

Evaluation of Insulin Delivery Strategies for Bronson Health Group

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Abstract

Purpose: The Institute for Safe Medication Practices has published numerous safety alerts in regards to institutional insulin pen use focused on the misuse of insulin pens and subsequent transmission of infections. Other institutions may use floor-stock insulin; however, The Joint Commission has provided recent guidance against using multiuse vials on multiple patients. The purpose of this study is to evaluate Bronson Healthcare Group's different methods of insulin administration to determine a cost-effective strategy while meeting regulatory requirements. Secondary endpoints will evaluate safety and nursing preference of different types of insulin delivery.

Methods: Retrospective data was collected in the form of medication safety event forms, insulin purchasing records, hospital-wide insulin usage reports, number of patient-days reports, and a nursing survey. Insulin use, purchasing data, and safety event reports were collected from August 2013 to August 2014 from Bronson Methodist Hospital and Bronson Battle Creek Hospital. The nursing survey was distributed to inpatient Bronson facilities from January 22 to February 5, 2015. Aggregate data was collected and analyzed via Microsoft Excel. Descriptive statistics were used to evaluate the primary outcome. Chi squared and t-tests were used for secondary outcomes as appropriate.

Results: By switching to short-acting insulin administered from 3 mL single-patient insulin lispro vials and pharmacy-drawn long-acting insulin detemir the hospital system could potentially save approximately \$22,000 a year. Data did not support there being a safer method of insulin delivery. Nursing preference data indicated that nurses prefer delivery methods with which they are more familiar.

Conclusion: In combination with recommended best safety practices as reported by multiple nationally recognized safety organizations, we can conclude that the most cost-effective methods of insulin delivery for the Bronson Health System would be pharmacy technician drawn single doses of long acting insulin detemir and single patient 3 mL vials of insulin lispro.

Keywords: Insulin delivery; Medication safety; Health care; Diabetes

Introduction

Nearly one-fourth of inpatient days are attributed to patients with diabetes, and the majority of these patients are managed with insulin during their hospitalization [1]. An institutional insulin delivery strategy has been a hot topic around the nation for years. The invention of the insulin pen in the 1980's resulted in a transition toward inpatient pen usage. This change was driven by thoughts that pens would offer more accurate dosing, greater ease of administration, and easier device education for diabetic patients for outpatient use. More recently, The Institute for Safe Medication Practices has published numerous safety alerts in regards to institutional insulin pen use focusing on the misuse of insulin pens and subsequent transmission of infections such as HIV, Hepatitis B, and Hepatitis C [2-5]. The Joint Commission has also provided recent publications taking a stand against using multiuse vials, including insulin, on multiple patients [6]. Based on these high-profile organizational statements, it is obvious that current insulin delivery methods utilized are prone to serious safety events. As such, a comprehensive analysis of

insulin administration practice needed to be conducted for Bronson Health Group. While patient safety is always a primary concern, the concept of insulin use also encompasses differences in cost and administration preference. Multiple studies have been conducted evaluating cost differences between pens, Multiuse Multiple Patient Vials (MMPV), and Multiuse Single Patient Vials (MSPV) [7,8]. These studies all generally demonstrate that MMPVs offer the most cost-savings with the least amount of waste; however, a recent study demonstrated that when switching from 10 mL floor stock vials to 3 mL single patient vials and pens there was a 33.1% reduction in overall number of units of insulin purchased, and an 8.6% reduction in insulin acquisition costs [9]. There is very little literature demonstrating nursing administration preference in an institution. One study reviewed nursing satisfaction through a survey assessing convenience, preparation, administration time, and confidence in giving the appropriate dose while using insulin pens [10]. This study showed that pens were viewed to be more convenient and required less time to prepare and administer than traditional vial and syringe insulin delivery. Here they did not evaluate common administration issues that may occur with pens. Such issues may include errors in preparation and administration of an insulin dose. Reviewing nurse

