

Denmark

Optimising medicine management and reducing waste: a digitised approach for Danish healthcare

Challenge

The absence of a standardised tracking system in Central Denmark's hospitals had made it arduous for pharmacists to gain a comprehensive overview of medicine stock and identify packages approaching their expiration dates. The manual nature of inventory management further compounded the challenge, leading to time-consuming and error-prone processes. Additionally, the fragmentation between departments and hospitals hindered the efficient sharing of medical resources. There was a lack of a streamlined mechanism to redistribute medications, meaning some areas were not using supplies while others faced shortages.

Approach

To address these challenges, a specialised smartphone application was developed. This application leverages GS1 standards and smartphone camera capabilities to scan barcodes. Pharmacists can simply scan each item, so creating a virtual catalogue of medicine packages which provides real-time visibility of expiration dates. This is much more efficient than previous manual processes – it is more than two and a half times' quicker. It also supports the seamless sharing of medicine between departments and hospitals, ensuring optimal use of resources and promoting collaboration among healthcare professionals. Over 16 months, more than 3,900 packages with a value of over €260,000 have been reallocated to other areas for use before their expiry.



Introduction

An in-house developed smartphone application has been implemented, empowering hospital pharmacy staff to effectively scan barcodes, establish an inventory overview, and support the sharing of medicine across various departments and hospitals. This is aligned with the "Too Good to Go" initiative that has been implemented at hospitals in the Central Denmark region. The initiative is designed to reduce medicines wastage. The application leverages the industry standard GS1 framework and uses a smartphone camera as a barcode scanner, thereby enabling the creation of an organised virtual catalogue of the medicine packages within each designated medicine room. This systematic approach means pharmacists can readily gain a holistic perspective of the stock and expiration dates. This enables the identification of medicine pack-

ages that will soon pass their expiration dates. Upon detecting such packages in a given medicine room, pharmacists can promptly "release" the medicine, making it available for their colleagues from other departments and so reducing waste. Aarhus University Hospital introduced the application in January 2022. Within the first year of use, the diligent efforts of the pharmacists resulted in the successful reallocation of medicine worth over €175,000. This achievement prompted the rollout of the application to all six hospitals within the Central Denmark Region: a total of 332 medicine rooms. Today, this integrated solution stands as a testament to a commitment to optimise sustainability, medicine management, and resource allocation.

Background and motivation

Hospital pharmacy within the Central Denmark Region plays a crucial role in providing comprehensive medication services at the hospitals. These services encompass the likes of medication ordering, storage, and diligent verification of expiry dates.

To combat the issue of medicine wastage resulting from expired medication, a thorough assessment of medicine packages was undertaken every six months within the hospital's medicine rooms. This process was both time-consuming and reliant on manual efforts, requiring pharmacists to meticulously transcribe package details onto paper. Reallocating medicine to different departments before expiration presented a formidable challenge, as it necessitated educated guesses about the needs of colleagues.

Adding to the complexity, expiration dates are denoted through a multitude of conventions such as "Expiry date," "Exp.," "Verwendbar bis," "Niet te gebruiken na," "Use by latest," or "Use by before." Depending on the specific notation employed, the expiration date may refer to either the last day of the specified month or the last day of the preceding month. This diversity in markings elevates the risk of misinterpretation, potentially leading to premature or delayed disposal of medication and jeopardising patient safety, sustainability, and overall economic efficiency.

In an endeavour to streamline and modernise these manual and time-consuming workflows and improve sustainability in the hospital, a dig-

"In the past, we read the information on the medicine packages and expiration dates manually and wrote it down on paper forms. It was very time consuming and could lead to misinterpretation of expiration dates due to the varying wording conventions."

Anne Lund Sørensen,
Pharmacologist, Aarhus University Hospital,
Member of the project group

ital project was initiated in 2020. Pharmacy collaborated with the local IT department to develop a user-friendly smartphone application. This innovative application aimed to enhance workflow agility, embrace digitisation and support seamless access to critical information.

