the top section, patient T test is currently receiving dialysis and has one medication still to receive. The middle section shows that T Test has received a medication, but it was not marked in the EHR as having been witnessed by a senior clinician. Lastly, the bottom section shows that patient J Bloggs has completed his treatment but had an outstanding medication due to be given that was missed and not marked as being missed intentionally. This is classed as a never-event.

Given the data sample included only test records, it was not possible to implement in a real dialysis treatment scenario. Best efforts were made to replicate many of the complex medication regimes of SBU dialysis patients and nurses were tasked with running mock sessions on the test data.

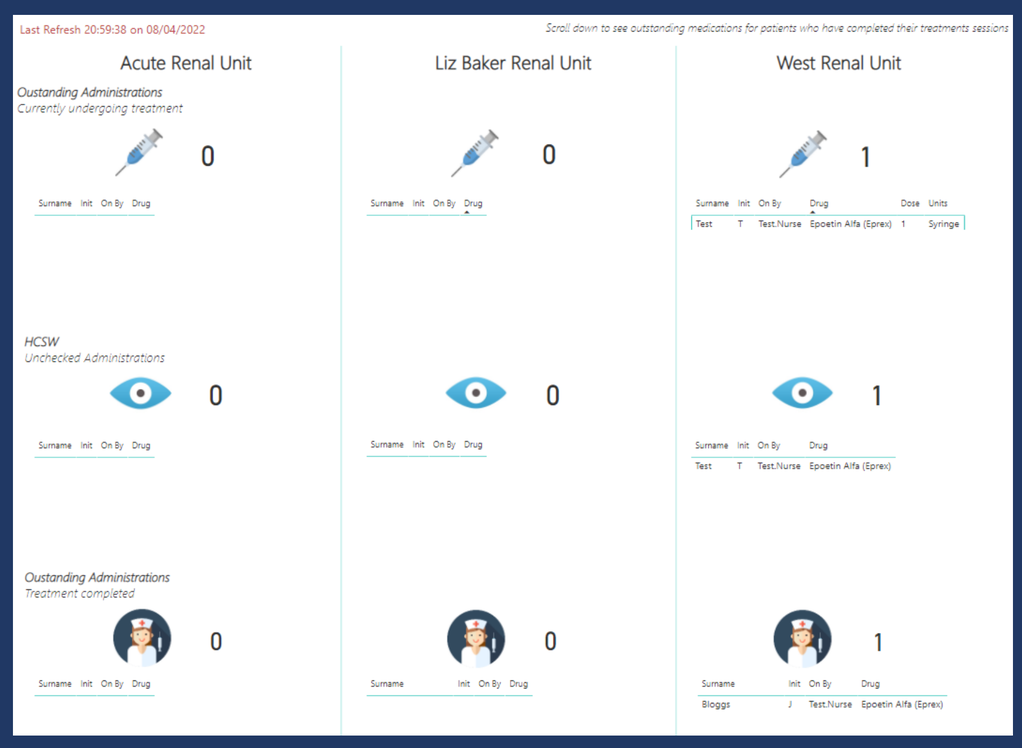

Figure 3. (left) – Example digital medication dashboard depicting "due", "due to be witnessed" and "non-witnessed within 24 hrs medications"

5. Findings

A digital dashboard at the clinicians fingertips puts the current picture in front of them when it is needed. Nurses could see accurate drug data without need to travel back and forth to a distant computer or consult paper-based, often illegible notes. Additionally, less paper notes at the patient bedside would mean less clutter in the treatment areas. These two points alone were considered to reduce the cognitive load on nursing staff and enable more time to care for the patient, improving the patient experience.

During initial tests, it was predicted that a digital medication dashboard would release 18 labour hours per day across 2 HD shifts and 6 nurses on each shift. Moreover, initial indications suggest a 95% decrease in accidental missed medication doses, with the remaining 5% allowing for system downtime.

The below graphic (figure 4.) represents prospective medication surveillance for those people with life long kidney failure, requiring haemodialysis treatment at a treatment centre.

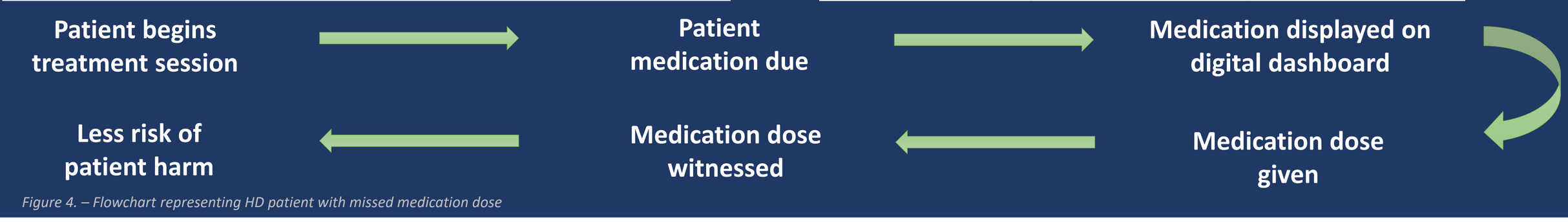

Figure 4. – Flowchart representing HD patient with missed medication dose

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[1]. R. T. Sutton, D. Pincock, D. C. Baumgart, D. C. Sadowski, R. N. Fedorak, and K. I. Kroeker, "An overview of clinical decision support systems: benefits, risks, and strategies for success," npj Digit. Med. 2020 31, vol. 3, no. 1, pp. 1–10, Feb. 2020, doi: 10.1038/s41746-020-0221-y.
[2]. Christopher Murphy, "The Evolution Of User Experience Design | Adobe XD Ideas," 2019. https://xd.adobe.com/ideas/guides/evolution-user-experience-design-intro/ (accessed Feb. 15, 2022)
[3]. V. Zaydfudim et al., "Implementation of a real-time compliance dashboard to help reduce SICU ventilator-associated pneumonia with the ventilator bundle," Arch. Surg., vol. 144, no. 7, pp. 656–661, 2009, doi: 10.1001/archsurg.2009.117