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Title of project:

Effect of pneumatic tubing system on regular insulin concentration

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ABSTRACT

Specific Aims: To describe the effect of transport via pneumatic tube system on the concentrations of bags of regular insulin.

Methods: Twelve intravenous (IV) bags of regular insulin in normal saline with a concentration of one unit per milliliter were prepared, with six bags acting as the control group and six bags as the experimental group. Bags in the experimental group were transported to stations labeled X, Y, and Z which were at varying distances from the pharmacy. Bags in the control group were walked to the same tube stations. Three samples from each bag were analyzed using the ValiMed™ medication validation system before and after transport and the reported standard deviations (SDs) from the mean were recorded.

Main Results: At baseline there were no statistically significant differences in the standard deviations (SDs) between the control and experimental group ($p = 0.1008$). SDs after transport compared to baseline SDs produced statistically significant differences ($p < 0.005$) except for the control group transported to tube station Z ($p = 0.0867$).

Conclusions: The SDs after either transport produced a statistically significant difference when compared to baseline except for one group of insulin bags. This indicates that concentration may not be affected by method of delivery, since statistically significant difference occurred regardless of transport method. It appears to be safe to transport insulin IV infusion bags by pneumatic tube system.

INTRODUCTION

Pneumatic tube systems (PTS) are used in hospitals to transport medications and specimen samples. PTS has proven to be a powerful tool to clinicians, providing rapid and efficient passage of materials from one area to another.[1] Automation and technology quickly perform delivery tasks that would have been relegated to pharmacy staff, freeing them to perform clinical work that is not so easily accomplished by robots and computers. However, PTS is not without its drawbacks. For example, transport through the PTS is associated with shaking and dropping of the container, leading to concerns about the integrity of the contents within the container after transport. This concern has resulted in research examining the effect pneumatic tube system transport has on various substances such as blood samples, platelets, and medications. Studies have shown that PTS has no effect on viability of certain blood products, despite the fact that tubes may undergo multiple changes in g-force.[2-4] Recent evidence has even noted that patient blood and tissue samples may be transported through PTS without damage to the sample.[5] Currently, there are little data relating to the integrity of insulin products after transport through PTS and hospitals have varying policies about the transport of insulin via PTS.[6] Insulin is a medication of particular concern in that sufficient mechanical agitation causes disruption of the protein structure and aggregation of the product out of solution. Administration of such a mechanically agitated insulin product would result in inaccurate dosing and improper management of a patient's blood sugar. Therefore, the purpose of the study was to establish the effect the Swisslog PTS has on IV bags of regular insulin compounded in normal saline.

METHODS

Design: This study utilized a pretest-posttest design comparing concentration of insulin before and after the intervention.

Subjects: The study did not use human subjects.

Intervention: The independent variable is the method used to transport the IV bags. For the control group, 2 IV bags each were selected to be placed on a cart and walked a given distance. The distances were 0.1, 0.25, and 0.2 miles. For the experimental group, 2 IV bags each were selected to be sent from the PTS station in the pharmacy to an assigned PTS station. The PTS stations to which IV bags were sent were labeled X, Y, and Z and were 0.1, 0.25, and 0.2 miles away respectively from the PTS station within the pharmacy.

Measures: The data were collected by recording the standard deviations that the ValiMed™ machine reported for the three samples from each bag before and after transport. In addition to the standard deviations, bag number, and distanced walked or PTS station destination were also recorded.

Data Collection: Data were collected over the course of 2 days. On the first day, baseline measurements were taken. On the second day, the bags were transported by assigned method. Immediately after an insulin IV bag was transported samples were drawn, analyzed by the ValiMed™ machine, and reported standard deviations were recorded.

Data analysis: Independent t-test was used for reported standard deviations at baseline. Dependent t-tests were used to compare baseline standard deviations to standard deviations reported after transport method. The a-priori p-value was 0.05.

RESULTS

Baseline data are reported in Table 1. There were no statistically significant differences between the control and experimental groups at baseline. Tables 2 and 3 show the standard deviations reported by the ValiMed™ machine after transport for the control group and experimental group respectively. Table 4 shows the resulting p-values of dependent t-tests comparing the standard deviations of each group before and after transport. With the exception of the control group walked the distance to PTS station Z (0.2 miles), reported standard deviations before and after transport were significantly different ($p < 0.05$).

