Drug Optimization, Sustainability, and Evaluation (DOSE) Project in Alberta Health Services

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INTRODUCTION

Before amalgamation into Canada's first province-wide, fully integrated health system in 2009, Alberta Health Services (AHS) used a decentralized approach for the allocation and management of positive and negative variances in drug budgets and expenses to individual patient care areas in 12 separate health entities. With amalgamation, the former pharmacy departments were merged into the AHS Pharmacy Services program, and in 2012 drug budgets were centralized under this program, in an attempt to find efficiencies and cost savings. However, cost and utilization data continued to be spread across 5 unlinked systems, with no standardization of workflows, vocabulary, or types of data captured, and many hours of labour were required to manually gather and consolidate needed information. As such, it was soon realized that better understanding and reporting of drug utilization would facilitate improved financial stewardship of drug resources. Therefore, in 2013, AHS Pharmacy Services collaborated with the AHS Finance and Enterprise Business Intelligence departments on a project to create a data warehouse that would encompass information about drug utilization, prescribing, and expenditure, as well as patient and program information. The goal was to establish the foundation for a data-driven, evidence-based program that could be used to more effectively manage the provincial drug budget and address the full scope of pharmacy-related analytics within the health care organization. Six years later, the innovative DOSE (Drug Optimization, Sustainability, and Evaluation) data warehouse and phase 1 dashboards were ready for use by AHS leaders and staff.

DESCRIPTION OF THE PROJECT AND PROGRAM

The DOSE team consisted of more than 40 leaders and technical staff drawn from AHS Pharmacy Services, Analytics, and Information Technology (IT). Business and project plans were developed and approved, with each department contributing necessary resources for the endeavour.

The team started by gathering and analyzing data from each individual pharmacy information system (i.e., Meditech [Medical Information Technology, Inc], BDM [BDM Healthware Inc], Millennium PharmNet [Cerner], VAX [AHS]), and the purchasing/financial system (i.e., Oracle EBS [Oracle Corporation]) to determine which elements would fit the business requirements; these data were also assessed for information quality. Extracted data elements encompassed medication orders, medication dispensations, inventory transfers, drug catalogues, and purchase receipts. Data were extracted from each source system and were then consolidated and conformed to common provincial standards; this step was accomplished by means of 16 master reference tables, as required and as feasible, using Informatica software. One key master reference table was created for drugs, based on the Health Canada Drug Product Database.

An iterative process was used to develop various information products, incorporating feedback from stakeholders. Existing software infrastructure was leveraged, including the PowerDesigner modelling tool (from Sybase Inc), the PowerCenter for extract, transform, and load processing, and Analyst for data quality (both from Informatica). A total of 682 source pharmacy data elements were validated and consolidated into 376 data elements in 3 final views (i.e., medication orders and dispensations, drugs, and inventory transfers), which were then displayed as "dashboards" using software from Tableau Software, LLC (Figure 1). Metadata were documented and training resources developed for IT analysts to understand how to extract and use the data in response to various requests, including research and quality improvement projects. To comply with privacy requirements, a built-in auditing capability was set up to monitor access and use of the data. As the business owner, AHS Pharmacy Services maintains and governs access to the data.

The DOSE data set conforms data from 2012 to the current state; the data are obtained from 454 provincial sites and are updated daily. The data set represented an initial volume of 650 million records at completion of phase 1 in

2019, and the plan is to add roughly 100 million new records annually thereafter. Eight base dashboards were created for inventory transfer data: 1 database contains summary data, 1 database contains data related to financial coding, 3 databases are tied to formulary status, and 3 databases are based on geography (Figure 2). These dashboards can be filtered by date, site, zone, drug, dosage form, program, patient type, or unit. The dashboards are updated monthly. Future project phases include the creation of additional dashboards for ordering and dispensing information (Figure 3).

EVALUATION OF THE PROGRAM

The DOSE project was evaluated in the following ways: data quality, project management evaluation, and number of points of access by individual users.

