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Implementation and evaluation of a web based system for pharmacy stock management in rural Haiti

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Abstract

Managing the stock and supply of medication is essential for the provision of health care, especially in resource poor areas of the world. We have developed an innovative, web-based stock management system to support nine clinics in rural Haiti. Building on our experience with a web-based EMR system for our HIV patients, we developed a comprehensive stock tracking system that is modeled on the appearance of standardized WHO stock cards. The system allows pharmacy staff at all clinics to enter stock levels and also to request drugs and track shipments. Use of the system over the last 2 years has increased rapidly and we now track 450 products supporting care for 1.78 million patient visits annually. Over the last year drug stockouts have fallen from 2.6% to 1.1% and 97% of stock requests delivered were shipped within 1 day. We are now setting up this system in our clinics in rural Rwanda.

INTRODUCTION

Haiti is the poorest country in the Western Hemisphere and suffers from high levels of preventable diseases including infant and maternal mortality, tuberculosis, malaria, and diarrheal and respiratory diseases. It is also the most severely affected by HIV/AIDS with more than 3% of adults infected. Eight years ago the non-governmental organizations Partners In Health and Zanmi Lasante launched an innovative, community-based HIV treatment program in Haiti's impoverished Central Plateau. In 2002, Zanmi Lasante was awarded part of Haiti's grant from the Global Fund to Fight AIDS, Tuberculosis, and Malaria (GFATM) to expand this successful program to nine more sites in the Central Plateau. In

addition a system of comprehensive health care has been implemented in all clinics for all common diseases. Zanmi Lasante runs a central hospital housing a laboratory and the main drug warehouse, with smaller pharmacies and laboratories in the other eight sites.

Implementing this rapid treatment expansion in a region with few doctors and virtually no roads, electricity, or communications is a major challenge. Zanmi Lasante's initial experience in Cange with internet access via a satellite link showed that this was a practical way of establishing communication with the new sites. The new technologies allowed us to leapfrog the lack of infrastructure. In addition, scaling up the chronic care of HIV/AIDS to thousands of patients requires good information management. It is important to ensure that each patient can be identified and traced, that his or her health status is monitored effectively and that results from critical laboratory tests are monitored and communicated to doctors. To ensure this process worked effectively we developed and deployed a web-based electronic medical record for HIV and TB care as described previously[1]. The presence of internet access at each clinic allowed this system to be deployed to all sites.

Ensuring an uninterrupted supply of drugs is a crucial part of providing healthcare in a developing country. Stockouts are frequently encountered in such settings and can have severe detrimental effects on patient care. This is particularly important and visible in the case of complex chronic diseases like HIV and TB, where stockouts can lead not only to poorer outcomes but also to drug-resistance. The drug supply chain includes procurement, shipping, storage, and dispensing to patients. Accurate information on current stocks and estimates of future requirements is critical to avoiding stockouts and expired stock, and to allow cost-effective bulk purchasing.

BACKGROUND

The HIV Electronic Medical Record The HIV Electronic Medical Record (HIV-EMR)[1] is based on the technology developed for a web based tuberculosis electronic medical record in Peru[2]. Clinical information collected includes demographic data, clinical assessment, laboratory investigations, drug regimens and social circumstances. It was developed in French and English, with close consultation with local Haitian users to ensure it supported their needs. The system includes a library of web page analyses and reports that allow searches for patient groups based on characteristics such as age, drug regimen, and laboratory results.

Drug Supplies and Use All healthcare projects in developing countries need to have systems in place to assess the quantities of medications that are needed for the next six months or a year and to track what drug supplies are currently available. The standard approach to tracking the shipment and use of drug supplies, called the *consumption method[3],* is to calculate the amount of drugs that enter and leave the warehouse each month. This is typically accomplished with standard WHO stock cards that record the stock level for each type of product and all stock movements. In addition, the daily or weekly consumption of medications needs to be tracked in the pharmacies to assess upcoming demand for the warehouse. Several database systems have been developed to automate these processes and are used in a variety of environments from large national warehouses to small retail pharmacies. While these systems can be valuable in certain environments they generally lack important characteristics for projects in sites like rural Haiti.

