

BUSINESS CASE

Implementation of Bar-code Medication Administration System at the Sault Area Hospital (SAH)

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Senior Management Sponsor:

Management Responsibility:

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With the permission of the SAH, CSHP removed content that would have identified the names of organizations and individuals who were asked to complete the survey and those who responded to the survey. Minor formatting changes have been made to the original document.

Definition of the Bar-code Medication Administration (BCMA) System

“BCMA is a point of care system that requires positive patient identification and electronic verification of medication at the bedside before their administration” (Cescon et al., 2008). Bedside Medication Verification (BMV) is a name often used for such system.

Description and Intended Purpose

The realisation of the project includes implementation of technical solutions that will integrate information on each patient and will automatize information flow related to medication administration. The realisation of the project requires installation of hardware (scanners, PCs, portable and wireless technologies). Software solutions for BMV are provided by Medical Information Technology, Inc (MEDITECH).

Implementation of the project requires substantial investment. Start up costs include such components as planning, software, hardware, infrastructure, personnel training. Upon BMV implementation there could be a rise in operating costs due to increase in working hours of nurses, pharmacists, pharmacy technicians, as well as, due to increase in maintenance and technical support costs.

Implementation of the BMV project can raise efficiency of medication administration. By computerising the process of ordering, review and delivery of medications to patients, the SAH can reduce the number of medication errors, and thus contribute to its commitment to continuous quality improvement in patient safety, staff satisfaction, as well as reach higher economic efficiency of its operations.

BCMA and Reduction in the Number of Medication Errors

The important benefit of the BCMA system is reduction in the number of medication errors. According to the study by Barker et al. (2002), medication errors occur in hospitals approximately at a rate of 19%. The following categories and shares of mistakes were identified in the study: wrong time (43%), omission (30%), wrong dose (17%), and unauthorized drug (4%) (Barker et al. 2002). Leape et al. (1995) calculated

that 39% of errors occur at prescription stage, 12% relate to transcription, 11% to dispensing, 38% to medication administration process (Pennsylvania Patient Safety Authority, 2008). 7% of errors in hospitals are potentially harmful to patients (Barker et al. 2002). 0.19% of dispensed medication doses have errors that can result in adverse drug events (ADE) (Maviglia, 2007).

The BCMA system can help reduce the number of errors by integrating patient's information, by automatization of information flow and verification procedures of drug administration process. By using bar-code reading technology the system can reduce errors that occur when medication information is entered into the system. Imbedded automatic controls of the system can alert healthcare givers when discrepancies occur. The system can provide a more accurate Medication Administration Record (MAR). Such integrated online system can facilitate a real time access to necessary information. With increased control the system on a primary level can strongly contribute to the goal of achieving "5 rights": the right drug, the right dose, the right patient, the right route, the right time. More comprehensively, the BCMA system can address the following functionality levels:

Level 3

- Maximum Daily Dose
- Look-alikes / Sound-alikes
- High-Risk Warnings
- Clinical Action Reminders
- Near-Miss Reporting
- Other Reconciliations

Level 2

- Drug Reference
- Formulary Comments
- Nursing Workflow Tools

Level 1

- "Five rights"
- Online MAR

Source: American Hospital Association et al. 2002, © 2002 Medical Group

Evidence shows that introduction of information technologies to the process of drug administration significantly reduces error rates. The number of errors can decrease by 65% to 86% after the BCMA system implementation (Pennsylvania Patient Safety Advisory, 2008). Reduction in medication errors results in patients' safety and brings financial benefits to hospitals. According to the study performed by the Agency for Healthcare Research and Quality (AHRQ), which provides an analysis of impact of reduction in ADEs on hospital costs, savings for hospitals from using computerised medication systems can amount to US\$500,000 annually (Protocare Sciences, 2001).

Estimation of SAH's Financial Benefits from ADEs Reduction

Estimation of SAH's benefits from BMV is shown in the Table 1. It is based on the approach used by Maviglia et al. (2007) in their study of BMV implementation at the Brigham and Women's Hospital (BWH). Annual benefits from reduction in ADEs after BMV implementation at the SAH is estimated to be CA\$ 1,039, 387.