Data Quality

User acceptability testing was accomplished by asking members of the DOSE working group to answer a series of drug use and evaluation questions using the legacy pharmacy or financial systems versus DOSE. Results were compared by the working group chair, and any discrepancies were investigated to determine the cause. For questions related to numeric values, responses from the legacy and DOSE systems matched perfectly. Mismatches were found in answers to questions about top drugs by expenditure at individual sites; causes of discrepancies were further investigated and remedied if possible.

The following are examples of drug use and evaluation topics relevant to the project objectives:

- Most current utilization and cost implications of the AHS initiative for streamlining use of low-molecular-weight heparin are easily accessible to users within 10 minutes, with the ability to drill down to the data for individual sites and units and to show the effects of procurement interruptions (Figure 4).
- Expenditure reporting for the top 25 formulary and nonformulary drugs, which was previously done by 5 staff members over 11 working days, can now be done by 1 staff member in 0.5 day.
- Collection of drug information regarding amphotericin B utilization to inform clinical practice within and order set creation by the provincial hematology-oncology program, which formerly required 4 staff working for a total of 5.4 days, can now be completed by 1 pharmacist in a single day.

Project Management Evaluation

In July 2019, the remaining 39 members of the project team (including 16 [41%] from Pharmacy Services, 2 [5%] from IT, and 18 [46%] from Analytics) were surveyed. Of the 18 respondents (46% response rate), all felt that the meetings were either usually or always a valuable use of time and

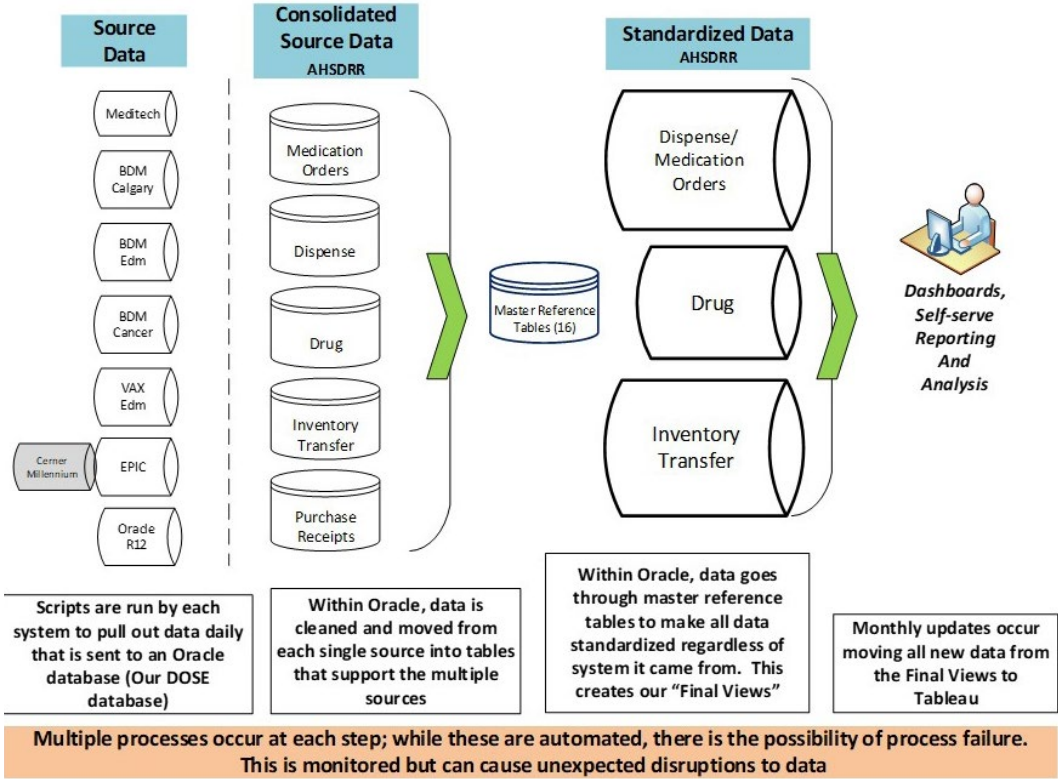

FIGURE 1. Schema for data flow from source systems to DOSE warehouse to DOSE dashboards. DOSE = Drug Optimization, Sustainability, and Evaluation project.

that overall the time dedicated to the project was well spent. Fifteen (83%) felt that the right people had been assigned to the project; 16 (89%) and 17 (94%) of respondents thought that communication from Analytics was effective and timely, respectively; and all respondents agreed or strongly agreed that they knew where to go with questions.

