Advances in the Application and Nursing Care of Insulin Pumps (Postprint)

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Abstract

Objective: To investigate whether insulin pumps can achieve better glycemic control and delay the onset of diabetic complications, thereby providing evidence for clinical nursing. Methods: Through literature search, it was found that the insulin pump is an artificial intelligence-controlled infusion device that can simulate the characteristics of physiological insulin secretion, and its efficacy in glycemic control has been confirmed by numerous studies. During treatment, patients were provided with comprehensive nursing care, and its effects were analyzed. Results: Through seven daily blood glucose monitoring sessions and assessment of dietary status, timely adjustments were made to the preprandial bolus doses and basal rates of the insulin pump, resulting in better glycemic control, reduced incidence of hypoglycemia and complications, and improved quality of life. Conclusion: The insulin pump is an effective method for diabetes treatment. Combined with comprehensive nursing intervention, it holds significant importance in clinical practice and has become the preferred approach for diabetes management.

Full Text

Preamble

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Application and Nursing Research Progress of Insulin Pump

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Abstract

Objective: To demonstrate that insulin pump therapy can effectively control blood glucose and delay the onset of diabetic complications, thereby providing evidence for clinical nursing practice. **Methods:** Through literature review, we identified that the insulin pump is an artificial intelligence-controlled infusion device that simulates physiological insulin secretion patterns, with its efficacy in glycemic control confirmed by numerous studies. During treatment, patients received comprehensive nursing care, and the outcomes were analyzed. **Results:** By monitoring blood glucose seven times daily and assessing dietary intake, we timely adjusted the pre-meal bolus and basal insulin delivery, resulting in improved glycemic control, reduced incidence of hypoglycemia and complications, and enhanced quality of life. **Conclusion:** Insulin pump therapy is an effective treatment for diabetes mellitus. Combined with comprehensive nursing intervention, it holds significant clinical importance and has become the preferred treatment approach.

Keywords: insulin pump; diabetes mellitus; nursing research

Insulin pumps can provide continuous basal insulin and pre-meal bolus insulin, with the ability to adjust infusion rates according to each patient' s blood glucose variations throughout different time periods. Simultaneously, they can reduce the probability of diabetic complications, thereby improving treatment compliance and patient satisfaction [1-2].

1 Working Principle of Insulin Pump

The device consists of a pump, syringe, and infusion tubing. Insulin solution is drawn into the syringe, which is then loaded into the pump and connected to the infusion tubing. The needle at the front end of the tubing is inserted subcutaneously. A battery-driven screw rod in the insulin pump pushes the syringe plunger, continuously delivering insulin subcutaneously according to the body' s required dosage, thereby achieving glycemic control.

2 Application Status of Insulin Pump in China

Insulin pumps have been widely used in China. Their compact size, portability, simple operation, and accurate dose adjustment have gradually led to acceptance of this delivery method among Chinese healthcare professionals [3].

3 Advantages of Intensive Insulin Pump Therapy for Diabetes

The primary harm of diabetes stems from its complications. Insulin pump therapy enables strict glycemic control, reducing the incidence of complications,

saving substantial costs associated with treating diabetic complications, improving patients' quality of life, and enhancing prognosis. Additionally, it avoids the pain associated with multiple daily insulin injections. This delivery method also lowers glycated hemoglobin levels, simplifies treatment protocols, and yields satisfactory therapeutic outcomes [4].

4 Nursing Care for Insulin Pump

Rational and correct use of insulin pumps can improve insulin resistance, achieve good glycemic control, and reduce complications. However, we must strengthen nursing care to ensure safe use of insulin pumps, shorten treatment duration, and improve patients' quality of life [5].

4.1.1 Psychological Nursing

For diabetic patients, the insulin pump is a novel glucose control device that may seem unfamiliar and generate numerous concerns, particularly among elderly patients. Common worries include whether wearing the device will affect daily life, cause physical discomfort or hypoglycemia, and how to handle pump malfunctions. To address these concerns, nurses should patiently listen to patients' questions, provide thorough answers, explain the safety, advantages, and convenience of intensive therapy with insulin pumps—including the elimination of painful multiple daily injections—provide relevant materials, and alleviate fear and anxiety to promote better treatment cooperation [6].

4.1.2 Health Education

Before insulin pump installation, patients should understand the purpose, procedural steps, expected outcomes, and necessity of insulin pump therapy. Nurses should explain post-installation precautions and emergency handling of pump alarms to eliminate concerns and secure patient cooperation.

