The Development of a Self-directed Learning Module for Rural Emergency Nurses On Pediatric Diabetic Ketoacidosis

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Abstract

Background: Newfoundland and Labrador has a high incidence of type 1 diabetes and diabetic ketoacidosis (DKA) is a complication of type 1 diabetes. A clinical practice guideline was developed for the treatment of pediatric diabetic ketoacidosis (DKA) to standardize care in all Emergency Departments and improve patient outcomes. Rural emergency nurses are requires to maintain their competency and acquire new knowledge as stated by the Association of Registered Nurses of Newfoundland and Labrador (ARNNL). **Purpose:** The purpose of this practicum was to develop a self-learning module for rural emergency nurses to increase their knowledge and understanding of the clinical practise guideline to assess, treat, and prevent pediatric ketoacidosis. **Methods:** Two methodologies were used in this practicum. A review of the literature and consultations with key stakeholders were completed. **Results:** The self-learning module created was composed of three units and focused on the learning needs of rural emergency nurses in the areas of assessment, treatment, and prevention of pediatric DKA. **Conclusion:** The goal of the practicum was to increase rural emergency nurses' knowledge and implementation of the clinical practice guideline when assessing and treating children and families experiencing DKA to improve patient outcomes. A planned evaluation of the self-learning module will be conducted following dissemination of the module throughout the rural Emergency Departments.

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Development of a Self-directed Learning Module for Rural Emergency Nurses on Pediatric Diabetic Ketoacidosis

According to the Association of Registered Nurses of Newfoundland and Labrador's standards for nursing practice (2013) patients are best served when nurses continually enhance knowledge, skill, and judgement. Nurses working in rural emergencies are challenged with maintaining continuing education competency for a large age range of patients facing various life threatening illnesses. Due to financial restriction on education by the employer, nurses are responsible to fulfill education needs on their own time. In my experience, pediatric emergencies are often cited by rural nurses as an area where experience and education are needed.

Type 1 diabetes is the most common form of diabetes in children and the Avalon Peninsula of Newfoundland has one of the highest incidences of type 1 diabetes reported worldwide (Newhook et al., 2004). A complication associated with diabetes is DKA, which is a life threatening condition caused by elevated blood sugars resulting in production of an acid called ketone in the blood. DKA is a leading cause of hospitalization and the leading cause of death and morbidity among children with type 1 diabetes (Alaghehbandan et al., 2006). However, DKA is a preventable condition (Jackman et al., 2015; Glaser et al., 2001; Edge et al., 2012; Tieder et al., 2013). Educating nurses is an important step in reducing the incidence of DKA. When nurses are knowledgeable on the prevention, diagnosis, and treatment of DKA they apply best practice guidelines and contribute to improved patient outcomes.

In the spring of 2013 Dr. Leanne Newhook distributed a resource binder on pediatric DKA funded by the Public Health Agency of Canada. The campaign's purpose was to develop guidelines for the management of pediatric DKA for health care professionals working in Emergency Departments. I have a personal interest in type 1 diabetes so I reviewed the binder contents. I was surprised to find that most of my colleges were not aware of the binder's existence. I felt that the binder provided valuable information for nurses when faced with caring for a child with DKA and early detection of type 1 diabetes. Therefore, for my practicum project I created a self-learning module for nurses tailored to their learning needs on the diagnosis, treatment, and prevention of DKA supported by a strong dissemination plan to ensure nurses avail of the module.

Background

The practicum setting was Placentia Health Center's Emergency Department in Placentia, Newfoundland. The emergency has three beds. The staff consists of two RNs, one responsible for the ER and the other for ten acute care beds. However, the nurses work together and share responsibilities. There is a physician, usually a general practitioner, on call 24 hours a day but physicians do not stay in the building after clinic hours and are called in when needed. The RN is responsible to triage patients on arrival, report assessment to the physician, and initiate investigations and treatments. Critical patients are stabilized and transferred to a tertiary hospital, usually in St. John's. The ER RN usually accompanies the patient on transfer via ambulance if no other staff is available. It is crucial that RNs are knowledgeable in pediatric assessment.

Rational

The rationale for developing this module is that the Avalon Peninsula in Newfoundland appears to have the highest incidence of childhood type 1 diabetes worldwide (Newhook et al., 2004). DKA is the result of complete omission of insulin or lack of insulin and is the leading cause of death in children with type 1 diabetes (PHAC, 2011). Omission of insulin or treatment error is the leading causes of recurrent DKA (Barrios et al., 2012; Merkley, 2004). A Janeway chart review by Jackman et al. (2015) between 2007-2011 showed that there were 90 cases of DKA admitted to the Janeway hospital. About 60% of the cases occurred in existing diabetes patients and 40% were in patients with a new diagnosis of type 1 diabetes. Several of the children with a new diagnosis were delayed or missed, especially children less than five years old. These children presented with more severe symptoms and acidosis. Educational interventions, such as a module for rural emergency nurses on pediatric diabetic ketoacidosis, can potentially reduce morbidity and mortality of patients with DKA (King et al., 2012; Rewers, 2012). Reducing the incidence of DKA and minimizing effects of DKA will prevent extensive treatment and hospitalization, thus reducing healthcare costs and improving the lives of children with type 1 diabetes.

Goals and Objectives

The overall goal of this practicum was to increase rural emergency nurses` knowledge of the diagnosis, treatment, and prevention of pediatric DKA. Knowledge and application of the clinical practice guidelines for DKA will provide patients with consistent evidence based care that will improve patient outcomes.

The objectives addressed in this practicum were:

1) To conduct a literature review on the educational needs of RNs for pediatric DKA, including incidence and prevalence of type 1 diabetes and DKA, treatment of DKA and complications, and implications for nursing.
2) To complete consultations with key stakeholders. Staff nurses, senior and junior, site manager, clinical nurse specialists, clinical educators, and an Endocrinologist were consulted to select module content, best methods for dissemination, and provide feedback throughout the development phase.
3) To develop a self-learning module for rural emergency nurses on pediatric DKA based on data collected from the literature review and consultation with healthcare professionals and parents of children with type 1 diabetes.
4) To demonstrate advanced nursing practice competencies through development of a pediatric DKA module.

Overview of the Methodologies

To achieve the objectives of the practicum two methodologies were implemented. The two methodologies were a review of the literature and consultation with key stakeholders. Each methodology is summarized in the following sections of the report.

Summary of the Literature

Literature Review Methodology

An extensive literature review has been conducted to examine the need for diabetic ketoacidosis (DKA) guideline education for nurses. Several databases were

explored including CINAHL and PubMed. These sites were accessed via Memorial University of Newfoundland's online library. The search was limited to include articles from 2005 to the present, written in the English language, developed with a research design, and had a PDF file available. Key words and topics searched were *diabetic ketoacidosis (DKA), nurse's knowledge, guidelines, Type 1 Diabetes, treatment,* and *self-learning module*. Literature was also collected from government data bases, pediatric text books, and agencies, such as Canadian Diabetes Association. The search resulted in the development of several themes such as: incidence and prevalence of type 1 diabetes and pediatric DKA, treatment and complications of DKA, risk factors associated with DKA, implication for nursing practice, theories, and the role of self-learning module for nurses. The complete literature review is found in Appendix A.

Incidence and Prevalence of type 1 diabetes and DKA

To determine if development of a module on pediatric DKA was necessary a literature search was conducted to see if DKA was a prevalent issue with the pediatric population. Studies showed that type 1 diabetes is the most common form of diabetes in children (Newhook et al., 2004). The incidence of type 1 diabetes increased at a steady rate from 1987 to 2012 (Newhook et al., 2004: Newhook et al., 2008; Newhook, Penny, Fiander, and Dowden, 2012). The Avalon Peninsula of Newfoundland has one of the highest incidences of type 1 diabetes worldwide. Eastern Health services this area; therefore, diabetes education is necessary for emergency nurses on diabetes and associated complications.

Studies show that the leading cause of hospitalization for children in Newfoundland and Labrador with type 1 diabetes is DKA (Alaghehbandan, Collins, Newhook, & Mac Donald, 2006). Between years 1995-2002 the hospitalization rate for DKA increased. Female gender and older age were predictive factors for DKA. DKA remains a leading cause of hospitalization and the leading cause of death and morbidity among children with type 1 diabetes. With the increase in prevalence of type 1 diabetes worldwide there is also an increase in DKA (Alaghehbandan et al., 2006).

Jackman et al. (2015) conducted a study in Newfoundland and Labrador of 90 children diagnosed with DKA from 2007 - 2011. Of the study sample 39.5% were newly diagnosed with type 1 diabetes and 60.5% were previously diagnosed. Almost half of the pre-existing diabetes cases were recurrent DKA (49.1%). Of the newly diagnosed patients with DKA, 64% had been seen by a physician prior to diagnosis (missed diagnosis).

Treatment and Complications of DKA

The best way to treat DKA is to follow evidence based care in the form of best practice guidelines. Guidelines for DKA were developed by The International Society for Pediatrics and Adolescent Diabetes (ISPAD) and presented in the form of an algorithm (Wolfsdorf et al., 2014). The literature was reviewed to investigate the management of pediatric patients with DKA presenting to ERs. Medical record examination showed that clinical practice guidelines are not being followed completely (Ferreri, 2007). Intravenous fluids and insulin interventions were not administered as suggested in the guidelines as treatment for pediatric DKA (Edge et al., 2012; Barrios et al., 2012; Ferreri, 2007). These

studies led to the recommendation of best ER practice management of pediatric DKA to include a specific DKA guideline/protocol and access to pediatric endocrinologist.

Ongoing work must be taken to make protocols available, support dissemination of information, and provide diabetic education to nurses working with pediatric patients in ER (Edge et al., 2012). Managers, clinical educators, and champions can provide the support needed to expose nurses to the information, provide ongoing support to implement the knowledge, and monitor the guideline use ensuring it becomes part of everyday practice (Beik, Anger, Forni, Bawa, & Szumita, 2013).

Cerebral edema. In most cases children experiencing DKA recover following treatment with insulin, intravenous fluids, and electrolyte replacement. However, cerebral edema, an infrequent complication, may develop resulting in death (Glaser & Kuppermann, 2004). Of the children that developed DKA 23% died from cerebral edema and 15% survive with neurological complications. DKA related cerebral edema accounts for 70% to 80% of diabetes related deaths in children under 12 years of age (Statistics Canada, 2008).

Most episodes of DKA cerebral edema will occur four to twelve hours after treatment has been initiated. Signs of developing cerebral edema include; headache, vomiting, altered level state of consciousness, decreased pain response, decorticate or decerebrate posturing, cranial nerve palsies, hypertension, bradycardia, and abnormal respiratory pattern (Metzger, 2010). One study showed that children presented with DKA at diagnosis of diabetes and the cerebral edema frequency was 0.68% (2/292 episodes of

DKA). Hypokalemia was significantly more common at onset of diabetes than in patients with established diabetes (Hanas, Lingren, & Lindblad, 2007).

Three variables were found in the literature to be associated with poor outcomes of children with DKA-related cerebral edema. These variables include an elevated initial BUN concentration, more profound neurologic depression at the time of diagnosis of cerebral edema, and intubation associated with hyperventilation (Marcin et al., 2002). Patient with DKA may present with dehydration. However, excessive use of fluids can place the patient at risk of developing cerebral edema. Fluid treatment was not consistent with current recommendations (Rutledge & Couch, 2000). Continuing education regarding fluid replacement for children with DKA is needed for ER health providers due to the risk of cerebral edema. The study results were applied to case studies to enhance nurses' understanding of the importance of proper and continuous patient assessment throughout diagnosis, treatment, and recovery period.

Risk Factors Associated with DKA

When triaging patients, insight into potential risk factors associated with DKA may help to guide assessment questions lending to early diagnosis and treatment of DKA. Studies show that more severe cases of DKA occurred in younger, newly diagnosed patients and recurrent DKA (Tieder et al., 2013). A new diagnosis of type 1 diabetes, interrupted insulin delivery in insulin pump therapy, and missed diagnosis of type 1 diabetes were the most common factors associated with DKA (Jackman et al., 2015; Pawlowicz, Birkholz, Niedzwiecki, & Balcerska, 2009; Szypowska & Skorka, 2011).

Most cases of DKA are preventable. Therefore, early detection and improved education for families and healthcare providers, especially those outside of pediatric centers, is needed to reduce missed diagnoses and eliminate DKA (Jackman et al., 2015). These studies support the use of a self-learning module among rural ER nurses to disseminate pediatric DKA clinical practice guidelines.

Fritsch et al. (2011) produced a study to determine the incidence and risk factors associated with pediatric DKA. The three groups were compared and patients with recurrent DKA were found to be older, have a higher HbA1c, and a higher insulin dose. DKA was also higher in females and patients with migration background. Jackman et al. (2015) found that the incidence of DKA was higher in females in Newfoundland and Labrador. Out of 90 children admitted to hospital with DKA in Newfoundland and Labrador from 2007 to 2011, 60% were female and 40% male. The study findings will be incorporated into the self-learning module to help nurses identify individuals who may be at high risk for developing DKA

Insulin pump use is a risk factor associated with DKA (Jackman et al., 2015). Reported causes of DKA were missed insulin dose, gastroenteritis, technical pump problems, infection, and social problems (Hanas, Lindgren, & Lindblad, 2009). The DKA frequency of insulin pump users was twice that of patients using injections. Patients using the insulin pump experienced more episodes of DKA within the first year of commencing pump use. Based on this study's results information regarding management of diabetes when ill with a virus or infection to avoid hyperglycemia should be included in the self-

learning module, emphasizing gastroenteritis and troubleshooting insulin pumps. (Maahs et al., 2014)

Implications for Nursing

The health care team, including nurses, plays an instrumental role in preventing, diagnosing, and treating DKA (Griffis et al., 2007). Efficient assessments, such as early diagnosis of type 1 diabetes, diabetes management, and education interventions for patients with pre-existing diabetes, can reduce episodes and severity of DKA (Fritsch et al., 2011). It is necessary for nurses to stay current in diabetes knowledge. This can be achieved by attending educational in-services or completing self-learning modules. Studies show that nurses' perceived knowledge is statistically significant when correlated with actual knowledge (Chan & Zang ,2007). The literature strongly suggests the use of education to address the knowledge gaps in best practice for patients with diabetes (Chan & Zang, 2007; Griffis et al., 2007; Haas, 2006; Manchester, 2008; Rubin, Moshang, & Jabbour, 2007; Hollis, Glaister, & Lapsley, 2014). These findings support provision of education that is tailored to the needs of nurses to maintain a standard of diabetes knowledge.

Studies lend support to using convenient methods of education delivery to busy nurses. Online education offers flexibility in accessing evidence-based research findings when caring for patients with diabetes (Young, 201 Griffis, Morrison, Beauvais, & Bellefountaine, 2007). The module will be available on the Eastern health Emergency homepage for easy access for nurses.

Role of Self-Learning Module

Online education meets the needs of busy self-directed adult learners (Ladell-Thomas, 2012; Wessel, Tannery, & Epstein, 2009). It is challenging to design and implement learning sessions for nurses due to restrictions established by Eastern Health for education leave. A self-directed learning module consists of clear objectives, well-structured content, a variety of authentic tasks to reinforce learning that is relevant and applicable to nurses' real life experiences (Cercone, 2008). Nursing research shows that self-learning tools are effective at increasing nurses' knowledge (Riley-Doucet, 2008; Lehr et al., 2005; Phillips et al., 2014). The self-learning manual is flexible and allowed nurses to review material at their own pace, which is important considering their busy work schedules.

Research has shown that there are many ways to support dissemination and implementation of CPG. These include education, leadership support, champions, facilitators, team work, advocates, and an interdisciplinary approach (Ploeg et al., 2007; Banait et al., 2003; Bekkering et al., 2005; Jain et al., 2006; Barrios et al., 2012; Bahtsevani , William, Stiltz, & Ostman, 2010). Posters and a webinar would make nurses aware that the module is located on the intranet. Working with site managers to select nurses that are strong leaders to act as site champions would ensure that the self- learning module is reviewed and applied. In addition, a short presentation on the module could be delivered on nursing education days.

Theories

Theories provide the framework for the processes used to evaluate, implement, and plan programs, such as developing education modalities for nurses (Mc Kenzie, Neiger, & Thackeray, 2013). Interventions that are based on theory have a greater success rate (McKenzie et al., 2013). Appropriate theories were reviewed to help develop the best plan to provide education to rural emergency nurses. To underpin the self-directed learning module Knowles' Adult Learning Theory, The Instructional Design Framework, and Family-centered Care were selected.

Knowles' adult learning theory. Knowles' Adult Learning Theory recognizes that the adult learner is an autonomous and self-directed learner, who is motivated to learn and incorporates choice and responsibility into the learning process. This theory is appropriate for educating nurses about pediatric DKA prevention, diagnosis, and treatment because it identifies the learners needs and focuses on self-directed learning.

The self-directed learning module content will incorporate Knowles' six elements of adult learning (as cited in Mitchell & Courtney, 2005): (1) a need to know; a review of current literature showed that a knowledge gap exists regarding nursing diabetes management and that pediatric DKA patients outcomes improve with use of clinical practice guidelines. This literature support will enable nurses to see that continuing education regarding diabetes care and implementation of clinical practice guidelines for treating diabetes emergencies, such as DKA, is essential. The self-learning module will focus only on the learning needs of the rural emergency nurse highlighting how to assess,

identify, treat, and prevent pediatric DKA. (2) a responsibility for ones' own learning; nurses are responsible for continuing learning to stay abreast of new technology and treatments offered to patients that avail of the emergency department's services. The Association for Registered Nurses of Newfoundland and Labrador requires nurses to obtain clinical competency hours to maintain licensure. Credit for completing the module will be provided toward clinical competency hours. The module will be self-directed and additional information will be provided via links to other on-line sources, (3) the role of experience as a tool for learning; case studies based on typical presentations and scenarios in the emergency department will be highlighted in the module allowing nurses to build upon existing knowledge and experience. Problem-based learning will be an important component of the module (4) the ability to apply information to one's life experiences and (5) applying problem centered care to real life problems; information regarding the incidence and prevalence of type 1 diabetes and complications will be included in the module. Reinforcing this information will enable nurses to relate the importance of learning about clinical practice guidelines to treat diabetes emergencies in their specific work site and community. Problem centered care will be highlighted through the use of case studies after each unit in the module to reinforce information discussed, and (6) motivation to learn; when lobbying to promote use of the module it will be reinforced that nurses are accountable for continuing education as outlined in the ARRNL's standards and the Canadian Nurses Code of Ethics. Emphasizing the high incidence of type 1 diabetes and the increased chance of caring for a child with DKA in a rural ER will motivate nurses to learn and use the clinical guidelines to provide the best care possible to patients. Research has shown that nurses want more education about diabetes. Addressing

elements one through five in the self-directed learning module will motivate nurses to learn and implement clinical practice guidelines and information in module.

Instructional design framework. The Instructional Design Framework (IDF) offers an outline for designing education lessons. IDF is appropriate to guide the development of the self-directed learning module (Kinzie, 2005). IDF consists of five stages: (1) gain attention; the self-directed learning module identifies risk factors associated with type 1 diabetes and pediatric DKA which are applied to case studies to illustrate main points, (2) present stimulus material; facts regarding type 1 diabetes and associated complications will be presented in the module. Supplementary material is provided to reinforce information assessment, diagnosis, and prevention of DKA. To assess nurse understanding of the material true and false questions, matching, and case studies were used (3) use models to demonstrate; the content covered in the module includes the clinical practice guidelines for DKA and insulin pump use for continuous insulin administration. The material is presented using DKA treatment guideline algorithm and pictures of insulin pump features, (4) elicit performance; vignettes highlight trouble shooting with insulin pumps and patients experiences with DKA, and (5) enhance retention; the content covered allows for application of knowledge of the clinical practice guidelines focusing on critical thinking and reflection. Material from all sections of the module is reviewed and tested using multiple choice questions and case studies.

Family-centered care. The Emergency Department site on the Eastern Health webpage states that patient and family centered care is an approach to the planning,

delivery, and evaluation of healthcare that focuses on partnership between patients, families, and healthcare workers. Family plays a vital role in ensuring the well-being of a patient. This concept underpins the philosophy of family centered care. The principles of family centered care include: dignity and respect, information sharing, participation, and collaboration. To communicate more effectively with patients and families healthcare workers have to show families that they care about them, understand their concerns, and that they can be trusted to take care of them (Eastern Health, 2015). Providing emotional support to families when children require treatment in an ER contributes to positive coping with children's medical problems (Hemmelgarn, Glisson, & Dukes, 2001). Nurses have a good understanding of family-centered care and a positive attitude toward the philosophy (Coyne et al., 2011; Trajkovski et al., 2012). However, research shows that a family centered approach is not always used by nurses (Uhl, Fisher, Docherty, & Brandon, 2013; Khalaila, 2014; Mikkelsen &Frederiksen, 2011). Each unit of the module has a section on family centered care which provides suggestions on ways to incorporate the philosophy.

Summary of Consultations

A total of ten consultations were conducted involving one novice nurse, one senior nurse, the PHC Nurse Manager, two parents of children with type 1 diabetes, an Endocrinologist, Diabetes Nurse Educator, Nurse Researcher, Clinical Nurse Specialist, and Clinical Educator. Data was collected by project developer by interview either in person or by telephone, limited to 30 minutes**.** All responses to questions made by consultants were transcribed into a table in a Microsoft Word document and organized by

question and analyzed for common themes between similar types of participants. Outliners were identified as well. The consultation report is available in Appendix B.

Consultation Results

Seven questions were asked in the interview process. Open-ended questions were used and clarification was given when requested by participants. Common themes were identified from the data collected was used as module content and to develop a dissemination plan. Consulting with healthcare workers and parents I learned that prevention education is important to reduce the incidence of DKA. It is important to develop and design the self-learning module based on the learning needs of rural nurses highlighting the needs of children/families with type 1 diabetes. The participants interviewed all supported the module development. At Placentia Health Center several nurses reported not reviewing the pediatric DKA binder. Therefore, additional interventions are needed to assist with dissemination of the DKA protocols/guidelines including ongoing support to ensure nurses avail of the information in the learning module. Providing practitioners with support during the implementation phase of clinical practice guidelines (CPG) is essential.

There were four themes that emerged from the interview data; content, design, dissemination plan, and support. The first theme contained data to include in the module. Some examples are vital signs, Glasgow Coma Scale, dehydration, monitoring for cerebral edema, and signs and symptoms of DKA. The second theme focused on the design of the module. Suggestions made by key informants included: electronic format, printable option, use of color, diagrams, point form, and quizzes with case studies. The

third theme provided feedback on the dissemination plan to promote the module. The consultation data included the use of posters, support from managers/champions, presentations on education days, and webinars. The last theme highlighted ways to provide support to nurses as they continue their education. Key informants suggested granting of continuing competency program hours, make education flexible and accessible, time to complete module at work (night shifts), and use of nursing champions. Support for families when seeking treatment in the ER for sick children with DKA was discussed. Proposed ways to provide family support included incorporating family centered care; develop relationship between parents and nurses based on trust, understanding, support, and partnership. The interviews provided useful data for module content and plans for dissemination of the module.

Development of Module

For this practicum, the project developed was a self-learning module for rural emergency nurses on pediatric DKA including three units. Each unit has the same designed format. The content in each unit is divided into sections, each section having a list of learning objectives that are addressed within the material presented. To make the material more visually appealing figures and tables were used. Textboxes highlighted important points within the main body of the content. Each unit ends with a section highlighting family-centered care, a conclusion, and review questions. Answers to the review questions are provided at the end of the module along with a list of additional recourses. The module can be found in Appendix C.