Table 1. Calculation of Benefits from ADEs Reduction after BMV Implementation

Annual number of hospital admissions at the BWH (735 beds)	35,000	A	Maviglia et al., 2007
Annual number of hospital admissions at the SAH (289 beds)	13,190	B	SAH Financial Analyst ¹
Admissions ratio of the SAH relative to the BWH	38%	C	=B/A
Number of doses dispensed annually at the BWH	6,000,000	D	Maviglia et al., 2007
Estimated number of doses dispensed at the SAH	2,261,143	E	=D*C
Potential ADEs rate before BMV implementation	0.19%	F	Maviglia et al., 2007
Potential ADEs rate after BMV implementation	0.07%	G	Maviglia et al., 2007
ADEs rate decrease after BMV implementation	0.12%	H	=F-G
Potential ADEs resulting in actual ADEs	13%	I	Maviglia et al., 2007
Percentage of dispensing errors that are not intercepted	66%	J	Maviglia et al., 2007 ²
Doses effected by BMV	84%	K	Maviglia et al., 2007
Cost of an ADE, CA\$	5,156	L	Maviglia et al., 2007 ³
Annual number of prevented ADEs after BMV	202	M	=E*H*I*J*K
Estimated annual SAH's savings as a result of decrease in ADEs rate after BMV implementation, CA\$	1,039,387	N	=L*M

¹ Amount for 2008/09 financial year.

² 34% of errors are intercepted.

³ Amount of US\$ 4,685 was translated to Canadian dollars and adjusted for inflation.

BMV Implementation Cost

Implementation of the BCMA system requires substantial investment, which could include the following categories:

- Planning 61.4%
- Software 20.3%
- Infrastructure 6.7%
- Training 5.9%
- Equipment 5.8%

Source (Maviglia et al., 2007)

Software cost includes integration with existing pharmacy software programs; hardware can include ultraportable laptop computers, scanners, and equipment for the pharmacy repackaging center; infrastructure cost: wireless local area network; planning costs:

expenses incurred by key individuals who met with vendors, evaluated products, and made decisions about new pharmacy procedures and workflow; training cost: both initial and periodic trainings due to staff turnover (Maviglia et al., 2007).

On-going costs associated with the purchase of the system include:

- Software licence fee (perpetual license, one-time fee)
- Monthly support fee
- Hardware cost
- Installation fee
- Implementation/consulting costs for system configuration
- Training, including staffing, materials, and other resources.

Source: Protocare Sciences, 2001

According to the study performed in the USA by the Food and Drug Administration, an estimated start-up cost for an average 191-bed hospital can amount to US\$377,000 (FDA, 2003).

At the Brigham and Women’s Hospital (735 beds) the total implementation cost including cost of preparation, setting up and running the system for the first 3.5 years amounted to US\$1.3 million (2005 US dollars) (Maviglia et al., 2007).

Estimation of SAH’s BMV Implementation Costs

Taking calculations performed by Maviglia et al. (2007) for BWH, BMV implementation cost for the SAH was estimated to be CA\$ 1,330,912 (Table 2).

Table 2. Calculation of BMV Implementation Costs for the SAH

Cost component	BWH cost shares, %	BWH implement. costs, CA\$ ¹	SAH implement. costs, CA\$	Comments on SAH’s BMV costs calculations
Planning	61%	878,501	878,501	Same amount as for the BWH with assumption that carousel lease cost doesn't depend on the number of patient admissions
Software	20%	290,449	290,449	Same amount as for the BWH with assumption that software cost doesn't depend on the number of patient admissions
Infrastructure	7%	95,862	36,428	Adjusted by the admissions ratio a the SAH relative to the BWH (38%) (See Table 1)
Training	6%	84,416	94,000	Calculated using SAH statistics (See Table 3)
Equipment	6%	82,985	31,534	Adjusted by the admissions ratio a the SAH relative to the BWH (38%) (See Table 1)
Total	100%	1,432,213	1,330,912	

¹ Source Maviglia et al, 2007, Amounts were transferred from US\$ to CA\$ and adjusted for inflation. Cost includes preparation, setting up and running the system for the first 3.5 years.