Requirements for pharmacy inventory and tracking systems for resource-poor settings:

- Design that is easily implemented and adapted to user needs
- Multi-language capability
- Ability to support and backup the system in remote sites
- Support for ordering and tracking of supplies

- Real-time overview of stock in all sites

We started with a design based on WHO stock cards that provided a simple and familiar interface for staff to track drugs at the warehouse level. This was augmented with tools that take advantage of our networked architecture to automate and simplify communication and report generation.

DESIGN AND METHODS

Electronic Stock Card The initial design of the electronic stock system was to implement stock cards as web pages that could be accessed from a list of available medications in the formulary. This approach simplified the transcription of data from the paper cards and was familiar to the staff. The big advantage over the paper systems was the ability to provide reports of stock levels and to flag low stock. The Zanmi Lasante formulary has been organized into discrete categories of products: HIV/AIDS, tuberculosis, oral medications, injectable medications, topical medications, narcotics, nutrition products, laboratory supplies, medical consumables, radiology supplies and surgical consumables. The system allows the warehouse manager to add additional categories and to rearrange products between categories. This drug formulary also includes information on product dose size, administration route, and standard dose ranges, and is linked to the HIV-EMR's prescribing module for key HIV and TB medications.

For each warehouse, each product has an electronic stock card which tracks incoming and outgoing flow, as well as lot number, expiration date and current available balance. (Figure 1) These electronic stock cards enable the pharmacists, as well as the procurement division of Partners In Health responsible for placing drug orders annually, to share accurate and up-to-date stock information. We implemented a prototype system in 2004 that tracked stock in our central warehouse, but it did not achieve wide use, probably due to it's inability to handle the inter-warehouse ordering process. We then developed the current system which covers ZL's whole warehouse workflow. This system was rolled out in November 2005 and quickly adopted by the ZL pharmacists. It has now replaced the old paper stock card system as the primary source of stock information.

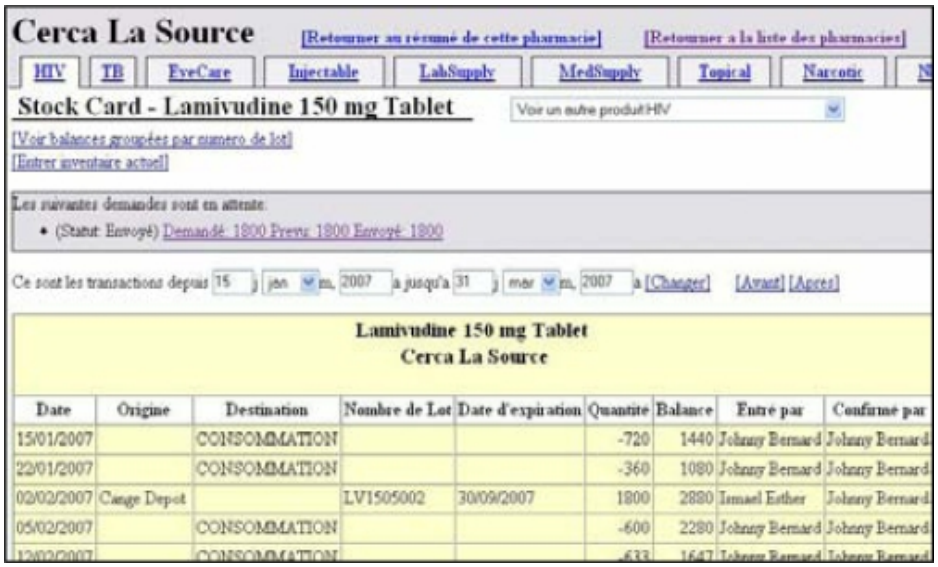

Figure 1

an electronic stock card (detail)