Unit one provides guidance on the key features of the patient assessment required for an accurate diagnosis of DKA. Definition of DKA and its pathophysiology were included to enhance nurses understanding of the condition to assistance with triage and physical assessment of a child with DKA. The signs and symptoms of dehydration, the vital signs, level of consciousness, and laboratory values were reviewed in this unit because the information collected through the assessment will determine the appropriate treatment.

Unit two focuses on the treatment of pediatric DKA and is divided into four sections. The clinical practice guidelines for treating pediatric DKA are reviewed containing the clinical guidelines adapted by the Janeway Children's Hospital from British Columbia's Children's Hospital DKA Tool Kit and International Society for Pediatric and Adolescent Diabetes (ISPAD) Pediatric DKA Guidelines (Wolfsdorf et al., 2014). Ongoing assessment is emphasized because throughout the treatment phase the child has to be monitored for their response to interventions and possible development of complications, such as cerebral edema. Intravenous fluids are discussed in section 2.2 and the focus is on the role of fluids in DKA treatment, types of fluids, methods for initiating IV access in children, and the guidelines for IV fluid administration for pediatric DKA. Section 2.3 focuses on insulin administration for the treatment of DKA including review of types of insulin, preparing an insulin infusion, and guidelines for administration. Cerebral edema is reviewed in detail in section 2.4 and it includes information from the literature on who is at risk for developing cerebral edema, the signs and symptoms, and the treatment.

The final unit, unit three focuses on the prevention and early detection of pediatric DKA. Research study findings are presented to show that many cases of DKA occur in children newly diagnosed with type 1 diabetes or recurrent episodes of DKA. Therefore, education for the detection of type 1 diabetes and methods of preventing DKA will be beneficial in reducing the incidences of DKA. The causes of hyperglycemia are reviewed and suggestions are made to prevent hyperglycemia. Insulin pump is defined and the benefits of its use are listed. Pictures are provided of the pump and pump supplies. Common problems associated with the insulin pump are discussed. Information is provided on prevention of hyperglycemia and DKA when children are sick, experiencing mental disorders, and transitioning through the development stage of adolescence.

Advanced Nursing Competencies

The Canadian Nurses Association (2008) lists four advanced nursing practice competencies. By developing a self-learning module to enhance rural emergency nurses' learning of pediatric DKA guidelines I have demonstrated the following competencies: clinical, research, leadership, consultation, and collaboration.

Clinical Competency

The clinical competency was demonstrated by working in conjunction with parents who care for children with type 1diabetes, healthcare team members, and rural emergency nurses, to develop a module based on comprehensive care which will support nurses as they learn and apply the DKA guidelines. Advanced assessment skills, intervention strategies, research literature, consultation data, and conceptual theories were used to develop the module content. Implementation of clinical practice guidelines for

DKA involved incorporating knowledge into practice. The module will assist rural emergency nurses in the understanding of the assessment, diagnosis, treatment, and prevention of pediatric DKA, thus improving the standard of care provided to children and their families.

Research Competency

According to The Canadian Nurses Association (2008) fulfillment of the research competency requires the generation, synthesis, and usage of research evidence. I demonstrated this competency by critically appraising research articles from the literature search conducted and basing the module content on significant research findings. Research evidence was used to support the clinical practice guidelines, module content, and the dissemination plan. Incorporating research into the module is an effective way to bring research evidence to nurses and integrate evidence based practice into the rural emergency department.

Leadership Competency

I have taken the initiative to continue my education and contribute to the education of my peers, in the hopes of improving the delivery of care to children experiencing type 1 diabetes complications. Developing a self-learning module demonstrates an innovative way to improve the rural emergency department's implementation of clinical practice guidelines. These actions demonstrate fulfillment of the leadership competency. I advocated for families caring for children with type 1 diabetes by ensuring they receive the best possible evidenced-based care. The self-directed module will be a resource for nurses as they diagnose, treat, and prevent DKA. I

have shown leadership skills by identifying a gap in nurses' education on pediatric DKA and responded by developing a module to fill the gap.

Consultation and Collaboration Competency

The final competency satisfied via the development of a self-learning module is consultation and collaboration. I consulted with several members of the healthcare team to gain support, collect data, and develop a dissemination plan for the module. I interviewed experts and families; their input was incorporated into the module design and content. Gaining support from all key stakeholders helped to develop a module that is beneficial to rural ER nurses and the patients they care for. Collaborating with my advisor throughout practicum has helped me to accept corrective criticism and strive to develop a module at an advanced level.

Next Steps

The final product at the end of this practicum was a self-learning module for rural emergency nurses consisting of three units covering diagnosis, treatment, and prevention of pediatric DKA. The next step is to conduct an evaluation of the module by key stakeholders, primarily the RNs in rural emergencies. Feedback will be used to modify the module. The evaluation plan requires development. Possible evaluation for the module could involve informal interviews with nurses that complete the module. Access to nurses who complete the module can be obtained when they request their competency hour verification either through site manager or clinical educator.

Throughout the module development stage I utilized two of my coworkers to proof read and provide feedback on module content and design. Both felt that the module content included valuable information and that the module would be a useful resource for

nurses. Typing errors, spelling errors, sentence clarity, and module design was corrected and modified based on my peers' feedback.

The initial plan of the dissemination process was to distribute the module on the Eastern Health Emergency Website for easy access for nurses. Before this can be achieved, the module must be reviewed and approved by the Regional Program Coordinator and the Regional Program Director.

An important part of education programs is the plan of delivery. Consideration has to be given to how the following questions. How are nurses going to hear about the module? Who is going to support and encourage the modules use? Who is going to answer questions that nurses may have after reading the module? The suggested dissemination plan includes distribution of posters to each ER site notifying the location of the module on the intranet. A brief power point presentation can be given on the module at RN education days and conferences. Managers and Clinical Educators can provide active ongoing support for the use of clinical practice guidelines, work with nursing staff to select appropriate nurse champions to promote the use of the module, and follow up to identify if clinical practice guidelines are being utilized appropriately in their department.

It is essential to develop, disseminate, and provide ongoing support for the module using creative methods to ensure the education reaches nurses and benefits patients. Seeking input from stakeholders on how to develop and disseminate the module will help make the implementation process a success.

Conclusion

Working on developing outputs for N6660 and N6661 I learned that there is a need for a self-learning module for nurses on pediatric DKA and that it was important to develop it using knowledge from previous courses and data gathered through the literature review and consultations. However, having a strong dissemination plan is equally important. Ensuring that the module is available to and used by nurses will require ongoing support and follow up. Education modules for nurses have to consider adult learning styles. Therefore, the Knowles 'Adult Learning Theory, Instructional Design Framework, and Family Centered Care underpinned the module.

The goals and objectives for this practicum were met. I have completed the literature review, consultation with key stakeholders, the self-learning module on pediatric DKA, and advanced nursing competencies application. Throughout the practicum my learning has been exponential, primarily in the area of computer skills and module design. I have increased my knowledge of the clinical practice guidelines for treating pediatric DKA and plan to act as a champion to share my knowledge with my peers and encourage their use of the module.

The practicum experience has taught me how to collaboration and network with key stakeholders to learn from their expertise in the area of pediatric DKA and experience with developing and disseminating education to nurses. Conducting interviews over the summer months was challenging because it was difficult to connect with individuals due to summer holidays. Therefore, telephone interviews were used.

The main theme I will take away from the practicum experience is that parents expected nurses to know the clinical practice guidelines for the treatment of DKA. My

hope is that this module will fulfill parent's expectations and all nurses in rural emergency departments will take the time to review the module. In addition, the module will effectively increase nurses' knowledge and confidence when caring for children and their families experiencing DKA and deliver evidence-based care in a professional, caring way.

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Appendix A: Literature Review

Understanding Pediatric Diabetic ketoacidosis: Literature Review

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Abstract

The literature reports that Newfoundland and Labrador has a high incidence of type 1 diabetes and a high hospital admission rate for pediatric diabetic ketoacidosis. Rural emergency nurses require support through education for management for pediatric emergencies because they do not have a Pediatric Physician, Endocrinologists, or Nurse Educator on site. Nurses will benefit from a reference guide that will assist with stabilization and transportation of the patient to the Janeway Hospital. In response to the learning needs of rural emergency nurses and to fulfill nurses' obligation to continue education as outlines in the Canadian Nurses Association Code of Ethics and the Association of Registered Nurses of Newfoundland and Labrador's Standards of Practice, information collected from the literature review will be compiled into a self-directed learning module. The module will be tailored to the needs of rural emergency nurses including information on triaging, assessing, treating DKA, and patient/family education regarding prevention of DKA. A self-learning module was chosen to provide flexibility to nurses, accommodate busy work schedules, and compensate for lack of continuing education sessions provided by the employer. The module will be based on Knowles' Adult Learning Theory and Instructional Design Framework.

Understanding Pediatric Diabetic Ketoacidosis: A Literature Review

Nurses that work in rural emergency department care for a wide range of patients; the elderly, adults, children, and infants. In this work environment it is challenging to remain proficient in necessary nursing skills due to the large range of patient ages and the special needs per age group. Pediatric emergencies are not an everyday occurrence in rural emergency departments. Therefore, it is imperative for nurses to avail of continuing education opportunities which can help them stay competent in skills required to treat life threatening medical crises when they arise. One situation where pediatric patients require urgent care that is guided by clinical practice guidelines is diabetic ketoacidosis. Newfoundland and Labrador has a high rate of type 1 diabetes and insulin pump use. Hence, it is possible that nurses working in rural emergency departments will care for a pediatric patient with type 1 diabetes experiencing DKA.

In 2013 Dr. Leigh Anne Newhook developed the Newfoundland and Labrador Pediatric DKA Project to promote early detection of type 1 diabetes, prevent DKA, and provide education to healthcare workers around the clinical practice guidelines for treating DKA. To reinforce and assist with dissemination of the information provided in this binder I will develop a self-learning module tailored to the needs of rural emergency nurses to increase their knowledge and confidence when working with pediatric patients experiencing DKA. To gather support and supplementary material for the module I reviewed available literature, including research journals. It is essential to base the self-learning guide on evidence available in the literature to assist with identifying nurses' learning needs and to ensure patients are receiving the best care possible.

An extensive literature review has been conducted to examine the need for diabetic ketoacidosis (DKA) guideline education for nurses. Several databases were explored including CINAHL and PubMed. These sites were accessed via Memorial University of Newfoundland's online library. The search was limited to include articles from 2005 to the present, written in the English language, developed with a research design, and had a PDF file available. Key words and topics searched were *diabetic ketoacidosis (DKA), nurse's knowledge, guidelines, Type 1 Diabetes, treatment,* and *self-learning module*. The search resulted in the development of several themes such as: incidence and prevalence of type 1 diabetes and pediatric DKA, treatment and complications of DKA, risk factors associated with DKA, implication for nursing practice, theories, and the role of self-learning module for nurses.

The Incidence and Prevalence of Type 1 diabetes and DKA

Children with type 1 diabetes may experience episodes of ill health related to their inability to maintain blood sugar within a normal range. Hyperglycemia is defined as blood glucose reading above 11mmol/l. If blood sugars remain above normal for an extended period of time a condition called DKA may develop. DKA is a result of severe insulin deficiency or insulin resistance. It is defined by an elevated serum glucose of > 11mmol/l; acidosis (venous pH<7.30 or bicarbonate level of < 15mmol/l); serum ketonemia; ketonemia, ketonuria, and glycosyria (Koul, 2008). The signs of DKA include polyuria, polydipsia, nocturia, and tachypnea. A child experiencing DKA may present to the emergency room with dehydration, vomiting, epigastric pain, hypotension, fruity odor on breath, emesis, and altered level of consciousness (Koul, 2008). However, DKA is a

preventable condition (Jackman et al., 2015; Glaser et al., 2001; Edge et al., 2012; Tieder et al., 2013). It is important for nurses to be knowledgeable about DKA and share this knowledge with patients and their families to reduce episodes of DKA.

Type 1 diabetes is the most common form diabetes in children (Newhook et al., 2004). Newhook et al. (2004) conducted a prospective cohort study to determine the incidence of type 1 diabetes among children aged 0-14 years from 1987 to 2002 on the Avalon Peninsula of Newfoundland. Over the study period 294 children were diagnosed with type 1 diabetes resulting in an incidence rate of 35.93 with a 95% confidence interval of 31.82-40.03. The incidence increased linearly at the rate of 1.25 per 100,000 individuals per year. Between 1987 to 2005 there were 732 new cases of type 1 diabetes reported in children ages 0-14 years. The overall mean incidence per 100,000 individuals per year was 35.08 (95% confidence interval: 32.54, 37.62) (Newhook et al., 2008). The Avalon Peninsula of Newfoundland has one of the highest incidences of type 1 diabetes worldwide.

Newhook, Penny, Fiander, and Dowden (2012) conducted a retrospective time trend study in Newfoundland and Labrador between 1987 to 2010 to determine the incidence of type 1 diabetes among children ages 0-14 years. Between 2007 and 2010 the incidence of type 1 diabetes for children ages 0-14 years was 49.9 per 100 000 populations per year (95% CI: 42.2-57.6). The incidence of type 1 diabetes increased, therefore, it is important for health care providers to be knowledgeable regarding the diagnosis and treatment DKA and provide patient education to maintain optimum health.

Alaghehbandan, Collins, Newhook, and Mac Donald (2006) conducted a study to calculate the incidence and hospitalization rates of children with type 1 diabetes in Newfoundland and Labrador between the years 1995-2002. There were a total of 894 episodes of hospital discharges for children ages 0-19 years with type 1 diabetes, representing a hospitalization rate of 88.6 per 100,000 persons over the seven year study. Overall, the hospitalization rate increased over the study period (P= 0.00011). Out of the 894 hospitalizations, 216 were for DKA resulting in a DKA incidence rate of 41.7 per 100,000 persons over the seven year period. The incidence rate of type 1 diabetes among children ages 0-7 years was 19.0 per 100,000 persons over seven years. Female gender and older age were predictive factors for DKA. DKA remains a leading cause of hospitalization and the leading cause of death and morbidity among children with type 1 diabetes. Due to the increase in prevalence of type 1 diabetes worldwide there is an increase in DKA (Alaghehbandan et al., 2006). Diabetes education for patients, families, and health care professionals could reduce hospitalization rates associated with DKA because it is a preventable condition.

Other countries are also experiencing frequent episodes of pediatric DKA. In Germany a study was conducted by Neu et al. (2009) to analyze the frequency, clinical characteristics, and trends associated with DKA at the onset of type 1 diabetes. Data from 14,664 patients with type 1 diabetes, from 106 pediatric diabetes centers in Germany and Austria, were collected between the years 1995-2007. DKA was observed in 21.1% of patients. Therefore, almost a quarter of children were in DKA when diagnosed with diabetes. Early detection of type 1 diabetes could prevent children from becoming

seriously ill. The frequency of DKA remained unchanged throughout the 13 year study. The frequency of DKA among children less than five years of age was 26.5%. The continuing high frequency of DKA warrants educational campaigns aimed at health professionals and the general public to bring awareness to early detection and treatment of type 1 diabetes to reduce the occurrence of DKA.

Treatment of DKA and Complications

Initially children with DKA may present to the emergency department for immediate care due to the urgent nature of the illness (Barrios et al., 2012; Glaser & Kuppermann, 2004). Rural emergency department do not specialize in pediatric care. Therefore, pediatric patients are stabilized and transferred to the closest pediatric emergency department. Depending on the severity of the DKA symptoms the child may be admitted to the Intensive Care Unit or the medical ward. In Newfoundland and Labrador the only pediatric ER is located in St.John's. A study conducted by Barrios et al. (2012) investigated the management of pediatric patients with DKA presenting to ERs in Illinois, USA (See Appendix A for the literature tables that are included with this literature review). A survey was conducted and medical records were reviewed regarding managing pediatric patients with DKA in 116 ERs. Only 34% of the ERs had a DKA guideline or policy and 37% did not have pediatric endocrinology services. There were 532 medical records reviewed between January 2008 to June 2010, 87% of patients received an initial intravenous (IV) isotonic sodium chloride solution within the first hour and 74% of patients received IV insulin infusion/drip after the initial fluid bolus. Both interventions are not recommended as treatment for pediatric DKA (Edge et al., 2012).

The results of the study led to the recommendation of best ER practice management of pediatric DKA to include a specific DKA guideline/protocol and access to pediatric endocrinologist. ER departments within Eastern Health have access to pediatric DKA treatment guidelines in the Newfoundland and Labrador Pediatric DKA Project. A self-learning module would assist with the dissemination of the guideline.

Edge et al. (2012) conducted a survey in the United Kingdom to compare hospitals' care of children with type 1 diabetes to the Department of Health Children's Diabetes Working Group's care standards. The audit surveyed all 27 organizations in southern England. The results of the study showed that protocols for DKA, surgery, new diagnosis, and hypoglycemia were found on 70% of wards and only available in 52% of ERs. Only 33% of nurses working in ER were trained diabetes nurses. The audit results showed that some standards can be achieved such as having protocols and guidelines for care of children with diabetes available, providing education sessions on management of children with diabetes, and having a DKA protocol in place. One of the stated standards was having a trained diabetic nurse work every shift in the ER. However, meeting this standard is challenging, especially in a rural ER departments where recruitment is difficult and a lower volume of pediatric patients are seen. Ongoing work must be taken to make protocols available, support dissemination of information, and provide diabetic education to nurses working with pediatric patients in ER.

It is important to determine how early detection and early intervention can reduce serious complications associated with DKA. Striving to continually improve the delivery of care through the implementing of protocols or guidelines can reduce the cost

associated with hospital stays and produce consistent, effective care to patients. Ferreri (2007) completed a review of medical records at a large teaching hospital in New England to determine if the American Diabetes Association's (ADA) guidelines were being followed. The study involved participants older than 18 years but the finding are applicable to the treatment of children. The researchers support the use of guidelines to direct care, and education for practitioners who care for patients with DKA. The sample consisted of 54 cases. The ADA recommends an overlap of insulin infusion and subcutaneous insulin of at least 60 minutes. The study results showed that two thirds of the charts reviewed did not meet this recommendation. Subcutaneous insulin must be given time to start acting before the intravenous insulin infusion is stopped to keep plasma insulin levels within range during the change. Both doctors and nurses need to understand this concept so that guidelines can be put in place and followed. It is important for everyone involved in the care of patients with DKA to be aware of criteria for the use of specific protocols.

Beik, Anger, Forni, Bawa, and Szumita (2013) conducted a single-center retrospective descriptive study to evaluate the impact of an institutional guideline and order set for hyperglycemic emergencies, including DKA. There were two phases of the data collection. Phase one assessed practice guideline implementation from September 2007 to September 2009 and phase two assessed practice postguideline and order set introduction from February 2011 to April 2012. The study sample consisted of 172 adult patients (91 phase one and 81 phase two). Implementation of an institutional guideline and order set for hyperglycemia emergencies decreased Intensive Care Unit (ICU) length

of hospital stay and time to anion gap closure. There was no difference in rates of hypoglycemia between groups. Guidelines and protocols for the management of DKA can improve clinical outcomes but education is needed to ensure adherence to best practice measures and ongoing assessment is essential to ensure continued guideline use. Nurses must learn about the treatment of DKA and apply the knowledge through application of clinical practice guidelines. Managers can provide the support needed to expose nurses to the information, provide ongoing support to implement the knowledge, and monitor the guideline use to ensure that the guidelines become part of everyday practice.

Cerebral edema. In most cases children experiencing DKA recover following treatment with insulin, intravenous fluids, and electrolyte replacement. However, cerebral edema, an infrequent complication, may develop resulting in death (Glaser & Kuppermann, 2004). A Canadian surveillance study reported that 23% of children that developed DKA cerebral edema died and 15% survived with neurological complications. DKA related cerebral edema accounts for 70% to 80% of diabetes related deaths in children under 12 years (Statistics Canada, 2008).

Most episodes of DKA cerebral edema will occur four to twelve hours after treatment has been initiated. Signs of developing cerebral edema include; headache, vomiting, altered level state of consciousness, decreased pain response, decorticate or decerebrate posturing, cranial nerve palsies, hypertension, bradycardia, and abnormal respiratory pattern (Metzger, 2010). In Sweden, between 1999-2000, 16% of children presented with DKA at diagnosis of diabetes. The frequency of cerebral edema was 0.68% (2/292 episodes of DKA). Symptoms of cerebral edema such as, headache,

vomiting, and lethargy were recorded in 16 patients. In two of the cases, medication was administered and both patients recovered within one to two hours. Of the cases reviewed it was noted that hypokalemia was significantly more common at onset of diabetes than in patients with established diabetes (Hanas, Lingren, & Lindblad, 2007).

The self-learning module will supplement the information in the Newfoundland and Labrador DKA Project binder. The information will help nurses in rural emergencies identify signs of DKA and increase awareness that there are patients that are at greater risk for developing DKA. Once treatment has been initiated in the ER it is critical that nurses monitor their patients for signs of cerebral edema.

Marcin et al. (2002) investigated the relationship between outcomes of children with DKA-related cerebral edema, baseline clinical features, and treatment for cerebral edema. The study sample size consisted of 61 children under the age of 18 years. Chart review showed that out of the 61 patients having cerebral edema 13 died, 4 survived in a vegetative state, 36 survived with no persistent neurological deficits, and 8 survived with mild or moderate neurological disabilities. Three variables were found to be associated with poor outcomes of children with DKA-related cerebral edema. These variables include an elevated initial BUN concentration, more profound neurologic depression at the time of diagnosis of cerebral edema, and intubation associated with hyperventilation. Patients with more severe dehydration at initial examination were more likely to have adverse outcomes. A similar study conducted by Glaser et al. (2001) found that children with DKA who have low partial pressures of arterial carbon dioxide, high serum urea nitrogen concentrations at diagnosis, and who are treated with bicarbonate are at

increased risk for developing cerebral edema. In addition, low serum sodium concentration levels during therapy can increase probability of cerebral edema.

Dehydration is treated with IV fluids. However, excessive use of fluids can place the patient at risk of developing cerebral edema. In Alberta, between 1991-1996, Rutledge and Couch (2000) reviewed the emergency department management of children presenting in DKA to determine if current recommendations for fluid therapy are practiced. The chart review found 49 cases of DKA in 37 patients. Eight patients had more than one episode of DKA in the study period. In the study sample forty-one cases (84%), 82% treated at a primary or secondary health center and 67% at a tertiary center, received a normal saline bolus with a mean fluid volume of 18.3 ml/kg given within the first hour. Excessive fluid therapy continued after four hours. At the time of this study the authors found that fluid management of children in DKA was not consistent with current recommendations. Continuing education regarding fluid replacement for children with DKA is needed for ER health providers due to the risk of cerebral edema.

Information regarding variables associated with outcomes for children with DKA-related cerebral edema is important to include in the self-learning module. The study results can be applied to a case study or vignette to enhance nurses' understanding of the importance of proper and continuous patient assessment throughout diagnosis, treatment, and recovery period. Assessing for level of dehydration and identifying the severity of dehydration at initial presentation in ER will be emphasised in the module material.

