# Perioperative management of people with diabetes using CSII therapy

Lori Stooksberry

**It is inevitable that healthcare workers in hospitals will need to care for people who are using continuous subcutaneous insulin infusion (CSII) therapy and will need education and protocols to manage such patients. Therefore, a pre-test/post-test quantitative survey was used to discern the educational needs of a group of 11 perioperative nurses at a rural hospital. Each participant was asked to complete a questionnaire regarding the management of people using CSII therapy. The participants were given an educational presentation to read and then asked to retake the post-test questionnaire. Although the participants showed slight improvement in their pre- and post-test mean scores, the overall results show that an education deficit still exists among this sample with the need for additional education and follow-up research.**

**Article points**

1. Increasing numbers of people with diabetes are using continuous subcutaneous insulin infusion (CSII) therapy and attend hospital as inpatients for surgery.
2. There are no standard guidelines regarding management of people using CSII therapy in the surgical or inpatient setting.
3. The author used a pre-test/post-test quantitative survey to discern the educational needs of a group of 11 perioperative nurses at a rural hospital
4. The participants showed slight improvement in their scores, but the overall results show that an education deficit still exists, with the need for further education and follow up.

**Key words**

- CSII therapy
- Education
- Inpatient care
- Perioperative care

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Continuous subcutaneous insulin infusion (CSII) therapy, or pump therapy, was first used in the late 1970s and is now in widespread use, especially in the USA. However, it is estimated that fewer than 5% of people with type 1 diabetes currently use pumps in the UK, compared with over 15% in Germany and Sweden, and around 40% in the USA (Pickup, 2011).

The usage of CSII therapy in the USA has grown from 70 000 in 1998 to over 300 000 (Scheiner et al, 2008). Technological advances have increased the appeal of pump therapy to both patients and clinicians (Scheiner et al, 2008).

While the UK offers structured patient education and support for people starting CSII, the situation in the USA is rather different, with many patients reporting that they received less than 3 hours initial pump education, and furthermore that the only healthcare professional they could contact in an emergency was via the device manufacturer's hotline (Grunberger et al, 2010).

Diabetes is characterised by increased blood glucose levels that can cause micro- and macrovascular damage, and evidence is mounting that the early and intensive management of hyperglycaemia significantly decreases the development of progressive micro- and macrovascular complications of diabetes (American Association of Diabetes Educators, 2009).

## Proposal

It is inevitable that healthcare workers within the hospital setting will care for people who use CSII. However, there is minimal published data regarding surgical management of people using CSII therapy.

After investigation it was determined that a regional hospital in the southern USA lacked a policy outlining the care of people using CSII therapy. Nurses in this hospital therefore lacked the proper education and the necessary resources to provide safe, quality care for pump users. These factors combine to create a potentially hazardous environment for people using CSII that could lead to disturbances in blood glucose levels, resulting in a wide array of associated complications.

One prospective solution is the development of an educational plan outlining the management of surgical patients using CSII therapy and dissemination of this plan through computerised educational activities.

There have been no previous attempts at solving the problem at this institution. This includes no attempts to implement a policy or to provide educational opportunities for nurses, ancillary staff, and physicians regarding insulin pump therapy.

## Literature review

A review of current literature has revealed that there are no standard guidelines regarding management of people using CSII therapy in the surgical or inpatient setting of hospitals in the USA.

It was not until recently that hospitals started to focus on glycaemic control of inpatients. In 2006, there were 46 million inpatient surgeries performed in the USA (Centers for Disease Control and Prevention, 2010). As the prevalence of type 1 diabetes increases, more people with the condition will be admitted for surgery and require blood glucose management (Marks, 2003). It is also clear that people with diabetes who maintain optimal glycaemic control are less likely to develop surgical complications (Marks, 2003). However, with the increased attention to maintaining optimal blood glucose levels of surgical patients, the development of tested protocols and guidelines for people using CSII therapy and undergoing surgery are warranted (Lee et al, 2004).

There are currently no national data regarding the exact number of people using insulin pump therapy in the USA, but it is estimated to be over 300 000 (Scheiner et al, 2008); therefore, analysis of resulting medication errors and complications is limited (Cook, 2009). Since most hospitals have began to realise the inevitability of caring for people using CSII therapy, some have began to develop policies outlining the parameters for continued insulin pump usage while in the hospital. However, the key to any policy regarding insulin pump management must be strongly based on effective communication between the pump user and the hospital staff.

