Inpatient Insulin Pump Therapy: Assessing the Effectiveness of an Educational Program

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Loma Linda University, a Seventh-day Adventist Christian health sciences institution, seeks to further the healing and teaching ministry of Jesus Christ "to make man whole".
Presentation Objectives

- Sharing an exemplar of an evidence-based DNP Capstone Project that facilitates an educational intervention among healthcare providers to recognize continuous subcutaneous insulin infusion (CSII) in the inpatient setting.

- Demonstrate how education of CSII increases knowledge and confidence among healthcare providers.

- Identify a model and conceptual evidence-based nursing framework that promotes a partnership between patients and healthcare providers.

- Describe nursing practice doctorate outcomes in clinical, research and education that contributes to patient empowerment.
Does Evidence Create a Need for Change?

- Provide for a strong validity by integrating best possible research, clinical expertise and patient needs in the clinical setting.
  - Critically review current practice.
  - Understand the use of electronic and computerized, and integrated systems for patient care associated with diabetes management.
  - Application of effective decision-making in a timely manner.
- Raise the standard of practice.
- Sustainable change requires commitment.
The Evolution of Diabetes Management
Evolution of Insulin Pump Therapy

Improving patient health outcomes through the use of technological advances.
Pancreatic Function and Classification of Diabetes

- **Type 1** - AKA Type I, IDDM, Juvenile onset.
  - Absolute insulin deficiency.
    - Autoimmune defect.
- **Type 2** AKA type II, NIDDM, Adult onset.
  - Begins with **insulin resistance**.
    - Gradual Beta Cell failure
    - Relative insulin deficiency.
Normal Mealtime Insulin Response

<table>
<thead>
<tr>
<th>Time of Day</th>
<th>Insulin (units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 AM</td>
<td>0</td>
</tr>
<tr>
<td>8 AM</td>
<td>10</td>
</tr>
<tr>
<td>Noon</td>
<td>20</td>
</tr>
<tr>
<td>3 PM</td>
<td>30</td>
</tr>
<tr>
<td>6 PM</td>
<td>40</td>
</tr>
<tr>
<td>9 PM</td>
<td>50</td>
</tr>
<tr>
<td>Midnight</td>
<td>60</td>
</tr>
<tr>
<td>3 AM</td>
<td>70</td>
</tr>
<tr>
<td>6 AM</td>
<td>0</td>
</tr>
</tbody>
</table>

Physiologic insulin levels.

Meals.
Reflective Practice Creates a Need for Change

- A 44 year old male sustained an injury requiring radiological diagnostic imaging.
- History of Type -1 diabetes wears an insulin pump.
- Insulin pump was discontinued.
- An alternative insulin regimen was implemented by the primary care team.
- “Human Error” nurse didn’t administer long acting insulin.
- Lesson learned ~ proposed guidelines for CSII are necessary to improve patient expected outcomes.
Reflective Practice Creates a Need for Change

- 22 year old female history of Type 1 Diabetes Mellitus.
- Admitted for perforated appendix that resulted in an abdominal abscess.
- Hemoglobin A1C 8.1% = to a blood glucose of 180’s.
- Insulin regimen consists of multiple daily injections (MDI) versus CSII.
  - Established carbohydrate ratio is 1:6.
  - Established insulin sensitivity correction ratio is 1:20 mg/dL for an elevated glucose above 120 mg/dL.
Maintaining Optimal Glucose Control in Response to the Metabolic Stress Response

- ↑ Stress hormones and peptide
- ↑ Glucose
- ↓ Insulin
- ↑ Free fatty acids
- ↑ Ketones
- ↑ Lactose

- Immune dysfunction
- Infection dissemination

- Cellular injury/apoptosis
- Inflammation
- Tissue damage
- Altered tissue/wound repair
- Acidosis
- Infarction/ischemia

- Prolonged hospital stay
- Disability and death

- ↑ Reactive O₂ species
- ↑ Transcription factors
- ↑ Secondary mediators
Relative Risk of Progression of Diabetes Complications (DCCT)\(^4\)
In 2008, the American Diabetes Association stated “Diabetes Mellitus is a group of metabolic disorders characterized by hyperglycemia” (p.S62).\(^5\)