4.1.3 Preparation of Insulin and Equipment

Insulin should be removed from the refrigerator in advance and allowed to reach near-room temperature before use, with careful checking of expiration dates and types. Insulin pump devices matching the pump model should be selected. First, set the date and time, then draw the insulin solution, connect the infusion tubing, and purge all air from the tubing. Adjust the basal rate according to medical orders and set it for standby use [7]. Finally, recheck that the pump battery is sufficiently charged, tubing connections are secure, and the time and date settings are correct.

4.1.4 Installation and Injection Site Preparation

During insulin pump installation, assist the patient in assuming a supine or seated position. The abdomen around the navel is typically selected as the infu-

sion site, avoiding areas with indurations, trauma, or scabs. Infusion sites susceptible to compression, such as around the waistband, should also be avoided to minimize the impact of patient movement on insulin delivery [8]. After cleaning the site with alcohol swabs twice and allowing it to dry, insert the needle perpendicularly, secure it with sterile transparent dressing, place the insulin pump in a pocket or fix it to a waistband with appropriate tightness, and finally verify that the pump is functioning normally.

4.2.1 Close Monitoring of Blood Glucose

As an important method for intensive diabetes treatment, insulin pumps can stabilize blood glucose control. Healthcare personnel should measure and record blood glucose seven times daily: before three meals, after three meals, and at bedtime. If hyperglycemia or hypoglycemia is detected, physicians should be notified immediately for timely management. Based on glucose levels, basal rates or pre-meal boluses should be promptly adjusted according to medical orders to ensure stable glycemic control [9].

4.2.2 Management While Wearing the Pump

Healthcare personnel should instruct patients to promptly call the nurse on duty if the insulin pump makes abnormal sounds, and to seek nursing assistance for separation and simple handling before undergoing special examinations such as MRI or CT [10]. To ensure proper insulin absorption, infusion sites should be changed weekly. During pump wear, observe for insulin leakage, needle blockage, or dislodgement, and address any issues promptly.

4.2.3 Strict Handover and Inspection System

Handover should be conducted twice daily, including pump operation and infusion status, remaining insulin and battery levels, presence of redness, induration, exudate, or pain at infusion sites, needle dislodgement, dressing loosening or curling, and any alarm conditions. Any issues should be promptly addressed and documented. Elderly patients and pregnant women require focused handover and timely documentation.

4.2.4 Nursing for Common Problems in Insulin Pump Use

4.2.4.1 Hypoglycemia Hypoglycemia can also occur with insulin pump use, primarily related to incorrect infusion timing or dosage, increased patient activity, reduced food intake, alcohol consumption, and other factors [11]. When blood glucose falls below 5 mmol/L, patients should immediately consume sugar cubes or glucose solution, and insulin dosage should be adjusted according to medical orders. For self-care-capable patients, instruct them to carry candy when going out for emergencies.

4.2.4.2 Abnormal Hyperglycemia Pump-related factors include: (1) tubing blockage or leakage. If hyperglycemia results from poor absorption at the infusion site or device, simply replace the infusion set and site. If air bubbles block the tubing, promptly purge air from the device or tubing. (2) Expired insulin or high environmental temperature requires replacing with new insulin. (3) Program errors necessitate resetting according to medical orders and reinstallation. Patients with hyperglycemia symptoms should receive insulin through alternative routes immediately [12].

4.2.4.3 Infusion Obstruction This is a common cause of pump alarms. If blockage occurs in the infusion set or tubing, tubing is kinked or bent, or insulin absorption at the infusion site is poor, the cause must be promptly identified and addressed. Healthcare personnel should frequently check pump operation and function.

4.2.4.4 Skin Infection The most common causes include failure to regularly change infusion sites, non-standard aseptic technique, and patient allergy to adhesive tape or dressings, manifesting as skin redness, itching, and pain [13]. These issues require prompt attention, with regular site changes. For allergic patients, apply disinfectant and antimicrobial agents.

4.2.4.5 Pain or Irritation at Infusion Site This primarily results from infrequent site changes (sites should be changed weekly), non-standard aseptic technique (strict aseptic operation required before each installation), and patient allergy to sterile dressings or adhesive tape (can be mitigated with hypoallergenic tape).

For most diabetic patients, using insulin pumps for glycemic control is essential, playing an important role in restoring pancreatic β-cell function and preventing diabetic complications. Clinical data demonstrate that insulin pumps are widely used clinically; however, there is no unified standard for treatment and management. Diabetes specialist nurses and physicians must continue to explore how to better standardize insulin pump therapy and management for diabetic patients, establishing standardized treatment and management models to improve insulin pump utilization rates and better serve diabetic patients, thereby enhancing their quality of life [14].

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Note: Figure translations are in progress. See original paper for figures.