Figure 1. Estimated BMV Implementation Costs for the SAH

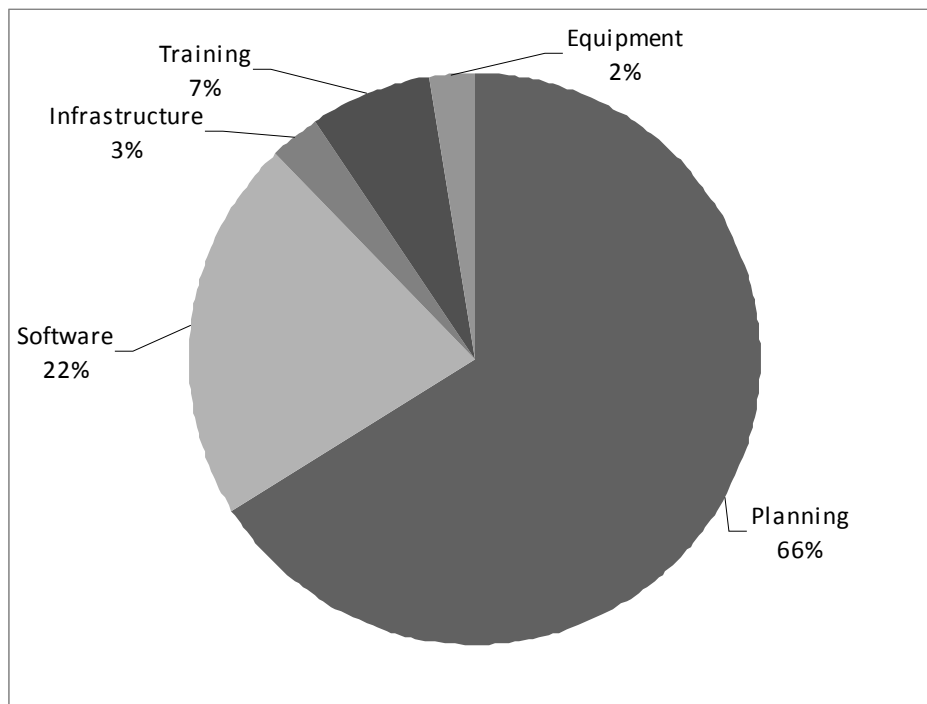


Table 3 Calculation of Training Costs of BMV Implementation at the SAH

	Number of employees ¹	Number of training hours	Salary rates per hour	Training cost
Nurses	762	4	30	91,440
Pharmacists	12	2	50	1,200
Pharmacy technicians	23	2	25	1,150
Total				93,790

¹Source: SAH Financial Analyst

BMV Operating Costs

Annual operating cost for an average 191-bed hospital was estimated to be US\$320,000 (FDA, 2003). BMV operating cost at the BWH amounted to US\$342,000 (2007 US\$) and included the following components:

- Carousel lease (33.9%)
- Medication repackaging (31.8%)
- Operation and maintenance (20.4%)
- Labor (13.8%)

Source: Maviglia et al., 2007

According to the survey of hospitals which have already implemented the BMV system performed by the SAH (Appendix B), the following factors can increase operating costs after the BMV implementation :

- Change to 24/7 operating cycle
- Manual bar-coding of non unit-dose medications
- Manual entering of physician orders into the system
- Adjusting to the system

The [CSHP removed the name], a 381-bed hospital, indicated an increase of weekly working hours by 12 for nurses, and by 6 for pharmacists after the implementation of the system (Appendix B).

Experience of the [CSHP removed the name], also revealed an increase in working hours of pharmacists, however after implementation of computerised physician orders the working hours went back down (Appendix B), overall, however, the workload increased after BMV implementation.

According to the FDA (2003), operating costs can increase upon implementation of the BMV system. Such increase could come from change in procedures. Difficulties can arise in the situations when medications can not be accommodated by the bar-code reading systems, for example, when multiple doses of the same medications are to be administered to different patients at the same time (FDA 2003). Also moving bed-side units (scanners) from room to room, as well as need of multiple scan swipes for reading bar-codes could result in operating difficulties (FDA 2003).

Estimation of BMV Operating Costs for the SAH

Upon implementation of the BMV system at the SAH, the hospital's pharmacy will most likely need to switch to 24/7 working cycle to provide continuous coverage of medication bar-coding and dispensing. Cost of night coverage of one pharmacist/technician per one week can be estimated in the following way:

1 pharmacist * 8hours per night * 7nights * \$50 per hour rate = \$2,800 per week
(\$134,400 per year)

1 technician * 8hours per night * 7nights * \$25 per hour rate = \$1,400 per week
(\$67,200 per year)

