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COMPUTERIZED MAINTENANCE MANAGEMENT SYSTEM FOR A CONSOLIDATED PROGRAM

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INTRODUCTION

Clinical Engineering (CE) departments require a documentation system, whether it's paper, computerized or cloud based. The Computerized Maintenance Management System (CMMS) database has been described as early as 1985 (Kresch, 1985). Others have documented the functionality of the CMMS as a repository for: service history data, preventive maintenance schedules, warranty periods, and alerts & hazards (Cohen, 2001). When venturing into a consolidated operation the CMMS provides a focus point for conversations about business processes, operational requirements, technology management, and support of clinical services. This paper will focus on the planning and implementation of a CMMS implementation; highlight some of the practical challenges associated with combining operations and data from disparate CMMS systems into one database.

BACKGROUND

In the fall of 2009, the Ministry of Health for the Province of British Columbia mandated the consolidation of the four Biomedical Engineering (BME) operations in the lower mainland Vancouver. At the time, each BME department reported to their respective health authority (HA): Providence Health Care, Provincial Services Health Authority, Vancouver Coastal Health Authority and Fraser Health Authority. Over the next few years the Lower Mainland Biomedical Engineering (LMBME) program evolved to a size of 180 staff across 27 major hospitals supporting greater than 90,000 medical devices. The decision to move towards a new and common CMMS was used as the key driver to rewrite business processes and implement change towards a common objective. Over a period of two years the LMBME tendered, evaluated, planned and implemented a web based, configurable, off-the-shelf CMMS program.

GOVERNANCE

The planning and implementation phases involved a steering committee including a director (leader), an engineer, a supervisor representative and a technologist representative from each HA. The primary role of the steering committee was to prepare the data for migration and make decisions and recommendations in the best interest of the consolidated program. This involved introducing basic fundamental changes to business processes for most employees. These phases spanned from the end of the request for proposal (RFP) award up to the point of the system go-live date. The committee reports to the executive director of the LMBME program.

The HAs unanimously decided that dedicated administrators would best serve the CMMS need as opposed to split duties. Two full-time database administrators (DBA) were hired for the post go-live phase and the purpose of

the CMMS steering committee was reshaped as an advisory body. This phase involved continued data cleaning, revision of controls on data input, performing regular data integrity audits, and developing successive modules and functionality of the CMMS for rollout.

VISION FOR ONE SYSTEM

The immediate need was to combine three disparate CMMS databases and create a common mindset for a functional system. The legacy CMMS programs had widely different database structures, and captured different "relevant" information. The LMBME vision for our CMMS did not stray too far from the primary purpose of a CMMS (Cohen, 2001; Kresch, 1985):

1) A repository for assets
2) Document history related to the assets:
    a. Work Order (WO) & service history
    b. Alerts management,
    c. Manuals,
    d. Service Contracts, and
    e. Purchase Order (PO) information,
3) Preventive Maintenance Schedules
4) Reporting capability
5) Real-time reference
6) Parts inventory and usage history

What do we want out of the system?

The difference with the LMBME approach compared to legacy CMMS systems is a fundamental shift in thinking to a broader perspective. In past, individuals would put *all* information into the CMMS because it might be important one day. The problem with this thinking is that the information that individuals think are important may not match the objectives of the consolidated program to record and report as a group. We started to ask the question – *what do we want to get out of the system?* This honed our focus to only capture relevant information. We decided early on that if we don't understand what information we want out of the CMMS defining what goes in is difficult. This question governed every subsequent decision with the CMMS implementation.

CMMS Access

A mandatory criterion of the RFP was for CMMS programs having web-based interface and functionality. Our experience with legacy systems taught us this method is best for the future direction of the program and general computing trends. The selected vendor is 100% web enabled allowing access to the database from any personal computer (running windows and .net) that has access to the Internet. This functionality enabled at-home work and offsite work.

Our selected vendor also offered the option to host our database for an annual fee. This option freed us from hospital-IT imposed constraints and gave greater flexibility to our future expansion of the CMMS.