Flow of stock The stock card pages also show available stock grouped by lot number and expiration date, as well as quantities of stock currently in transit between sites. Reports of stock balance and transfer information can be generated by date or required time period. Where lack of telephones and difficult road conditions once acted as delivery barriers, the system of online ordering through the EMR allows for immediate communication of stock needs between team members. Each of our 9 clinic sites has an electronic warehouse homepage that gives them access to balance overviews, detailed stock cards, reports about historical consumption and shipments, and allows them to request stock from the central depot. The central warehouse pharmacy team has access to additional dashboards to track the progress of site-based stock requests, and to view ZL-wide data summaries and historical records of stock flow to the satellite clinics.

The Online Ordering Process

1. Pharmacists based at the clinics place all requests for stock online choosing products by category and specifying quantities, the desired delivery date, and occasionally adding free-text comments. The electronic order form assists the pharmacist by showing their clinic's current balances available and highlighting balances below a predefined minimum (Figure 2).

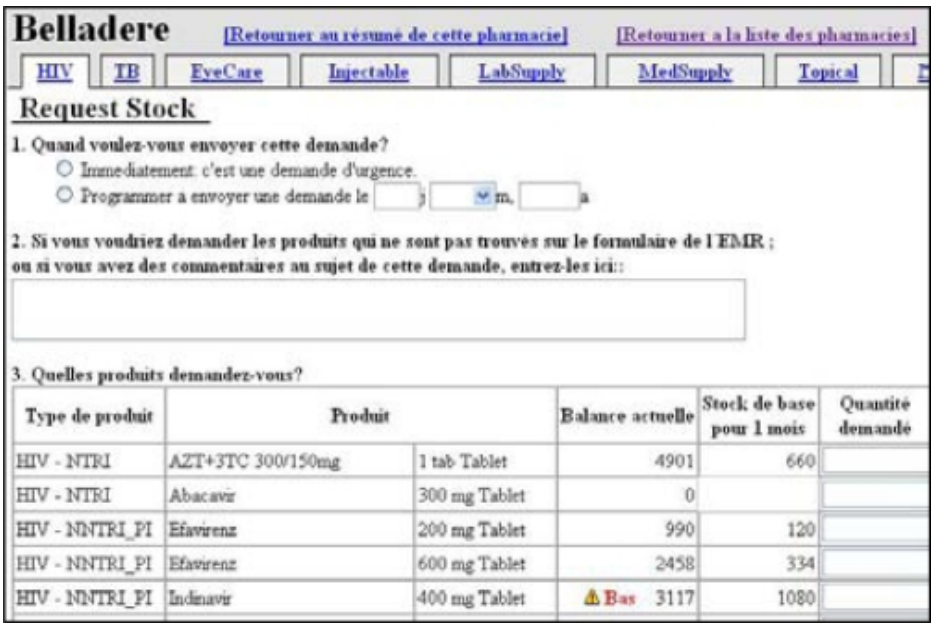

Figure 2

Placing an online order

2. This stock request is stored in the database, and an email notification is sent to the pharmacist at the central warehouse.

3. The pharmacy staff at the central warehouse print out the details of each incoming order from their dashboard page in the EMR and work with pharmacy aides to confirm that the physical stock is available in the central warehouse to fully meet the needs of the request.

4. Once this initial confirmation is complete, the central warehouse staff enter the expected shipment details (delivery date, quantities and lot numbers, additional products being sent, and free-text notes) into the system. An email is then sent to the site pharmacist to inform her that her request has been received and is being processed.