According to Cook (2009), the guidelines and written policy for instituting CSII therapy in the inpatient hospital setting should consist of three basic components:

- A list of contraindications to inpatient CSII.
- A set of guidelines to direct the medical staff on insulin pump management.
- A signed patient informed consent that details conditions for usage of CSII therapy in the hospital.

People using CSII are also expected to bring their own supplies from home (e.g. infusion sets and catheters).

In an analysis of CSII therapy at the hospital that developed and implemented this policy, Bailon et al (2009) examined 50 admissions involving 35 people who were using outpatient insulin pump therapy. Only 62% of patients were deemed to be candidates for continued usage of insulin pump therapy after admission. Of those eligible, 80% had an insulin pump documented on admission; 100% had a documented blood glucose level on admission; 77% had a signed patient consent form, and 81% had completed preprinted insulin pump orders. There were no adverse reactions such as site infections, diabetic ketoacidosis or pump malfunction (Cook, 2009).

The evidence does indicate that the implementation of an insulin pump policy at

Page points

1. There is minimal published data regarding surgical management of people using pump therapy.
2. Given the numbers of people using insulin pumps, the development of guidelines for managing people who are using continuous subcutaneous insulin infusion therapy and undergoing surgery is warranted.
3. The evidence does indicate that the implementation of an insulin pump policy can be beneficial in increasing staff awareness.

Page points

1. Two studies have reported on the implementation of insulin pump policies and found policies were beneficial in increasing staff awareness.
2. Due to the rising number of people using continuous subcutaneous insulin infusion therapy and the unavailability of resources for nurses caring for these patients in acute care and surgical settings, the author undertook to evaluate the educational needs of perioperative nurses.
3. A quasiexperimental one-group design for data collection was chosen because the subjects of this research study were not randomly assigned to treatment or control groups.

this facility was beneficial in increasing staff awareness and documentation; however, it does not address the effectiveness of CSII on controlling blood glucose levels.

Leonhardi et al (2008) also conducted a study on their hospital's experiences after implementing a CSII policy. The article describes the written guidelines used for management of CSII in the hospital, including contraindications for continued insulin pump use in the hospital, a set of rules to guide medical staff about insulin pump management, and a required signed informed consent form that details the use of CSII therapy while in the hospital. Nearly two-thirds of patients were able to continue CSII therapy following admission and the overall compliance with the insulin pump policy was high (Leonhardi et al, 2008).

The American Diabetes Association (2009) lists several factors that should be considered in self-management of diabetes within the hospital setting:

- Diabetes self-management within the hospital setting may be appropriate for adult patients who have a stable level of consciousness, have stable daily insulin requirements, and successfully conduct self-management of their diabetes at home
- Furthermore, the patient, nursing staff, and physician must agree that the patient's self-management is appropriate under the conditions of hospitalisation.
- While people are conducting self-management of their diabetes in the hospital setting, it is important that the basal, prandial, and correction bolus doses of insulin and results of glucose monitoring are recorded as part of the patient's medical record.

**Table 1. Pre-test and post-test correct responses per question.**

| Question no. | Pre-test | Post-test |
|---|---|---|
| 1. | 91% | 82% |
| 2. | 9% | 46% |
| 3. | 91% | 64% |
| 4. | 64% | 73% |
| 5. | 46% | 46% |
| 6. | 27% | 46% |
| 7. | 55% | 91% |
| 8. | 100% | 91% |
| 9. | 55% | 73% |
| 10. | 9% | 36% |
| 11. | 18% | 64% |
| 12. | 18% | 73% |
| 13. | 64% | 73% |
| 14. | 73% | 64% |

(Questions can be seen in *Appendix 1*)

## Methodology

A quasiexperimental one-group (pre-test/post-test) design was used for collection of data. This design was chosen because the subjects of this research study were not randomly assigned to treatment or control groups; therefore, a true experiment was not possible.

Due to the rising number of people using CSII therapy and the unavailability of resources for nurses caring for these patients in acute care and surgical settings, the educational needs of a population of nurses in the perioperative area at this healthcare facility were evaluated.

Institutional review board approval was obtained through the University of North Alabama. Administrative approval was obtained through the director of patient care services at the healthcare facility.

A quota sample was used to ensure that proportional segments of the population were included in the sample. The population upon which the sample was based consisted of 25 registered nurses working in the ambulatory surgery area and nine registered nurses working in the post-anaesthesia care unit (PACU). Participants who were interested in participating were contacted via email.