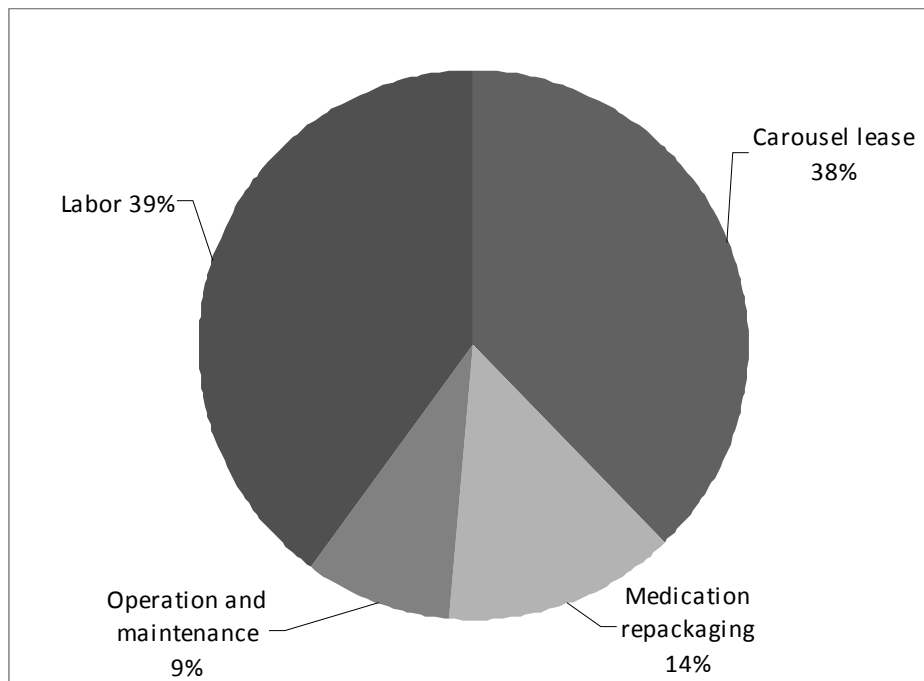
Estimation of BMV operating costs at the SAH presented below is based on the analysis of the BMV system at the Brigham and Women's Hospital (BWH). Estimated SAH's annual BMV operation cost is CA\$ 336,665 (Table 4).

Table 4. Calculation of BMV Operating Cost for the SAH

Cost component	BWH cost shares, %	BWH operating cost, CA\$ ¹	SAH operating cost, CA\$	Comments on SAH's BMV costs calculations
Carousel lease	33.90%	127,602	127,602	Same amount as for the BWH with assumption that carousel lease cost doesn't depend on the number of patient admissions
Medication repackaging	31.80%	119,697	45,485	Adjusted by the admissions ratio a the SAH relative to the BWH (38%) (See Table 1)
Operation and maintenance	20.40%	76,787	29,179	Adjusted by the admissions ratio a the SAH relative to the BWH (38%) (See Table 1)
Labor	13.90%	52,320	134,400	Includes salary of pharmacist hours needed to cover night shifts =1pharmacist*8hours*7nights a week*4 weeks*12 months
Total	100%	376,406	336,665	

¹Source Maviglia et al, 2007, Amounts were transferred from US\$ to CA\$ and adjusted for inflation.