5. Once the stock for the shipment has been prepared, the pharmacy team reconfirms product quantities against the EMR-generated request.
6. Once the stock is loaded for delivery, the final quantities and lot numbers are entered into the EMR. This electronically transfers stock to the site warehouse and sends a shipment notification email to the site-based pharmacist. Product stock that is in transit appears at the top of the product category page and is noted separately in italics in site stock levels until its arrival has been confirmed.
7. When the shipment arrives at the site, it is immediately inventoried and checked against a printout of the shipment notification from the EMR.
8. The site-based pharmacist confirms the actual quantities and lot numbers received, completing the workflow.
9. The system then records the incoming stock on the product stock cards and merges the shipment into the site's stock balance.
10. A final email is sent to the central warehouse staff to notify them that the shipment was received; this email also highlights any discrepancies between quantities recorded as sent from the warehouse and received at the site, allowing the team to investigate any potential losses.

Consumption Information Each week the pharmacists at all clinics enter in information on consumption for each product listed on the formulary with the corresponding lot number and associated expiration date. This data is then compiled into site-based as well as system wide consumption reports which serve as accurate predictive tools upon which to base purchasing estimates and measure incremental growth trends. This consumption information (along with per-patient regimens in the case of HIV and TB meds) is used by the pharmacy team to calculate average monthly consumption. Alerts are automatically triggered for any site that has less than three months of a product in stock, prompting the site's pharmacists to place an order from the central depot.

Consumption information compiled from all sites is used to set minimum stock alert levels for the central warehouse (currently 6 months of average usage due to long lead times on bulk orders, shipments, and customs clearance). When stock balances fall below that level, the system alerts the head pharmacist and Boston-based purchasing team that an order will need to be placed imminently to avoid a stock out.

We have recently added expiration alarms that give sites advance warning when a lot in a warehouse is approaching its expiration date so that stock levels can be replenished before expiry, or so that excess stock can be redistributed to other sites for immediate use. To further prevent low stock levels, the head pharmacist can view a program-wide stock breakdown by site and product, which highlights products below their warning levels. Additional functions accommodate the entry of bi-annual inventory information, as each site warehouse confirms physical stock quantities, aiming to reconcile inventory balances with the EMR's recorded electronic balance.

RESULTS

Experience in using the system in rural Haiti Zanmi Lasante supports a very large-scale operation in Haiti: we saw over 1.78 million patient-visits in 2006, and the warehouse stock system manages all 450 products in our formulary, with a combined total of 46.6 million units of all products in stock (March 2007). It has 18 regular users (based in the central depot, the site pharmacies, and Boston), who in 2006 logged into the system 3,799 times and entered 78,378 product-transactions.

System use has been sustained and growing. In the first 9 weeks after rollout (November 2005), 8.9 electronic orders were entered per week, increasing to 14.8 orders per week one year later, and 30.3 orders per week in the first 9 weeks of 2007 (orders are normally for groups of products of one category).

Further, the system has improved the pharmacy team's workflow, increased efficiency in stock distribution, and dramatically reduced response times. Before the system's implementation all stock requests were made via email messages, with a typical delivery response time of 3 or more days. Of the 670 online orders delivered since the system's rollout, 531 (79%) were processed and dispensed on the same or next day as the request was sent. Recent performance is even more impressive: of the 190 online orders delivered so far in 2007, 82 (43%) were shipped on the same day as being requested, 102 (54%) were shipped the next day, and the remaining 6 (3%) took between three and seven days to ship.

Consumption Information The tools that track stock levels and alert for low stock have been associated with a notable decrease in the number of reported pharmaceutical and supply stock-outs since the system was first implemented. According to daily site reports filled out electronically by a separate ZL team, we had 1569 product-days of stockout of key medications out of 60,608 observed product-days in the first quarter of 2006, versus 634 product-days of stockout in 58,576 observed product-days in the last quarter of 2006. This decrease (from 2.6% to 1.1%, $P<0.001$) represents excellent performance for clinics in this type of environment[4].

Reporting Tools The system's stock management and consumption tools allow us to automatically generate internal monthly and quarterly reports detailing stock and usage, including reports specific to important product types, such as HIV/AIDS medications and narcotics. The system is now essential in compiling the stock distribution and usage information to complete required reports for donor agencies and monitoring groups. In addition to general-purpose reports, we have implemented specific reports for the GFATM, the Haitian Ministry of Health, and the Soge Bank Foundation.