Close collaboration between clinicians and software developers

The IT department within the Central Denmark Region has a dedicated in-house software development team known as Dias. With a diverse range of responsibilities, Dias is tasked with the development and management of a self-hosted on-premise Kubernetes platform, as well as the analysis, design, development, implementation, and ongoing operation of digital solutions tailored to meet the needs of the region's hospitals.



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Using two established data centres within the region, Dias builds and maintains a cloud native platform. This ensures secure and reliable applications and compliance with GDPR (General Data Protection Regulation) requirements. The team adopts a microservice architecture, promoting reliability, scalability, and component reusability across various systems. Dias' goal is to innovate healthcare technology, enhance efficiency, and improve user experience for hospital staff and for patients.

A collaborative project group was established for the development of the app, bridging the two departments of pharmacy and IT. The aim was to create a shared understanding of the challenges and opportunities, as well as a framework for continuous clarification and validation processes.

Development began in summer 2021. Inhouse development, and the absence of a formal requirement specification, allowed for heightened flexibility and adaptability, enabling the development team to readily incorporate new ideas and features as their expertise deepened. This iterative process ensured a refined and enlightened approach to meeting the project's objectives.

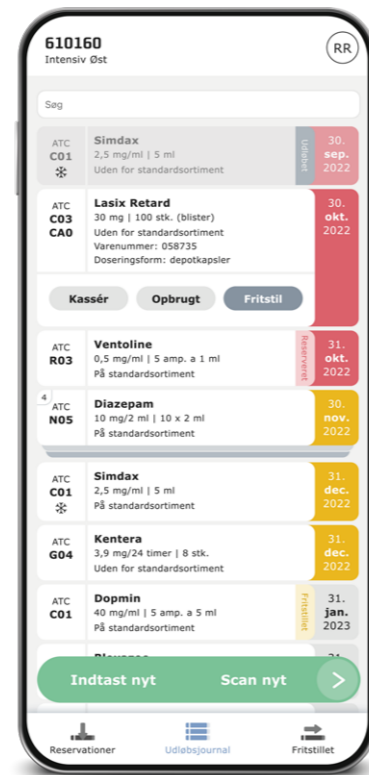
The close collaboration of the project group supported a rapid feedback loop, resulting in a positive user experience with the initial product. This aspect is particularly important when introducing new systems and workflows into the busy schedules of clinicians, ensuring smooth adoption and integration into their existing routines.

"From day one, the developers have been with us in the clinic to experience our everyday life and understand the challenges we face. The collaboration with Dias has been great."

Charlotte Arp Sørensen
Pharmacist, Aarhus University Hospital
Member of the project group

"They have managed to develop an app that is user friendly for everyone, which also means that staff have been positive right from the start of the implementation."

Charlotte Madsen
Pharmacologist, Gødstrup Hospital



The application

To access the application, pharmacy staff members are required to log in using their designated work credentials. For first time users, a prompt guides them through the process of adding primary medicine rooms to their profiles. Typically, a pharmacist is responsible for overseeing and managing five to 10 medicine rooms.

Upon selecting a primary medicine room, the application displays a well-organised and sorted overview of the available medicines, with those closest to expiration appearing at the top of the list. Expired medicines are clearly labelled as "Expired," ensuring prompt identification and appropriate disposal.

The application uses a colour-coded system to support users in the efficient management of medicine rooms. Medicines with expiration dates within one month are highlighted in red, indicating the need for immediate attention. Those with expiration dates within three months are marked in yellow, enabling proactive planning and monitoring.

Medicines can be added to the inventory in one of two ways. Either users can manually search for specific medicines in the comprehensive medicine catalogue provided by the application. Alternatively, they can use the smartphone's camera to scan the barcode on the medicine package, which automatically retrieves the necessary information and adds it to the list.

By using the GS1 DataMatrix standard, the expiration date is extracted directly from the barcode. This removes the need for pharmacologists to interpret the date, addressing one of the main challenges of the previous manual workflow.

The application therefore streamlines the process of inventory management, ensuring accurate tracking, and promoting the timely disposal of expired medicines. This systematic approach contributes to the overall efficiency and safety of medicine service within healthcare facilities.

Upon selecting a medicine item from the list, the user is presented with three options: "Used", "Discard", and "Release."