DISCUSSION

The reason that there is a difference in SD from baseline may be explained by the binding of insulin to the bag which happens regardless of the delivery method. Therefore, the results suggest that pneumatic tubing of insulin does not affect concentration significantly. Of note, there was an outlier in the baseline SD in group Z (2.4345) which should have been re-measured or thrown out as there is more than 1 SD between the highest and lowest value. This may be machine or user error.

Since no literature exists concerning the tubing of regular insulin, we were unable to compare the findings from our study with similar, published studies.

Our study is limited by several factors. For example, our sample size was limited by cost. In addition, the study assumes that the ambient environment (e.g. temperature) is consistent within the PTS and will not have additional effects on insulin concentration. Moreover, results may not be generalizable to hospitals utilizing PTS other than Swisslog, and the distance measured by the pedometer may not reflect the actual distance traveled by the tube in the

tube system. Furthermore, standard deviation inherently does not indicate change in one direction; however, concentration would be expected to decrease, not increase. Finally, continuous insulin IV is typically titrated to effect, therefore clinicians can usually increase/decrease rates to overcome any alterations in concentration.

CONCLUSIONS

The concentration of insulin was statistically different from baseline but was not affected by the method of delivery (walking or PTS). It appears safe to tube insulin IV infusion bags.

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Table 1.

Baseline Data

Bag #	Sample 1 Standard Deviations	Sample 2 Standard Deviations	Sample 3 Standard Deviations
1	1.1690	0.1061	0.2700
2	0.8790	0.4874	0.4587
3	0.8120	0.1993	0.1860
4	0.9610	0.1393	0.3123
5	0.8250	0.2689	0.0236
6	1.3228	0.7877	0.6491
7	0.9580	0.1713	0.2969
8	0.1730	0.3266	0.3487
9	0.5200	0.1962	0.0736
10	0.7009	0.2021	0.2964
11	0.9380	0.1678	0.0752
12	0.8070	0.0554	0.0024

ValiMed™ reported SD of all insulin IV continuous infusion bags at baseline (before transport. No statistical significance between groups were found at baseline ($p = 0.1008$).

Table 2.

Control Group Data

Bag # / Tube Station	Sample 1 Standard Deviations	Sample 2 Standard Deviations	Sample 3 Standard Deviations
1 / X	1.5372	1.6438	1.8857
2 / X	1.4961	1.7742	1.7037
3 / Y	1.7561	1.5182	1.8741
4 / Y	1.8601	1.7862	1.4623
5 / Z	1.3550	2.4345	1.5683
6 / Z	0.9325	1.0942	1.2618

ValiMed™ reported SD of control group after being walked to assigned tube stations. Distance from the PTS station in the pharmacy to PTS stations X, Y, and Z were 0.1, 0.25, and 0.2 miles respectively.

Table 3. Experimental Group Data

Bag # / Tube Station	Sample 1 Standard Deviations	Sample 2 Standard Deviations	Sample 3 Standard Deviations
7 / X	1.5133	1.7931	1.8162
8 / X	1.8527	1.7025	1.6801
9 / Y	1.5137	0.3094	1.6766
10 / Y	1.9020	1.6077	1.7054
11 / Z	1.6887	1.5574	1.6526
12 / Z	1.6671	1.6311	2.0110

ValiMed™ reported SD of experimental group after being transported by PTS to the assigned tube stations. Distance from the PTS station in the pharmacy to PTS stations X, Y, and Z were 0.1, 0.25, and 0.2 miles respectively.

Table 4.

P-values When Control and Experimental Groups Standard Deviations Are Compared to Baseline

Tube Station	Control (Bag #'s)	Experimental (Bag #'s)
X	0.0030 (1 & 2)	0.0005 (7 & 8)
Y	0.0003 (3 & 4)	0.0037 (9 & 10)
Z	0.0867 (5 & 6)	0.0009 (11 & 12)

Table 4. P-values resulting from dependent T-tests comparing SD before and after transport.

APPENDICES

Experimental Table:

Date/Time of Test	Bag ID	Time in Tube (s)	Sample 1 Standard Deviations from the Mean	Sample 2 Standard Deviations from the Mean	Sample 3 Standard Deviations from the Mean

Control Table:

Date	Bag ID	Distance Walked	Sample 1 Standard Deviations from the Mean	Sample 2 Standard Deviations from the Mean	Sample 3 Standard Deviations from the Mean