DATA MANAGEMENT

Data Entry Control

An early decision was to allow technologists to enter some key data so as not to impede their workflow, such as new equipment with existing models in the CMMS, addition of serial numbers, IT information, etc. However, with 180 staff entering data we needed to devise quality control strategies for data entry:

1) DBAs control the configuration of the CMMS, and form layouts creating forcing functions of program at data entry including pick lists, drop downs, key mandatory fields lists, PM schedule templates, and common form layouts,
2) DBAs centralized data input to create new manufacturer and model pairings if they don't already exist in the database. Pictures of the faceplate and back-plate of the new model are required prior to entry in the CMMS for verification of the new model,
3) Supervisor verification to sign-off on data entered into the system by technologists.
4) DBAs are the 2nd check after supervisor verification to sign-off

The decision to open the data entry to more people means more data auditing to uncover inconsistencies in the data. DBAs define and execute audits to clean up fragmented, inconsistent data and determine how best to prevent it.

Asset Record

We had to rethink which assets go into our CMMS from a fresh perspective. The LMBME developed a guideline to define *What Constitutes a Clinical Engineering Asset* and decide what assets are acceptable to enter in the CMMS. Do these assets fall under our responsibility or, if not, who looks after them? (e.g. laboratory equipment or physiotherapy equipment). Some assets in the system were identified as accessories or non-assets (keyboards, mice, webcams, etc.) and were removed entirely from the database (King, 2014). Often, BME programs are too quick to agree to do work on a device without considering the long-term ramifications.

The entry of an asset into the CMMS is the dividing line between agreeing to keep the whole asset record or agreeing to perform some cursory service, such as the incoming inspection while not maintaining the asset record.

A guideline was developed to determine a model for an asset (out of scope for this paper). Manufacturers were also pared down so that we only had one of each manufacturer (e.g. GE Healthcare, not GE Healthcare Canada and GE Medical, etc.). A rule set was that if a company acquires another, the parent company then becomes the manufacturer in the asset record for all the manufacturer and model pairings.

The ECRI universal medical device nomenclature system (UMDNS), helped define what to name devices, improving the consistency and integrity of the data.

We also defined the minimum amount of information to substantiate an asset record. A unique asset was defined as having a distinct manufacturer and model pairing (e.g. Covidien-840). Pairing a manufacturer and model automatically links a number of core fields with default information such as: Health Canada medical device license number, the ECRI device code, ECRI device description, the model name and a picture of the device.

Data: Consistency, Accuracy & Completeness

After defining our manufacturer and model pairing we used this list to clean and align the data between each of the four databases. The process to combine the databases followed the mantra of consistency, accuracy then completeness of the asset record in this priority order.

Consistency means that we decide on one manufacture and model for each unique device and agree to it. This forces interpretation of the existing data and some models may get lumped in with others when they should be distinct (e.g. CADDSolis and CADDPrizm). If model names were similar, but were different one had to be chosen to proceed (e.g. CADDSolis or CADD2120). Right or wrong this was a necessary first step towards combining disparate systems, which happened during the planning and implementation phase.

Accuracy was emphasized post go-live. This was achieved with the help of the eyes of all the staff. When known discrepancies in the data were raised, the data administrators fixed the data to accurately reflect the true manufacturer and model of the device, or any other core fields. Also, they were careful to apply any changes throughout the database and to all similar devices.

Completeness of the asset record is a long-term goal for data integrity. These are for fields that are in addition to the core fields in the asset record.

CULTURE

Culture was one of the most difficult things to change with the CMMS implementation. Even after go-live it requires ongoing care to foster positive results. Each HA had developed unique work related processes that had to be understood, analyzed and reconstructed for a common business process. Some of the cultural shifts are explained below.

Time recording

The committee made the decision that this would *not* be a time recording system (i.e. vacation, holidays, education leave, etc). Time entered into the system must be directly related to an asset or a specific group of assets, so that the cost of maintaining assets would be more accurately calculated.