Risk Factors Associated with DKA

Working in a rural emergency department warrants the need to be knowledgeable regarding the potential risk factors associated with DKA because the ER triage nurse may be the first person to assess the patient. When triaging patients insight into risk factors may help to guide assessment questions lending to early diagnosis and treatment of DKA. Newfoundland and Labrador has a very high incidence of type 1 diabetes and admission rate for DKA, including newly diagnosed patients and patients with type 1 diabetes (Newhook et al., 2012). Jackman et al. (2015) carried out a retrospective study of 90 children diagnosed with DKA from 2007-2011. Of the study sample 39.5% were newly diagnosed with type 1 diabetes and 60.5% were previously diagnosed. More severe cases of DKA occurred in younger, newly diagnosed patients. Almost half of the pre-existing diabetes cases were recurrent DKA (49.1%). The most common characteristic of newly diagnosed patients were weight loss, bedwetting, polyuria, polydipsia, and neurological symptoms. Patient with pre-existing diabetes presented to the ER with abdominal pain and vomiting. A new diagnosis of type 1 diabetes and issues related to interrupted insulin delivery in pre-existing patients using insulin pump therapy were the most common factors associated with DKA. Of the newly diagnosed patients with DKA, 64% had been seen by a physician prior to diagnosis. Most cases of DKA are preventable. Therefore, early detection and improved education for families and healthcare providers, especially those outside of pediatric centers, is needed to reduce missed diagnoses and eliminate DKA (Jackman et al., 2015). In the study sample 42.9% of newly diagnoses and 57.1% of children with pre-existing diabetes patients were treated at a peripheral hospital prior to

transfer to the Janeway Hospital. This study supports the use of a self-learning module among rural ER nurses to disseminate pediatric DKA clinical practice guidelines.

Findings of this study are supported by Pawlowicz, Birkholz, Niedzwiecki, and Balcerska (2009). They conducted a study in Poland between 1999-2005 to estimate the frequency of difficulty in diagnosing type 1 diabetes and if demographic factors have any influence on the diagnosis delay. The sample size consisted of 474 cases. The demographic factor that played a significant role in delayed diagnosis is the patient's age, especially below two years (Szypowska & Skorka, 2011). Age was a factor in 67 cases of DKA (14.13%). Most frequently family doctors were responsible for wrong preliminary diagnosis. It is important to provide continuing education to all care providers, including nurses in rural emergency department, regarding the risk factors associated with diagnosis and treatment of type 1 diabetes and complications, such as DKA, to ensure children are receiving evidence-based care which may reduce morbidity and prevent ICU admission. Careful assessment must be completed on children two years of age and younger due to the high risk of experiencing DKA, which may be related to delay in diagnosis and more aggressive beta cell destruction (Szypowska & Skorka). If diabetes is identified early development of DKA may be eliminated. Being proactive will prevent DKA and avoid extensive interventions and treatments.

Tieder et al. (2013) studied the variation in hospital resource utilization and readmission for DKA across United States hospitals between 2004-2009. There were 24, 890 DKA admissions, and 20.3% were readmissions for repeat DKA after one year. The mean hospital cost was $7,142 and mean length of hospital stay was 2.5 days.

Readmission for DKA within a year of hospitalization is common. Based on the study findings, interventions are needed in the United Sates to reduce the high readmission rate associated with DKA (Tieder et al., 2013). Increasing rural emergency nurse's knowledge of the DKA risk factors can improve nurse's ability to provide patient and family education. Nurses can provide support to patients when seen in ER to help improve compliance with diabetic regime, identify reasons why DKA is reoccurring, and provide referrals for ongoing support from social workers, dieticians or endocrinologist.

In Germany and Austria, Fritsch et al. (2011) produced a study to determine the incidence and risk factors associated with pediatric DKA. Based on the continuous diabetes data acquisition system for prospective surveillance a multicenter survey was designed. Study sample was selected from the data base over a 13 year period (1995-2008). Data from 28, 770 patients from 267 centers were analyzed. The mean age of the cohort was 13.96 plus or minus 4.0 years. A total of 94.1% had no episodes of DKA, 4.9% had one episode, and 1% experienced recurrent DKA. The three groups were compared and patients with recurrent DKA were found to be older ($p< 0.01$), have a higher HbA1c ($p<0.01$), and a higher insulin dose ($p<0.01$). DKA was also higher in females ($p=0.03$) and patients with migration background ($p=0.02$). Jackman et al. (2015) found that the incidence of DKA was higher in females in Newfoundland and Labrador. Out of 90 children admitted to hospital with DKA in Newfoundland and Labrador between 2007-2011, 60% were female and 40% male. The study findings will be incorporated into the self-learning module to help nurses identify individuals who may be at high risk for developing DKA. DKA rates in Germany and Austria are significantly

higher in females, children with migratory background, and patients in their early teenage years. These findings are comparable to other studies conducted in Canada and the United States (Jackman et al., 2015; Tieder et al., 2013).

As previously stated, insulin pump use is a risk factor associated with DKA (Jackman et al., 2015). Hanas, Lindgren, and Lindblad (2009) investigated triggering factors and insulin pump use in episodes of DKA in Sweden over a one year period (1999-2000). Data were collected via questionnaire completed by pediatric Diabetologists (an endocrinologist that specializes in diabetes mellitus). Throughout the study time period 142 cases of DKA were identified in 115 children. Fourteen children had more than one episode of DKA. Thirty of the 115 patients used insulin pumps. The overall incidence of DKA for children with or without insulin pumps was 1.4/100 patient years in 1999 and 1.7/100 patient years in 2000. However, the incidence for insulin pump used was 3.2/100 patient years in 1999 and 3.6/100 patient years in 2000. Reported causes of DKA were missed insulin dose (48.6%), gastroenteritis (14.1%), technical pump problems (12.7%), infection (13.4%), social problems (1.4%), unknown (9.8%). The DKA frequency of insulin pump users was twice that of patients using injections. Patients using the insulin pump experienced 77% of episodes of DKA within the first year of commencing pump use. Based on this study's results information regarding management of diabetes when ill with a virus or infection to avoid hyperglycemia should be included in the self-learning module, emphasizing gastroenteritis and troubleshooting insulin pumps. Maahs et al. (2014) used diabetes registry data in the United States and Germany to compare the frequency of severe hyperglycemia and DKA. The frequency of one or

more reported DKA events was higher in the US. However, the proportion of those with at least 1 DKA event in the past year was greater among insulin pump users compared to injection users in Germany (p=0.01). This study also supports the fact that insulin pump use places children at risk of developing DKA.

Implications for Nursing Practice

The health care team, including nurses, plays an instrumental role in preventing, diagnosing, and treating DKA (Griffis et al., 2007). Efficient assessments, such as early diagnosis of type 1 diabetes, diabetes management, and education interventions for patients with pre-existing diabetes, can reduce episodes and severity of DKA (Fritsch et al., 2011). It is necessary for nurses to stay current in diabetes knowledge. This can be achieved by attending educational in-services or completing self-learning modules. In Hong Kong over a one year period (September 2004 – July 2005), Chan and Zang (2007) conducted a descriptive correlation study in two hospitals to determine nurses' perceived and actual diabetes knowledge in relation to the nurses' profiles. A structured questionnaire (an instrument consisting of two parts: content validity score of 0.99, reliability of 0.91 and 0.95, Cronbach's alpha 0.90 and 0.79) was completed by 245 nurses (response rate of 61.1%). Descriptive statistical analysis was conducted using SPSS12.0 and several techniques were used. A cluster analysis grouped the sample according to the similarity of their responses and analysis yielded three clusters. Nurses in cluster one (40.4% of respondents) were characterized by good competence and high diabetes knowledge compared to cluster two and three, cluster three (16.3%) reported low competence and knowledge compared to cluster one and two, and cluster two (43.3%)

held both positive and moderate competence and knowledge. Overall, nurses' perceived knowledge was statistically significant when correlated with actual knowledge (rs=0.32). The study findings support provision of education that is tailored to the needs of nurses to maintain a standard of diabetes knowledge. Nurses have the responsibility to be knowledgeable and provide education to patients with up to date information. Limitations of this study included the use of a self-reported questionnaire, which may introduce response bias and errors related to respondent honesty. The sample size was small and limited to two hospitals. Therefore, the information cannot be generalized to the general population and further studies are required to confirm findings. This study has evidence to support the provision of diabetes and DKA education for nurses.

The literature strongly suggests the use of education to address the knowledge gaps in best practice for patients with diabetes (Chan & Zang, 2007; Griffis et al., 2007; Haas, 2006; Manchester, 2008; Rubin, Moshang, & Jabbour, 2007; Hollis, Glaister, & Lapsley, 2014 (Appendix A); El-Deirawi, & Zuraikat, 2001). At a hospital in Pennsylvania, Young (2011) evaluated nurses' knowledge of diabetes and deficits of care for patients with diabetes. A needs assessment based on diabetes care was administered and underpinned the development of educational materials. Nurses were invited to attend a live educational session or complete an online manual. Two sessions comprised the live education and nurses were asked to complete a 15 item quiz post presentation. Nurses who completed the online manual did a 20 item quiz. Both groups were asked to complete a satisfaction survey based on the education sessions. All 10 nurses in the live session completed the quiz and survey. However, 36 out of 50 nurses in the online group

completed the quiz and 30 out of 50 completed the survey. Nurses in the live session were 100% satisfied and the online group were 58% highly satisfied and 42% satisfied with material. Both groups did well in the quiz scores, with the online group achieving the highest mean score of 95%. Study limitations included lack of measure of patient outcomes. It was not determined if the increase in knowledge impacted positively on patient outcomes. The sample size was small and conveniently selected from one hospital in Pennsylvania, thus reducing generalizability of study findings. The authors did not report the reliability or validity of the data collection instruments used and a pretest was not administered to determine if the educational intervention contributed to the quiz scores and acquired knowledge. The study lends support to using convenient methods of education deliver to busy nurses. Online education offers flexibility in accessing evidence-based research findings when caring for patients with diabetes.

Continued support was given to nurses regarding diabetes care to improve patient outcomes in an Ontario study conducted in 2004 in six rural hospitals by Griffis, Morrison, Beauvais, & Bellefountaine (2007). A needs assessment was conducted with acute care nurses (N=152) from two urban and six rural hospitals in Ontario to determine nurses' diabetes knowledge and preferred method of receiving continuing educations. A survey, consisting of multiple-choice questions, was developed by diabetes educator specialists. The instrument was pilot-tested for readability and content by acute care nurses and the feedback was used to revise the study. The authors did not report content reliability and validity scores. The survey consisted of six themes and the study results showed that the three with the largest knowledge gap were therapeutic goals (32.8%),

medications (38.5%), and types of diabetes/therapies (39.9%). The preferred form of continuing education was inservices (82%), followed by workshops (62%), facts sheets (47.3%), videos (40%), and online courses (30%). A knowledge gap was identified in all six themes and continuing education is needed in all areas. The study limitation was the small sample size taken from hospitals in Northern Ontario which limits the generalization of study findings. However, the study does lend support to continuing diabetes education for nurses based on evidence-based clinical practice guidelines. The authors acknowledge that the translation of knowledge into practice is the key to improving patient outcomes and suggest that nursing leaders can play an important role in implementing strategies to support acute care nurses as they continue diabetes education.

Theories

To meet the requirements for N6660 I will develop a self-directed learning module for rural emergency nurses to supplement the clinical practice guidelines for the diagnosis and treatment of pediatric DKA outlined in the Newfoundland and Labrador DKA Project binder. Use of a self-directed learning module will help to disseminate the DKA clinical practice guidelines and assist with the translation of knowledge into practice. Theories provide the framework for the processes used to evaluate, implement, and plan programs, such as developing education modalities for nurses (Mc Kenzie, Neiger, & Thackeray, 2013).

Interventions that are based on theory have a greater success rate (McKenzie et al., 2013). Therefore, I reviewed appropriate theories to help develop the best plan to

provide education to rural emergency nurses. To underpin the self-directed learning module I have chosen Knowles' Adult Learning Theory and The Instructional Design Framework.

Knowles' Adult Learning Theory recognizes that the adult learner is an autonomous and self-directed learner, who is motivated to learn and incorporates choice and responsibility into the learning process. This theory is appropriate for educating nurses about pediatric DKA prevention, diagnosis, and treatment because it identifies the learners needs and focuses on self-directed learning. The following are needed for optimum learning to occur; a need to know, a responsibility for one's own learning, the role of experience as a tool for learning, the ability to apply the information to ones' life situation, motivation to learn, and problem centered learning with real life problems (as cited in Mitchell & Courtney, 2005). This knowledge will be applied to the development of the self-directed module to ensure the success of the project.

The self-directed learning module content will incorporate Knowles' six elements of adult learning: (1) a need to know; a review of current literature showed that a knowledge gap exists regarding nursing diabetes management and that pediatric DKA patients outcomes improve with use of clinical practice guidelines. This literature support will enable nurses to see that continuing education regarding diabetes care and implementation of clinical practice guidelines for treating diabetes emergencies, such as DKA, is essential. The self-learning module will focus only on the learning needs of the rural emergency nurse highlighting how to assess, identify, treat, and prevent pediatric DKA. Emphasis will be placed on prevention through education of patients and families,

(2) a responsibility for ones' own learning; nurses are responsible for continuing learning to stay abreast of new technology and treatments offered to patients that avail of the emergency department's services. The Association for Registered Nurses of Newfoundland and Labrador requires nurses to obtain clinical competency hours to maintain licensure. Credit for completing the module will be provided toward clinical competency hours. The module will be self-directed and additional information will be provided via links to other on-line sources, (3) the role of experience as a tool for learning; case studies based on typical presentations and scenarios in the emergency department will be highlighted in the module allowing nurses to build upon existing knowledge and experience. Problem-based learning will be an important component of the module. Nurses have reported that they do not feel confident dealing with pediatric emergencies, including children using insulin pumps and experiencing DKA. The self-directed learning module will help increase nurses' confidence in caring for this cohort, (4) the ability to apply information to one's life experiences and (5) applying problem centered care to real life problems; information regarding the incidence and prevalence of type 1 diabetes and complications (e.g. DKA) will be included in the module. Reinforcing this information will enable nurses to relate the importance of learning about clinical practice guidelines to treat diabetes emergencies in their specific work site and community. Problem centered care will be highlighted through the use of case studies and vignettes after each chapter in the module to reinforce information discussed, and (6) motivation to learn; when lobbying to promote use of the module it will be reinforced that nurses are accountable for continuing education as outlined in the ARRNL's standards and the Canadian Nurses Code of Ethics. Emphasizing the high incidence of type 1

diabetes and the increased chance of caring for a child with DKA in a rural ER will motivate nurses to learn and use the clinical guidelines to provide the best care possible to patients. Research has shown that nurses want more education about diabetes. Addressing elements one through five in the self-directed learning module will motivate nurses to learn and implement knowledge gained from the Newfoundland and Labrador Pediatric DKA Project and module.

The Instructional Design Framework (IDF) offers an outline for designing education lessons. IDF is appropriate to guide the development of the self-directed learning module (Kinzie, 2005). IDF consists of five stages: (1) gain attention; when developing the self-directed learning module risk factors associated with type 1 diabetes and pediatric DKA will be identified and applied to case studies to illustrate main points, (2) present stimulus material; this stage will involve the presentation of facts regarding type 1 diabetes and associated complications. Supplementary material will be provided to reinforce information in the Newfoundland and Labrador Pediatric DKA Project binder, including illustrations, charts, true and false questions, matching, and fill in the blanks, (3) use models to demonstrate; the content covered will include the clinical practice guidelines for DKA and insulin pump use for continuous insulin administration. The material will be presented using DKA treatment guideline algorithm and pictures of insulin pump features, (4) elicit performance; vignettes will be used to highlight trouble shooting with insulin pumps and patients experiences with DKA, and (5) enhance retention; the content covered will allow for application of knowledge covered in DKA

binder focusing on critical thinking and reflection. Material from all sections of the module will be reviewed and tested using multiple choice questions.

Role of Self-Learning Module

Online education meets the needs of busy self-directed adult learners (Ladell-Thomas, 2012; Wessel, Tannery, & Epstein, 2009). It is challenging to design and implement learning sessions for nurses due to the criteria established by Eastern Health for education leave, which made paid leave to attend education session obsolete unless the session was essential for the job. Scheduling educational in-services on work days does not always work due to lack of nursing coverage. Therefore, making education available on-line via the eastern Health Intranet is an attractive, feasible alternative. A self-directed learning module consists of clear objectives, well-structured content, a variety of authentic tasks to reinforce learning that is relevant and applicable to nurses' real life experiences (Cercone, 2008).

In Michigan, Riley-Doucet (2008) conducted descriptive pilot study to determine the effectiveness of a preceptor orientation self-learning manual for preceptor preparation. Only 119 nurses of the study sample (N=150) returned the posttest and demographic questionnaires. The data collection instrument was a posttest developed by the researchers. They did not report content validity or reliability. Data was analyzed using SPSS 14.0 at the two-tailed .05 alpha level. Overall, the nurses were satisfied with the self-learning tool and demonstrated mastery of learning the manual objectives by obtaining a post-test mean score of 90.13 (SD=7.019). The self-study manual was flexible

and allowed nurses to review material at their own pace, which is important considering their busy work schedules.

In Quebec and Ireland, Lehr et al. (2005) conducted a study to develop, pretest, and revise an electronic learning module to teach health care professionals on the use of the Pediatric Respiratory Assessment Measure (PRAM) to assess acute asthma severity. The pilot module consisted of a tutorial and three case scenario sections and was tested by the study sample (N=72) consisting of 19 physicians, 22 nurses, four respiratory therapists, and 27 health care trainees. Expertise was reported by participants and results showed 26% were beginners, 35% competent, and 39% expert. The accuracy of experts was superior to beginners (OR 1.79, 1.15, and 2.79, respectively). Performance improved significantly between the first and later half of cases ($P<0.001$). The module to learn PRAM was rated by the participants as clear (96%), relevant (98%), realistic (94%), and useful (99%). This study lends support to the use of online education tools to enhance health care workers knowledge and skills. Using mixed methods, including tutorials and scenarios was approved by study participants and enhanced learning. This method of providing education would be applicable to use to provide DKA education to rural ER nurses.

Phillips et al. (2014) tested the impact an online pain assessment learning module on nurses' pain assessment competencies and if patients' reported pain ratings were impacted by the intervention. This pre-post-test study, conducted in Australia in 2012, was conducted with nurses specializing in palliative care services (N=34). The survey, The Self-Perceived Pain Assessment Competencies (Self-PAC Survey), was developed

by an expert panel and consisted of 17 questions. There are three sections of the survey. The internal consistency reliability of section one is reported as 0.944, section two as 0.846, and section three as 0.919. Chart audits (N=60), conducted by trained research assistants, were completed one month and six weeks post the education intervention. The study results showed that nurses (N=34) increased their pain assessment knowledge, assessment tool knowledge, and assessment confidence ($p<0.001$). Participants recorded pain scores in patients charts more often than non-participants ($p=0.021$). This pilot test support educational interventions to improve specialist palliative care nurses' pain assessment practices and the use of online self-directed learning modules.

Conclusion

Through an intensive literature search support has been provided for the development of a self-directed learning module to educate rural emergency nurses on the diagnosis, treatment, and prevention of pediatric DKA. The literature showed that a self-learning module will help disseminate the clinical practice guidelines for the treatment of DKA and support nursing education to improve practice and patient outcomes. Managers can play an important role in the dissemination process by providing ongoing support to nurses. Research articles demonstrated the importance of emphasizing nursing skills in the self-learning module. The nursing skills selected include; assessing for dehydration, monitoring patients for signs and symptoms of cerebral edema, IV fluid therapy, signs and symptoms of diabetes, use of an insulin pump, and sick day management for children with type 1 diabetes. It is important for nurses to be aware of patients that are at high risk for developing DKA, including; insulin pump users, females, children presenting at

diagnosis, and children that have experienced DKA in the past (recurrent DKA). The self-directed learning module will supplement information in the Newfoundland and Labrador Pediatric DKA Project and focus specifically on the needs of rural emergency nurses, be developed using Knowles' Adult Learning Theory and IDF, and enable nurses to learn about the DKA risk factors, causes, complication, and management. Through dissemination and implementation of the pediatric DKA clinical practice guidelines rural emergency nurses will become more confident as they assess, stabilize and transfer patients with DKA. The module will help ensure patients receive the best care and family/patient education possible, resulting in improved patient outcomes and possible decrease in episodes of DKA.

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Appendix A-Literature Tables

Author/Date	Study Design/ Sampling/Setting Characteristics	Variables and Measures/ Reliability/Validity	Relevant Outcomes	Limitations
Griffis, Morrison, Beauvais, and Bellefountaine, 2007	Objective: to identify Ontario's acute care nurses diabetes education needs -Cross-sectional study -8 hospitals in Ontario -152 surveys completed (Response rate not stated) -Inclusion/exclusion criteria not stated	Self -administered survey assessing nurses' Diabetes knowledge (18 questions & open ended section) -questions not tested, alpha not stated Survey data: single score per respondent compared by univariate of variance, descriptive Stats, survey questions average scores reported	Top 3 knowledge gaps: Therapeutic goals (32.8%), medications (38.5%), types of diabetes/therapies (39.9%). -Inservices (82%) preferred method of education	Convenience sample -Small sample, reduce generalizability -reliability and validity Not reported
Lehr et al. 2013	Objective: to develop,pretest, & revise a pediatrics asthma e-learning module for Healthcare workers (HCW) -Cross-sectional study -1hospital in Montreal,1in Ireland -72 HCW pilot test Inclusion/exclusion criteria not stated	E-module :tutorial &18 cases	Self-reported level of expertise (26% beginner,35% compedent,39% expert) -performance of experts superior to beginners (OR 1.79, 1.15 & 2.79) -Performance improved significantly between first and second half of cases ($p<0.001$) Module rated as clear (96%), relevant(98%),realistic(94%),&useful (99%)	Pre- test not use, unable to compare scores pre/post -small sample –decrease generalizability of findings Reliability and validity not reported

Riley-Doucet, C. 2008	Objective: to determine effectiveness of self-directed learning tool for nurses who precept student nurses -cross-sectional, descriptive study -pilot test -Various teaching hospital in Midwest USA N=180 invited N=150 participated N=119 returned questionnaire & posttest	Demographic survey (10 questions) -posttest (25 questions) -Learning tool(12 pages, developed by experts & pilot tested-content validity) -reliability not reported -demographic data, satisfaction with tool, & mastery of learning objectives analyzes using descriptive stats	Participants satisfied with self-learning tool (M=4.49, SD=0.569) ,helpful (M=4.41,SD0.615), mastery of learning objectives mean score on posttest 90.13 (SD=7.019) -self-directed tool effective method for providing education to preceptors to help prepare for their role	Self-reporting questionnaires-reporting bias -the study was designed to test the preceptors opinion on the self -directed learning tool which prepared them for being preceptors. The students were not questioned on their opinion regarding how well the preceptor did -reliability not tested
Rutledge and Couch,2000	Objective: to review ER management of pediatric DKA to determine if guidelines are followed for fluid therapy -descriptive study-retrospective chart	Chart review=patients<17 years &DKA -inclusion criteria given -N=49 cases -clinical & lab data, IV fluid, & insulin bolus	41/49 cases ordered IV bolus -6 cases gave infusion rate above guidelines -mean amount IV fluid after 1hr=18.3+-16ml/kg, 4hrs=42.3+-24ml/kg -primary and secondary sites gave	-No information provided about chart review-Who conducted it-possible Bias

	review -Alberta tertiary hospital , patients transferred from primary &secondary sites	analyzed -student's t-test used to compare 3 sites	higher amounts of fluid(p=.04&p=.006) -36 cases received insulin bolus(73%). No significant difference between sites -9 patients were given IV sodium Bicarb.no significant difference between sites. -Fluid management is high, not meeting guidelines	-Small sample can't generalize findings -milder cases of DKA may not have been transferred to tertiary hospital not included in review
Tieder at al. 2013	Objective: To characterize hospital resource use & readmission rates for pediatric DKA -multicenter retrospective cohort study -38 hospitals in USA	Data collected from Pediatric Health Information System(PHIS) -inclusion/exclusion criteria given -24,890 cases of DKA -variation across hospitals for cost, length of stay(LOS),&readmission analyzed mixed effects linear & logistic regression used	20.3% cases readmission within 1 yr -cost $7142, LOS 2.5 days, -differences across hospitals for cost,LOS, and readmission rates (p<.001) -Readmission within 1 yr is common in USA	unreliable collection of all patient characteristics -Adjustment was made for differences in patient characteristics but unobserved difference may remain -data not included from ERs -unable to determine cause of

				readmission rates
Edge et al. 2012	Objective: to compare current pediatric diabetes care in 27 diabetes hospitals/services in England to standards -cross-sectional study -100% response rate to questionnaires	Questionnaire designed by steering group(content validity)-no other info given -data analyzed average scores reported	4 diabetes protocols were available -generally available on all wards of hospital (70% had all 4) -ER less available 52% -nurses trained in pediatrics in ER (33%) -diabetes education sessions for ER (26%)	Questionnaire reliability and validity not reported -very little information given about how data was collected & analyzed -more studies needed to determine general-izability of findings
Barrios et al. 2012	Objective: to explore the variability in Pediatric DKA management -11 ERs in Illinois -survey response 94% -cross sectional study	Survey-14 questions & scenarios, developed by experts(content validity) -532 chart reviews,randomly selected, inclusion criteria given -data aggregated by size; 2 groups l, large and small facilities	34% ERs no DKA guidelines -37% no endocrinology services -case scenarios showed high % not following protocol for fluid & insulin use -chart review confirmed that protocol not used within the first hour of treatment -Educational module needed to teach guidelines for pediatric DKA	Study was limited to ER and hypothetical case scenarios -survey questions were limited to collect data in a timely

		Pearsons tests used to evaluated differences in groups -surveys (p<0.05) -case scenarios (p<0.05), chart reviews(p<0.01),surveys &reviews(p<0.01)		manner -chart review did not include info outside of ER,mortality rate & cerebral edema not recorded, unable to draw conclusions about ER care -reliability & validity of survey not reported
Beik et al. 2013	Objective: to evaluate guidelines and order sets for hyperglycemia emergencies in ER -retrospective descriptive study -N=172 adult patients(group 1 n=91 & 2 n=81 -large Boston hospital -charts reviewed preguidelines group1 (2007-2009)& postguidelines group 2 (2011-2012) -inclusion/exclusion	-continuous data analyzed using unpaired student ‘s t test -categorical data used X2/Fisher’s exact test(p<.05) -sample 80% power (N=126)	No difference in Length of stay (LOS) in hospital in 1 & 2 (p=.49) -ICU LOS shorter (p<.01) - group 2 increased ketone assessment (p=.030),glucose testing (p,.010), anion gap closure (p<.01)	Single investigator collected data-interpretation & reporting bias -design limitations, need further studies (RCT) -different screening methods used for both groups-patients

	criteria stated			may have been missed
Glaser et al. 2001	Objective: to evaluate the association between cerebral edema(CE) and demo & biochem characteristics, & interventions -case-control study -multicenter study, 10 pediatric centers USA & Australia -group 1(N=61)DKA&CE -group 2(N=181)(control)DKA no CE randomly selected -group 3 (N=174)(control)matched	-logistic regression used to compare 3 groups -1 data recorder each site, 10% recorders tested for interrater agreement (kappa stat 0.9) -analysis of variance for continuous variables &chi-square for categorical	Group1 & group2 comparison: CE associated with lower arterial CO2 ($p<0.001$)& higher serum urea nitrogen concentration($p=0.003$) -Group1 & group3 comparison: same as 1&2and use of bicarbonate($p=0.008$)	Confounding factors not tested influenced findings -participants without CT scan can't be certain neurological signs are due to CE.