satisfaction also encompassed evaluating needle stick injuries incurred by nurses during administration, and this investigation revealed that needle sticks were less common when using insulin pens. Currently, differences exist between our hospitals methods for insulin delivery. One hospital employs an insulin pen model for short-acting insulin, whereas another employs a 3 ml floor-stock model for short-acting insulin. Long-acting insulin's are also handled differently with one hospital sending dosages pre-drawn patient specific with the other dispensing 10 mL vials for floor-stock use. Literature does not outline a best method of insulin delivery therefore an analysis of current and proposed practice is necessary to be conducted in order to provide data to help standardize patient care within the health system. The goal of this investigation was to determine the most cost-effective method of insulin delivery for short and long-acting insulin. The study was also to determine if any method of delivery was safer, or preferred to nursing staff.

Methods

This was a retrospective observational study conducted at two hospitals in the Bronson Health Group. The study was classified as exempt by the Bronson Health Group Institutional Review Board (IRB). The study period was August 2013-August 2014. The primary objective of this study was to create a budgetary impact assessment to examine the effect of different insulin delivery methods and distributions systems for hospitalized patients between organizations within the health system. Secondary objectives were to determine if any insulin delivery system was safer than another, and to evaluate if any method of insulin was more profoundly preferred by staff administering insulin to the patient. The two facilities included in the study used different methods of insulin delivery based on type of insulin. Bronson Battle Creek (BBC), a 189 bed community hospital, utilized 3 mL floor-stock insulin lispro for short-acting insulin and 10 mL floor-stock insulin detemir for long-acting insulin. Bronson Methodist Hospital (BMH), a 434 bed tertiary hospital, utilized single patient 3 mL insulin aspart pens for short-acting insulin and pharmacy prepared single dose syringes of insulin glargine for long-acting insulin.

Type Insulin	of Delivery Method	Cost Per Product (\$)	Cost Per Milliliter (\$)
Insulin Glargine	10 mL Vial	227.00	23.00
Insulin Detemir	10 mL Vial	182.00	18.00
Insulin Lispro	3 mL Vial	13.00	5.00
Insulin Lispro	3 mL Pen	17.00	6.00
Insulin Aspart	3 mL Pen	15.00	5.00

Table 1: Insulin Pricing.

This study included utilization of aggregate purchase data from each facilities' wholesaler and aggregate insulin utilization data run from hospital EMR systems for patients that received one or more doses of insulin during the study period. Number of patient days was collected in order to compare usage between the two different sized facilities. Data collected was used to determine amount of insulin wasted and rate of insulin usage and waste per patient day based on the type of insulin delivery method. Results were reported as current and potential

yearly costs for each insulin delivery strategy at each facility based on average pricing at time of research reported in Table 1. Adverse events and errors related to insulin were collected from internal data from Risk Management departments at both Bronson Battle Creek and Bronson Methodist hospitals. This information could then be assessed to determine if any specific delivery strategy appeared to be safer than another. Safety events reported as nursing needle sticks to employee health were also collected to determine if a particular delivery method was more prone to administration injury to the nursing staff. In order to assess staff perception of insulin delivery strategies a voluntary survey on insulin practice and perceptions was distributed to organizational staff (nursing) via an opinion survey created by the information technology department. The survey included 14 multiple choice questions and was available to staff from January 22, 2015-February 05, 2015. Descriptive statistics were used to evaluate the primary objective. Secondary end points were evaluated using the chi squared test for nominal data and the T test for ordinal data as appropriate. A 5% level of significance was used to evaluate statistical significance in all analyses.

Results

The primary objective was first reviewed by collecting insulin purchasing, hospital-wide usage, and number of patient day's data as demonstrated in Table 2. This information allowed us to calculate hypothetical situations of insulin delivery for each hospital based on our rates of insulin wasted per patient day and then multiplied by the individual hospital's number of patient days. From these numbers we could calculate how much insulin would need to be purchased for each scenario assuming similar waste patterns. Cost was then calculated by multiplying number of units needing to be purchased for each scenario by the pricing listed in Table 1 and presented in Table 3.