Work Order Documentation

Work Order documentation compliance required regular reinforcement, coaching and explanation. Supervisors audited completed

work orders and initiated feedback with each technologist each month such as, when to put in a WO, what information to put in the WO, when to enter the data. What they found was that one group of technologists did not provide sufficient information, and another group of meticulous technologists provide far too much detail in their WO notes. Culture change was achieved by reinforcement of what is relevant information and what is not for work order entry. This personal approach helped technologists get on the right track and worked towards our goal to get consistent data going into the system.

Some sites were storing WO entry on paper that would be entered once a week. This was discouraged and the LMBME expectation was that WO entry did not have to occur in real-time rather in a reasonable time.

The CMMS team also designed a simplified corrective repair WO form created for one asset and a multi-asset WO for Alerts management. We also provide up-to-date notifications to users through the status of the WO as it moves through BME from an online work request, to testing, waiting for parts and return to clinical service. A WO allows multiple time charges, and should reflect what was done at key milestones on a WO.

Supervisors meetings

Monthly meetings were established to allow for a dialogue between the steering committee and the supervisors to disseminate information and learn what works and what doesn't work. This reserved time to get feedback on the CMMS direction, get buy-in, and make collective decisions for the LMBME program moving forward. These meetings identified the need for common decisions that could be applied across the organization and not allow for silo operations.

Alerts, Hazards & Recalls

Amalgamating databases meant that we no longer required multiple people managing alerts, hazards & recalls for each CMMS system. Having consistent, accurate and complete data requires only one person to monitor all alerts (ECRI, Health Canada, FDA and Vendors). That person is able to confidently query the database to determine all assets that apply to the alert, and then open a mult-asset WO for documentation.

Privacy & Security

We wrote a policy for CMMS privacy. No patient identifier information or LMBME staff personal information that isn't already employer information (e.g. technologist names and employee number) shall be entered into the system. The CMMS it is not intended to house this information and BME has little use for it. An audit is done quarterly to ensure compliance.

FUTURE USE

The go-live of the CMMS focused on delivering the core requirements for a technologist to perform their work. Table 1 summarizes additional functionality and modules that are active or being developed for future rollout.

Table 1: Additional Functionality and Modules

Functionality and Modules	**Utility to LMBME Program**	**Status**
Online Web Request	Ability for customers to submit online web requests for corrective repair for medical equipment. This automatically opens a WO in the CMMS.	Active
Attachments	Provide detailed and specific referential information: POs, manuals, service contracts, end-of-life letters, warranties, terms and conditions of contracts, photos, Technical Procedures, etc.	Active
IT Information	Custom fields for IT related information of medical devices on the hospital network.	Active
PM Schedules (Modules)	We use 3 priorities: critical, normal and not schedule. One PM engineer managing classification and schedules based on device type. Incoming inspection is a PM, next PM due based on this date. Staff can generate their own PMs in CMMS.	Active
Reports	Canned reports in the program, and access to create customized reports from the database.	Active
PM Job Procedures	Developing standard PM procedures and checklists for	In Progress

	each device type. Approximately 200 critical devices complete.	
End-of-X Information	Upload end-of-life, support and manufacturing information uploaded for manufacture and model pairing.	In Progress
Parts (Module)	Three methods, on the fly (active), parts catalogue (in-progress) and parts inventory (future). Control over who sets up the parts catalogue.	In Progress
Capital Planning	Consistency, purchase price, copy of PO and contracts, institute a replacement cost (not purchase cost)	Future
Service Contract (Module)	Alerts user when contracts need to be renewed. External service – warranty, time and materials, pro bono – upload service report within 72 hours.	Future
Decommissioning Medical Equipment	A formalized process to decommission medical equipment from clinical service and remove it from the CMMS.	Future
Tablet Access (Module)	Customized app for iOS device to access the CMMS.	Future
Resource Planning	With good data we can determine the average tool time per device type. This will help manage required resources.	Future

CONCLUSION

The CMMS remains the core of any CE program. The LMBME planning and implementation of the CMMS provided structure for conversations about business processes, operational requirements, technology management, and support of clinical services. We have shared our defined vision for one system and discussed some of the practical challenges associated with combining operation and data from disparate CMMS systems into one database. We have considered our data management strategies to ensure data integrity, quality and consistency, and discussed our renewed culture to align biomedical engineering practices and dream towards future uses.

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