Jackman et al. 2015	Objective: to identify characteristics and precipitating factors associated with pediatric DKA -retrospective cross-sectional study -tertiary pediatric hospital, St.John's NL -Chart review, data collected by research nurse using piloted tool -inclusion criteria given	-demographics, biochemical characteristics, & reasons for DKA analyzed.- -Chi-square & Fishers exact tests used with categorical variables -t-test & non-parametric Kruskal-Wallis tests for continuous	-90 children with DKA, 39.5% newly diagnosed, 60.5% previously diagnosed -more sever DKA occurred in younger new patients -49.1% recurrent DKA -64% with DKA had a missed diagnoses of type 1 diabetes -most cases of DKA could be prevented	Possible interpretation and reporting bias due to chart review - represents single sample (decreased general -izability -sample bias, more sever DKA and younger children, transfer of patients from community hospitals to tertiary hospital
Pawlowicz et al. 2009	Objective: to estimate frequency of difficulties in T1DM diagnosis and influence of demographic factors -Hospital in Poland & 19 regional hospitals -N=474 children with delayed diagnosis T1DM	Excel used to construct data; clinical, lab, family history Statistics analyses performed by Statistics 7.1 -Shapiro-Wilk test analyzed variables for normal spread	Difficulties in diagnosing T1DM found in 67 cases (14.13%) main cause of DKA (p=0.00) -Patient's age significant influence on diagnosis delay (p=0.01), children below 2 years (p=0.00)	Possible bias due to chart review (interpretation and reporting) -single sample decreased general -izability

	-retrospective hospital chart review -cross-sectional study design	-parametric tests for stats analysis (normal) -non-parametric used for non-normal -non-parametric X2 test used for qualitative variables -significance level p=0.05		
Fritsch et al. 2011	Objective: to determine incidence & risk factors for pediatric DKA -data base in Germany & Austria N=28,770 children with T1DM -cross-sectional design method	-descriptive data as mean positive and negative standard deviation -Comparisons made with Kruskal-Wallis test or Fisher's exact test -confounding effects of demographic data multivariable	94.1% no episode DKA -4.9% 1 episode -1.0% recurrent Comparison of these 3 group , recurrent group had higher age ($p<0.01$), A1C($p<0.01$), & insulin dose ($p<0.01$) DKA higher in females ($p=0.03$) and migration background ($p=0.02$)	Sample collected from large data base covering large area, variation in DKA related to services & education available -retrospective-reporting and interpretation bias -reliability and validity of data collection system reported
Hanas, Lindgren, and Lindblad, 2009	Objective: to investigate triggering factors and insulin pumps on DKA -cross-section design	Results presented as mean positive and negative standard deviation	142 episodes DKA -reported causes of DKA : missed insulin(48.6%), gastroenteritis (14.1%), pump problems (12.7%),	Gastroenteritis may cause a false diagnosis of DKA

	-retrospective data collection -questionnaire completed by Diabetologist at each center -all diabetes centers in Sweden -N=292 cases of DKA out of 265 children N=115 used for this study	-two-sided t test adjusted for unequal variances, Levene's test compared means	infection (13.4%), social problems (1.4%), unknown (5.6%) -30 patients used insulin pumps, -overall incidence of DKA 1.7/100 patient years in 2000 -incidence DKA in pump users 3.6/100 -DKA frequency in pump users was twice that of injections. 77% occurred within 1 year after pump use.	-study was performed when pump use increased rapidly, patient were not use to trouble shooting pump to avoid DKA -possible Bias due to Diabetologists reporting and interpreting data
Chan and Zang, 2007	Objective: to identify nurses' perceived & actual diabetes knowledge and relationship with nurses' profile -descriptive correlation survey -2 hospitals in Hong Kong -N=245 nurses -Questionnaire (2 parts)-content validity score 0.99. strong construct validity & internal	SPSS used for data analysis -cluster analysis used -ordinal data and skewed patterns, chi square test & Kruskal-Wallis test used -Mann-Whitney U test used for post hoc pair-wise analysis	Results showed 3 clusters: Cluster 1=good competency and good knowledge Cluster 2=positive and moderate competence & knowledge Cluster 3=low competence & knowledge -nurses' perceived knowledge was significantly correlated with actual knowledge (rs=0.32) -Nurses' diabetes knowledge should be provided and maintained at a certain level	Self-reported questionnaire – bias -convenience sample-not random-bias, not represent population -small sample restricted to 2 hospitals, decrease general -izability

	consistency reported -convenience sample			
Hollis, Glaister, and Lapsley, 2014	Objective: to determine the diabetes knowledge level of nurses I regional/rural setting in Australia -cross-sectional study design -questionnaire (14 items) Pilot tested & Internal consistency (alph=0.94) -N=52 nurses Response rate of 57%	Data analysis presented as mean and percentages -no other info given regarding statistical	Pathophysiological knowledge was strong (M=88%), glucose monitoring (87%), dietary less strong (79.5%), medication (54%) -nurses have deficit in diabetes knowledge and need continuing education	Convenience sample-not random-bias -small sample restricted to 1 region in Australia -questionnaire-recall & reporting bias

Appendix B: Consultation Report

Consultation Report for the Development of a Self-learning Module

on Pediatric Diabetes Ketoacidosis

Memorial University

Leeann Wadman

Consultation Report for Development of a Self-Learning Module on Pediatric Diabetes Ketoacidosis

In fulfillment of N6660 I propose to develop a self-directed learning module for rural emergency nurses on the prevention, diagnosis, and treatment of pediatric diabetes ketoacidosis (DKA). Providing continuing education opportunities based on pediatric DKA is important because rural emergency nurses are infrequently exposed to pediatric emergencies resulting in decreased confidence and knowledge of applicable clinical practice guidelines. Type 1 diabetes is the most common form of diabetes in children and the Avalon Peninsula of Newfoundland has one of the highest incidences of type 1 diabetes reported worldwide (Newhook et al., 2004). A complication associated with diabetes is DKA, which is a life threatening condition caused by elevated blood sugars resulting in production of an acid called ketone in the blood. DKA is a leading cause of hospitalization and the leading cause of death and morbidity among children with type 1 diabetes. Due to the increase in prevalence of type 1 diabetes worldwide, the possibility of increasing DKA events is concerning (Alaghehbandan et al., 2006). However, DKA is a preventable condition (Jackman et al., 2015; Glaser et al., 2001; Edge et al., 2012; Tieder et al., 2013). Educating nurses is an important step in reducing the incidence of DKA. When nurses are knowledgeable on the prevention, diagnosis, and treatment of DKA they can provide ongoing patient education to reduce complications associated with type 1 diabetes.

A self-learning module was selected because this style of learning allows the individual to take initiative and responsibility for their learning. Using the self-directed learning module will allow nurses to select, manage, and assess their own learning

activities, which can be pursued at any time or place (Garrison, 1997). A self-learning module facilitates learning but nurses will be responsible for planning, implementing, and evaluating their own work (O'Shea, 2003). The module will be available on the Eastern Health intranet in an attempt to increase access to nurses. I will use the information form the Newfoundland and Labrador Pediatric DKA Project that was distributed to rural emergency departments and doctor's offices in 2013. The learning resource provides education to health care providers on early detection of type 1 diabetes, diagnoses, prevention and treatment of diabetic ketoacidosis.

At Placentia Health Center several nurses reported not reviewing the pediatric DKA binder. Therefore, additional interventions are needed to assist with dissemination of the DKA protocols/guidelines including ongoing support to ensure nurses avail of the information in the learning module. Providing practitioners with support during the implementation phase of clinical practice guidelines (CPG) is essential. Ongoing monitoring is needed until the CPG becomes a routine part of practice. Research has shown that there are many ways to support dissemination and implementation of CPG. These include education, leadership support, champions, facilitators, team work, advocates, and interdisciplinary approach (Ploeg et al., 2007; Banait et al., 2003; Bekkering et al., 2005; Jain et al., 2006; Barrios et al., 2012; Bahtsevani , William, Stiltz, & Ostman, 2010). Working with site managers and selecting staff that are strong leaders to act as site champions would ensure that the self-directed learning module, which is based on the clinical practice guidelines for treating DKA, is reviewed and that the information is applied when a child with DKA presents to the emergency. Poster

distributed to the rural emergency could make nurses aware of the module on the intranet. Another way to bring awareness to the location of the module is to create a webinar for ER nurses. On nursing education days, a short presentation on the module could be delivered.

Consultations

Consultations were conducted with a variety of individuals including; experts working at the Janeway Children's Hospital, rural emergency department nurses, nursing educators, and parents. The data collected will be used to develop a self-learning module on pediatric DKA for rural emergency nurses. The consultation objectives were:

1) To establish support for the development of a self-learning module for rural emergency nurses on the prevention, diagnosis, and treatment of pediatric DKA.
2) To supplement the self-learning module with content based on expert opinion.
3) To enhance the self-learning module with information collected from individuals who have experienced children with DKA and are not experts (junior nurses and parents).
4) To develop an effective self-learning module that will make nurses want to learn about pediatric DKA.

Consultation Methodology

Setting

Permission was obtained from site manager to conduct interviews at Placentia Health Center in the board room. However, if the individuals had an office at the site it was used for the consultation. Interviews with experts from the Janeway Children's Hospital were all conducted via telephone. The Placentia Health Center consists of an emergency department (ER), a ten bed acute care unit, three units of long term care, and an outpatients department (OPD). The ER is staffed by eight full time nurses and relief is provided by casual and float nurses. General Practitioners form the OPD provide physician on call coverage.

Consultants

A total of ten consultations were conducted involving one novice nurse, one senior nurse, the PHC Nurse Manager, two parents of children with type 1 diabetes, an Endocrinologist, Diabetes Nurse Educator, Nurse Researcher, Clinical Nurse Specialist (CNS), and Clinical Educator (CE). The novice nurse graduated in 2013, works as a float nurse covering acute care, ER, and long term care, and has limited pediatric experience. The senior nurse has worked as a RN for 20 years and holds a bachelor's degree with an ER certification.

The PHC Nurse Manger of the ER is new to the position, holding the position for the past three months. She has a master's of nursing degree and has held various nursing

positions throughout her 15 year career. Her work duties include overseeing operations of the ER, acute care, and one unit of the long term care.

Two parents of children with type 1 diabetes were interviewed. One child developed type 1 diabetes at the age of five and has been living with the chronic disease for eight years. The child uses an insulin pump and continuous glucose monitor. The second child is 13 years old and was newly diagnosed with type 1 diabetes six months ago. At the time of diagnoses the child presented to the ER and was in DKA, resulting in admission to the Janeway Intensive Care Unit (ICU).

The Endocrinologist consulted works at the Janeway Children's Hospital, teaches at Memorial School of Medicine, and is a researcher. She has written several research articles on the incidence and prevalence of type1 diabetes and DKA in Newfoundland and Labrador. The Nurse Researcher works at the Janeway and played an important role in the development and dissemination of the Newfoundland and Labrador DKA Project. She has experience developing learning modules for healthcare professionals.

The Diabetes Nurse Educator has thirty years of experience working at the Janeway primarily with diabetes education and insulin pump training. She developed a DKA toolkit for families living with type 1 diabetes to teach DKA prevention and diagnosis. She has nursing research experience primarily focused on type 1 diabetes and DKA incidence and prevalence in Newfoundland and Labrador.

The Clinical Nurse Specialist working with the Emergency and Paramedicine program was consulted. She has a Bachelor' and Master's degree in nursing and has spent the majority of her 30 year career in policy development and education. She has limited

pediatric experience. She is responsible for the Emergency Department homepage on the Eastern Health Intranet and has experience developing educational materials and presentations for nurses.

The Clinical Educator for Janeway Emergency Services has a Master's degree in nursing and has been working in her current position for ten years. She is responsible for the learning needs of nurses working at the Janeway Emergency. She has experience disseminating clinical practice guidelines (CPG) and providing onsite support to nurses as they learn and implement CPG.

Data Collection

Data was collected by project developer via interview, limited to 30 minutes. However, two interviews went over the 30 minute time frame. Times for interviews were prearranged with the consultants by telephone or email. A group of parents known to the primary developer were informed of the plan to develop a learning resource and volunteered to provide information for the project. A script (Appendix A) was used to guide the interview. If the consultant needed clarification of questions by the interviewer the script was modified. Throughout the interview the participant's responses to questions were recorded on paper. To ensure responses recorded were accurate the interviewer's notes were read back to the interviewee.

Data Analysis

All responses to questions made by consultants were transcribed into a table in a Microsoft Word document. The responses were organized by question and analyzed for

common themes between similar types of participants. Common themes across groups were also observed. Different responses that did not fit any theme were also identified.

Ethical Considerations

According to the checklist found in appendix B review by the Health Research Ethics Review Board was not required to develop a self-directed learning module for rural emergency nurses on the diagnosis, prevention, and treatment of pediatric diabetes ketoacidosis. When collecting data from consultants through an interview process it is the responsibility of the project developer to ensure the protection of study participants and to remain alert to unanticipated ethical dilemmas (Streubert & Carpenter, 2011). Several steps were taken by the project developer to ensure the consultant`s privacy was maintained and that the data was not bias.

Invitation letters (Appendix C) were distributed to consultants via email and at the beginning of the interview the letter was read to the consultant by the interviewer. The letter informed potential consultants that they had the right to refuse to participate and to refuse to answer any questions. Assurance of confidentiality was provided by informing the participants that the data collected would be stored in a locked filing cabinet, that initials instead of names were written on the notes from the interview, and that the data would be destroyed once the module was developed. Participants had the opportunity to ask questions and contact information for the developer and supervisor were provided.

Bias

The sample of consultants interviewed was selected by the developer on the bases of accessibility. Therefore, the sample was a convenient sample. Bias can influence a

distortion in data collection, thus distorting the truth. A convenient sample may introduce bias (Polit & Beck, 2012). Steps were taken by the developer to reduce possible bias. Consultants were encouraged to answer questions honestly. They were told that their opinions, based on their experience, were valuable and would be used to develop a module that would benefit nurses as they cared for children with type 1 diabetes.

Results

Seven questions were asked in the interview process (Appendix C) and ten interviews were conducted. Open-ended questions were used and clarification was given when requested by participants. Common themes were identified from the data collected which will be used as module content and to develop a dissemination plan. Consulting with healthcare workers and parents I learned that prevention education is important to reduce the incidence of DKA. It is important to develop and design the self-learning module based on the learning needs of rural nurses highlighting the needs of children/families with type 1 diabetes. 100% support was received from the participants interviewed. Themes that emerged from the interview data included:

1) Content: assessment skills including vital signs, Glascow Comma Scale, dehydration, monitoring for cerebral edema, signs and symptoms of DKA, risk factors, clinical practice guidelines, triaging information, IV initiation in children, and sick day management.

2) Design: electronic format, printable option, nursing resource, suit nurses learning style and work/life style, standardization of care, visually appealing, use of color, diagrams, point form, pictures, algorithms, and quizzes with case studies.
3) Dissemination plan: posters, support from managers/champions, lectures, presentations on education days, communication binder, and webinars.
4) Support: incorporate family centered care; develop relationship between parents and nurses based on trust, understanding, support, and partnership. Parents should be respected, understood, informed, supported, and present. Nurses should act as advocates, share information, and help reduce stress. Nurses require support as they complete continuing education. Forms of support include: granting of continuing competency program hours, managerial/employer, make education flexible and accessible, time to complete module at work (night shifts), nursing champions, praise, and recognition

The module will be a resource, help standardize care, increase nurses' comfort level, and increase parents' confidence level in the care offered in rural ERs.

There were some responses made in the interviews that were different from what other participants stated. Parents of children with type 1 diabetes stated that they felt that it was the accountability of the employers (Eastern Health) and employees (doctors, nurses) to be knowledgeable in the diagnosis, and treatment of diabetes and DKA. One parent stated that the module could help prevent missed diagnosis of diabetes and prevent invasive treatment in ICU for DKA. The Nurse Manager commented that emails do not work when communicating with nurses regarding education materials. She also

commented that dissemination would be more effective if completed by developer, instead of passing it on to a third party to disseminate, because this method is more personable and allows the nurse to identify with developer.

The responses made by members from the same group, i.e. rural nurses, expert consultants, and parents, were similar with common themes among groups. The interviews provided useful data for module content and plans for dissemination of the module.

Discussion

The participants' responses are important because they helped to identify needs of nurses and families in rural emergency departments when pediatric DKA occurs. The common themes identified are reflective of Knowles' Adult Learning Theory, the Instructional Design Framework, and the philosophy of family centered care.

Knowles' Adult Learning Theory

Knowles' Adult Learning Theory recognizes that the adult learner is an autonomous and self-directed learner, who is motivated to learn and incorporates choice and responsibility into the learning process. This theory is appropriate for educating nurses about pediatric DKA prevention, diagnosis, and treatment because it identifies the learners needs and focuses on self-directed learning. The following are needed for optimum learning to occur; a need to know, a responsibility for one's own learning, the role of experience as a tool for learning, the ability to apply the information to ones' life situation, motivation to learn, and problem centered learning with real life problems (as cited in Mitchell & Courtney, 2005).

The self-directed learning module content will incorporate Knowles' six elements of adult learning: (1) a need to know; when interviewed rural ER nurses stated that they wanted to learn about DKA to provide better care to their patients (2) a responsibility for ones' own learning; nurses and nursing experts felt that continuing education was a part of nurses' accountability and that education should be flexible to allow them to meet continuing education needs, (3) the role of experience as a tool for learning; nurses stated that the module should include case studies based on typical presentations and scenarios in the emergency department allowing nurses to build upon existing knowledge and experience, (4) ability to apply information to one's life experiences, (5) applying problem centered care to real life problems; to encourage nurses to use the module interview participants stated that information regarding the incidence and prevalence of type 1 diabetes and complications (e.g. DKA) should be included. Reinforcing this information will enable nurses to relate the importance of learning about clinical practice guidelines to treat diabetes emergencies in their specific work site and community, and (6) motivation to learn; interview data showed that nurses require support from the employer and site manager or clinical educator to meet education needs. Making education flexible and accessible, provide CCP hours, praise, and recognition will help motivate nurses to learn about pediatric DKA.

Instructional Design Framework

The Instructional Design Framework (IDF) offers an outline for designing education lessons. IDF is appropriate to guide the development of the self-directed learning module (Kinzie, 2005). IDF consists of five stages: (1) gain attention; nurses

requested identification of risk factors associated with type 1 diabetes and pediatric DKA and use of case studies to illustrate main points, (2) present stimulus material; participants suggested that the module include information regarding the pathophysiology of type 1 diabetes and associated complications, use of supplementary material to aid learning including illustrations, charts, and quizzes after each module, (3) use models to demonstrate; participants stated that making the module visually appealing will entice nurses to use it, suggestions included; use of color, flow charts/diagrams, intranet, posters, point form, easy to use, and interactive, (4) elicit performance; nurses requested that the module include case studies and quizzes (5) enhance retention; interview participants agreed that the module should include a review section to test knowledge and encourage critical thinking and reflection.

Family Centered Care

The Emergency Department site on the Eastern Health webpage states that patient and family centered care is an approach to the planning, delivery, and evaluation of healthcare that focuses on partnership between patients, families, and healthcare workers. Family plays a vital role in ensuring the well-being of a patient. This concept underpins the philosophy of family centered care. The principles of family centered care include; dignity and respect, information sharing, participation, and collaboration. To communicate more effectively with patients and families healthcare workers have to show families that they care about them, understand their concerns, and that they can be trusted to take care of them (Eastern Health, 2015). Providing emotional support to families when the children require treatment in an ER contributes to positive coping with

children's medical problems (Hemmelgarn, Glisson, & Dukes, 2001). Nursing has a good understanding of family-centered care and a positive attitude toward the philosophy (Coyne et al., 2011; Trajkovski et al., 2012). The data provided from nurses and nursing experts supported family-centered care in the ER and they believed that the healthcare worker and parent relationship should be based on trust, respect, and understanding. Nurses stated that they are advocates for patients and hope to reduce stress for parents when their child is ill. However, research shows that a family centered approach is not always used by nurses (Uhl, Fisher, Docherty, & Brandon, 2013; Khalaila, 2014; Mikkelsen &Frederiksen, 2011). The module will incorporate the family centered care philosophy through the use of case studies, and scenarios. Education on this topic will provide support to nurses as they incorporation the philosophy when working with families experiencing DKA.