Figure 2. Estimated BMV Operating Costs for the SAH



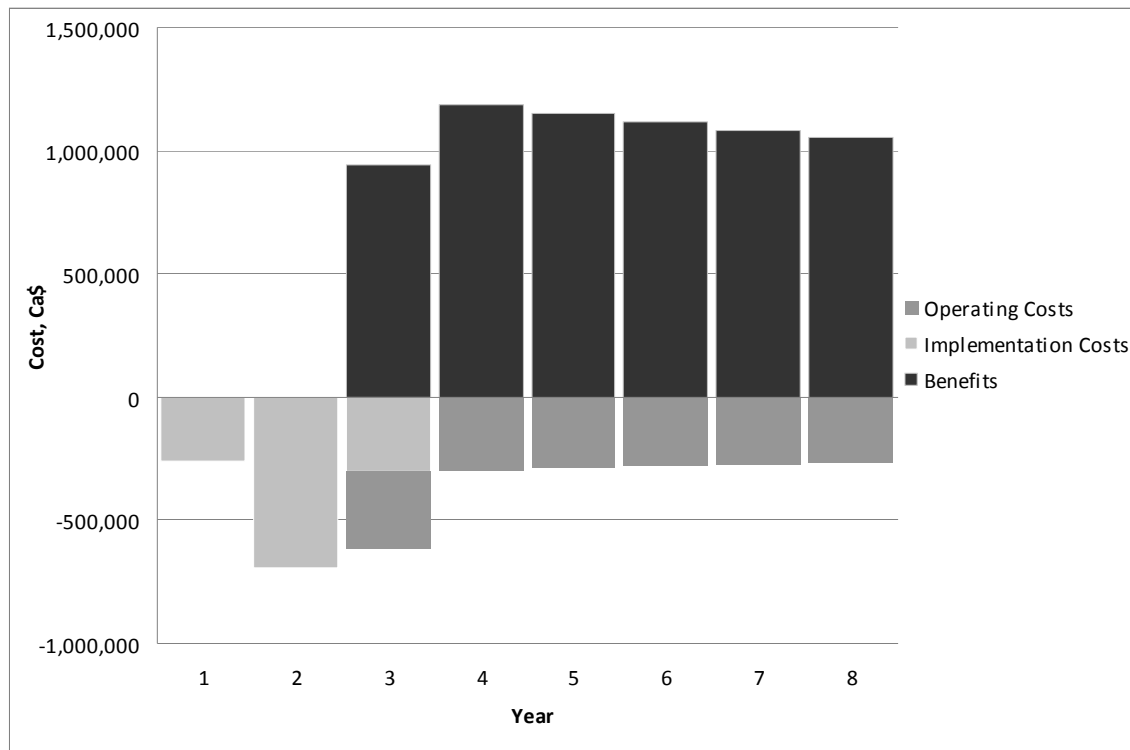
Financial Timeline of BMV Implementation and Operation Calculated for the SAH

Cost analysis of the BCMA system implementation with a focus on pharmacy dispensing process showed that related investment can be offset in a period from 5 to 10 years as a result of reduction in medication errors (Maviglia et al, 2007, Cescon et al., 2008). Cumulatively, BMV benefits are expected to cover related costs at the SAH in 4 years period.

Table 5. SAH's Financial Timeline (in time discounted 2009 CA\$)

Year	1	2	3	4	5	6	7	8
Benefits			940,611	1,182,498	1,148,056	1,114,618	1,082,153	1,050,634
Implement. Costs	-258,430	-689,982	-304,493					
Operating Costs			-308,097	-299,123	-290,411	-281,952	-273,740	-265,767
Savings/Cost	-258,430	-689,982	328,021	883,375	857,646	832,666	808,413	784,867
Cumulatively	-258,430	-948,411	-620,390	262,985	1,120,631	1,953,297	2,761,710	3,546,578

Figure 3. BMV Financial Timeline at the SAH



Implementation of eMAR without BMV Stations

It is technically possible to implement eMAR without BMV stations. In such a case nurses would record medications without scanning them.

Opinion of [CSHP removed the name]: "I do not recommend this option as it sets up bad practice so that when you do implement BMV your scan rates will be low plus you have by-passed the more crucial safety check."

BCMA System Selection

The following criteria should be considered when choosing a BCMA system:

- Nursing satisfaction with usability
- Pharmacy satisfaction with usability
- Availability and usability of portable, wireless BCMA equipment (handheld scanners)
- Ability to integrate with the existing hospital computing infrastructure
- Usefulness of the alert system in BCMA (e.g., reduced "nuisance" alerts, ability of nursing/pharmacy to easily deal with alerts)
- Connectivity and integration with current pharmacy automation (e.g., cabinets, robotics)
- Amount of implementation support (in hours, days, or weeks) by the vendor
- Integration and compatibility with hospital's existing bar-code scanning systems
- Compatibility with hospital's pharmacy medication packaging system
- Types of and accessibility to system reports (e.g., scanning compliance by nurse/nursing unit, avoided errors)
- Ability to extract data for reviewing quality indicators for the BCMA system
- Ongoing support of the system (e.g., routine maintenance, emergency calls)
- Amount of process redesign necessary to implement BCMA

Source: Weber, 2008

What Can go Wrong after the BCMA System Implementation:

Based on experience of the BCMA system implementation at the University of Pittsburg Medical Centre the following "work-arounds" can undermine the effectiveness of the system:

- Scanning without visual check of MAR
- Not scanning patient first to verify their identities
- Administering medication without using BCMA scanners
- Placing bar-codes for medication on paper or other documents
- Scanning the medication bar-code after the medication was removed from its package

Source: Weber, 2008

Appendix A

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Appendix B

Survey of Hospitals with Running BMV systems

A List of Hospitals Included in the Survey

According to the Medical Information Technology, Inc. there are 513 sites that are live with the BMV system. 19 Hospitals were selected for the survey. 4 Responses were received.