Long Acting Insulin Year Data		
	BMH Insulin Glargine	BBC Insulin Detemir
Administered Units	288,915	170,757
Purchased Units	382,000	303,000
Wasted Units	93,085	132,243
Number of Patient Days	100,081	40,470
Wasted Units per Patient Day*	0.9	3.3
Short Acting Insulin Year Data		
	BMH Insulin Aspart	BBC Insulin Lispro
Administered Units	174,576	121,410
Purchased Units	2,176,500	346,800
Wasted Units	2,001,933	225,390
Number of Patient Days	1,000,081	40,470
Wasted Units per Patient Day*	20.0	5.6
*p<0.01		

Table 2: Annual Insulin Units Usage.

	Long-Acting Insulin Costs	
	BMH (Cost difference from current method), \$	BBC (Cost difference from current method), \$
Floor-stock Insulin Glargine 10 mL vials	140,399 (+53,777)	68,708 (+13,498)
Floor-Stock Insulin Detemir 10 mL vials	112,816 (+26,194)	55,210
Pharmacy Drawn Insulin Glargine 10 mL vials	86,622	46,980 (-8,230)
Pharmacy Drawn Insulin Detemir 10 mL vials	69,604 (-17,018)	37,750 (-17,460)
	Short-Acting Insulin Costs	
	BMH (Cost difference from current method), \$	BBC (Cost difference from current method), \$
Floor-stock Insulin Lispro 3 mL vial	32,855 (-79,235)	15,502
Single Patient Insulin Lispro 3 mL vial	97,290 (-14,800)	42,148 (+26,646)
Single Patient Insulin Lispro 3 mL pen	121,521 (+9,431)	52,645 (+37,143)
Single Patient Insulin Aspart 3 mL pen	112,090	48,559 (+33,057)

Table 3: Yearly Costs for Insulin Delivery Methods.

Data indicated that having pharmacy technicians draw up long-acting insulin doses was more cost-efficient than having floor-stock vials. Our long-acting insulin data also indicated there was an additional cost savings opportunity for the health system to use insulin detemir instead of insulin glargine. By making this transition to pharmacy drawn single doses of insulin detemir BBC could save over \$17,000 a year and BMH could save about \$17,000 a year by switching to this brand of insulin.

Short-acting insulin data would be cheapest by utilizing the 3 mL floor-stock model; however, best safety practices as mentioned above strongly recommend avoiding making one product available for multiple patients. Due to national safety concerns we attempted to find the next most cost-effective means of insulin delivery. Out of the several products available for short-acting insulin data shows that using the 3 mL single patient insulin lispro vial would be most cost-effective. Switching from the insulin aspart pen to the insulin lispro vial at BMH would offer a yearly cost savings of \$14,800. Any switch to a single patient product would result in a cost increase for BBC but the smallest increase in yearly costs would be by switching to the insulin lispro single patient vial resulting in a cost increase of about \$26,600 a year.

Safety event data was collected for the study period and resulted in 32 events at BMH and 15 events at BBC. In order to compare number of events by hospital size we calculated number of events per 10,000 patient days. This information resulted in a rate of 3.2 at BMH and 3.7 at BBC, the difference between these rates were not significant. The most common type of errors reported at both facilities were related to insulin drip use, and the next most common error was improper storage of insulin pens.

Nursing survey information was collected and reported in Table 4. This information indicated that there is no statistically significant difference in level of nursing experience at either facility. Numbers also indicated that nurses at BMH prefer using insulin pens, and nurses at BBC prefer using insulin vial and syringe for delivery.