Conclusion

The consultation objectives for this project were met. Support was provided by all participants throughout the ten consultations for the development of a module based on pediatric DKA. I learned that the nurses are not familiar with the DKA clinical practice guidelines and are not comfortable caring for critically ill children. Therefore, the module is a necessity. Rural ER nurses and Nursing Experts provided valuable suggestions for module content to ensure nurses' learning needs were addressed. Suggestions included information on assessment skills, insulin pumps, risk factors, monitoring for cerebral edema and dehydration, clinical practice guidelines, and sick day management. Parents provided insight regarding their experiences and the importance of family-centered care

when treating children with DKA in the ER. Parent's stated that they wanted to be part of their child's care by being informed, supported, present, and understood. The nursing participants stated that parents should be supported and considered a partner in their child's care. However, I was surprised to learn that there is a contradiction between what nurses' say and what they do because the literature states that nurses do not always apply family centered care to their practice. This issue will be addressed in the module through use of case studies and scenarios.

Parents reported that they believed it is the responsibility of the employer to ensure nursing staff are versed in the prevention, diagnosis, and treatment of DKA. It is challenging to provide nurses with the required education due to the restrictions Eastern Health have placed on funding for continuing education. Experienced CE and CNS stated that the task of providing education in the work place is an ongoing challenging issue. Therefore, it is essential to develop, disseminate, and provide ongoing support for the module using creative methods to ensure the education reaches nurses and benefits patients. Seeking input from participants on how to develop and disseminate the module will make nurses want to learn about DKA. The suggested dissemination plan included active ongoing support from managers and champions, use of follow up to address questions and concerns and identify problems with module use, use of intranet for access, webinars, and presentations at nursing education days.

Overall, the consultations were successful in meeting the outlined objectives ensuring that the module is worth creating, contains valuable information for nurses to

improve care, and is disseminated in an effective way so nurses are aware of its existence, avail of it, and apply CPG when treating a child with DKA.

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Appendix A

Interview Questions

Interview Questions

Thank-you for participating in this interview. I encourage you to be open and honest when stating your opinion. The consultation objectives are:

1) To establish support for the development of a self-learning module for rural emergency nurses on the prevention, diagnosis, and treatment of pediatric DKA.
2) To supplement the self-learning module with content based on expert opinion.
3) To enhance the self-learning module with information collected from individuals who have experienced caring for children with DKA at home and in Health Center.
4) To develop an effective self-learning module that makes nurses want to learn about pediatric DKA.

Meeting the stated objectives will assist with the development of a self-learning module which will benefit rural emergency nurses and the patients they care for.

Interview Questions

1) Do you think there is a need for a self-learning module for rural emergency nurses based on prevention, diagnosis, and treatment of pediatric DKA? Please Explain.
2) What value does such a module have to emergency care practice and the health of children with type 1 diabetes?
3) What are three critical things an Emergency Nurse should know when caring for a child with DKA? What else should they know?

4) What is the best way to design and disseminate the module so nurses will use it?

5) What is the best way to provide support to nurses as they attempt to satisfy continuing

education needs?

6) Parent Question: If your child became ill and required care in the ER, what would be your expectations regarding the care received and your relationship with the Healthcare Workers providing the care?

7) Nurses and Nursing Experts Question: When caring for a child in DKA in the ER, what are your expectations regarding the relationship with parents?

Appendix B

Health Research Ethics Authority Screening Tool

	Question	Yes	No
1.	Is the project funded by, or being submitted to, a research funding agency for a research grant or award that requires research ethics review	❒	●
2.	Are there any local policies which require this project to undergo review by a Research Ethics Board?	❒	●
	IF YES to either of the above, the project should be submitted to a Research Ethics Board. **IF NO** to both questions, continue to complete the checklist.	❒	❒
3.	Is the primary purpose of the project to contribute to the growing body of knowledge regarding health and/or health systems that are generally accessible through academic literature?	●	❒
4.	Is the project designed to answer a specific research question or to test an explicit hypothesis?	❒	●
5.	Does the project involve a comparison of multiple sites, control sites, and/or control groups?	❒	●
6.	Is the project design and methodology adequate to support generalizations that go beyond the particular population the sample is being drawn from?		☒
7.	Does the project impose any additional burdens on participants beyond what would be expected through a typically expected course of care or role expectations?	❒	●
LINE A: SUBTOTAL Questions 3 through 7 = (Count the # of Yes responses)		2	5
8.	Are many of the participants in the project also likely to be among those who might potentially benefit from the result of the project as it proceeds?	●	❒
9.	Is the project intended to define a best practice within your organization or practice?	●	❒
10.	Would the project still be done at your site, even if there were no opportunity to publish the results or if the results might not be applicable anywhere else?	●	❒
11.	Does the statement of purpose of the project refer explicitly to the features of a particular program, Organization, or region, rather than using more general terminology such as rural vs. urban populations?	❒	●
12.	Is the current project part of a continuous process of gathering or monitoring data within an organization?		0
LINE B: SUBTOTAL Questions 8 through 12 = (Count the # of Yes responses)		3	2
	SUMMARY **See Interpretation Below**	5	7

Interpretation:

- If the sum of Line A is greater than Line B, the most probable purpose is **research**. The project should be submitted to an REB.
- If the sum of Line B is greater than Line A, the most probable purpose is **quality/evaluation**. Proceed with locally relevant process for ethics review (may not necessarily involve an REB).
- If the sums are equal, seek a second opinion to further explore whether the project should be classified as Research or as Quality and Evaluation.

These guidelines are used at Memorial University of Newfoundland and were adapted from ALBERTA RESEARCH ETHICS COMMUNITY CONSENSUS INITIATIVE (ARECCI). Further information can be found at: http://www.hrea.ca/Ethics-Review-Required.aspx

Appendix C

Invitation Letter

Dear Potential Consultant,

I am writing to invite you to participate in an interview related to the development of a learning module covering the prevention, diagnosis, and treatment of pediatric diabetic ketoacidosis (DKA). The learning module is a practicum project in partial fulfillment of my master in nursing degree at MUN. Consultation with key stakeholders is a requirement of the project and I would appreciate about 30 minutes of your time to explore your perspective on the learning module. The purpose of the module is to circulate the DKA clinical practice guidelines to rural emergency nurses to increases their comfort level when caring for children experiencing DKA, to ensure patients are receiving the best possible, evidence based care, and to improve patient outcomes.

In 2013 Dr. Leigh Anne Newhook conducted a campaign to bring awareness to the prevention, diagnosis, and treatment of pediatric DKA. Information binders and posters were distributed to emergency departments and clinics throughout eastern Health. I propose to develop a self-learning module that will supplement the binder and assist with the dissemination of the information. A self- learning module has been selected to allow rural emergency nurses to set their own learning pace and review additional information, depending on their learning needs. A literature search has been conducted and information has been collected to include in the module. In addition, I am seeking your expert opinion and experience in regards to what should be included in the module.

Your participation is voluntary and you can withdraw your decision to participate at any time. You are free to refuse to answer any questions you wish throughout the interview. Offering your knowledge and advice on the development of the module will benefit nurses as they care for children with type1 diabetes experiencing complications such as DKA. Your involvement will require approximately thirty minutes of your time, with no physical risk to you.

The information gathered will be kept in a secure and locked location until the module has been developed, then the data will be destroyed. The only individuals that will see the data are the developer, Leeann Wadman, and Memorial University Master of Nursing Program Advisor, Joy Maddigan.

If you have any questions regarding this project and your involvement please contact Leeann Wadman BNRN, Principal Project Developer at (709) 227-0104 or by

email at leeann.wadman@easternhealth.ca. Joy Maddigan PhD, can be reached at jmaddagan@mun.ca

Please keep a copy of this letter for your records. Your involvement in the interview will indicate you read the letter and are consenting to participate as a consultant.

Thank-you for your time.

Sincerely,

Leeann Wadman BNRN

Appendix C

Self-learning Module for Rural Emergency Nurses

On Pediatric Diabetic ketoacidosis

Table of Contents

Unit Three: Prevention

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Introduction

Why should rural emergency nurses complete this self-directed learning module on pediatric diabetic ketoacidosis (DKA)?

Type 1 diabetes is the most common form of diabetes in children and the Avalon Peninsula of Newfoundland has one of the highest incidences of type 1 diabetes reported worldwide (Newhook et al., 2004). DKA, a complication related to hyperglycemia, is a leading cause of hospitalization and the leading cause of death and morbidity among children with type 1 diabetes. The increase in prevalence of type 1 diabetes worldwide can contribute to an increase in episodes of DKA (Alaghehbandan et al., 2006). However, DKA is a preventable condition (Jackman et al., 2015; Glaser et al., 2001; Edge et al., 2012; Tieder et al., 2013). There is a very large chance that a child with DKA may arrive at any rural Emergency Departments within Eastern Health. This module will help you prepare to provide standardize care through the use of clinical practice guidelines, while applying family-centered care, contributing to improved patient outcomes.

According to the Association of Registered Nurses of Newfoundland and Labrador (ARNNL) the standards of practice for registered nurses are broad statements that outline the performance required of registered nurses. The standards require Registered Nurses to assume responsibility for continuing competency, through participating in the continuing competency program, and maintaining and enhancing their knowledge and skills (ARNNL, 2013). Parents emphasized during consultation that they expect nurses in the Emergency Department to know how to care for children with DKA. This module will provide you with a continuing education opportunity which will build on your existing knowledge of diabetes.

What is the purpose of the module?

This module will act as a resource when you are providing care to children and their families experiencing DKA. The self-learning module has been developed to enhance your knowledge and competencies. The module provides overview of the clinical practice guidelines for treating pediatric DKA which standardizes care across all Eastern Health Emergency Departments. Adherence to clinical guidelines is shown to improve outcomes in children with diabetes experiencing DKA and this module is designed to customize the clinical practice guidelines to make them more useful to nurses working in rural emergencies.

The module is comprised of three units that cover the diagnosis, treatment, and prevention of DKA in children from 0-18 years of age. More specifically:

Unit One provides information on DKA and how it is diagnosed. The information focuses on assessment skills required to triage, provide continuous patient care in the ER department, and patient transfer via ambulance to the Janeway Children's Hospital. Unit one includes topics such as: dehydration, vital signs, level of consciousness, and pertinent laboratory values.

Unit Two contains information on the treatment of DKA. The clinical practice guidelines for treating DKA are reviewed. Additional information is included on types of insulin, intravenous fluids (IV), IV initiation in children, and cerebral edema which can be a complication associated with treatment of DKA.

Unit Three addresses the prevention of DKA. This section is critical because DKA is preventable. With appropriate knowledge and skill children and their families can learn to avoid DKA and ER nurses can make an important contribution to their health and well-being. Topics in this unit include early detection of type 1 diabetes, prevention of hyperglycemia by trouble shooting insulin pumps, preventing DKA when experiencing hyperglycemia due to viruses or bacterial infections, and review of behaviors which may lead to hyperglycemia and DKA.

What is the best way to use this Module?

A self-directed learning module was chosen to provide you with up-to-date comprehensive information that you can complete at your own pace and convenience. It is recommended that you review the sections of the module in sequence and complete the questions after each section. If you require additional information to supplement the module links to web sites will be provided at the end of the module along with answers to questions.

Unit One: Diagnosis

Unit one provides guidance on the key features of the patient assessment required for an accurate diagnosis of DKA. An understanding of what DKA is and its pathophysiology will help with history taking and physical assessment of a child with DKA. It is important to pay particular attention to the signs and symptoms of dehydration, the vital signs, level of consciousness, and laboratory values. The information collected through the assessment will help determine the appropriate treatment.

Section 1.1 Pathophysiology of Diabetic Ketoacidosis

Upon completion of Section 1.1 you will be able to:

- Define diabetic ketoacidosis (DKA)
- Describe the pathophysiology of DKA

Without insulin, glucose is unable to enter the cell, thus, increasing the blood streams concentration of glucose. When glucose is unavailable for cellular metabolism the body chooses alternate sources of energy, principally fat. Through the digestive process fats are broken down into fatty acids and glycerol. The fat cells is then converted by the liver to ketone bodies, including beta-hydroxybutyric acid, acetoacetic acid, and acetone. Excess ketones are eliminated in the urine or the lungs. The ketone bodies in the blood are strong acids that lower serum pH, producing ketoacidosis (Hockenberry & Wilson, 2011).

Ketones are organic acids that produce excessive quantities of free hydrogen ions, causing a fall in plasma pH. When this occurs, chemical buffers in the plasma, principally bicarbonate, combine with the hydrogen ions to form carbonic acid, which breaks down into water and carbon dioxide. The respiratory system attempts to eliminate the excess carbon dioxide by increasing the depth and rate of breaths (Hockenberry & Wilson, 2011). The ketones are buffered by sodium and potassium in the plasma. The kidneys attempt to compensate for the increase in pH by increasing tubular secretion of hydrogen and ammonium ions in exchange for fixed base, depleting the base buffer concentration (Hockenberry & Wilson, 2011).

> Kussmaul respirations are the hyperventilation characteristics of metabolic acidosis.
>
> Hockenberry &Wilson, 2011

When cells die, potassium is released from the intracellular fluid to the extracellular fluid, the blood stream, and excreted by the kidneys. The total body potassium is decreased, even though the serum potassium level may be

elevated as a result of decreased fluid volume. Alteration in serum and tissue potassium can cause cardiac arrest (Hockenberry & Wilson, 2011).

If these conditions are not reversed by insulin therapy in combination with correction of fluid deficiency and electrolyte imbalance, progressive deterioration occurs. Complications include dehydration, electrolyte imbalance, acidosis, coma, and death. Diabetic ketoacidosis (DKA) should be diagnosed promptly and treated in an intensive care unit (TREKK, 2013).

SIGNS and SYMPTOMS of DIABETES

- **Hyperglycemia:** increased concentration of glucose in the blood
- **Glycosuria:** glucose in the urine
- **Polyuria:** increase in volume of urine
- **Polydipsia:** excessive thirst
- **Polyphagia:** increased hunger
- **Weight loss**
- **Recurrent vaginal and urinary tract infections**, especially **Candida Albicans** (yeast infection)
- **Abdominal discomfort**
- **Dry skin**
- **Blurred vision**
- **Sores that are slow to heal**
- **Nocturia:** bed wetting
- **Decreased energy**

Section 1.2: Assessment

Upon completion of this unit you will be able to:

- Identify the signs and symptoms of diabetes and DKA
- Discus the diagnostic criteria for DKA
- Differential between mild, moderate, and severe DKA

Rural nurses may conduct initial assessment of a children experiencing DKA. Therefore, it is of primary importance for nurses to understand the signs and symptoms of diabetes and DKA. A large number of children are diagnosed with type 1 diabetes because they become fatally ill with DKA. The signs and symptoms of diabetes are listed in the textbox to the left. **The following is a clinical example of a child presenting to triage with new onset type 1 diabetes**.

Connie is a five year old female brought to the ER by her mother. The mother reports a four week history of increased thirst, increased appetite, weight loss, decreased energy and two episodes of wetting the bed at night. On exam Connie reports that her abdomen hurts but it is not tender to touch. Blood glucose is 20mmol/L, Glasgow Coma Scale is 15, and vital signs are normal. Urinalysis is positive for ketones and glucose.

SIGNS and SYMPTOMS of DKA

- Polyuria
- Polydipsia
- Dehydration
- Weight loss
- Lethargy
- Nausea and/or vomiting
- Abdominal pain
- Fruity or acetone-smelling breath
- Flushed face
- Confusion
- Hyperventilation and Kussmaul breathing (rapid, deep, sighing mouth-breathing)
- Increased heart rate and increased respirations, and possible low blood pressure
- Assess for signs and symptoms of infection

Wolfsdorf et al., 2014

DKA signs and symptoms. A child presenting with DKA may have a new diagnosis of diabetes, therefore, their presentation may include the signs and symptoms of diabetes plus the signs and symptoms of DKA. A child with a new onset of diabetes presenting with DKA may report a history of symptoms that has been occurring for a longer duration; not just days but weeks or months. However, a child with existing type 1 diabetes can develop DKA over a short period of time; within hours. The signs and symptoms of DKA can be found at the textbox to the left and figure 1on page 9.

The following is a clinical example of a child presenting to triage with a diabetes and DKA.

Sam, a 13 year old boy, presents to the ER with his parents. Sam looks unwell. Parents report that Sam's blood glucose has been greater than 20 mmol/L for the past 24 hours. He uses an insulin pump and the insulin site was changed yesterday morning. He has been taking correction boluses to lower the glucose reading but they remain high. Sam reports abdominal pain, nausea and two episodes of vomiting. His

breath has a fruity smell and respirations are deep and rapid. Sam is sleepy and slightly confused. Blood glucose is 24mmol/L, respirations 28, pulse 100, blood pressure 100/60 and temperature 36ºC. Glasgow Coma Scale is 13. Urine is positive for glucose and ketones.

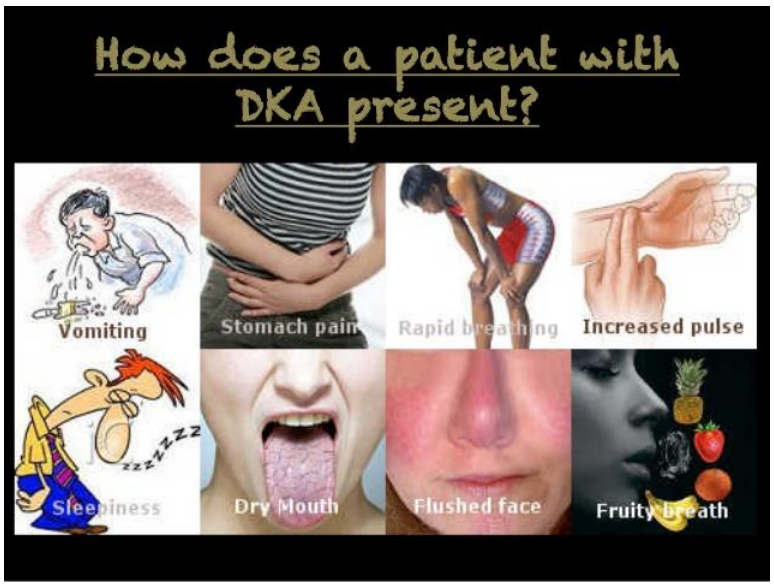


Figure 1: Signs and symptoms of DKA. Retrieved from: http://www.slideshare.net/kerrynrohit/diabetic-ketoacidosis-40748135

Along with the patient assessment and presenting complaint, **blood work** is needed to determine a diagnosis of DKA. Once the blood work has been analyzed a confirmed diagnosis of DKA can be made. The diagnostic criteria for DKA can be found in the textbox to the right.

The **severity** of the DKA depends on the extent of the pH/bicarbonate depression (Wolfsdorf et al., 2014) and is outlined in Table 1 below. To determine the severity of DKA, pH and bicarbonate levels must be measured. The lower the pH and bicarb levels are, the greater the severity DKA.

Diagnostic Criteria for DKA

- Hyperglycemia >11 mmol/L
- Venous pH< 7.3
- Sodium Bicarbonate < 15 mmol/L
- Moderate or large ketone level in blood or urine

Wolfsdorf et al., 2014

Table 1

Assessing Severity of DKA

Severity of DKA	pH	Bicarb
Mild	<7.3	<15mmol/L
Moderate	<7.2	<10mmol/L
Severe	<7.1	<5mmol/L

Section 1.2.1 Dehydration

Upon completing section 1.2.1 you will be able to:

- Define dehydration and identify the types of dehydration
- Differentiate between the degrees of dehydration
- Discus the clinical manifestations of dehydration
- List the three most reliable predictors of dehydration
- Identify triage level of a patient experiencing dehydration

Include in the assessment of a child with DKA the presence of dehydration and the degree of dehydration. The following section address types, degrees and signs of dehydration. **Dehydration** occurs when the total output of fluid exceeds the total intake. Some causes of dehydration include lack of oral intake in combination with high environmental temperatures, vomiting, diarrhea, DKA, and extensive burns (Hockenberry & Wilson, 2011).

Assessing dehydration is important due to the possibility of impending shock

It is important to understand that there are different types of shock and that each type will have different signs and symptoms. The types of dehydration are characterized by electrolyte and water deficits. The loss of either intracellular or extracellular fluid contributes to the signs and symptoms of dehydration. Table 2 provides an overview of the types of dehydration including root cause and symptoms (King et al., 2003).

Table 2

Types of Dehydration

Types of Dehydration	Cause	Signs and Symptoms
Isotonic	Electrolyte and water deficits are equal Loss of extracellular fluid	Decreased plasma volume Decreased blood volume Plasma sodium within normal limits Hypovolemic shock
Hypotonic	Electrolyte deficit > water deficit Water moves from extracellular space to intracellular space	Extracellular volume loss More sever signs of dehydration Plasma sodium levels are low
Hypertonic	Water loss>electrolyte loss Loss of water over longer period of time or larger intake of electrolytes Fluid shift from intracellular to extracellular	**Very Dangerous** Main cause is diarrhea High plasma sodium Concentration High risk for seizures Decreased level of consciousness, hyper-reflexia and hyperirritability

Similar to DKA, dehydration can be characterized by degrees. Signs and symptoms of dehydration are rated as either; mild, moderate, or severe as shown in Table 3 below. Determining the degree of dehydration is important to include in the child's assessment to help develop the treatment plan (King et al., 2003).

Table 3
Degrees of Dehydration

Symptoms	Mild	Moderate	Severe
Fluid volume loss	<50 ml/kg	50-90 ml/kg	>100 ml/kg
Skin color	Pale	Grey	Mottled
Skin elasticity	Decreased	Poor	Very poor
Mucous membranes	Dry	Very dry	Parched
Urinary output	Decreased	Oliguria[x]	Marked oliguria and azotemia[xx]
Blood pressure	Normal	Normal or lowered	Lowered
Pulse	Normal or increased	Increased	Rapid and thready
Capillary filling time	< 2 seconds	2-3 seconds	> 3 seconds

[x] **oliguria:** a urinary output of less than 1 ml/kg/hr or 300 ml/m2
[xx] **Azotemia:** the accumulation of nitrogenous waste within the blood

Understanding the clinical manifestations of dehydration helps to create a picture of a child's presentation at triage (see Table 4). Once the type of dehydration has been established, the typical physical presentation can be determined (King et al., 2003).

Table 4

Clinical Picture of Dehydration

Assessment	Isotonic (Loss of water and salt)	Hypotonic (Loss of salt in excess of water)	Hypertonic (Loss of water in excess of salt)
Skin **Color** **Temperature** **Turgor** **Feel**	 Gray Cold Poor Dry	 Gray Cold Very poor Clammy	 Gray Cold or hot Fair Thickened, doughy
Mucous membranes	Dry	Slightly moist	Parched
Tearing and salivation	Absent	Absent	Absent
Eyeball	Sunken	Sunken	Sunken
Fontanel	Sunken	Sunken	Sunken
Body temperature	Subnormal or elevated	Subnormal or elevated	Subnormal or elevated
Pulse	Rapid	Very rapid	Moderately rapid
Respirations	Rapid	Rapid	Rapid
Behavior	Irritable to lethargic	Lethargic to comatose; convulsions	Marked lethargy with extreme hyperirritability on stimulation

When assessing a child between the ages of 1-5 years the three most reliable predictors for detecting 5% dehydration is listed in the textbox to the left.