The study was explained in detail, as well as the purpose of the study, and the legal and ethical rights of the participants. Study participants were informed that they would be allowed to withdraw from the study at any time. Participants were informed that all information obtained in the study will remain confidential and will be stored in a locked

cabinet for a period of 7 years. Each participant signed an informed consent form and was given a copy. There were a total of 11 participants, representing approximately one third of the nurses in each perioperative area ambulatory surgery (*n*=8) and PACU (*n*=3).

Permission was obtained to use a continuing education questionnaire (*Appendix 1*) from an article published in the *American Journal of Nursing* (Savinetti-Rose and Bolmer, 1997). The questions were based on dietary guidelines, perioperative management of hyperglycaemia and hypoglycaemia using CSII therapy and caring for people using CSII.

The questionnaire was uploaded to an online survey website. The participants were emailed a link to the online survey and asked to take the pre-test version of the questionnaire. After a period of 2 weeks the pre-test survey was closed. At this time the participants were emailed a PowerPoint presentation. The participants were given 1 week to review the educational information. After this week, the post-test questionnaire was emailed to the participants, who were asked to not use the presentation when taking the post-test survey. The post-test questionnaire was an exact duplicate of the pre-test questionnaire.

## Findings

A group of 11 nurses from the perioperative area at the healthcare facility completed both the pre-test and post-test questionnaires. The mean score on the pre-test was 60% (SD=15.62). The median score was 64% and the mode was also 64%. The range was 36–86%. The results of the post-test showed some improvement with a mean score of 70% (SD=18.33). The median score 79% and the mode was 50%. The range was 43–93%. *Figure 1* represents a comparison between the overall percentages of correct responses based upon the number of participants.

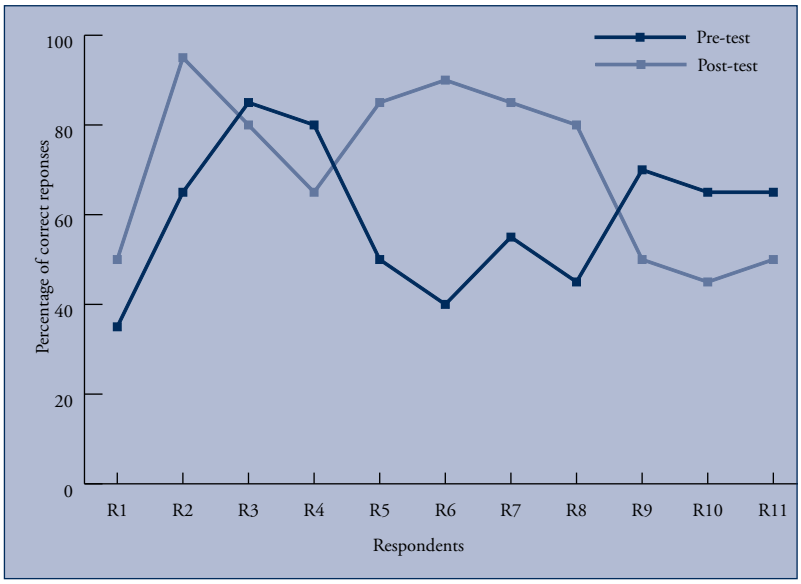


***Figure 1 Comparison of pre-test and post-test overall percentage of correct responses***

The data can be further analysed by individual question. *Table 1* represents a comparison between the pre-test and post-test of the percentage of correct responses per question. For example, 91% of the participants answered question one correctly on the pre-test, while only 82% of the participants answered the same question correctly on the post-test.

When reviewing the results of the post-test, nine of the 14 questions yielded a higher percentage of correct responses when compared with the pre-test. Four questions had a lower number of correct responses on the post-test when compared with the pre-test. There was also one question that yielded no change in the percentage of correct responses when comparing the pre-test and post-test.

Further statistical analysis of the data was performed including an analysis of variance (ANOVA) test, a paired t-test, and Pearson's correlation. The ANOVA test was used to

**Table 2. Results of analysis of variance (ANOVA) test.**

| | Sum of squares | df | Mean square | Fisher F-value | Significance |
|---|---|---|---|---|---|
| Between groups | 550.000 | 1 | 555.000 | 1.940 | 0.179 |
| Within groups | 5670.289 | 20 | 283.514 | | |
| Total | 6220.289 | 21 | | | |

**Appendix 1. Continuous subcutaneous insulin infusion therapy questionnaire (Savinetti-Rose and Bolmer, 1997).**

*After reading each statement, please mark the correct answer. There is only one correct answer per question.*

1. Which of the following statements about continuous subcutaneous insulin infusion (CSII) therapy is true?
   a) It has only been available commercially for the past eight years.
   b) It has been unpopular with patients because it demands such strict adherence to meal schedules.
   c) It provides regular, intermittent boluses of insulin throughout the fasting state.
   d) It has been shown to be more effective than multiple daily injection (MDI) therapy in controlling blood glucose.