The "Used" option is selected when the package is no longer present in the medicine room, indicating that it has been administered or dispensed by a nurse or doctor.

The "Discard" option is selected when the user determines that a medicine package has expired or is no longer suitable for use. Upon choosing this option, the user is prompted to enter the quantity remaining in the package. This important step enables the generation of an accurate disposal report, providing valuable data for business intelligence purposes. By capturing precise information about the amount of medicine being discarded, the application facilitates comprehensive analytics and informed decision-making. This feature underscores the way in which the application's supports meticulous



Karin Aagot Møller Jørgensen

record-keeping, as well as its ability to contribute meaningful insights for optimising processes and resource management.

The "Release" option serves as a pivotal component of the inventory management process, enabling pharmacologists to classify medicines that are unlikely to be used before their expiration dates. By selecting the "Release" option, pharmacologists make these medicines available to colleagues from other departments or hospitals through the "Released Medicine List".

To reserve a medicine package for a specific medicine room, the user can simply click on an item in the list. This action adds the medicine to the "Reservation List". Within this, users can find detailed information about the reserved medicine, including the contact details of the colleague responsible for the release. Additionally, the pneumatic tube number of the medicine room where the medicine is reserved can be viewed, allowing seamless communication and efficient retrieval of the reserved medicine.

An additional administrator application serves as a comprehensive tool for managing and monitoring the usage of the smartphone app. It provides users with quick access to valuable statistics, including data on medicine relocation, usage, and disposal. Administrators can retrieve detailed reports on medicine disposal and conveniently export them into Excel-readable files for further analysis and record-keeping. The administrator application also hosts a comprehensive user manual for the smartphone application.

"The implementation has gone terrifically. The app is very easy to use - it's like shopping in a store, where you scan the items yourself. With the app, we are more at the forefront now and get to use the medicine in other sections. So that's a big advantage, because then we get to use it instead of throwing it away"

Charlotte Hjorth
Pharmacologist, Silkeborg Hospital

"Everyone has been super excited to use the expiration app and I'm already hearing that people now are looking forward to checking expiration dates, instead of it being a chore"

Charlotte Madsen
Pharmacologist, Gødstrup Hospital

"The app is easy to use. It is quick to scan medicine and it helps to ensure that we interpret the expiry dates much better than before"

Karin Aagot Møller Jørgensen
Pharmacologist, Aarhus University Hospital
Member of the project group

Results

Implementation of the initial version of the application began at Aarhus University Hospital in January 2022. Through a phased rollout strategy spanning three months, it was successfully deployed across various departments, encompassing a total of 147 medicine rooms.

In early 2023, a decision was made to extend the application's implementation to the five other regional hospitals in the Central Denmark Region. Following a similar timeline of a few months, the application was successfully implemented in all the hospitals. Currently, it serves a total of 332 medicine rooms, and the number of scanned packages has already exceeded 50,000.

Over the past 16 months, the application has supported the reallocation of over 3,900 packages before their expiry, amounting to a value of more than €260,000. This efficient management of medicine inventory has contributed to significant cost savings and waste reduction.

Time measurements have revealed that the application is more than 2.5 times faster than previous manual processes. This substantial increase in efficiency underscores the significant benefits and time savings achieved through the adoption of the application in healthcare facilities.



Charlotte Hjorth

Perspective

With the successful implementation of the application across all hospitals, a vast amount of data is now being generated. This data holds immense potential for business intelligence, procurement enhancements, and even machine learning for supply and demand forecasting.

Through robust business intelligence processes, the data can be analysed and interpreted to gain valuable insights into operational patterns,

trends, and performance. This can enable healthcare organisations to make data-driven decisions, optimise processes and identify areas for improvement.

By analysing historical usage patterns, demand fluctuations, and expiration trends, organisations can also optimise procurement strategies, ensure adequate stock levels, and minimise waste.

The accumulated data can be harnessed for advanced analytics and machine learning algorithms. By applying predictive modelling and forecasting techniques, healthcare organisations can gain valuable foresight into future supply and demand scenarios. This enables proactive planning, efficient allocation of resources, and improved responsiveness to changing needs.