Estimated that 150 million people in the world have diabetes.\(^6\)

This number is expected to increase to 300 million by the year 2025; most of these cases will be type 2 diabetes.\(^7\)

Estimated prevalence of hospitalized patients is 12.4\% to 25\%.\(^8\)
Significance of the Problem

- More than 200,000 diabetics worldwide are using CSII as an intervention to manage glucose control.\(^9\)

- “Self-management may be appropriate for competent adult patients who have a stable level of consciousness” (ADA, 2010, p. S46).\(^8\)

- American Association Clinical Endocrinology (AACE) recognizes the use of inpatient pump therapy be made available in certain clinical situations.\(^9\)

- “The availability of hospital personnel with expertise in CSII is essential when encountering inpatients using insulin pumps” (Moghissi, et. al. p. 1124).\(^10\)
Significance of the Problem

- Lack of published standardized guidelines from local and national authorities to allow patients to continue CSII after a hospital admission.  

- Performance gaps that exist in the management of hyperglycemia in the inpatient setting are multifactorial.

- American Association of Clinical Endocrinologists (AACE) and American Diabetes Association (ADA) recognize the importance of glucose control across the continuum of care.  

Does education of CSII demonstrate an improvement of knowledge and confidence among healthcare providers to recognize CSII for select inpatients?
Modern Day Insulin Pumps
Indications for CSII ~ Pump Therapy

- Hypoglycemic events requiring third party assistance or interfering with work, school, or family obligations.
- A1C >7.0-7.5%, accompanied by frequent severe hypoglycemia (<55 mg/dL).
- Frequent and unpredictable fluctuations in blood glucose levels.
- Patient perception that diabetes management impedes the pursuit of personal or professional goals.
Benefits of “Pump Therapy”

Benefits of Continuous Subcutaneous Insulin Infusion (CSII).
- Eliminating individual injections.
- Delivers insulin more accurately.
- Flexibility with meal times.
- Can improve quality of life.
- Reduced HbA1c.

Patient Empowerment
- Patient-Centered Approach
Continuous Subcutaneous Insulin Infusion ~ CSII
Basal Insulin Delivery

- Steady “Drip” of Insulin.
- Matches glucose released by the liver.
- Meets body’s basic energy needs.
- May need different settings at different times of day.
Bolus Insulin Delivery

- Given to “cover” carbohydrates with meals and/or snacks.
- Used to “correct” high blood glucose levels.
Regular insulin sliding scales as monotherapy is shown to be ineffective.

Hyperglycemia increases mortality, infection rate and prolongs hospital length of stay (LOS).

Some patients may be candidates to self-manage glucose control in the inpatient setting.

CSII is associated with significant improvement in glycemic control.
Using the Evidence to Implement a Change in Clinical Practice

- Diabetes prevalence and costs continue to grow.
- There is a notable increase in hospital admissions of patients that use pump therapy.
- A potential barrier to intensive management is lack of provider awareness with CSII.
- Concurrent illness, stress, dietary changes, and activity contribute to hyperglycemia.
- Type 1 patients have individualized insulin requirements.
Insulin Pump Therapy - Review

- Intensive management is required to achieve the targets of good control.
- Insulin pump therapy continues to be proven to have significant clinical and lifestyle advantages compared to multiple daily injections (MDI).
- Indications for pump therapy have expanded as data indicates its utility in a broader population.
- The standardized pump initiation process can be used for a successful and long term therapy change.
Central Questions to Consider

- Will healthcare providers recognize CSII as a form of insulin infusion that can mimic the normal function of a pancreas?

- Will knowledge of CSII promote a patient-centered approach to inpatient diabetes management?

- Will the results of the pilot project promote sustainability for future educational opportunities for healthcare providers?
Three interacting systems.
Several concepts relevant for each system.