Survey Form

Dear Madam/ Sir,

Please complete the following survey and send your response to:

[CSHP removed the name]

Email: [CSHP removed the email address]

Fax: [removed] (to the attention of [name removed])

Hospital's name:

Contact person:

Medication verification modules implemented (BMV, eMAR, nursing documentation, physician order entry, other):

BMV software programs installed:

BMV hardware equipment and vendors:

Hours of staff training for BMV implementation purposes

Nurses:

Pharmacists:

Pharmacy Technicians:

Estimated increase/decrease of weekly working hours after BMV implementation

Nurses:

Pharmacists:

Pharmacy Technicians:

Overall staff satisfaction after BMV implementation

Nurses:

Pharmacists:

Pharmacy Technicians:

Significant costs of operating BMV system:

Comments:

Thank you for your response.

Sincerely, [CSHP removed the name]

Survey Responses

Hospital's name: [CSHP removed the name]

Contact person: [CSHP removed the name]

Medication verification modules implemented: **MEDITECH Client/ Server BMV**

BMV software programs installed: **MEDITECH BMV, PHA**

BMV hardware equipment and vendors: **Lionville Medication Carts with laptop installed on top, RF wireless system**

Hours of staff training for BMV implementation purposes

Nurses: **4 hrs**

Pharmacists: **4 hrs**

Pharmacy Technicians: **2 – 4 hrs**

Estimated increase/decrease of weekly working hours after BMV implementation – **Unable to quantify at this time. Require 24/7 pharmacy coverage – our new model is to enhance scope of Pharmacy technicians and they will cover night shift.**

Nurses:

Pharmacists:

Pharmacy Technicians:

Overall staff satisfaction after BMV implementation **Currently working with 2 University students from [name removed] to evaluate the system**

Nurses:

Pharmacists:

Pharmacy Technicians:

Significant costs of operating BMV system: **yes it is significant but have to look at outcome, patient safety aspect outweighs the cost. Very difficult to measure ROI.**

Hospital's name: [CSHP removed the name]
Contact person: [CSHP removed the name]

Medication verification modules implemented: **All modules are implemented (BMV, Pharmacy verification, Physician Order Manager, etc). BMV was implemented in 2005.**

BMV software programs installed: **Meditech**

Hardware equipment and vendors: **Scanners: Voyager Metrologic (Honeywell); Carts: Lionville; the hospital has three carts. Each cart has a computer installed (the carts could have had to be modified to accommodate computers). There are also several portable computers (called stingers).**

Hours of staff training for BMV implementation purposes **There were several stages of implementation and trainings. Most of the learning comes from experience: learning by doing**

Nurses: **8 hrs**

Pharmacists: **not significant number of hours of training (there is only one pharmacist at the hospital)**

Pharmacy Technicians: **technicians are outsourced by the hospital, difficult to estimate hours**

Estimated increase/decrease of weekly working hours after BMV implementation

Nurses:

Pharmacists: **After implementation of eMAR the process was very time consuming, because the pharmacist had to manually enter all orders 24/7, however after the Physician Order Manager system was implemented there was no need to have 24/7 coverage, and working hours went down. Overall the workload increased, but more is being accomplished in the same period of time.**

Pharmacy Technicians: **All non unit-dose products had to be manually bar-coded, a time consuming process for pharmacy technicians. Since technicians are outsourced, hard to estimate increase in hours.**

Overall staff satisfaction after BMV implementation

It takes about a year to get used to the new system. But overall positive satisfaction.