Overall, the availability of this rich dataset opens up a wide range of possibilities for leveraging data-driven insights and advancing healthcare operations. The application's comprehensive data collection and analysis capabilities contribute to informed decision-making, enhanced efficiency, and improved patient care within healthcare facilities.

Next steps

After winning two digitisation awards in autumn 2022, the application gained significant recognition and generated positive publicity. As a result, the remaining regions of Denmark have expressed keen interest in adopting the application. Since all regions use the same procurement system, the process of expanding its usage across Denmark should be relatively straightforward. The next logical step would involve collaborating with one of the regions to determine the optimal approach for hosting the application and implementing local login services.

There is also a wide range of further development opportunities to explore. One would be leveraging the generated data to enhance the hospitals' supply chains, reducing the procurement of unnecessary medications and improving overall efficiency.

It would be valuable to incorporate a delivery feature into the application, addressing the issue of medication not being refrigerated promptly after delivery, which often leads to wastage. Given the contact details of pharmacologists responsible for medicine rooms are already within the application, sending alerts via text message or email is another possible area to explore. This approach would use the hospital's existing infrastructure, where each location has a dedicated Global Location Number (GLN). As a result, the service assistant responsible for medication delivery could simply scan a DataMatrix, streamlining the process further.

Another step forward would involve using the application, or creating a spin-off application, for other medical equipment with expiration dates. This has immense potential for resource sharing across the hospital as every operating room maintains its own equipment depot.

Conclusion

The implementation of the smartphone application in the hospitals of the Central Denmark Region has successfully addressed the challenge of medicine waste and improved medicine management. The application, collaboratively developed by the pharmacy and the IT department Dias, leverages the GS1 framework and smartphone camera capabilities to create a virtual catalogue of medicine packages. This provides real-time visibility of expiration dates and enables the sharing of medicine resources between departments and hospitals.

The absence of a standardised tracking system and the manual nature of inventory management had previously led to medicine wastage. The application has overcome these challenges by providing a holistic overview of medicine stock across departments and hospitals, streamlining inventory management processes, and facilitating the timely disposal of expired medicines. It has also enabled pharmacologists to release medicines that are unlikely to be used before their expiration dates, making them available to colleagues from other departments.

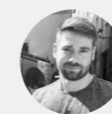
The benefits of the application's implementation have been significant. Over 16 months, more than 3,900 packages with a value of over €260,000 have been reallocated before their expiry, leading to cost savings and waste reduction. The application is also 2.5 times quicker than previous manual processes.

The platform's agile infrastructure enabled a seamless expansion from a single hospital to six within a remarkably short period of two months. This rapid scaling occurred without any interruptions or complications, showcasing the platform's robustness and efficiency.

The vast amount of data generated by the application holds the potential for business intelligence, procurement enhancements, and supply and demand forecasting. The successful implementation of the application in all hospitals in the Central Denmark Region serves as a testament to a commitment to optimise sustainability, medicine management, and resource allocation.

Overall, the smartphone application has proven to be a valuable tool in reducing medicine waste, improving medicine management processes, and promoting collaboration among healthcare professionals. Its successful implementation and positive feedback from users highlight its potential to drive positive change in healthcare facilities beyond the Central Denmark Region.

About the author



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Software Developer, Dias

Rune Dalsenni Rask works at Dias, a small in-house development team inside the IT department of Central Denmark Region.

He primarily works as a software developer, but as the team operates on a crossfunctional principle he also takes on additional responsibilities. This includes acting as a project leader, coordinator, and serving as a liaison between the team and the users, ensuring their needs are understood and addressed effectively.

He holds a master's in Computer Engineering (Civil Engineering) from Aarhus University.

About the organisation



Central Denmark Region is one of five administrative regions in Denmark. Located in the central part of the Jutland peninsula, Central Denmark Region is home to more than 1.3 million people, which makes it the second-largest region in Denmark. The primary responsibility of the regions is to administer the healthcare system and services. Central Denmark Region is responsible for nine somatic hospitals and eight psychiatric hospital departments, pre-hospital emergency services, general practitioners, and practicing specialist doctors. The region also operates several specialised social care institutions in agreement with local municipalities.

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