FIGURE 2. Example of dashboard for the Drug Optimization, Sustainability, and Evaluation (DOSE) project.

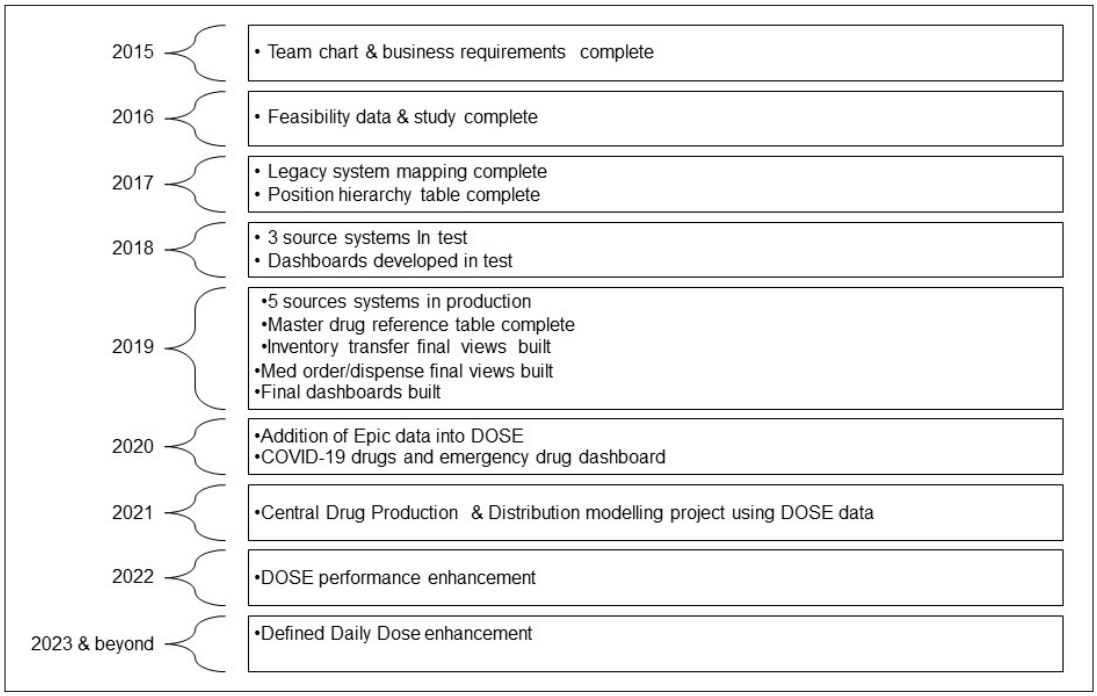

FIGURE 3. Major milestones achieved during the Drug Optimization, Sustainability, and Evaluation (DOSE) project.