Nurses: **increased clinical role**

Pharmacists: **increased clinical role**

Pharmacy Technicians:

Significant costs of operating BMV system:

Comments: **expensive, labour intensive system, which results in benefits of gaining online access to important data**

Hospital's name: [CSHP removed the name]

Contact person: [CSHP removed the name]

Medication verification modules implemented: **BMV- Bedside Medication Verification**

BMV software programs installed: **Meditech**

BMV hardware equipment and vendors: **Motion CS, Rubbermaid Mini Med**

Hours of staff training for BMV implementation purposes

Nurses: **4 hrs; Super user 8**

Pharmacists: **2**

Pharmacy Technicians: **2**

Estimated increase/decrease of weekly working hours after BMV implementation

Nurses: **increased by 12**

Pharmacists: **increased by 6**

Pharmacy Technicians: **0**

Overall staff satisfaction after BMV implementation

Nurses: **satisfied**

Pharmacists: **satisfied**

Pharmacy Technicians: **satisfied**

Significant costs of operating BMV system: **Pharmacy needs to bar-code all medications**

Comments:

Hospital's name: [CSHP removed the name]
Contact person: [CSHP removed the name]
Medication verification modules implemented: **eMAR, BMV**

BMV software programs installed: **MEDITECH client/server**

BMV hardware equipment and vendors: **SYMBOL DS 6706 (scanner), C5 (portable computer with build in scanner). Very satisfied with the vendor. Bar-codes on the patient wrists were set to include a hidden character so it wouldn't be possible to scan other printed out bar-codes.**

Hours of staff training for BMV implementation purposes

Nurses: **0.5 hrs**
Pharmacists: **not significant**
Pharmacy Technicians: **not significant**

Estimated increase/decrease of weekly working hours after BMV implementation
Neutral. Before implementation pharmacy already worked 24/7. Every order coming has to be scanned by technician

Nurses:
Pharmacists:
Pharmacy Technicians:

Overall staff satisfaction after BMV implementation

Nurses: **There was resistance from the nurses, but overall satisfied**
Pharmacists: **There was a problem with MEDITECH with partial doses (the problem was fixed), overall satisfied.**
Pharmacy Technicians:

Significant costs of operating BMV system:

Comments: **Reached 95% compliance, error reduction is successful. The BMV was implemented a year ago at a 50 beds hospital.**