**Basic assumptions**
- Nursing focus is the care of human being.
- Nursing goal is the health care of individuals & groups.
- Human beings- are open systems interacting constantly with their environment.
Implementing Evidence-Based Nursing Theory with Research

- Imogene King’s Interacting Systems Creates an Opportunity for Change \(^{12}\)
Major Components of the Framework

- Personal Systems
  - Comprises of the patient as a person and the nurse as a person both functioning as total systems.

- Interpersonal systems
  - Involves interactions between groups (dyads, triads or small groups).

- Social systems
  - Are organized boundary system of social roles, behaviors, and practices developed to maintain values and the mechanisms to regulate the practices and rules.
Concepts Related to Each System

- Concepts for Personal System
  - Perception, Self, Growth & Development, Body image, Space, Time.
- Concepts for Interpersonal System
  - Interaction, Communication, Transaction, Role, Stress.
- Concepts for Social System
  - Organization, Authority, Power, Status, Decision making.
Measuring Knowledge and Confidence

For the purpose of the project, knowledge and confidence were defined separately.

- **Knowledge** was defined as the ability to understand the indications and contraindications of pump therapy.

- **Confidence** was defined as the ability to demonstrate self-assurance with the procedure specific knowledge and competent management of an insulin pump competently.
Project Methodology ~ Phases 1-5

**Phase 1**
- IRB Approval
- All Participants Consented

**Phase 2**
- February 2011 Transplant Unit Staff Meeting
- Baseline Knowledge and Confidence Questionnaire

**Phase 3**
- 60 minute Educational Intervention
- Power Point Presentation

**Phase 4**
- 30 minute Hands-on Pump Session (Setting and Operating)
- Question and Answer

**Phase 5**
- Completing the initial post-intervention questionnaire
- Followed by completion of second post-test survey two weeks later
Methodology

- A convenience sample of \( n=17 \).
- A total of 12 questions were designed to represent a precise measurement embedded mixed-method design.
- The educational effectiveness of the intervention, measured in terms of nurses’ knowledge and confidence and illustrated in narratives concerning inpatient pump therapy and its potential barriers.
Analysis of Quantitative Data

- Frequencies, means standard deviations (SD) and percentages summarize categorical variables.

- A repeated measures ANOVA compared the mean scores of quantitative variables between 3 data points.

- Tukey’s post hoc test performed a pairwise comparison to see where the significant difference occurred.

- Cronbach’s alpha measured internal consistency on scale items that propose to measure the same general construct that produce similar scores.
Transplant Unit Cohort ($n=17$)

Characteristics

- Level of education varied with Bachelors ranking the highest rank (77%).

- Years of service varied with over 20 years of service ranking the highest rank (35%).

- Previous pump experience demonstrates almost similar findings when comparing independent CSII experience to no experience (53% compared to 47%).

- 100% of participants reported they do not hold certification as a Certified Diabetes Educator (CDE).
## Quantitative Data Analysis

### Table 1: Population Characteristics: (n=17)

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Educational Degree</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Associates in Applied Science</td>
<td>3</td>
<td>18</td>
</tr>
<tr>
<td>Bachelors</td>
<td>13</td>
<td>77</td>
</tr>
<tr>
<td>Masters</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Doctorate</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Years of Professional Service</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-5 years</td>
<td>5</td>
<td>29</td>
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<tr>
<td>6-10 years</td>
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<td>18</td>
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<tr>
<td>11-15 years</td>
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<td>12</td>
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<tr>
<td>16-20 years</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Greater than 20 years</td>
<td>6</td>
<td>35</td>
</tr>
<tr>
<td><strong>Previous Experience with Insulin Pump Therapy</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>8</td>
<td>47</td>
</tr>
<tr>
<td>Yes</td>
<td>9</td>
<td>53</td>
</tr>
<tr>
<td><strong>Certified as a Certified Diabetes Educator (CDE)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>17</td>
<td>100</td>
</tr>
<tr>
<td>Yes</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
### Table 2: Confidence and Knowledge Assessment