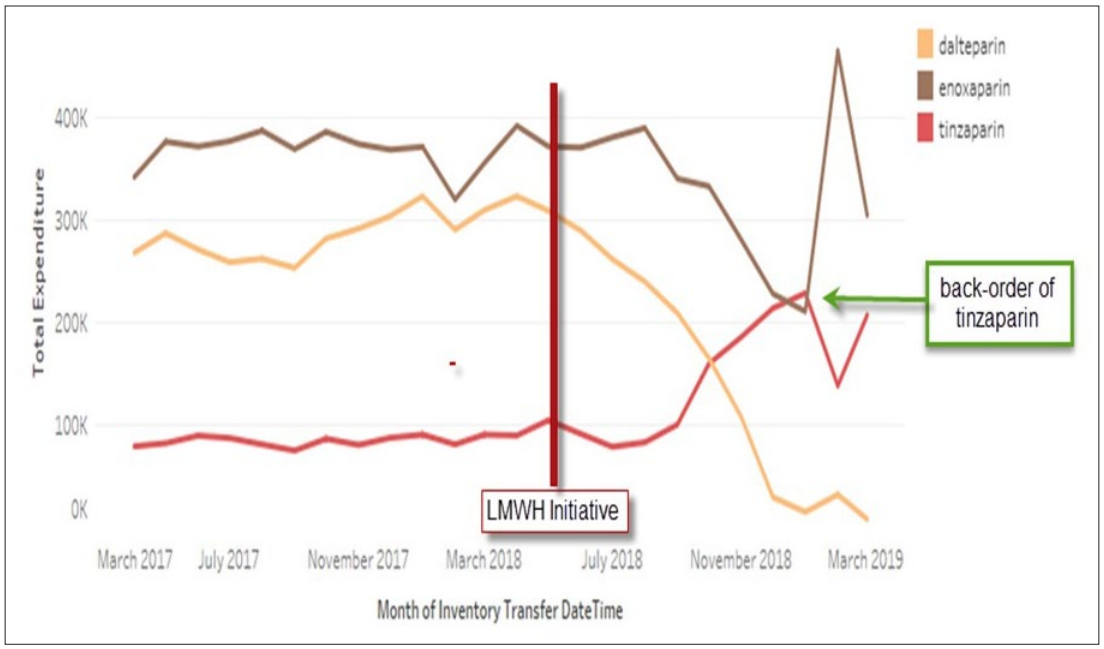

FIGURE 4. Dashboard for the Drug Optimization, Sustainability, and Evaluation (DOSE) project, showing the effect of low-molecular-weight heparin initiative on expenditures for dalteparin, enoxaparin, and tinzaparin over 2 years.

Continued Use

Since launch of the dashboards, their utilization has grown substantially, to totals of 80 users and 2040 hits by September 2021. Daily average hit counts have increased from 9 to 14. The top 3 users accessed DOSE between 211 and 278 times, averaging 0.88–1.16 times per day, based on 240 worked days per year.

CHALLENGES

The DOSE project was large in scope and resource requirements, because of the amount and types of data being extracted. Half of the post-project survey respondents felt that more time had been spent on the project than originally anticipated because of its complexity. As well, 7 (39%) of the respondents felt that those assigned to the project had been allowed insufficient time to complete the work.

The initial business plan estimated project completion in 23 months, with 11.75 full-time equivalents (FTEs); in reality, however, the project required 78 months and 25.03 FTEs. One contributing factor may have been the difference in priority assigned to the project by different teams. For example, DOSE was regarded as high-priority work within Pharmacy Services, whereas for IT, it was considered a low priority.

As well, significant changes in medication management occurred over the course of the project, which affected data outputs. For example, the Alberta College of Pharmacy mandated compliance with USP General Chapter <797> standards for compounding and repackaging of sterile and nonsterile products by 2021, which led to less batching and fewer products made by nurses and a corresponding change to expenditures for drugs, supplies, and wastage; these adjustments created additional challenges for data analytics. In addition, the need to wait for source system data and to address competing project priorities added to the overall time required for the DOSE project.

Data quality issues identified in the source data were due to errors in recording purchases and vendor delivery, as well as delays in receiving credits, other accounting problems, and user errors, similar to other data reported from warehouse builds.[1-6] Attribution of drug costs and use to the appropriate clinical service was a problem because the computer systems were not completely synchronized with patient movements and not all patient orders were entered in the pharmacy information systems. It was assumed that the attribution errors evened out over time, and these were not further addressed; however, the true extent of the contribution of these errors will be seen as a single provincial clinical information system is rolled out to all of AHS in future years.[2] A large number of null expenditures have appeared in the DOSE data set, where financial data cannot be mapped to a corresponding functional centre. This problem will be addressed through the current data quality project in AHS.