Demographics	BBC n=58 (%)	BMH n=81 (%)
Number of Years of Nursing Experience		
<1 year	5	3
1-3 year	20	20
3-5 year	8	14
5-10 year	5	13
>10 year	20	31
Preference Questions		
Dose Preparation		
Strong Pen Preference	5 (8.5)	36 (44.5)
Pen Preference	6 (10)	26 (32)
No Preference	26 (45)	18 (22)
Vial Preference	11 (19)	1 (1.5)
Strong Vial Preference	10 (17.5)	0
Dose Administration		
Strong Pen Preference	4 (7)	31 (38.5)
Pen Preference	5 (8.5)	22 (27)
No Preference	25 (43)	22 (27)
Vial Preference	12 (20.5)	5 (6)
Strong Vial Preference	11 (19)	1 (1.5)
Confidence in Correct Dose		
Strong Pen Preference	3 (5)	21 (26)
Pen Preference	7 (12)	22 (27)

No Preference	22 (38)	32 (39.5)
Vial Preference	15 (25.5)	5 (6)
Strong Vial Preference	10 (17.5)	1 (1.5)
Most Comfortable Administering		
Strong Pen Preference	3 (5)	27 (33)
Pen Preference	6 (10)	25 (31)
No Preference	19 (32.5)	23 (28.5)
Vial Preference	16 (27.5)	6 (7.5)
Strong Vial Preference	12 (20.5)	0
Delivery Method Best for Inpatient Use		
Floor-stock vials	24 (41)	5 (6)
Single Pt Vials	19 (33)	4 (5)
Single Pt Pens	12 (21)	71 (88)
Administration Technique		
Self-Reported Needles Sticks		
Vial & Syringe	8 (14)	9 (11)
Pen	1 (1.5)	2 (2.5)
Do You Prime the Insulin Pen before Each Injection?		
Yes	NA	78 (96)
No	NA	2 (2.5)
Do You Store Floor-stock Vials in Locations Other Than Med Rooms?		
Yes	8 (14)	NA
No	50 (86)	NA
Have You Ever Observed Insulin Leaking onto a Patient's Skin after Administering an Insulin Pen Dose?		
Yes	NA	57 (70)
No	NA	23 (28)

Table 4: Nursing survey results.

Discussion

Financial information indicated that pharmacy drawn insulin detemir would provide the most cost-effective long-acting insulin delivery. Short-acting insulin information showed greatest potential cost savings by using a floor-stock model; however, Joint Commission Standards indicate using a single patient product whenever possible. Because of the safety standards we chose to evaluate cost savings for short-acting insulin based on single patient products. We did find opportunity for cost savings at one of the facilities, but because of transition to single patient products standardization resulted in a cost increase for BBC. The information presented indicates single patient 3 mL vials to be a cheaper alternative to single patient pens, which is also supported by ISMP recommendations.

Safety data presented outlined that one hospital did not have a greater number of safety events related to insulin over another. This indicates that all methods of insulin delivery used in the Bronson Health System are similarly safe. The events reported primarily focused on issues relating to insulin drip usage which did not correlate with the intent of this study.

Nursing survey data indicated that while each facility preferred different methods of insulin delivery, they each preferred the method they were most accustomed to using. After considering this, whichever strategy utilized system-wide would need to incorporate re-education. Our reported administrating technique data also supports the idea of re-education based on inconsistent pen priming, improper storage of vials, and insulin leaking on a patient's skin following dose administration.

Limitations of this investigation include evaluating all types of insulin delivery methods and types of insulin, as well as calculating waste based on acquisition and usage data compared to actual observed waste. Other limitations included having faulty data from BBC for short-acting insulin and having to extrapolate data based on 2 months of usage, and including all of BMH's long-acting insulin data when any dose greater than 100 units allowed for an entire 10 mL vial of long-acting insulin are sent to the floor for that specific patient. Number of safety events reported could also have been low due to lack of reporting, which could have indicated one method of administration to be safer than another. We did not include cost of syringe, needle, pen tip, or nursing time for administration based on previous studies that indicated these costs were similar regardless of delivery method used [8,9].

Another factor that may determine a superior method of insulin delivery is accuracy of the insulin delivery method. Previous studies indicate that generally there is no difference in accuracy of insulin doses between vial and syringe and insulin pen delivery systems [11]. The caveat to this conclusion is that doses less than 5 units have been shown to be more accurate when administered via insulin pen [12,13]. Due to the complicated process of assessing dosing accuracy and general societal acceptance that pens and vials are similar in accuracy, we did not evaluate this factor in our review.