<table>
<thead>
<tr>
<th></th>
<th>Mean ± SD Baseline (1)</th>
<th>Mean ± SD Immediate (2)</th>
<th>Mean ± SD After Two Weeks (3)</th>
<th>P-Value</th>
<th>Significant Post Hoc Test</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Meal “Bolus” Confidence</strong></td>
<td>2.59 ± 1.176</td>
<td>4.06 ± 1.088</td>
<td>4.29 ± 0.772</td>
<td>0.001*</td>
<td>1 vs. 2 and 1 vs. 3</td>
</tr>
<tr>
<td><strong>Confidence in Patient Selection</strong></td>
<td>3.71 ± 0.588</td>
<td>4.53 ± 0.514</td>
<td>4.65 ± 0.493</td>
<td>0.000*</td>
<td>1 vs. 2 and 1 vs. 3</td>
</tr>
<tr>
<td><strong>Integration of Concepts of Basal/Bolus Benefits of CSII</strong></td>
<td>3.59 ± 0.939</td>
<td>4.35 ± 0.786</td>
<td>4.35 ± 0.493</td>
<td>0.008*</td>
<td>1 vs. 2 and 1 vs. 3</td>
</tr>
<tr>
<td><strong>Benefits of CSII</strong></td>
<td>3.59 ± 1.278</td>
<td>4.88 ± 0.332</td>
<td>4.82 ± 0.529</td>
<td>0.000*</td>
<td>1 vs. 2 and 1 vs. 3</td>
</tr>
<tr>
<td><strong>Total Confidence</strong></td>
<td>9.88 ± 1.996</td>
<td>12.94 ± 2.015</td>
<td>13.29 ± 1.40</td>
<td>0.000*</td>
<td>1 vs. 2 and 1 vs. 3</td>
</tr>
<tr>
<td><strong>Total Knowledge</strong></td>
<td>8.24 ± 1.56</td>
<td>9.94 ± 0.899</td>
<td>10.24 ± 1.09</td>
<td>0.000*</td>
<td>1 vs. 2 and 1 vs. 3</td>
</tr>
</tbody>
</table>

Repeated Measures ANOVA with one within subjects Factor (time)

* is significant at 0.05
Quantitative Data Analysis
Quantitative Data Analysis

**Integrate "Basal" and "Bolus" premise**

<table>
<thead>
<tr>
<th>Time</th>
<th>Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>3.588</td>
</tr>
<tr>
<td>Immediate post-</td>
<td>4.353</td>
</tr>
<tr>
<td>2 wk post-intervention</td>
<td>4.383</td>
</tr>
</tbody>
</table>

**Benefits**

<table>
<thead>
<tr>
<th>Time</th>
<th>Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>3.588</td>
</tr>
<tr>
<td>Immediate post-</td>
<td>4.882</td>
</tr>
<tr>
<td>2 wk post-intervention</td>
<td>4.824</td>
</tr>
</tbody>
</table>
Quantitative Data Analysis

**Total Confidence**

- Baseline: 9.88
- Immediate post-intervention: 12.94
- 2 wks post-intervention: 13.29

**Total Knowledge**

- Baseline: 9.24
- Immediate post-intervention: 9.94
- 2 wks post-intervention: 10.24
Summarizing the Quantitative Data

- Comparisons of the test means demonstrating a significant increase in total confidence and total knowledge.
- Total confidence included the concepts of Meal “Bolus” Confidence, Select Confidence, and Integrate the Premise of “Basal” and “Bolus”.
- Total knowledge included eleven possible correct responses in 7 questions. The overall difference was statistically significant (P<0.000).
- Significant results were reported on all items measuring total knowledge and total confidence (P<0.05).
50% (n=8) of the participants indicted that they had previous pump experience.

Further examination of the individual items showed significant differences (p<0.05) between data points 1 and 2, and 1 and 3.

The significance within this analysis may also be related to incorporating the hands-on demonstration and operation of the insulin pump.
Use of open-ended questions allowed for answers unanticipated responses in their own words.