2. How often should an insulin pump's infusion set and insertion site be changed?
   a) Every 6 to 12 hours. b) Every 24 to 36 hours. c) Every 60 to 72 hours. d) Every week

3. The basal rate delivered by an insulin pump is:
   a) The amount of insulin given while the patient is asleep and cannot monitor his insulin requirements.
   b) The amount of insulin to be given just before mealtimes.
   c) The sum total of the patient's 24-hour insulin needs.
   d) The amount of insulin to be given continuously during a 24-hour period.

4. Jeanne Singer, age 35, was diagnosed with type 1 diabetes 4 years ago but has never achieved good glycaemic control despite repeated changes in her MDI regimen. She finally agreed to try CSII. Her initial basal rate is 0.8 units/hour of regular insulin, but she has always had early-morning hyperglycaemia due to the dawn phenomenon. Which of the following is her physician most likely to prescribe to correct that situation?
   a) Dropping her basal rate to 0.6 units/hour from 2 am to 8 am.
   b) Programming an 8-unit bolus for 4 am each morning.
   c) Raising her basal rate to 1.2 units/hour from 2 am to 8 am.
   d) Programming a 10-unit bolus for 9 am each morning.

5. Ms Singer weighs 61.4 kg and usually consumes about 42 g of carbohydrates at lunch, which she eats every day at noon. An appropriate preprandial bolus of insulin programmed to be given at 11:30 am daily would be:
   a) 1 unit. b) 3 units. c) 2 units. d) 4 units.

6. Of the following types of insulin, which is most commonly prescribed for use with insulin pumps?
   a) NPH b) Ultralente c) Lispro (Humalog) d) Regular

7. After an adjustment period of several weeks, Ms Singer finally achieves good glycaemic control. She is admitted to your gynaecology surgery unit for an exploratory laparotomy, possible excision of several large endometriomas, and possible tubal plasty. As the nurse caring for her, you would be expected to do all the following except:
   a) Report any problems with the pump's operation.
   b) Monitor and document her blood glucose levels.
   c) Notify her physician of any changes in her condition postoperatively that might leave her unable to operate the pump.
   d) Reprogram her insulin pump according to her postoperative insulin orders.

*Continued overleaf…*

evaluate the differences between the two groups across testing times. The results of this test are presented in *Table 2*.

The paired t-test was used to determine whether the two group means are different. In other words, it tests whether the mean scores are more different that would be expected by chance (LoBiondo-Wood and Haber, 2006). The two-tailed *P* value equals 0.2186, which according to conventional criteria is not statistically significant. There is a 95% confidence interval for the two groups.

A Pearson r test was also conducted to determine the relationship between the pre-test

**Appendix 1. Continuous subcutaneous insulin infusion therapy questionnaire (Savinetti-Rose and Bolmer, 1997).**

8. You obtain a blood glucose reading of 40 mg/dL (2.2 mmol/L) for Ms Singer on her first postoperative day. Which of the following should you do first?
   a) Recheck her blood glucose to confirm hypoglycaemia.
   b) Give her glucose tablets by mouth.
   c) Perform a urine ketone test.
   d) Administer an injection of glucagon.

9. Ms Singer has a blood glucose reading of 270 mg/dL (14.98 mmol/L) on her second postoperative day. Concerned that she might be developing diabetic ketoacidosis, you first:
   a) Activate the pump's suspend mode.
   b) Perform a urine ketone test.
   c) Reprogram her pump, increasing her basal insulin rate to at least 4 units/hour.
   d) Remove the pump and resume her previous MDI regimen.

10. You notify the physician of the rise in Ms Singer's blood glucose and he prescribes an increased basal rate. One hour later, the reading is 290 mg/dL (16.1 mmol/L). Her vital signs are stable and she has developed no postoperative complications. Your next step should be to:
    a) Replace the infusion set.
    b) Perform another blood glucose test to make sure it is accurate.
    c) Suggest that the physician order an even higher basal rate.
    d) Remove the pump and resume her previous MDI regimen.