Conclusion

Based on our results, in combination with recommended best safety practices as reported by multiple nationally recognized safety organizations, we can conclude that the most cost-effective methods of insulin delivery for the Bronson Healthcare Group would be pharmacy technician drawn single doses of long-acting insulin detemir and single patient 3 mL vials of insulin lispro. Secondary outcomes of safety events and nursing preference do not outline a preferred practice and thus support transitioning to the cheaper methods of administration.

By transitioning to single patient products at BBC there would be a cost increase in purchasing short-acting insulin; however, system-wide there would still be a cost savings of \$22,632. More cost savings could be created via contracting opportunities once products are standardized. As a result, tens of thousands of dollars can be saved through standardization and product maximization.

In order to make progress toward these pharmacy leaders have begun to take requests to each facility individual Pharmacy and Therapeutic Committees. We will also need to offer education to

nursing about appropriate vial and syringe technique for administration, and educate pharmacy staff on their role in drawing up long-acting insulin doses.

Further research may need to be done to incorporate more factors such as different pricing options offered to institutions through different contracts. Another factor that was not considered in our research was what products insurance companies are more likely to cover in an outpatient setting. If patients are educated to use one product but their insurance will only provide the other, this could have the effect that the type of insulin delivery ideally should be used in hospitals. Nonetheless, the study shows that regulatory compliance can be achieved alongside lowering drug costs compared to current practices.

References

1. Schmeltz LR (2009) Safe insulin use in the hospital setting. *Hosp Pract* 37: 51-59.
2. The Institute for Safe Medical Practices (2013) ISMP Quarterly Action Agenda: Remove multiple-dose pen devices from inpatient use. *Medication Safety Alert*.
3. The Institute for Safe Medical Practices (2013) Ongoing Concern about Insulin Pen Reuse Shows Hospitals Need to Consider Transitioning Away from them. *Medical Safety Alert*.
4. The Institute for Safe Medical Practices (2009) Reuse of Insulin Pen for Multiple Patients Risks Transmission of Blood Borne Disease. *Medical Safety Alert*.
5. The Institute for Safe Medical Practices (2008) Considering Insulin Pens for Routine Hospital Use? Consider this. *Medical Safety Alert*.
6. The Joint Commission (2014) Preventing infection from the misuse of vials. *Sentinel Event Alert*.
7. Davis EM, Christensen CM, Nystrom KK, Foral PA, Destache C (2008) Patient satisfaction and costs associated with insulin administered by pen device or syringe during hospitalization. *Am J Health Syst Pharm* 65: 1347-1357.
8. Lee LJ, Smolen LJ, Klein TM, Foster SA, Whiteman D, et al. (2012) Budget impact analysis of insulin therapies and associated delivery systems. *Am J Health Syst Pharm* 69: 958-965.
9. Edmondson G, Criswell J, Krueger L, Eby EL (2014) Economic impact of converting from 10-mL insulin vials to 3-mL vials and pens in a hospital setting. *Am J Health Syst Pharm* 71: 1485-1489.
10. Davis E, Bebee A, Crawford L, Destache C (2009) Nurse Satisfaction Using Insulin Pens in Hospitalized Patients. *Diabetes Educ* 35: 799-809.
11. Gnanalingham MG, Newland B, Smith CP (1998) Accuracy and reproducibility of low dose insulin administration using pen-injectors and syringes. *Arch Dis Child* 79: 59-62.
12. Keith K, Nicholson D, Rogers D (2004) Accuracy and Precision of Low-Dose Insulin Administration Using Syringes, Pen Injectors, and a Pump. *Clin Pediatr* 43: 69-74.
13. Korytkowski M, Bell D, Jacobsen C, Suwannasari R (2003) A multicenter, Randomized, Open-Label, Comparative, Two-Period Crossover Trial of Preference, Efficacy, and Safety Profiles of a Prefilled, Disposable Pen and Conventional Vial/Syringe for Insulin Injection in Patients with Type 1 or 2 Diabetes Mellitus. *Clin Ther* 25: 2836-2848.