Appendix C

Workflow Charts

Chart 1. Current Process of Medication Administration at the SAH

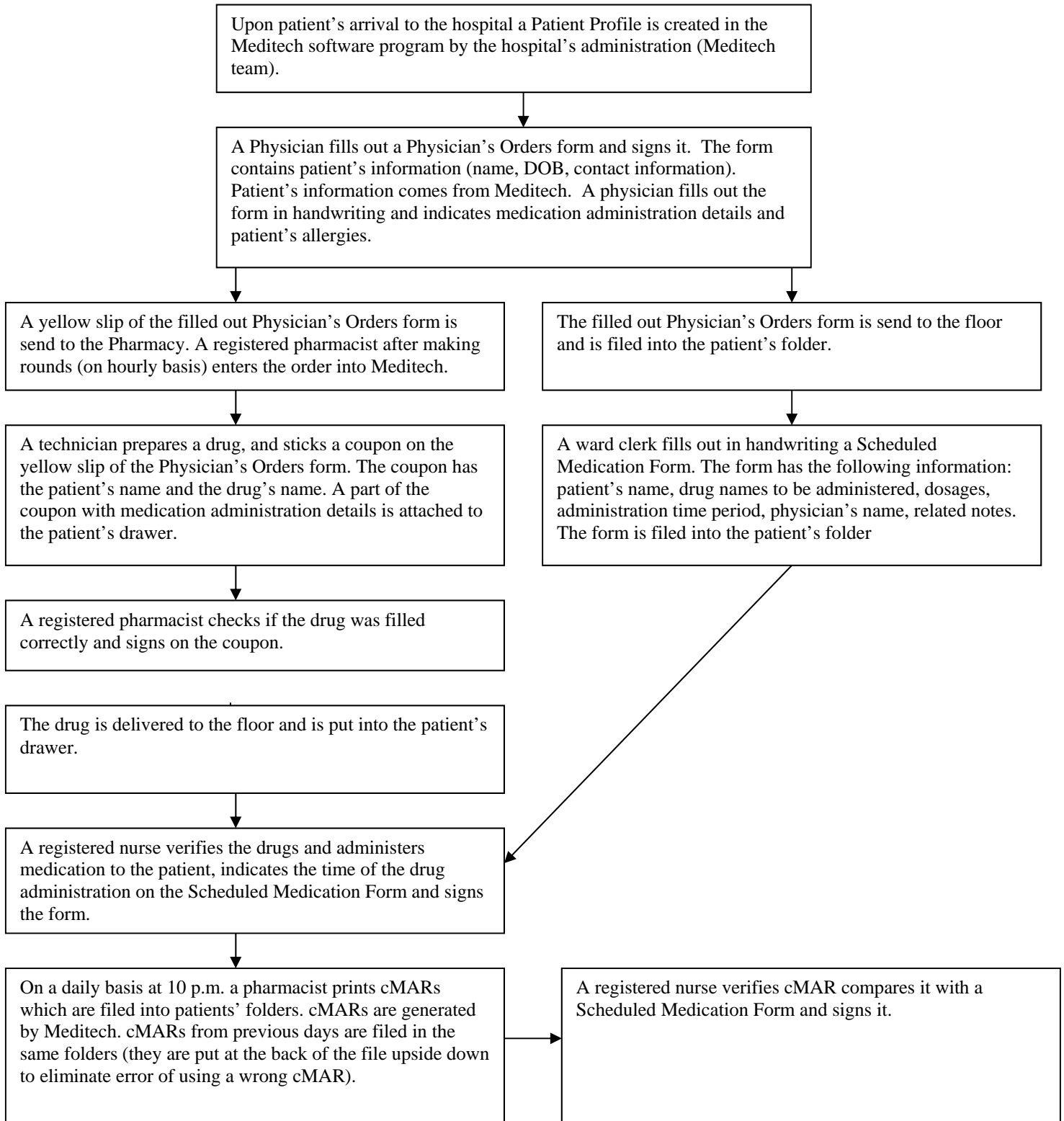
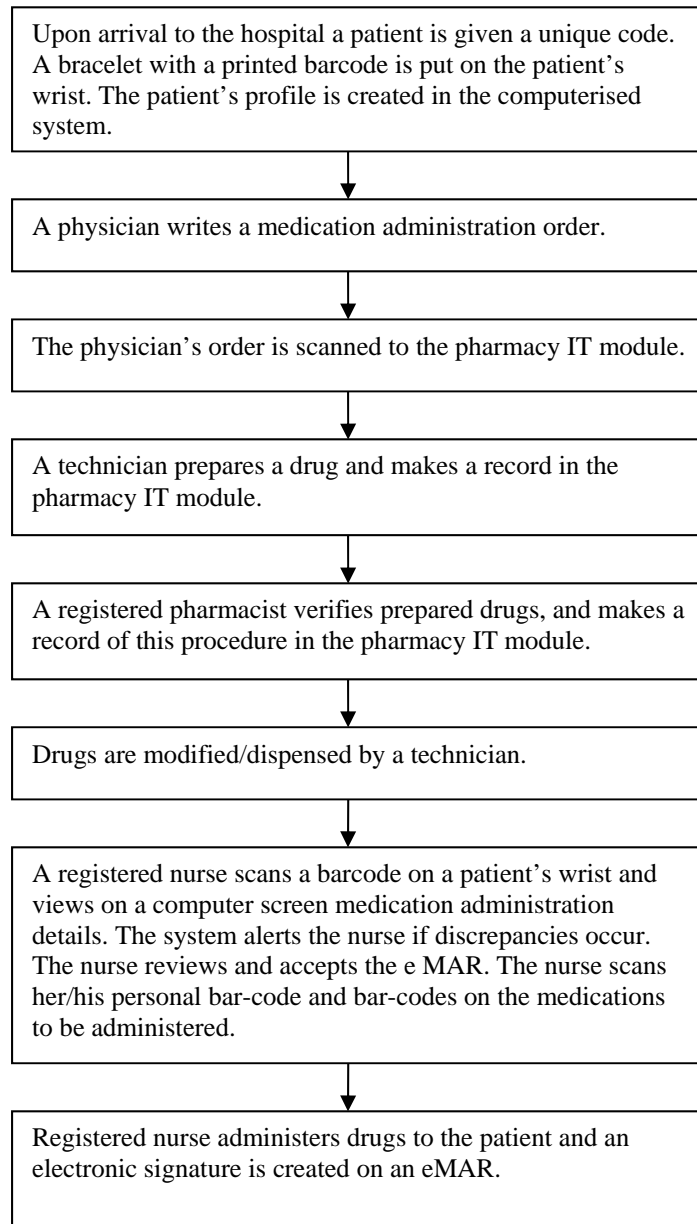


Chart 2 Expected Process of Medication Administration after the BCMA System Implementation



Appendix D

[CSHP removed content]