Predictors of Dehydration

1. **Prolonged capillary refill (normal ≥ 1.5 to 2.5 seconds**
2. **Abnormal skin turgor; presence of tenting or inelastic skin**
3. **Abnormal respiratory pattern (hyperpnea)**

Wolfsdorf et al., 2014

The child's weight is also a significant determinant of dehydration and assists in evaluating the percentage of total body fluid lost. It is important to record the child's weight in kilograms on the triage form. (Hockenberry & Wilson, 2011)

Triage. Rural emergency nurses have several responsibilities such as triaging, treating, and accompanying the child on ambulance transfer. Part of the

initial assessment is to determine the acuity level of the patient. The Canadian Triage and Acuity Scale (CTAS) is used to assign one of five triage levels to the patient to determine how soon the patient should be seen by nurse and physician in the ER. The triage levels are (Canadian Association of Emergency Physicians, 2015):

- **Triage 1: time to nurse and physician immediate**
- **Triage 2: time to nurse immediate, time to physician 15 minutes**
- **Triage 3: time to nurse 30 minutes, time to physician 30 minutes**
- **Triage 4: time to nurse 60 minutes, time to physician 60 minutes**
- **Triage 5: time to nurse 120 minutes, time to physician 120 minutes**

The child may present with more than one presenting complaint, such as hyperglycemia, decreased level of consciousness, and dehydration. A child can be scored on each complaint; however, the complaint is used that gives the highest triage score. CTAS level can be assigned for a child presenting in the ER with dehydration based on his/her presenting signs and symptoms as shown in Table 5 below. Children are triaged according to their hydration status. The presenting signs and symptoms are used to determine the degree of dehydration, and the triage score is assigned (Canadian association of Emergency Physicians, 2015).

Table 5

CTAS Level Based on Severity of Dehydration

Canadian Emergency Department Information Systems (CEDIS) Presenting Complaint	Second Order Modifier	CTAS Level
Nausea &/ vomiting; Diarrhea; General Weakness	**Severe dehydration:** marked Volume loss with classic signs of dehydration and signs and symptoms of shock	**1**
Nausea &/ vomiting; Diarrhea; General Weakness	**Moderate dehydration:** dry mucous membranes, tachycardia, decreased skin turgor and decreased urine output	**2**
Nausea &/vomiting; Diarrhea; General Weakness	**Mild dehydration:** stable vital signs with complaints of increasing thirst and concentrated urine; history of decreased intake or increased fluid loss or both	**3**

Canadian Emergency Department Information Systems (CEDIS) Presenting Complaint	Second Order Modifier	CTAS Level
Nausea &/ vomiting Diarrhea; General Weakness	**Potential dehydration:** no symptoms of dehydration but presenting cause of fluid loss ongoing	**4**

Retrieved from: http://www.caep.ca/resources/ctas

Dehydration can lead to shock. The child's presenting signs and symptoms can determine the level of shock. Once the level of shock is established, a triage score can be assigned if it is the highest score compared to other presenting symptoms. Table 6 describes the signs and symptoms of shock and the corresponding CTAS score (Canadian Association of Emergency Physicians, 2015).

Table 6

Triage Score Based on Level of Shock

Circulatory Status	CTAS Level
Shock: evidence of severe end-organ hypoperfusion: marked pallor, cool skin, diaphoresis, weak or thready pulse, hypotension, postural syncope, tachycardia or bradycardia, ineffective oxygenation, decreased level of consciousness. Could also appear as septic shock: flushed and febrile	1
Hemodynamic compromise: borderline profusion; pale, history of diaphoresis, unexplained tachycardia, postural hypotension, feeling faint, suspected hypotension	2
Vital signs at upper and lower ends of normal as they relate to the presenting complaint	3
Normal vital signs	4 & 5

Retrieved from: http://www.caep.ca/resources/ctas

Section 1.2.2: Vital signs

Upon completion of section 1.2.2 you will be able to:

- Describe the vital signs required to assess a patient with DKA
- Identify abnormal vital signs in children
- Discuss routes of temperature taking and the values associated with each route.

Vital signs provide valuable information regarding the health status of the patient. When triaging a patient with a possible new diagnosis of diabetes and/or existing diagnosis of diabetes and DKA the following vital signs should be completed an documented on emergency forms (TREKK, 2014). See textbox to the left for list of vital signs.

Vital Signs

1. Blood Pressure
2. Pulse
3. Respirations
4. Temperature
5. Oxygen Saturation
6. ECG
7. Blood Glucose (finger poke)
8. Urinalysis

TREKK, 2015

To identify significant changes in health status it is necessary to know the normal vital signs of a child. Table 7 describes the normal parameters based on age of the child (Wikipedia, 2015).

Table 7

Pediatric Vital Signs Normal Ranges

Age Group	Respiratory Rate	Heart Rate	Systolic Blood Pressure	Weight in kilos
Newborn	30-50	120-160	50-70	2-3
Infant(1-12 months)	20-30	80-140	75-100	4-10
Toddler (1-3 years)	20-30	80-130	80-110	10-14
Preschooler (3-5 years)	20-30	80-120	80-110	14-18
School age (6-12 years)	15-30	70-110	85-120	20-42
Adolescent (13 + years)	12-20	60-105	95-140	>50

Remember to practice taking vital signs on well children so you will have your technique perfected when you are assessing a critically ill child. It can be more challenging to obtain accurate vital sign readings from a child. Ask parents for help holding, positioning, and calming the child. Explain the procedure to the child and let them handle equipment. The following paragraphs include additional information on temperature and ECG. Temperature taking is discussed because there is more than one method to get a child's temperature. Eastern Health Emergencies have tympanic membrane thermometers available. ECG information is included because performing ECG on children is a task that is not performed frequently, therefore, a review of lead placement is provided. TREKK (2013) states that urinalysis is the sixth vital signs. If diabetes is expected urinalysis can confirm the diagnosis along with presenting symptoms and blood work.

Temperature. There are three common methods for temperature taking in children including: oral, tympanic, and axillary. The following are special instructions for obtaining accurate temperature readings with each method (Canadian Pediatric society, 2000).

Oral. When taking an oral temperature place the thermometer posteriorly in sublingual pocket at the back of the mouth at position X in figure 2. There are average readings for different areas of the mouth. Avoid the anterior region due to high risk of inaccurate readings. Do not take oral temperature after the child has ingested food or fluids or if the respiration rate greater than 18 due to risk of altered reading.

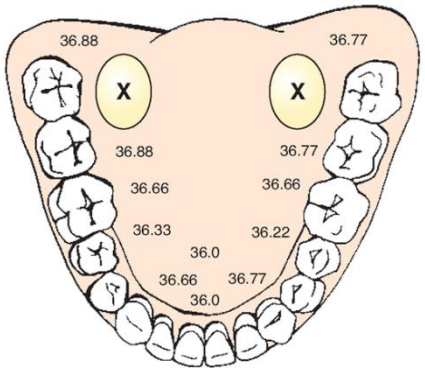


Figure 2: Placement of thermometer to obtain accurate oral temperature. Retrieved from : http://what-when-how.com/nursing/vital-signs-client-care-nursing-part-2/

Tympanic. The tympanic thermometer reads the infrared emission from the tympanic membrane in the ear. When taking a tympanic temperature cover probe with disposable plastic sheath. Place probe tip at proper angle to seal ear canal as shown in

figure 3. Wait 2-5 seconds after pressing button on thermometer for reading. Do not use ear if any of the following are present: pain, excessive ear wax, drainage, sores or injury. Parents may assist by holding child on lap facing them and placing arms around child as if in an embrace.

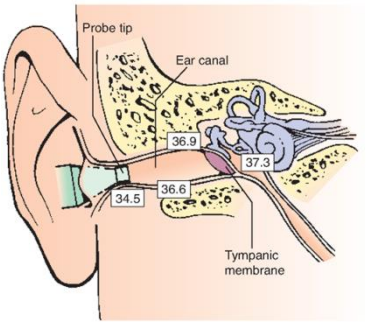


Figure 3: Placement of tympanic thermometer to obtain accurate temperature. Retrieved from : http://what-when-how.com/nursing/vital-signs-client-care-nursing-part-2/

Axillary. When taking an axillary temperature place thermometer in central position under arm and adduct arm close to chest wall as demonstrated in figure 4. If child is old enough let them assist with procedure.

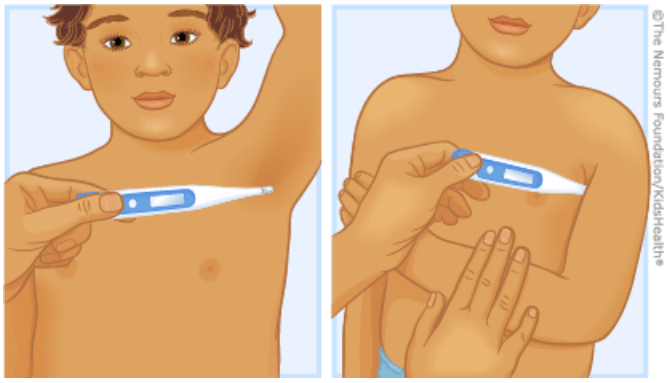


Figure 4: Correct position of thermometer when taking an axilla temperature. Retrieved from: http://www.seattlechildrens.org/kids-health/parents/general-health/aches-pains-and-injuries/fever-and-taking-your-child-s-temperature/

To ensure accuracy of temperature use site and method consistently.
Record site and reading on ER form.

Electrocardiogram. Complete an ECG on patient when in triage as part of the initial vital sign assessment. Children with DKA may experience arrhythmias related to electrolyte disturbances associated with dehydration. Early detection of cardiovascular complications is important to prevent cardiac arrest. Figure 1 below demonstrates landmarks for ECG lead placement.

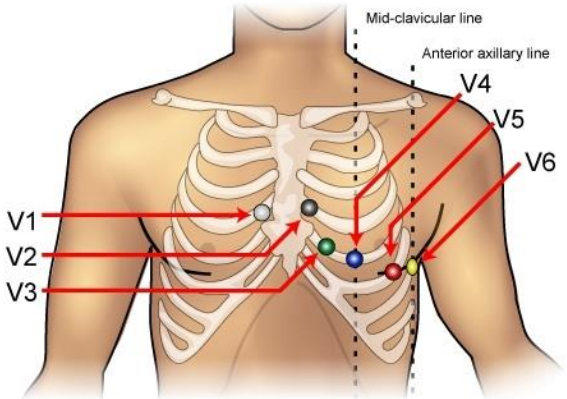
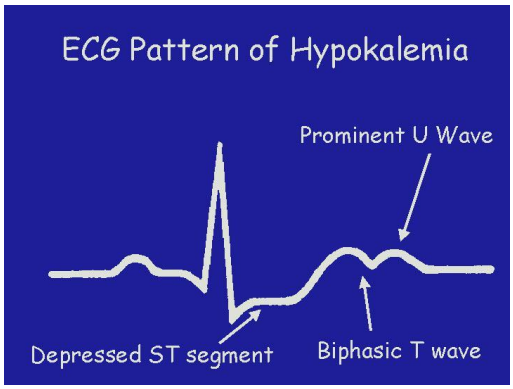


Figure 5: Placement of Electrocardiogram leads in a pediatric patient. Retrieved from: http://nursingcrib.com/medical-laboratory-diagnostic-test/ecg-lead-placement/

The positioning of pericardial leads for a 12 lead electrocardiogram is as follows:

- V1 place in fourth intercostal space immediately to right of sternum
- V2 place in fourth intercostal space immediately to the left of sternum
- V3 is midway between v2 and V4
- V4 place in fifth intercostal space left midclavicular line
- V5 and V6 are at same level as V4
- V5 place at anterior axillary line
- V6 place at mid-axillary line

Throughout treatment and ambulance transfer connect the child to the **cardiac monitor** for continuous assessment for hypo- or hyperkalemia. **Hypokalemia** is characterized as prolonged PR interval, flattened and inverted T wave, ST depression, prominent U waves, and long QT interval as shown in Figure 6 below**. Hyperkalemia** is characterized as tall, peaked, and symmetrical T waves and shortened T wave interval as shown in figure 6 (Wolfsdorf et al., 2014).



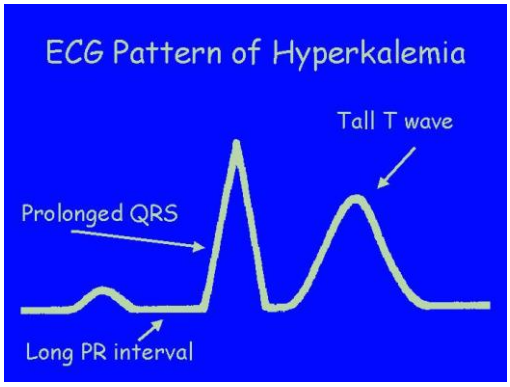


Figure 6: ECG diagram of the presentation of hypokalemia and hyperkalemia. Retrieved from:
http://emedicine.medscape.com/article/907111-overview

Section 1.2.3 Level of Consciousness

Upon completion of section 1.2.3 you will be able to:

- Apply the Glasgow Coma Scale when assessing level of consciousness in patient with DKA
- Triage patient according to level of consciousness

Neurological status provides valuable information about the child's health status. DKA can cause decreased level of consciousness. The sicker the child is the drowsier he/she may become. Hourly or more frequent as indicated conduct neurological observations for warning signs and symptoms of complications of DKA, such as cerebral edema. Use Glasgow Coma Scale (GCS) as shown in Table 8 and document value on ER record (Wolfsdorf et al., 2014). The GCS consists of three parameters and is scored between 3 and 15; 3 being the worst and 15 the best. One of the components of the GCS is the best verbal response, which cannot be assessed in

Table 8

Scoring the Glasgow Coma Scale

Best Eye Response	Best Verbal Response	Best Verbal Response (non-verbal children)	Best Motor Response
1. No eyes opening 2. Eyes opening to pain 3. Eyes opening to verbal command 4. Eyes open spontaneously	1. No verbal response 2. No words, Incomprehensive sounds; moaning 3. Words, incoherent 4. Confused, disoriented conversation 5. Oriented, normal conversation	1. No verbal response 2. Inconsolable, irritable, restless, cries 3. Inconsistently consolable, moans; makes vocal sounds 4. Consolable when crying, interacts inappropriately 5. Smiles, oriented to sound, follows objects and interacts	1. No motor response 2. Extension to pain 3. Flexion to pain 4. Withdrawal from pain 5. Localizes pain 6. Obeys commands

Retrieved from: https://en.wikipedia.org/wiki/Paediatric_Glasgow_Coma_Scale

non-verbal young children. A modification of the GCS was created for children too young to talk. Neurological assessment is a very important part of the assessment of a child with DKA.

Triage Based on Level of Consciousness. A patient can be triaged according to their level of consciousness. Include as part of the child's assessment in triage the GCS. If the child is not alert, the lower the GCS score will be, indicating that the child needs immediate assessment and treatment by physician and nurse. Table 9 below outlines the physical assessment findings that will determine the level of consciousness and the corresponding GCS and CTAS scores.

Table 9

CTAS Score Based on Level of Consciousness

Level of Consciousness (LOC)	GCS	CTAS Level
Unconscious: unable to protect airway, response to pain or loud noise only and without purpose, continuous seizure or progressive deterioration of LOC	**3-9**	**1**
Altered level of consciousness: response inappropriate to verbal stimuli; not oriented to person, place and time; impaired memory; altered behavior	**10-13**	**2**
Normal: use other modifiers to define CTAS	**14-15**	**3,4, or 5**

Retrieved from: http://www.caep.ca/resources/ctas

Section 1.2.4: Laboratory Values

Upon completion of section 1.2.4 you will be able to:

- Identify normal blood glucose readings in children
- Triage a patient based on glucose reading
- Identify blood work for patient presenting with possible DKA
- Define blood gas and determine acidosis
- Discus family centered care and ways to incorporate into the assessment process

Laboratory testing of a child's blood provides valuable information about the child's health status. The physician will order the investigations. However, a finger poke at the bedside can quickly determine blood glucose readings. Point of care blood glucose testing can be confirmed with laboratory analysis.

Normal Serum Glucose reading for a Child is 3.3-5.5 mmol/L

A child can be triaged according to blood sugar level. However, another modifier may be used to determine triage level if it gives a higher score. For example patient's glucometer reading was 20 mmol/l and presented signs of dehydration, you would give a score of 2, but if the patient was unconscious they would be given a CTAS level of 1.

Note: When measuring glucose with hospital meter, if it reads 'HI' the glucose reading is above 27.8 mmol/L. Reading should be confirmed by lab through drawing of blood

Triage Based on Blood Glucose. Table 10 below provides glucose levels, the symptoms, and the corresponding acuity or CTAS level.

Table 10

Blood Glucose Levels and Associated CTAS Scores

CEDIS Presenting Complaint	Blood Glucose Level	Symptoms	CTAS Level
Altered level of consciousness; Confusion; hypoglycemia	**<3**mmol/L	Confusion, diaphoresis, behavior changes, seizure No symptoms	**2** **3**
Altered level of consciousness; Confusion; hyperglycemia	**>18**mmol/L	Dyspnea, dehydration, weakness No symptoms	**2** **3**

Retrieved from: http://www.caep.ca/resources/ctas

Blood Work. The following blood work is recommended when diabetes and or DKA are suspected. The mnemonic for entering blood work included:

- Glucose: **GLUCO**
- Sodium: **LBC**
- Potassium
- Chloride
- Bicarbonate
- Urea
- Creatinine
- Osmolality: **OSMOL**
- Calcium: **CALCI**
- Phosphorus: **PHOSP**
- Capillary blood gas: **BLOOCU X2**
- Urinalysis: ketones, glucose and possible infection: **URINAP**
- Septic workup if infection suspected: **/ERSEPTIC**

(British Columbia's Children's Hospital, 2015).

When you enter **LBC** the following blood work is included: urea, sodium, potassium, chloride, carbon dioxide, creatinine, and globular filtration rate.

Blood gas. Blood gas measurements are sensitive indicators of change in respiratory status in acutely ill children. They provide information regarding lung function, lung adequacy, and tissue perfusion. Blood gases are essential for monitoring conditions involving hypoxia, CO2 retention, and pH (Hockenberry & Wilson, 2011). The laboratory values of pH, PCO2, HCO3, and PO2 are used to determine if the child is experiencing acidosis or alkalosis (Wolfsdorf et al., 2014). Table 11 below provides a comparison of blood gas values.

Table 11

Alkalosis and Acidosis Determined by Blood Gas Levels

Component	Definition	Normal Value	Acidosis	Alkalosis
pH	Indicates acid-base status	7.39	Less than 7.35 indicates excess of acid	Greater than 7.45 indicates excess of base
PCO2	Pressure exerted by dissolved CO2 in blood Under control by lungs Respiratory component	37 mmHg	Greater than 45 mm Hg	Less than 35 mm Hg
HCO3	Buffers effect of acid in blood Under control of kidneys Metabolic component	22 mEq/L	Less than 22 mEqL	Greater than 26 mEq/L
PO2	Pressure exerted by dissolved 02 in blood Indicated effectiveness of oxygenation by lungs	96 mm Hg	Less than 80mm Hg: hypoxia	Greater than 100 mm Hg

Family-centered Care

The Emergency Department site on the Eastern Health webpage states that patient and family-centered care is an approach to the planning, delivery, and evaluation of healthcare that focuses on partnership between patients, families, and healthcare workers. Family plays a vital role in ensuring the well-being of a patient. This concept underpins the philosophy of family-centered care. The principles of family-centered care include; dignity and respect, information sharing, participation, and collaboration. To communicate more effectively with patients and families healthcare workers have to show families that they care about them, understand their concerns, and that they can be trusted to take care of them (Eastern Health, 2015). Providing emotional support to families when their child requires treatment in an ER contributes to positive coping with the child's medical problems (Hemmelgarn, Glisson, & Dukes, 2001).

An emergency admission to an ER is a traumatic experience for the child and family. They may be facing a new diagnosis of diabetes or complication of their type 1 diabetes, such as DKA. Sudden onset of illness leaves little time for preparation and explanations. The child is exposed to a frightening environment with strangers who inflict

pain by initiating intravenous access and blood tests. Nurses in the ER should take all available opportunities to reduce fear and anxiety in children and parents (Hockenberry & Wilson, 2011).

There are many ways to demonstrate a family-centered approach to care. The following suggestions have been identified to support family-centred care throughout assessment and diagnosis of the child (Hockenberry &Wilson, 2011):

- Allow family to remain with the child when possible. If invasive measures are required assign a staff member to the family to provide them with support and explanations about procedures and conditions.
- Prepare parents and child for transfer and admission to the appropriate children's hospital, possibly the Intensive Care Unit (ICU). Be available to answer any questions or address any family concerns. Accompany family at bedside to provide emotional support. Encourage parents to stay with the child.
- Provide information about child's condition in understandable language appropriate for individuals with no medical knowledge. Repeat information often.
- Do nothing that will make the child more anxious. Maintain a calm, relaxed, and reassuring manner.
- Give competent, consistent nursing care to instill confidence in the child and family.
- Be honest with child to establish trust.

Conclusion of Unit 1: Diagnosis

You have completed Unit 1: Diagnosis. This unit has provided you with the essential knowledge and best practices for accurate assessment of a sick child with possible new onset diabetes, established diabetes, and DKA. Through the triage process you will collect a thorough history, conduct a physical exam, and initiate diagnostic testing, to help make a diagnosis of DKA. The data you collect will be used to select appropriate treatments as shown in Figure 7 below.

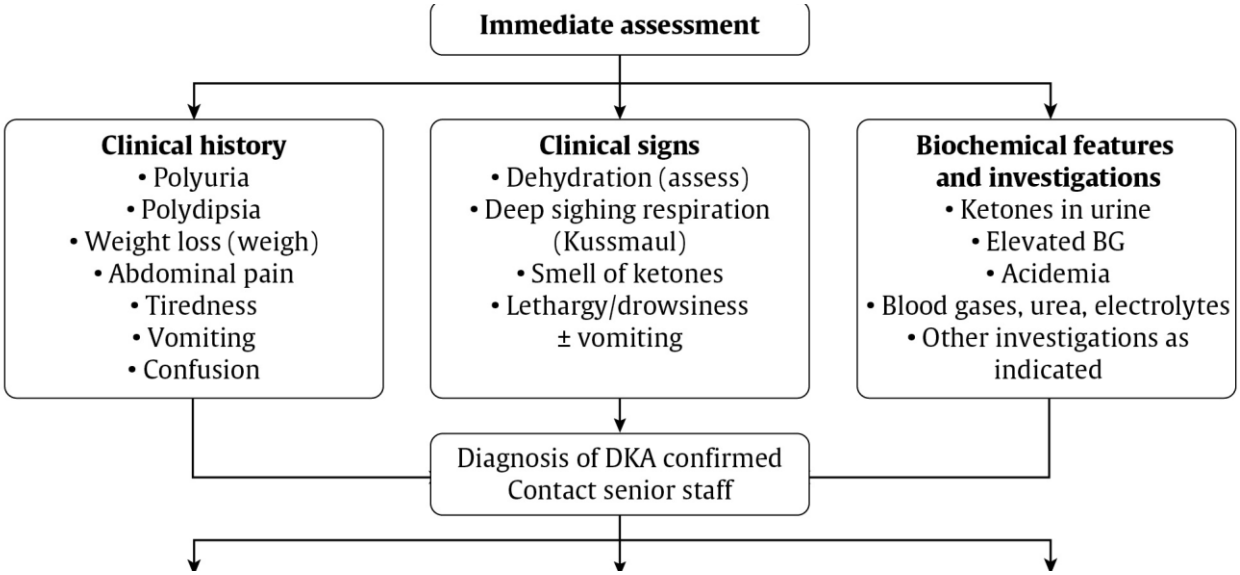


Figure 7: Summary of assessment and diagnosis of child with diabetes and DKA. Retrieved from: http://guidelines.diabetes.ca/browse/Chapter34

Unit One: Review Questions

To test your knowledge of unit 1, please complete the following questions. Answers are provided on page 48 of the module.