DISCUSSION AND RECOMMENDATIONS

The successful implementation of a web-based stock management system has efficiently solved many of the obstacles that existed while we relied on a paper-based stock card system. The system has facilitated dramatically increased communication between staff members of the local pharmacy team, allowing teams at remote sites located throughout the Central Plateau to communicate stock needs quickly, efficiently and with a high level of confirmation and status follow-up. With all stock orders organized in one location online and with outgoing stock linked directly to the quantities and lot numbers available in the central warehouse, urgent requests for medicines can be followed with a high degree of detail. Orders no longer run the risk of getting lost in email correspondence. Moreover, the system allows a diverse group of users to have access to the same information, allowing each group to use and analyze the data. This permits a multi-pronged approach to supply-chain management, with teams on the ground in Haiti, and procurement staff based in Boston working proactively to prevent product stock-outs.

The system's development and successful use has been dependent on the constant active involvement and participation of the local pharmacy team who would eventually become its end users. It was in fact pharmacists who were co-architects and builders of the system's design and functionalities. This involvement proved essential for system roll-out as the users were equipped with not only technical training and support, but also the ability to shape the system to their specific and at times evolving needs. In the system's current, more advanced phase this has proven essential in collecting quality user feedback. Regular contact between the users working on the ground in Haiti and a central point person responsible for troubleshooting and communicating unmet needs to the programming team, has proven fundamental for user morale and confidence in the system's capabilities.

Interacting with the Clinical HIV/AIDS Data The transition away from a paper-based management of HIV/AIDS patients to a functional electronic system has allowed for substantial innovation – most apparent in the dramatic increase in the communication and collaboration between clinical staff, pharmacists and data clerks that was observed upon rolling out the new EMR-based protocols. Doctors, nurses, pharmacist and data entry staff meet regularly at the clinic sites to review changes in patient regimen or treatment status. This ensures that all responsible parties are working with the same list of patients and have access to the same accurate information. The pharmacy team has successfully moved away from manually generated HIV/AIDS patient regimen lists in Word to electronic lists that are generated monthly by the EMR. These are kept up to date by data clerks at each site working to ensure data quality. These EMR generated patient lists are essential tools on the ground, enabling Zanmi Lasante pharmacists to accurately dispense HIV/AIDS medications to community health workers. These employees, known in Haiti as *accompanateurs*, are responsible for supervising directly observed therapy for our patients.

Accurate HIV/AIDS patient lists also allow the pharmacy team to estimate medication needs via regimen-based quantification methods[5]. These estimates could then be reconciled with actual stock consumption recorded in the stock management system which would greatly strengthen the analysis of drug usage and the rational management of ARVs. We currently use drug regimen data to suggest minimum stock levels for the warehouse system and plan to link this to consumption data.

Offline Data Entry Using a web-based system can greatly improve communication, but all our sites encounter frequent network interruptions, especially during the rainy season. We had previously built a Java offline data entry client[1] for entering patient data into the HIV-EMR while disconnected from the internet. At the insistence of the pharmacists, we extended that tool to provide them with offline views of their stock levels and to allow offline entry of stock requests, transfers, and consumption.

Data Quality Initial training sessions are held on site with pharmacists by procurement and IT staff, and follow up visits are made regularly. Data reconciliation and the updating of stock card balances are done with web-based functions and analyses, and regular data quality checks are performed.

CONCLUSIONS

This web-based stock management system is innovative in providing a communications link between the pharmacies as well as recording local stock levels. This has allowed the team at ZL in Haiti and their colleagues in the US to manage the stocks of more than 450 drugs across 9 sites as one unit. It has also crucially allowed tracking of stock flow and some tracing capabilities. In April 2007 we set up the same software at our six clinics in rural Rwanda and we are planning to use it in Malawi and Lesotho.

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