- **Enumeration/Word Count:**
  - The number of times a word appears in a document looking for similar themes.
  - Education: “Educate staff to meet CSII competency”.
  - Policy & Procedure: “Written policy for patient safety”.
  - Discreet concepts related to CSII: “Equipment Competency”, “Individualized patient insulin requirements”.

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**Qualitative Data Analysis**

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  - Policy & Procedure: “Written policy for patient safety”.
  - Discreet concepts related to CSII: “Equipment Competency”, “Individualized patient insulin requirements”.

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Qualitative Data Analysis

**Table 4: Qualitative Data Themes:**

In what areas would you suggest an improvement in a hospital policy to support continuous subcutaneous insulin infusion (CSII) for the inpatient setting?

<table>
<thead>
<tr>
<th></th>
<th>Data Point 1 Baseline</th>
<th>Data Point 2 Immediate Post Intervention</th>
<th>Data Point 3 Two Week Post Intervention</th>
<th>Total Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>10</td>
<td>8</td>
<td>1</td>
<td>19</td>
</tr>
<tr>
<td>Policy &amp; Procedures</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>Pump Therapy and Concepts</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>7</td>
</tr>
</tbody>
</table>

What are the possible barriers to implementing continuous subcutaneous insulin infusion (CSII) “pump therapy” in inpatients?

<table>
<thead>
<tr>
<th></th>
<th>Data Point 1 Baseline</th>
<th>Data Point 2 Immediate Post Intervention</th>
<th>Data Point 3 Two Week Post Intervention</th>
<th>Total Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of Education</td>
<td>4</td>
<td>17</td>
<td>3</td>
<td>24</td>
</tr>
<tr>
<td>Policy &amp; Procedures</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Pump Therapy Concepts</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>8</td>
</tr>
</tbody>
</table>
The qualitative data analysis identified three key themes.

These key themes are education and/or lack of education, policy and procedures, and pump therapy concepts.

It was learned that participants advocated for multidisciplinary education, frequent in-service of CSII, more hands-on practice with CSII devices.
Findings From This Project Imply

- **Knowledge** and **Confidence** of CSII were enhanced among healthcare providers as a result of an educational intervention.

- CSII can be safe and an effective method to control glucose in select patients during a hospitalization.

- The project has been firmly aligned to leading organizations in the field of diabetes management, and a theoretical framework that recognizes interacting systems.
Findings From This Project Imply

- The development of new technology and new knowledge raises the standard of practice.

- To successfully sustain change integration of best evidence, research, clinical expertise and patient's values facilitates the creation of an infrastructure for evidence-based practice standards (EBPS).
Strength and Limitations of the Project

**Strengths**

- Clear message that this project demonstrates healthcare providers are advocates for education related to CSII.
- Evidence-based practice aims to deliver patient-centered care in clinical complex situations.
- Recognize that shared ownership among patients and healthcare providers are necessary to develop clinical practice guidelines.

**Limitations**

- The protocol did not include physicians, surgeons and/or medical residents.
- No inpatient user of pump therapy were admitted during the project.
- Limited certified pump trainers are available as resources for healthcare providers.
Future Implications for Practice

- Apply for the Joint Commission's certificate of distinction for Inpatient Diabetes Care.
- Continue multidisciplinary education among members of the healthcare delivery team.
- Have Diabetes Nurse Educators become certified insulin pump trainers.
- Continue ongoing efforts to advocate for an inpatient CSII policy.
- Project was accepted for publication in March/April 2013, Journal for Nurses in Staff Development (JNSD).
Acknowledgments

- Deborah J. Kenny, PhD, RN, FAAN
  - Associate Professor and Associate Dean for Research at Beth-El College of Nursing and Health Sciences. University of Colorado at Colorado Springs.

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- Khaled Bahjri, MD, MPH
  - Assistant Professor, Epidemiology and Biostatistics at Loma Linda University. Loma Linda, CA.

- Lastly, individuals with Type 1 diabetes.
  - Who share their personal experience, challenges and obstacles to achieve optimal glucose control.
“Life is not over because you have diabetes. Make the most of what you have, be grateful”. Dale Evans
References