1. These are typical symptoms of Type 1 diabetes in children except:
    a) Weight loss
    b) Polyuria
    c) Weight gain
    d) Decreased energy
    e) Nocturnal enuresis

2. An eight year-old girl presents at the ER with a primary complaint of new onset nocturia. Weight is taken and recorded on chart in kilograms. The parents report that there is a 4kg weight loss since her last doctor's appointment six months ago. On exam she has normal vital signs and no signs or symptoms of infection. Which of the following actions do you undertake?
    a) Do not continue with assessment and assume that primary enuresis will be the diagnosis
    b) Check blood sugar with glucometer or check urine for glucose and ketones at triage
    c) Wait for doctor to give laboratory requisition to have glucose testing and urinalysis in the next few days
    d) Consider possible urinary tract infection and do no further investigations.

3. The following are usual signs/symptoms of DKA. Circle all that apply.
    a) Nausea and vomiting
    b) Fruity smelling breath
    c) Deep respiration
    d) Abdominal pain

4. John, a two-and-a-half year old boy presents to ER with a two week history of increased frequency of urination and increased thirst. He has been previously healthy. Physical exam is normal. The parents have been reassured by the family doctor that

the physical exam is normal and are told that his increased drinking and voiding are likely behavioral and normal for his age. However, they are still concerned. What investigations should be performed? Circle all that apply:

a) No investigations
b) Urine dipstick or urinalysis by lab
c) Glucometer test at bedside
d) Same day blood work to test blood glucose

5. Match the term with the definition.

Terms	Definitions
1. Hyperglycemia	1. Hyperventilation characteristics of metabolic acidosis.
2. Glycosuria	2. Organic acids that produce excess hydrogen ions, causing a fall in pH.
3. Polyuria	3. Total output of fluid exceeds total intake.
4. Polydipsia	4. Increase in volume of urine
5. Polyphagia	5. Bed wetting
6. Candida Albicans	6. Excessive thirst
7. Nocturia	7. Blood glucose reading greater than 11mmol/L
8. Kussmaul Respirations	8. Yeast Infection
9. Ketones	9. Glucose in urine.
10. Dehydration	10. Increased hunger

Unit Two: Treatment

Once the patient is triaged and diagnosed with DKA, the treatment begins. Ongoing assessment is required throughout the treatment phase to monitor the patient's response and to detect complications. The primary treatment of DKA is insulin and fluids. However, the use of clinical practice guidelines is recommended to prevent complications, such as cerebral edema. *In your ER the clinical practice guideline to treat DKA can be found in a binder called The Newfoundland and Labrador DKA Project, distributed by Dr. Leigh Anne Newhook in the spring of 2013. This unit has been developed in part to review the clinical practice guidelines adopted by the Janeway Children's Hospital from the International Society for Pediatric and Adolescent Diabetes (ISPAD). The guidelines assist practitioners with treatment decision to correct acidosis and preventing complications such as cerebral edema. The clinical practice guidelines are based on research and provide children with the best evidence based care.*

Section 2.1: DKA Guidelines

Upon completion of unit two you will be able to:

- Describe steps for initiating treatment for patient with DKA
- Identify goals of therapy for DKA

Guidelines for treatment of DKA are extensive and require the ER nurse to review the information prior to implementing them. Figure 8 on the next page provides you with a diagram of the steps outlined in the clinical practice guidelines for treating DKA. Research has shown that the use of clinical practice guidelines benefits both the health care provider and the patient (Barrios et al., 2012). Not only does the use of guidelines promote the delivery of standardized care, their use also reduces complications, and improves health outcomes for patients and families. The guidelines are suitable to treat the majority of cases of pediatric DKA. However, the guidelines cannot replace clinical observation and judgement. The clinical guidelines adapted by the Janeway Children's Hospital have been taken from British Columbia's Children's Hospital DKA Tool Kit and International Society for Pediatric and Adolescent Diabetes (ISPAD) Pediatric DKA Guidelines (Wolfsdorf et al., 2014).

The following nursing care is recommended prior to the administration of fluids and insulin (Wolfsdorf et al., 2014):

- Give oxygen to children with severe circulatory impairment or shock
- Insert 2 peripheral intravenous catheters
- Administer antibiotics to febrile patients after obtaining blood for blood cultures

- If child is unconscious or unable to void on demand insert a catheter into bladder
- If child is in severe DKA and is a triage 1, follow Pediatric Advanced Life Support guidelines for stabilization (Kleinman et al., 2010). Consider flight team for transfer to Janeway Hospital if the child is unstable.

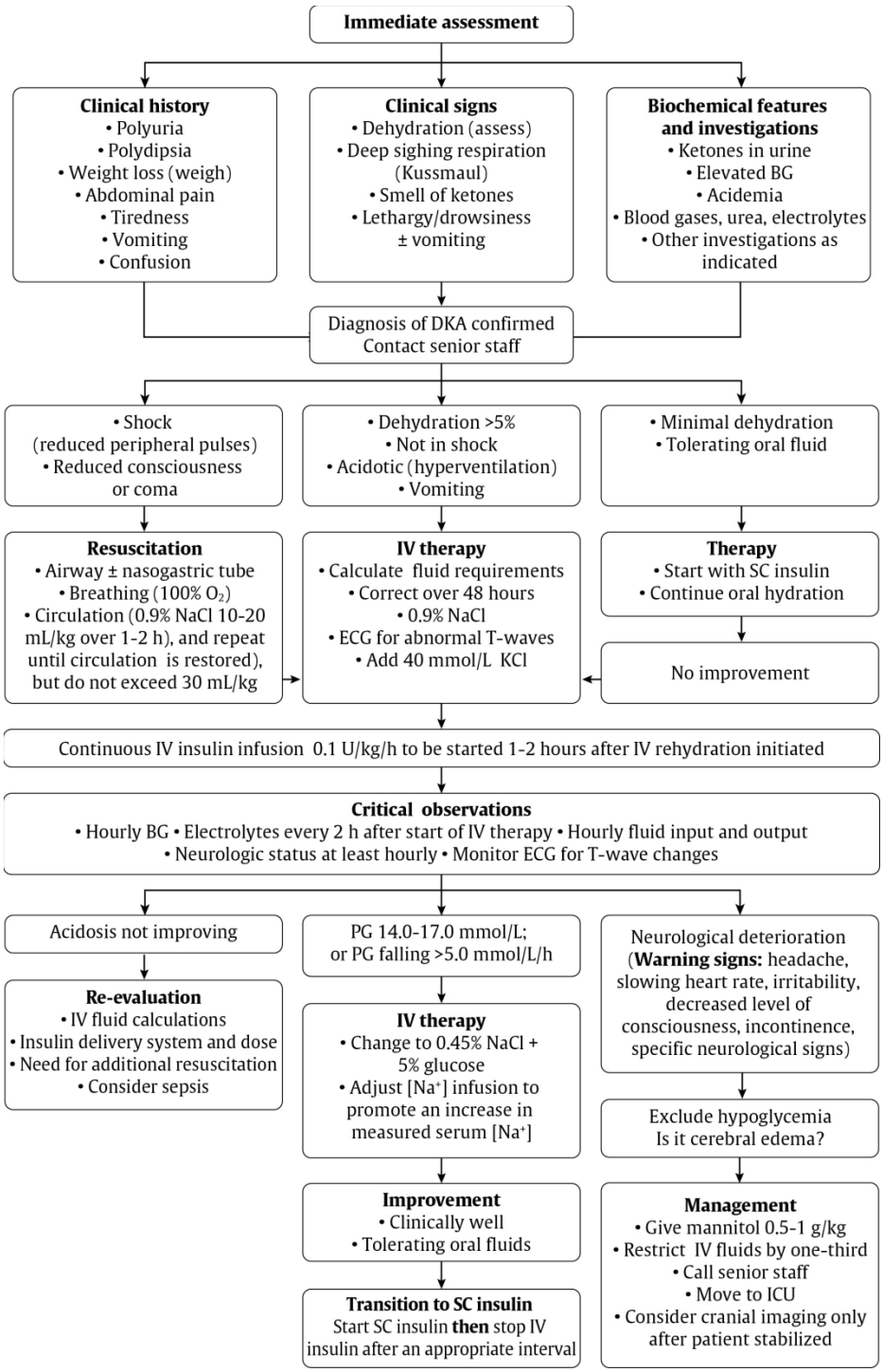


Figure 8: Algorithm for the management of diabetic ketoacidosis. Adapted from Dunger et al., (1999). Retrieved from: http://c.ymcdn.com/sites/www.ispad.org/resource/resmgr/Docs/CPCG_2014_CHAP_11.pdf

The objective of DKA therapy should be the gradual reduction in serum osmolality to prevent cerebral edema. This is achieved with careful fluid resuscitation and avoidance of bolus insulin. (Wolfsdorf et al., 2014). The following list contains the goals of DKA therapy.

- Correct dehydration
- Correct acidosis and reverse ketosis
- Restore blood glucose to near normal
- Monitor for complications of DKA
- Identify and treat any precipitating event

(Wolfsdorf et al., 2013)

The treatment of a child for DKA begins with immediate assessment, including, clinical history, clinical signs, and biochemical features and investigations, which are outlined in Unit one of this module (see Figure 8, previous page). When the patient is diagnosed with DKA and after the Endocrinologist has been consulted at the Janeway, treatment can be initiated. Depending on the child's immediate health status different interventions may be necessary. If, for example, the child is in shock with reduced level of consciousness then treatment will focus on resuscitation. The airway must be secured and intubation and a nasogastric tube considered. Oxygen is administered at 100% to ensure adequate oxygenation and improve circulation and 0.9% saline is given, 10-20 ml/kg over 1-2 hours, and repeat until circulation is restored.

If the child is not in shock but is greater than 5% dehydrated, experiencing hyperventilation, and vomiting IV fluid replacement is initiated. Fluid replacement is calculated and replaced over 48 hours with 0.9% saline plus 40 mml/L of potassium. An ECG is conducted to monitor for abnormal T-waves. If the child is only minimally dehydrated and tolerating oral fluids the treatment suggested is subcutaneous insulin and oral hydration. However, if the patient does not show improvement IV fluid replacement therapy is begun. Insulin therapy can begin 2 hours after fluid replacement. Insulin is administered as a continuous infusion at a rate of 0.05-1 unit/kg/hour. The child will require close observation throughout the treatment phase. Blood glucose and fluid intake and output are monitored hourly. Neurological status is assessed using the Glasgow Coma Scale (GCS) at least every hour. Blood work to assess electrolytes should be collected 2 hours after start of IV therapy and continued every two hours. Cardiac monitoring for T-wave changes is required. If acidosis is not improving

Do not exceed 30 ml/kg
Replace fluid loss over 48hours
Wolfsdorf et al., 2014

Insulin infusion begins 1-2 hours after fluids.
Observe neurological status at least every hour.
Wolfsdorf et al., 2014

IF Blood glucose ≤ 17 mmol/L or falls > 5 mmol/L
Start 0.45% saline + 5% glucose

Wolfsdorf et al., 2014

then IV fluid calculations and the amount of insulin is re-evaluated. Other sources of hyperglycemia must also be considered, such as sepsis.

If blood glucose levels are less than or equal to17mmol/l or the blood glucose falls more than 5 mmol/L/hour the IV fluid is changed from 0.9% saline to 0.45% saline with 5% glucose. The sodium infusion is adjusted to promote an increase in serum sodium. If the child begins to improve and is able to tolerate oral fluids then subcutaneous insulin is initiated and IV fluids are stopped.

Section 2.2 IV Fluids

Upon completion of section 2.2 you will be able to:

- Discus the role IV fluid has in treatment of DKA
- Differentiate between the types of IV fluid
- Discus method of IV initiation in child
- Discus the guidelines for IV fluids in DKA treatment

The first step in DKA treatment is the administration of IV fluids to correct the fluid loss due to dehydration. Fluids should be replaced over a 48 hour period. Large fluid boluses are potentially dangerous: IV fluids should be administered slowly and with caution, unless the child is in hypotensive shock. Only vary rarely will a 20 ml/kg fluid bolus be required to maintain perfusion (Wolfsdorf et al., 2014).

Hypotensive shock definition: is an emergent condition in which severe blood or fluid loss makes the heart unable to pump enough blood to the body.

Hockenberry &Wilson, 2011

Selection of IV fluid is based on the osmolality and electrolyte content. Types of IV fluids are listed in Table 13 below. Because infants and young children are subject to rapid fluid shifts, any IV solution given to them contains at least 0.2% NaCl to prevent **brain edema,** a disorder to which they are susceptible if given plain water (Hockenberry & Wilson, 2011).

Table 12

Types of IV Fluids

Type of fluid	Examples of fluids
Isotonic- same osmolality as body fluids such as plasma	0.9% normal saline, lactated Ringers, 5% dextrose in water
Hypertonic- has a greater concentration of solutes than plasma	10% dextrose in water
Hypotonic- has a lower concentration	Plain water, 0.2% sodium

IV initiation. To administer IV fluids IV access must be established. Establishing and maintaining vascular access in the young pediatric patient is one of the most difficult and stressful emergency nursing tasks. Provide emotional support to the child and their family. This procedure is anxiety-provoking for them as well. Allow parents to be present for procedure and assist with positioning and comforting of the child. The following list provides information on pediatric IV initiation (Hockenberry & Wilson, 2011).

- In most children a 22-24 gauge over-the-needle catheter is preferred.
- For small scalp veins a size 23-25 needle with flexible wings may be used.
- When possible avoid child's favored hand to reduce disability.
- Start with veins in extremities at most distal sites. Figure 9 below shows optimum vein location in a small child.
- When veins are not readily visible apply warm compresses, run warm water over extremity, hold limb in a dependent position below body level and gentle tap. A flashlight held against the skin sometimes helps.
- Using a tourniquet makes veins more visible but increases venous pressure and may make veins "blow".
- When securing IV site use minimal tape to avoid obscuring insertion site and reducing detection of infiltration.
- In emergency situations where IV access is difficult to establish a surgical cutdown procedure may be necessary or intraosseous infusion. Follow PALS guidelines for intraosseous IV access.

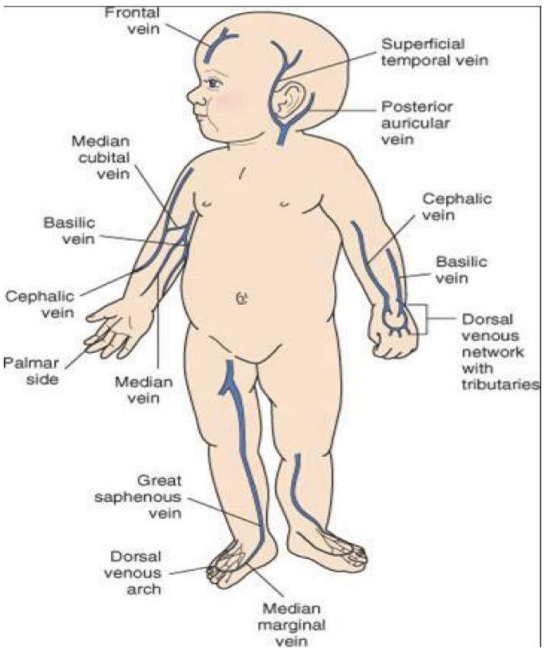


Figure 9: Vein location for vascular access in a small child. Retrieved from www.pinterest.com

Not all patient s who present with DKA will require IV hydration because the severity of the DKA is mild and the patient can tolerate oral hydration. When the patient is unwell and IV fluid administration is deemed necessary based on the child's presentation, assessment, and blood work values consider the following guidelines (Wolfsdorf et al., 2014):

- Give normal saline resuscitation bolus if patent has signs and symptoms of shock; recommended amount; **Hypotensive shock**---10-20 ml/kg 0.9%NS bolus **Normotensive shock**---7ml/kg over 30 minutes
- Do not use hypotonic fluids in the first 4-6 hours
- Goal to correct dehydration, acidosis, hyperglycemia over **48** hours
- Continually re-evaluate status (glycemia, acidosis, vital signs, mental status)
- Aim to decrease blood glucose by 3-5 mmol/L every hour
- Add dextrose as D5WNS when blood glucose <14-17 mmol/L or when decrease in glucose is too rapid(>5mmol/L)
- Estimate extent of dehydration in ml/kg(hypotension, tears, skin turgor, capillary refill; hematocrit)

IV fluid additives. In DKA treatment the guidelines state that **Potassium** (K+) replacement therapy is required regardless of the serum potassium concentration except in renal failure. If the child is **hypokalemic**, start potassium replacement at the time of initial volume expansion and before insulin therapy. If K+ concentration is normal start

replacing potassium after the first bolus of IV fluid. Start potassium infusion at the same time as starting insulin therapy. The starting K+ concentration is 40 mmol/L. Additional K+ replacement therapy should be based on serum potassium levels and should continue throughout IV fluid therapy (Wolfsodrf et al, 2014).

Potassium replacement therapy is required regardless of serum potassium level.

Section 2.3: Insulin

Upon completion of section 2.3 you will be able to:

- Identify types of insulin
- Discus the guidelines for insulin therapy in the treatment of DKA

The next important step in the treatment of DKA is the administration of insulin. However, close adherence to guidelines is required to reduce the risk of complications. Table 13 provides a review of types of insulin, guidelines for times for administration, and how long insulin remains active in blood stream.

Table 13

Types and Function of Insulin

Type	Onset (When start)	Onset (Most effective)	Duration	Timing
Bolus Insulins Rapid acting analogues Apidra Humalog Novo rapid	10-15 minutes	1-2 hours	3-5 hours	Give with 1 meal or more a day; give 0-15 minutes before or after meal
Short-acting Humulin –R Toronto	30 minutes	2-3 hours	6.5 hours	Give with 1 meal or more a day; inject 30-45 minutes before meal

Type	Onset (When start)	Onset (Most effective)	Duration	Timing
Basal Insulins Intermediate-acting insulin Humulin-N NPH	1-3 hours	5-8 hours	Up to 18 hours	Often started once daily at bedtime. May be given once or twice daily; timing not specific to meals
Long acting analogues Lantus Levemir	90 minutes	Not applicable	Lantus: up to 24 hours Levemir: 16-24 hours	Often started once daily at bedtime.Levemir may be given once or twice daily. Not meal specific
Premixed Insulins Premixed regular insulin Humulin 30/70 & Novolin Ge 30/70, 40/60, 50/50	Varies according to types of insulin	Contains fixed ratios of rapid-acting or short-acting insulin to % of intermediate-acting insulin	First number is long lasting, second is fast coverage for meals	Given with one or more meals per day. Inject 30-445 minutes prior to start of meal
Premixed insulin analogues NovoMix 30 & Humalog Mix 25, Mix 50	Varies according to type of insulin	Peak action based on insulin contained	Fast acting works immediately Long acting all day	Given with one or more meals per day. Inject 0-15 prior to start of meal.

Retrieved from: http://www.diabetes.ca/diabetes-and-you/healthy-living-resources/blood-glucose-insulin/getting-started-with-insulin

The clinical practice guidelines for administration of insulin to pediatric patients with DKA include the following rules (Wolfsdorf et al., 2014):

- Do not give bolus of insulin; **IV Boluses are always contra-indicated**
- Start IV insulin 1-2 hours after IV fluid initiation: **IV insulin given in the first 1-2 hours of DKA repair increases mortality**

- Infuse IV insulin at 0.1 U/kg/hr
- Maintain IV insulin infusion until anion gap and pH normalize
- Anion gap calculation is Na- (Cl+ HCO3) Normal=12±2mmol/L
- Monitor blood glucose at least every 1 hour on insulin infusion for hyper/hypoglycemia

Preparation of insulin infusion. Insulin is started 1-2 hours after initial DKA fluid management is begun. To prepare the insulin infusion, 50 units (0.5 ml) of Regular, short-acting insulin (Humulin R or Novolin Toronto) is added to a 500 ml bag of normal saline (or to D10/Normal Saline, if ordered by Physician). The concentration of insulin will equal 0.1 units/ml. The College Guardian feature on the intravenous pump can be used to determine the insulin concentration (British Columbia's Children's Hospital, 2012). To mix the insulin infusion, draw up the insulin in a tuberculin syringe with a $1\frac{1}{2}$ inch needle so that the insulin is injected past the plastic port of the IV bag. Do not use an insulin syringe, the needle is too small. Mix fluid continually to prevent insulin from settling in the port. Flush the tubing with the insulin infusion (British Columbia's Children's Hospital, 2012).

Mixing insulin infusion requires a double check by another nurse or physician

Section 2.4: Cerebral Edema

Upon completion of section 2.4 you will be able to:

- List the complications associated with DKA
- Define cerebral edema, identify the signs and symptoms, and describe the treatment
- Discus risk factors associated with DKA

Continuous assessment is required throughout the diagnosis and treatment of pediatric DKA to monitor for complications. Cerebral edema is a possible neurological complication that could occur. Electrolyte abnormalities that can arise are hyper/hypokalemia, hypophosphatemia, and hypomagnesemia. IV insulin infusion can cause hypoglycemia. Complications associated with the cardiopulmonary system include: hypovolemic shock, pulmonary edema, and arrhythmias. Other rare complications include bowel ischemia, acute renal failure, and pancreatitis (Wolfsdorf et al. 2014). Implementation of clinical practice guidelines is necessary to avoid complications and prevent the death of children experiencing DKA.

Abiding by clinical practice guidelines is critical when treating children with DKA to prevent neurological or cardiovascular injury which can lead to death. Constant observation of children receiving treatment for DKA is required to prevent complications. In children, the primary causes of mortality from DKA are:

- Not recognizing severity of shock
- Too much fluids causing cerebral edema
- Arrhythmia caused by hypokalemia

(Wolfsdorf et al., 2014)

Cerebral Edema: Subclinical brain swelling is common in children with DKA. Cerebral edema accounts for more than half of the 1-5% mortality rate of DKA in children. The etiology of cerebral edema remains unclear, but aggressive hydration has been implicated in several studies (Wolfsdorf et al., 2014). .

Risk factors for Cerebral Edema

- New onset of diabetes
- Age <5 years old
- Initial pH,7.1 or pCO2 <18
- High initial urea
- Failure of sodium to raise
- Rapid rehydration with hypotonic fluids (>50 ml/kg in first 4 hours)
- Insulin given as bolus or in the first hour of fluid administration
- Bicarbonate administration

(Newhook et al., 2012)

Not all children with DKA develop cerebral edema. The textbox to the left contains a list of risk factors commonly associated with cerebral edema. It is recommended to closely monitor children who present to the emergency department with these risk factors. The clinical practice guidelines for pediatric DKA include critical observation of neurological signs after initiation of treatment with IV fluids and IV insulin. The top five warning signs of cerebral edema include (Wolfsdorf et al., 2014):

- Headache with increasing vomiting
- Altered mentation or fluctuating level of consciousness
- Lethargy; not easily aroused
- Seizure
- Change in neurological status

Recheck blood glucose to ensure that altered level of consciousness is not related to hypoglycemia. Once hypoglycemia is ruled out initiate the following treatments (Wolfsdorf et al., 2014):

- Give mannitol 0.5-1 g/kg or hypertonic saline
- Reduce IV fluids by one-third
- Call Endocrinologist on call at the Janeway
- Transfer patient to ICU
- Once the patient is stable consider CT scan of head

If a patient develops a severe headache or alteration in vital signs, or GCS score <15:

- notify physician
- raise head of bed 30º
- decrease all IV fluids to 5ml/hour,
- prepare mannitol for infusion.

Wolfsdorf et al., 2014

Continuous assessment of patient is necessary for early detection of cerebral edema.

Family-centered Care

Family-centered care can be appropriately initiated throughout the child's treatment to help decrease the amount of stress experienced by the child and family. Venous access for IV fluid initiation has been identified as a stressful procedure for nurses and the child. To make the procedure less stressful nurses should inform parents when an IV catheter is needed. Explain the procedure, reasons for IV catheter insertion, how long catheter will remain in place, and what to expect before and after insertion. Parents should be offered the choice of staying with the child or leaving. If parents decide to stay, provide instruction on how to help throughout the procedure, such as holding the child and providing comfort. The child is told what is being done throughout every step of the procedure and ever effort is made to decrease the pain of needle insertion (EMLA cream, lidocaine gel or spray) (Hockenberry & Wilson, 2011).