IMPLICATIONS AND SIGNIFICANCE FOR PRACTICE

DOSE was the first large-scale informatics project undertaken by AHS Pharmacy Services, and many lessons were learned throughout the process. Allocating dedicated project resources, designating a project manager, and seeking buy-in from senior leaders were key, especially given that during

the course of the DOSE project, the province embarked on another, even larger electronic clinical information system project (called Connect Care) to house all AHS, partner, and affiliate medical records and information. As well, the initial plan to build core data tables one source system at a time was abandoned when it was realized that working on one table for all systems at the same time was more beneficial, because it prevented re-work. Also, more thorough investigation and understanding of site practices at the time of project initiation would likely have helped to identify additional unanticipated complexities in standardization, which hindered the team's ability to learn and improve the efficiency of the product build.

Although the main objectives of the DOSE project were related to drug utilization and cost implications, other, unanticipated uses have emerged:

- Drug record build for implementation in the Connect Care system
- Financial costing of drug budgets for novel clinical programs
- Creation of dashboards for COVID-19 and other pandemic medications, to help monitor and manage drug shortages
- Creation of a dashboard for wastage for AHS Pharmacy Services in the Calgary zone, which allows improvement in the process for managing cumulative expenses due to drug and supply wastage[3]
- Reporting of utilization of naloxone kits and suboxone for provincial harm reduction and opioid crisis initiatives
- Utilization data to help guide sites applying for Choosing Wisely Canada level 1 designation

More generally, DOSE is able to perform activities that are impossible for other data warehouses and applications described in the literature,[2] as summarized in Table 1.

CONCLUSION

Projecting future drug expenditures is difficult. Demographic, economic, and political conditions, as well as technological innovations, influence the use and price of medications. To effectively budget and manage expenditures, leaders need to be aware of the drivers of medication use and spending. Historically, a variety of portfolios within AHS Pharmacy Services have largely used manual, labour-intensive processes to obtain the information needed

TABLE 1. Comparison of DOSE with Other Data Warehouses and Applications

Topic	Other Data Warehouses or Applications[7]	DOSE	Benefits of DOSE
Data access and availability	Use of data in cost-accounting and purchasing systems only	Use of inventory transfer and medication order dose information	Prevent inaccuracies or gaps in drug use data
	Data typically from only a few sites	Data from 454 sites	Improved generalizability
	Use of claims data for public drug programs for patients in the community (e.g., in the United States, IQVIA National Sales Perspective database; in Canada, the National Prescription Drug Utilization Information System)[8] Data for hospital drug expenditures on specific drugs or drug classes lacking and difficult to find	Use of hospital drug expenditure and utilization data from a large health region	Ability to merge inpatient and outpatient drug databases to view costs from perspective of an integrated health system More accurate, ICD-9-driven, disease-based benchmarking of clinical practices within and external to AHS to identify best practices or measure specific outcomes for specific patient subtypes
User requirements	Requirement for specialized knowledge and skills to produce reports	Autogeneration of reports	Improved accessibility and timeliness of reports
System requirements and capabilities	Extraction of large data sets may affect system performance	External server and dedicated analysts	No effect on performance of source system
	Limited product information in summary form or large, unwieldy, unstandardized data components	Merger of similar products into one line item or breakout details on individual dosage forms	Improved identification of treatment variability among programs, sites, or units Easier cross-linking of pharmacy data with ICD-9 disease states/codes Improved standardization of cost-effective and clinically superior care

AHS = Alberta Health Services; DOSE = Drug Optimization, Sustainability, and Evaluation project; ICD-9 = International Classification of Diseases, Ninth Revision.

for drug budget forecasting and expenditure reports. The DOSE data warehouse and associated dashboards now offer a quick visual tool based on existing data to monitor performance and metrics and can help to quickly uncover any potential problems and guide more immediate action to remedy them.[3]

Although it is a powerful tool, DOSE is only one piece of the equation for improving drug use and evaluation by pharmacies. The technology enhancements must be accompanied by corresponding supports if desired outcomes are to be achieved. These outcomes include promoting a culture of process improvement and quality assurance for patient safety and change management strategies.[5] Although the AHS organization as a whole and Pharmacy Services more specifically already have this type of supporting infrastructure in place, more consistent application, along with use of various DOSE tools, could dramatically improve the development, implementation, and reinforcement of large-scale drug stewardship initiatives for even more cost savings and efficiencies.[9,10]

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