11. About how much of the dietary starches and sugars we consume is converted to blood glucose?
    a) 20%–30%  b) 70%–80%  c) 50%–60%  d) 90%–100%

12. About how much of the dietary protein we consume is converted to blood glucose?
    a) 20%  b) 70%  c) 50%  d) 90%

13. Assuming that Ms Singer's blood glucose level is controlled adequately by the basal insulin rate in the fasting state, 2 hours after a meal her blood glucose level:
    a) Should not rise more than 40 mg/dL (2.2 mmol/L) and should return to normal 2–3 hours after eating.
    b) Should not rise more than 40 mg/dL (2.2 mmol/L) and should return to normal 4–5 hours after eating.
    c) Should not rise more than 60 mg/dL (3.3 mmol/L) and should return to normal 2–3 hours after eating.
    d) Should not rise more than 60 mg/dL (3.3 mmol/L) and should return to normal 4–5 hours after eating.

14. The insulin sensitivity factor for an adult with type 1 diabetes is:
    a) Between 10 and 15 g carbohydrate per unit of insulin.
    b) The ratio between the grams of carbohydrate he/she eats and the units of insulin he/she needs to use them.
    c) The same as his insulin-to-carbohydrate ratio.
    d) All of the above.

and post-test results. The resulting statistic is –0.157 with a value of zero indicating no predictive relationships.

## Discussion

The results of the pre-test provide evidence that there is a knowledge deficit related to caring for patients using CSII therapy. After self-directed education via an online PowerPoint presentation there was an increase in mean score. However, the mean score only increased by 10% and the mean score on the post-test was only 70%. In retrospect a self-directed learning activity was not the most

efficient means of teaching new information to the participants. Another consideration is the preferred learning style of the participants. A PowerPoint presentation only appeals to a visual learner. It was not taken into account that auditory and kinetic learners may also exist within the sample. Therefore, the results of the study could have been affected by the preferred learning style of the participants. In future research, a more comprehensive means of education would be beneficial to the participants. A presentation that occurs in small groups and appeals to all three types of learning could meet the learning needs of a larger population within the sample.

## Conclusion

This study has multiple limitations such as the sampling method, sample size, and reliability of the instruments. The lack of randomisation and a control group is a threat to the internal validity of the study. This study only presented a minute percentage of the overall population of nurses at the hospital. With the inevitability of healthcare workers caring for people who use CSII therapy, the need for multidisciplinary education and development of resources is apparent.

Therefore, the development of an educational plan that includes an educational needs assessment, outlines the management of patients using CSII therapy, and includes multiple modes of dissemination is imperative to ensuring that patients using CSII therapy receive the highest degree of safe, quality care. ■

American Association of Diabetes Educators (2009) *AADE Position Statement: Continuous Subcutaneous Insulin Therapy Using a Pump*. AADE, Chicago, USA. Available at: http://bit.ly/y5B7hk (accessed 25.01.12)

American Diabetes Association (2009) Standards of medical care in diabetes. *Diabetes Care* **32**: 1–49

Bailon RM, Partlow BJ, Miller-Cage V et al (2009) Continuous subcutaneous insulin infusion (insulin pump) therapy can be safely used in the hospital in select patients. *Endocr Pract* **15**: 24–9

Centers for Disease Control and Prevention (2010) *FastStats: Inpatient Surgery*. CDC, Atlanta, USA. Available at: http://1.usa.gov/x9XYC4 (accessed 25.01.12)

Cook CB (2009) Are two insulin pumps better than one? Available at: http://1.usa.gov/wstewR (accessed 25.01.12)

Grunberger G, Bailey TS, Cohen AJ et al (2010) Statement by the American Association of Clinical Endocrinologists Consensus Panel on insulin pump management. *Endocr Pract* **16**: 746–62

Lee S, Im R, Magbual R (2004) Current perspectives on the use of continuous subcutaneous insulin infusion in the acute care setting and overview of therapy. *Crit Care Nurs Q* **27**: 172–84

Leonhardi BJ, Boyle ME, Beer KA et al (2008) Use of continuous subcutaneous insulin infusion (insulin pump) therapy in the hospital: a review of one institution's experience. *J Diabetes Sci Technol* **2**: 948–62

LoBiondo-Wood G, Haber J (2006) *Nursing Research Methods and Critical Appraisal for Evidence-Based Practice*. 6th edn. Mosby, St Louis

Marks JB (2003) Perioperative management of diabetes. *Am Fam Physician* **67**: 93–100

Pickup J (2011) Insulin pumps. *Int J Clin Pract* **65**: 16–9

Savinetti-Rose B, Bolmer L (1997) Understanding continuous subcutaneous insulin infusion therapy. *Am J Nurs* **97**: 42–9

Scheiner G, Sobel RJ, Smith DE et al (2008) Insulin pump therapy: guidelines for successful outcomes. *Diabetes Educ* **35**: 29S–41S