Conclusion Unit Two

You have completed Unit Two on the treatment of DKA. You should have a better understanding of the management of DKA, including the guidelines for the administration of IV fluids and IV insulin to treat DKA while using a family-center care approach. Information provided on cerebral edema should prepare you to identify when children develop cerebral edema and how to treat it.

Unit Two Review Questions

Case Study, continuation from question #4 unit one:

John had no investigation at his last ER visit. He was diagnosed with a UTI and sent home on antibiotics. John returns to ER two weeks later and he has progressively become more unwell, and has vomiting and abdominal pain for 24 hours.

Physical exam shows that he is lethargic and moderately dehydrated. He has tachycardia, tachypnea, is afebrile, and he has abdominal pain with guarding and diffuse tenderness. There is a fruity odor to his breath.

Investigations reveal:

Glucose 32.7 mmol/L	Normal: 3.5-5.5 mmol/L
Blood Gas:	
pH: 7.114	Normal: 7.35-7.45
pCO2: 18.0	Normal: 35-45
HCO3: 7.7	Normal: 21-28
Base excess: -18.8	Normal: -2 to +2mEq/L
Urinalysis: +++glucose	Normal: Negative
+++ketones	Normal: Negative

Discussion Questions:

1. What is the appropriate DKA treatment plan for John?
2. List appropriate nursing interventions for John.

Unit Three: Prevention

The best way to treat DKA is to prevent it from happening. Early detection of hyperglycemia and early treatment to return blood glucose to normal levels will prevent DKA or prevent severe DKA. For children with newly diagnosed type 1 diabetes early detection lends to early treatment with subcutaneous insulin which reduces hyperglycemia and prevents development of DKA.

Section 3.1: Early Detection of DKA and Hyperglycemia

Upon completion of section 3.1 you will be able to:

- Discus the importance of early detection in the treatment and prevention of DKA
- Identify factors that contribute to hyperglycemia

DKA research. Research shows that early detection of diabetes, and recognition of developing DKA reduce the severity of the illness. Jackman et al. (2015) conducted a study in Newfoundland and Labrador of 90 children diagnosed with DKA from 2007-2011. They found:

- Of the study sample 39.5% were newly diagnosed with type 1 diabetes and 60.5% were previously diagnosed.
- More severe cases of DKA occurred in younger, newly diagnosed patients.
- Almost half of the pre-existing diabetes cases were recurrent DKA (49.1%).
- A new diagnosis of type 1 diabetes and interrupted insulin delivery in pre-existing patients using insulin pump therapy were the most common factors associated with DKA.
- Of the newly diagnosed patients with DKA, 64% had been seen by a physician prior to diagnosis (missed diagnosis).

A child with new onset diabetes that is continually missed by family physician and/or ER physician is at a high risk for developing DKA. The longer their blood sugar runs high, the more dehydrated they become, the more severe the DKA. As all members of the healthcare team become more skilled at assessing for and detecting diabetes, the incidence of DKA will decrease. ER nurses should take all available opportunities to learn about early detection and prevention of DKA and include the information in patient/family teaching (Jackman et al., 2015).

It is imperative to be knowledgeable about the signs and symptoms of type 1 diabetes and DKA as listed in Unit one, section 1.2

Hyperglycemia. If a child has an unexplained high glucose reading, then the blood glucose should be rechecked within 2 hours. If the glucose reading

does not lower than interventions should be considered. After two consecutive blood glucose readings, urine should be dipped for presence of ketones. A correction bolus of insulin should be taken by needle. If the child is using an insulin pump, change the insertion site. Continue to monitor blood glucose every 2 hours. If glucose readings do not lower or the child begins to feel unwell with vomiting, consult the Janeway healthcare team.

Hyperglycemia can occur as the result of many factors. Some examples include:

- not taking enough insulin or deliberate omission of insulin for weight loss (eating disorder)
- not counting carbohydrates properly or abiding to diet plan
- interruption in insulin delivery or forgetting to bolus or take needle with meal or snack
- illness, medications, such as steroids, or stress
- growth hormones, insulin resistance (occurs in adolescence), and menstruation

Section 3.2.1 Insulin Pump Trouble Shooting

Upon completion of Section 3.2.1you will be able to:

- Define insulin pump
- Discus the benefits of an insulin pump
- List problems with insulin pump that contribute to DKA

Insulin pump. An insulin pump is a small (See figure 12), portable and water-resistant device that continually delivers rapid acting insulin via a cannula that is inserted into subcutaneous tissue of the child. The main benefit of using an insulin pump is improved glycemic control which reduces high blood glucose without increasing incidence of low blood glucose levels (Medtronic, 2015). The government of

Newfoundland and Labrador provided funding in 2007 –2010 for insulin pump therapy for children up to the age of 18 years. In 2010, the budget included the age group from 18-25 years. According to the Government of Newfoundland and Labrador (2011), the prevalence of type 1 diabetes in NL has increased and will continue to increase significantly. It is expected by 2020, 14.4% of NL population will have diabetes, 73,000 people. The Avalon Peninsula in Newfoundland appears to have the highest incidence of childhood

type 1 diabetes worldwide (Newhook et al., 2004; Newhook et al., 2012). Between 2007-2010, 450 children availed of the government project that funded the insulin pump (Diabetes in Newfoundland and Labrador, 2011). Therefore, insulin pump use is increasing in Newfoundland. Approximately, 6% of children worldwide with type 1 diabetes use an insulin pump (Jayasekara et al., 2011).

Figure 12: Insulin pump with an infusion set attached to a spring-loaded insertion device. Retrieved from: https://en.wikipedia.org/wiki/Insulin_pump

Additional benefits of the insulin pump include (Medtronic 2015):

- **Easier insulin dosing**: the insulin pump has a feature called the Bolus Wizard calculator which ensures accurate dosing by taking into account any active insulin still in the body, current blood glucose levels, carbohydrate intake, and basal rates set on pump, to determine the right dose of insulin you need. A basal rate is the set amount of insulin that is delivered by pump every hour. The individual can set several different basal rates to be delivered various times and amounts throughout a 24 hour period. A bolus of insulin is when a onetime dose of insulin is delivered all at once.
- **Fewer injections:** precise amounts of rapid insulin are delivered throughout the day by the infusion set which is replaced and filled with insulin from a mutlidose vial every 2-3 days.
- **Greater flexibility:** the pump can be adjusted to allow for exercise and episodes of illness, removed for swimming or contact sports. There is a temporary basal rate which can be reduced or increased depending on the need.
- **More convenience:** a wireless blood glucose meter automatically sends glucose reading to the pump, allowing for more accurate insulin calculations, the information is stored in a digital logbook, which can be downloaded and reviewed to assist with basal rate setting adjustments.

Insulin pump supplies. The supplies needed to operate an insulin pump include a reservoir and a quickset. The **Reservoir** is manually loaded with insulin is shown in figure 13 below. It is disposable and replaced every 2-3 days. It is available in 1.8 ml and 3.0 ml. **The Quickset** contains tubing which will connect the reservoir, which is placed in the insulin pump, to the insertion/insulin delivery site as shown in See Figure 14 below. At one end there is a needle which is inserted under the skin to guide the catheter into place. Its primary function is to deliver insulin. The needle is removed and placed in a sharps container. The Quickset is also changed every 2-3 days.

Figure 13: Insulin pump reservoir Retrieved from: https://en.wikipedia.org/wiki/Insulin_pump#/media/File:Insulin_pump_reservoir.jpg

Figure 14: Quickset. Retrieved from: www.medtonic-diabetes.com

Research has shown that insulin pump use improves glycemic control and hemoglobin A1C values (Cukierman-Yaffe et al., 2011; Plotnick et al., 2003; Wu et al., 2010). However, problems with the pump can contribute to the development of DKA. Common complications include:

- Catheter occluded/bent at insertion site, interrupting insulin delivery
- Tubing blocked, broken, leaking, or containing air bubbles
- Pump suspended for too long or malfunctioning
- Pump battery not replaced (pump uses a AAA battery)

In addition to insulin pump complications, problems can occur at the insulin injection site. Interruption of insulin delivery is caused by:

- Poor absorption of insulin due to not rotating sites or not changing every 2-3 days
- Site sensitivity; infection
- Infusion set not taped to skin properly or poor connection
- Wrong size set for body type. Infusion site needle is available in 6mm and 9mm

Families should have a backup plan in case the pump malfunctions. Companies have 1-800 numbers available and usually deliver a new pump within a day. In the meantime, insulin can be given by needle. Parents should have syringes on hand and the Janeway's number if they need assistance. Pump malfunctions creates stress; provide reassurance.

Section 3.2(b) Sick Day Management

Upon completion of section 3.2.2 you will be able to:

- Define sick-day management
- Discus steps to follow on sick-days to avoid DKA.

Sick-day management. Children with type 1 diabetes will become sick due to different causes other than diabetes related issues such as DKA. Children contract communicable viral infections such as gastroenteritis, colds, influenza; bacterial infections such as strep throat, pneumonia, etc. To keep blood glucose readings within normal range there are preventative measures children and their families can follow to keep the child from developing DKA in conjunction with the viral/bacterial infection.

TIPS

If a child presents to ER in DKA, and requires treatment, then ask patient/parents to remove pump and keep it secure within their possession.

It is not recommended to change site at bedtime because if there is a pump malfunction the child may be without insulin overnight leading to DKA.

TREKK, 2014

The key to controlling hyperglycemia when sick is close monitoring.

Providing child and family teaching is an important role of nurses. Some important points to discus with children and their parents to help avoid DKA include:

(Canadian Diabetes Association Clinical Practice Guideline Committee, 2013):

- When you have an unexplained high blood glucose reading do not ignore it, investigate and find the cause.
- If you are ill or have an infection you are at an increased risk for DKA. Check your blood glucose and ketones in urine every two hours and keep hydrated.
- When sick and not eating, do not stop basal insulin without checking with Diabetes Team
- When your blood sugars are >14mmol/L on two glucose tests in a row (2 hours apart), and if ketones are moderate to large in urine, go see your doctor or go to the ER (Fraser Health, 2013).
- When you are vomiting or have diarrhea longer than 24hours and you are unable to eat or drink seek medical help (Fraser Health, 2013).
- When you are sick drink 8-10 cups of sugar-free fluids each day (Fraser Health, 2013).

Section 3.2.3: Mental Illnesses / Disorders

Upon completion of section 3.2.3 you will be able to:

- Identify common mental disorders of children
- Discus the effect mental disorders have on type 1 diabetes
- Discus behavior displayed throughout adolescence that contributes to hyperglycemia
- Identify the role the rural ER nurse plays in intervention planning for type 1 diabetes patients with mental disorders and/or behavior problems

Living with a chronic illness like type 1 diabetes produces many challenges for children and their families. Life style changes and problem solving become a way of life. However, some families encounter more severe issues such as **mental illnesses or disorders**, which are cognitive, emotional or behavioral patterns that often cause suffering and may contribute to a reduced ability to function in everyday life (Hockenberry & Wilson, 2011). For children, particularly adolescents, there is a need to identify mental disorders associated with diabetes and develop interventions to reduce impact over the course of the child's development (Canadian Diabetes Association Clinical Practice Guideline Expert Committee, 2013). Studies have shown that mental disorders predict poor diabetes management and control (McDonnell et al, 2007). For example,

Common Mental Disorders

Depression
Anxiety Disorders
Eating Disorders
Externalizing disorders, such as:

- Attention Deficit/Hyperactive Disorder
- Conduct Disorder
- Oppositional Defiant Disorder

(Hockenberry & Wilson, 2011)

Jones et al., (2000) found that 10% of adolescent females with type I diabetes suffered from an eating disorder compared to 4% of female adolescents without diabetes. Insulin omission or manipulation was used as a weight loss tool.

It may be difficult dealing with psychological behaviors of a sick child with DKA and recurrent admission for DKA. If possible speak with the parents in a private area to collect the child's history. It may be difficult for the parents to talk about their child's mental health and they may become emotional. Take this opportunity to provide comfort and support. In addition, a social work consult can be made and/or the physician on call can make a referral to the Janeway hospital for an intervention for the child and their family.

Adolescence. Research has shown that adolescence is a time when children and their families may struggle with diabetes management lending to poor glycemic control (Metzger, 2010). When assessing adolescents with diabetes it may be helpful to keep be aware of the following behavioral health problems (Hockenberry & Wilson, 2011):

- Adolescence is a time of development when there is a strong desire to be like one's peers. However, having diabetes is different. Denial of diabetes is expressed by omitting insulin, not completing blood glucose testing, and not eating correctly. Attention –seeking behavior may be identified by frequent administration of inaccurate doses of insulin.
- Puberty is associated with decreased sensitivity to insulin that is normally compensated for by an increase in insulin from the pancreases. During adolescence insulin dosages need to be increased dramatically.
- Alcohol use puts adolescents at risk for poor glycemic control. Teens may believe that alcohol increases blood glucose levels but alcohol inhibits the release of glycogen from the liver, resulting in hypoglycemia. Behaviors associated with intoxication and hypoglycemia is similar, including shakiness, combativeness, slurred speech, and loss of consciousness.

Family-centered care. Do not assume that when a child is brought to your ER experiencing DKA that they are noncompliant. Many factors contribute to the development of DKA. It is important to collect a detailed history from the child and parents but it is no necessary to place blame. They came to the ER for help, they need support and reassurance. When the time is right, provide education on hyperglycemia and DKA prevention. Parents develop feelings of quilt when they have a child with a chronic disease. They made cope with these feelings in a few ways: overprotective or neglectful. Overprotection is a mechanism that justifies the parent's needs which eventually hampers the growth, development, and maturation of the child (Hockenberry & Wilson, 2011). The neglectful parent is blocking feelings that give them pain and gives responsibility to the child before they are mature enough to handle it (Hockenberry & Wilson). Develop an understanding of what the parent is going through before you pass judgement.

Conclusion of Unit 3: Prevention

You have completed Unit Three: Prevention. This unit should give you a better understanding of prevention of hyperglycemia and associated DKA with a family-centered care approach. You should be able to list factors that contribute to hyperglycemia, including management of blood glucose throughout sickness and mental and behavioral disorders. This unit should help you understand the benefits of insulin pump use and the problems associated with pump use that contributes to DKA.

Unit Three Review Questions

Critical Thinking Exercise (Hockenberry & Wilson, 2011)

Jane, 15 years old, has a 3-year history of diabetes and has been admitted to the ER and diagnosed with DKA. This is her fifth episode of DKA in the past year. Jane's parents are divorced, and she has four young siblings. You are preparing Jane for transfer to the Janeway. You are concerned about Jane's frequent episodes of DKA and enter a referral for the diabetes team. Areas of diabetes management that must be emphasized include (1) diet (2) exercise, (3) self-care, including checking blood glucose and insulin administration, (4) sliding scale insulin, (5) urine ketone testing when experiencing hyperglycemia, and (6) effective methods of handling emotional stressors.

Of the following issues that might be influencing the recurrent episodes of DKA, which one should be addressed **initially?**

Chose a response:

1. The responsibility Jane feels for the helping out at home.
2. Fluctuation of blood glucose levels around the time of menses with inadequate insulin dosage.
3. Stress related to parent's divorce.
4. Adolescent issues, such as seeking independence, and feeling different from peers.

Case Study

Marie a 4 year old girl with type 1 diabetes presents to a rural ER with a two day history of vomiting with no diarrhea, no fever, and hyperglycemia. Marie uses an insulin pump. Her parents report that her blood sugars have been running greater than 20mmol/L. She had been tolerating sips of fluids until about an hour ago, when she became quite sleepy and difficult to arouse. She has had good urine output.

Marie is treated with rapid acting insulin through her pump, with 3 different basal rates, and she bolusing for all meals and snacks. The parents have been bolusing extra amounts of insulin to correct the high blood sugars, however they have remained high. Her insulin pump insertion site was changed 2 day ago and it is changed regularly every 3 days.

The following highlights the results of her initial assessment:

Physical examination results. Maria is pale, and difficult to arouse. Her respirations are deep but she has good air entry with no crackles or wheezes. Her mouth is dry and her pupils are equal, reacting to light with accommodation. There is no papilledema, and her reflexes are normal. There are no signs of infection; abdomen is soft and non-tender to touch, with no guarding.

Vital signs and results of Laboratory Investigations:

	Marie's Vital Signs & Test Results	Normal Vital Signs
Heart Rate	160bpm	70-110 bpm
Respiratory Rate	40bpm	20-30 bpm
Blood Pressure	110/60 mmHg	80-100/60 mmHg
Temperature	37.4 ºC	37.4 ºC
Capillary Refill	8 seconds	2-3 seconds
Glucose	32 mmol/L	3.7-7.8 mmol/L
pH	7.0	7.35-7.45
Bicarbonate	8	21-28
Sodium	129mmol/L	134-145

Questions

1. What are possible precipitating factors of DKA?
2. Could DKA have been prevented in this case?
3. What factors may have led to this complication?

Multiple Choice/True and False

1. When a child with type 1 diabetes experiences illness, sick day management at home includes the following:
    a) Education for families regarding sick day management and prevention of DKA. Having a "sick-day toolkit" with instructions and back-up supplies such as ketone dip sticks and syringes available.
    b) 24 hour availability of telephone advice by a health care professional experienced in pediatric diabetes.
    c) Checking glucose and ketones every 2 hours, and keeping hydrated.
    d) Continue basal insulin even if not eating. Do not stop without consulting healthcare team.

e) Children should be assessed by a physician if signs and symptoms of DKA (look sick, very sleepy, deep breathing, dry mouth, fruity odor on breath, sunken eyes, abdominal pain, persistent vomiting)
f) All off the above.

2. What is not a possible problem with the insulin pump that could lead to DKA?
   a) Catheter occluded or bent at insertion site, interrupting insulin delivery.
   b) Setting several basal rates in a 24 hour period
   c) Air bubbles in tubing.
   d) Pump suspended for too long
   .

3. Medication, such as steroids, can increase blood glucose levels and contribute to the development of DKA? True or False

4. When treating a child with sever DKA in the ER keep insulin pump connected to child.
   True or False

Answers to Review Questions, All Units

Unit One Answers

1. (c) weight gain: Children newly diagnosed with type 1 diabetes experience weight loss due to lack of insulin to bring glucose to the cells.

2. (b) check blood sugar with glucometer or check urine for glucose and ketones at triage: Due to the presenting signs and symptoms, at triage it would be appropriate to check the blood glucose or check the urine for ketones/glucose. Type 1 diabetes is often missed as a diagnosis, it is better to rule out diabetes with less invasive tests.

3. (d) all of the above: Nausea, vomiting, fruity smelling breath, and deep respirations are all signs/symptoms of DKA.

4. (b), (c), & (d): Due to presenting signs and symptoms of type 1 diabetes further investigations should be completed right away. A glucose test can be done at bed side and then confirmed with blood work. Urine dip stick can be conducted by nurse and the confirmed by the laboratory.

5.

Matching

(1) Hyperglycemia:	(7) Blood glucose reading greater than 11mmol/L
(2) Glycosuria:	(9) Glucose in urine.
(3) Polyuria:	(4) Increase in volume of urine
(4) Polydipsia:	(6) Excessive Thirst
(5) Polyphagia:	(10) Increased Hunger
(6) Candida Albicans:	(8) Yeast Infection
(7) Nocturia:	(5) Bed Wetting
(8) Kussmaul Respirations:	(1) Hyperventilation characteristics of metabolic acidosis

(9) Ketones: (2) Organic acids that produce excess hydrogen ions, lowering pH

(10) Dehydration: (3) total output of fluids exceeds total intake.

Unit Two Answers

Case Study Answer:

The diagnosis of type 1 diabetes and DKA is usually straightforward with the presentation of typical symptoms and the presence of confirming laboratory blood values, especially in a previously health child. The treatment plan for child differs from adults due to the high risk of developing cerebral edema. The pediatric guidelines should be followed to aid in management.

Appropriate nursing interventions include (BCCH, 2012):

1. Keep patient NPO.
2. Weight patient for rehydration calculations
3. Apply pulse oximetry and cardiac monitor; Apply 100% oxygen if saturation is low or signs of shock.
4. Initiate intravenous access, 2 large bore catheters if possible.
5. Physician will order IV fluids; normotensive shock may receive 7ml/kg of normal saline over 30-60 minutes; with hypotensive shock a bolus of 10-20 ml/kg, no more than 40 ml/kg.
6. Add IV infusion of normal saline with potassium 40 mmol in the first one-two hours.
7. Start insulin infusion one-two hours after IV hydration is initiated.
8. Repeat neurovital signs every 15 minutes until stable, then hourly until discontinued.
9. Repeat blood work every 2 hours.
10. Close neurological monitoring and frequent rousing.
11. Monitor for headache, abnormal respirations, and behavioral changes
12. Check urine for ketones with each void.
13. Monitor Intake and output.

Unit Three Answers

Critical Thinking Exercise

The best response is number two. The issue that should be addressed first is the situation that is directly related to hyperglycemia. Adolescent females with diabetes tend to have fluctuations of blood glucose levels before, during, and after menses. Emotional stress related to increased responsibility, normal development tasks of adolescence, and personal loss from divorce can create stress and increase blood glucose. These issues need to be addressed as well. A referral can be made for support services.

Case Study

1. The precipitating factor is decreased insulin delivery through the insulin pump insertion site, she could have gastroenteritis as well.
2. DKA could have been prevented by following a sick day management plan. The first time she had 2 unexplained high glucose reading, her urine should have been checked for ketones and insulin pump set up changed. Insulin should have been administered by needle and glucose and urine checked every 2 hours until it returned to normal.
3. The possible factors that may have led to DKA include air bubbles in tubing, bent cannula at insertion site, and poor absorption at site due to not rotating sites.

Multiple Choice/True and False

1. All of the above.
2. (b) Setting several basal rates in a 24 hour period does not contribute to DKA. Basal insulin is insulin that is delivered every hour, several basal insulin doses can be set in a 24 hour period contributing to improved glycemic control.
3. True: steroids increase blood glucose.
4. False: When treating a child with sever DKA in the ER remove the insulin pump and give to parents to keep secure.

Additional Resources

Clinical Guidelines

Prevention of diabetic ketoacidosis in children and youth. Key elements from CDA 2008 Clinical

Practice Guidelines. Link to: http://www.diabetes.ca/documents/about-diabetes/prevention-ketoacidosis.pdf

Type 1 Diabetes in Children and Adolescents. Canadian Diabetes Association Clinical Practice

Guidelines Expert Committee (2013). Link to : http://guidelines.diabetes.ca/browse/chapter34

Toolkit

Diabetic Ketoacidosis Protocol Toolkit Link to:

http://www.bcchildrens.ca/Sevices/SpecializedPediatrics?endocrinologyDiabetesUnit/forprofessionals/dkaprotocol.htm

British Columbia Children's Hospital DKA protocol toolkit has been revised to conform to the International Society for Pediatric and Adolescent Diabetes Clinical Practice Consensus Guidelines 2009 Compendium. Link to: http://www.bcchildrens.ca/endocrinology-diabetes-site/documents/dkatoolkit.pdf

Documents

ISPAD Clinical Practice Consensus Guidelines 2009 Compendium Link to: http://c.ymcdn.com/sites/www.ispad.org/resource/resmgr/Docs/ispad_CPCG_2009_CHAPTER_10.pdf

Websites

Canadian Diabetes Association link to: http://www.diabetes.ca/

Insulin Pump information at: https://www.medtronicdiabetes.ca/

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