THE DEVELOPMENT OF A CLINICAL NURSING PRACTICE GUIDELINE FOR MANAGEMENT OF HYPOGLYCEMIA ASSOCIATED WITH INSULIN THERAPY AMONG TYPE II DIABETIC PATIENTS DURING HOSPITALIZATION

NAPHASSAWAN DERMKHUNTOD

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……..

Miss Naphassawan Dermkhuntod

Candidate

……..

Assoc. Prof. Sasima Kusuma Na Ayuthya,

Ph.D.(Biopharmaceutical Sciences)

Major-Advisor

……..

Asst. Prof. Aurawamon Sriyuktasuth,

D.S.N.

Co-Advisor

……

Prof. Banchong Mahaisavariya,

M.D.

Dean

Faculty of Graduate Studies

……

Assoc. Prof. Yajai Sitthimongkol,

Ph.D.(Nursing)

Chair

Master of Nursing Science

Faculty of Nursing

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for the degree of Master of Science (Adult Nursing)

on

27 August, 2008

……..
Miss Naphassawan Dermkhuntod
Candidate

……...
Asst. Prof. Usavadee Asdornwised,
Ph.D.(Nursing)
Chair

…….....
Assoc. Prof. Sasima Kusuma Na Ayuthya,
Ph.D.(Biopharmaceutical Sciences)
Member

……..
Mr. Petch Rawdaree
M.D.
Diploma of board of endocrinology,

……..
Asst. Prof. Aurawamon Sriyuktasuth,
D.S.N.
Member

…….
Prof. Banchong Mahaisavariya,
M.D.
Dean
Faculty of Graduate Studies
Mahidol University

……...
Assoc. Prof. Fongcum Tilokskulchai,
Ph.D.(Nursing)
Dean
Faculty of Nursing
Mahidol University

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NAPHASSAWAN DERMKHUNTOD 4936725 NSAN/M

M.N.S.(ADULT NURSING)

THEMATIC PAPER ADVISORS: SASIMA KUSUMA NA AYUTHYA, Ph.D. (BIO-PHARMACEUTICAL SCIENCES), AURAWAMON SRIYUKTASUTH, D.S.N.

ABSTRACT

Hypoglycemia episodes in type 2 diabetic patients are associated with insulin therapy. An episode is a significant clinical risk and a barrier to treatment for glycemic control in hospitalized patients.

This study aimed at developing a clinical nursing practice guideline (CNPG) for management of hypoglycemia episodes in type 2 diabetic patients who receive insulin therapy in hospitals. An evidence-based practice model by Soukup (2000) was used as the conceptual framework. It consists of 4 phases. In phase I, clinical problems are explored and identified. It was found that hypoglycemia is a significant clinical risk and it can be a cause of death. In phase II, evidences are gathered and then analyzed and synthesized. Five studies are included in this guideline. The synthesis of these studies provided a conceptual basis for developing a CNPG which consists of 3 major tasks: assessment, management and evaluation. The CNPG was examined by five experts for validity. For phase III and IV, a plan to implement the CNPG was identified. After the trial implementation, the CNPG will be revised to ensure that the guideline is suitable for further implementation in work units.

Before this CNPG is implemented, it is recommended that it should be integrated with continuous quality of improvement (CQI) and nurses should be trained to have the necessary skills and knowledge needed for implementation and utilization. In addition, the CNPG should be approved by the multidisciplinary team and the outcomes research should be implemented.

KEY WORDS: HYPOGLYCEMIA / TYPE II DIABETIC PATIENTS / GUIDELINE / HOSPITALIZATION/ MANAGEMENT/ NURSING PRACTICE GUIDELINE

74 pp.

การพัฒนาแนวปฏิบัติการพยาบาล เพื่อการจัดการภาวะน้ำตาลในเลือดต่ำ ในผู้ป่วยเบาหวานชนิดที่ 2 ที่ได้รับการรักษาด้วยอินซูลิน ขณะเข้ารับการรักษาในโรงพยาบาล
(THE DEVELOPMENT OF A CLINICAL NURSING PRACTICE GUIDELINE FOR MANAGEMENT HYPOGLYCEMIA ASSOCIATED WITH INSULIN THERAPY AMONG TYPE II DIABETIC PATIENTS DURING HOSPITALIZATION)

นภัสวรรณ เดิมขุนทด 4936725 NSAN/M

พย.ม.(การพยาบาลผู้ใหญ่)

คณะกรรมการควบคุมสารนิพนธ์: ศศิมา กุสุมา ณ อยุธยา, ปร.ด., อรวมน ศรียุกตศุทธ D.S.N

บทคัดย่อ

ภาวะน้ำตาลในเลือดต่ำในผู้ป่วยเบาหวานชนิดที่2 ที่ได้รับการรักษาด้วยอินซูลิน ขณะเข้ารับการรักษาในโรงพยาบาลเป็นความเสี่ยงทางคลินิกที่สำคัญ และเป็นอุปสรรคที่สำคัญของการรักษาเพื่อควบคุมระดับน้ำตาลในเลือดในระหว่างการเข้ารับการรักษาในโรงพยาบาล

การศึกษาครั้งนี้มีวัตถุประสงค์เพื่อพัฒนาแนวปฏิบัติการพยาบาล เพื่อการจัดการภาวะน้ำตาลในเลือดต่ำในผู้ป่วยเบาหวานชนิดที่ 2 ที่ได้รับการรักษาด้วยอินซูลิน ขณะเข้ารับการรักษาในโรงพยาบาล โดยใช้กรอบแนวคิดการใช้หลักฐานเชิงประจักษ์ ของซูคัพ (Soukup, 2000) มี 4 ระยะดังนี้ ระยะที่ 1 สำรวจและวิเคราะห์ปัญหา พบว่าภาวะน้ำตาลในเลือดต่ำในผู้ป่วยเบาหวานชนิดที่ 2 ที่ได้รับอินซูลินเป็นความเสี่ยงทางคลินิกที่สำคัญ และเป็นสาเหตุทำให้ผู้ป่วยเสียชีวิต ระยะที่ 2 สืบค้นหลักฐานเชิงประจักษ์ได้ทั้งหมด 5 เรื่อง นำมาวิเคราะห์ และสังเคราะห์ เพื่อให้ได้แนวคิดหลักในการนำมาพัฒนาเป็นแนวปฏิบัติการพยาบาล ซึ่งประกอบด้วย 3 แนวคิดหลัก คือ การประเมิน การจัดการ และการประเมินผล ภายหลังพัฒนาแนวปฏิบัติการพยาบาลนำเสนอต่อผู้ทรงคุณวุฒิจำนวน 5 ท่าน เพื่อตรวจสอบความถูกต้องเที่ยงตรงของเนื้อหา และเสนอแนะในการปรับปรุงเพิ่มเติมรายละเอียดของขั้นตอนการปฏิบัติให้มีความถูกต้อง เหมาะสม ในระยะที่ 3 และ 4 ผู้ศึกษาวางแผนนำแนวปฏิบัติการพยาบาลที่สร้างขึ้นไปทดลองใช้ และนำผลของการทดลองใช้มาปรับปรุงแก้ไขเพื่อให้เหมาะสมสามารถนำไปใช้ได้ในหน่วยงานจริง

ข้อเสนอแนะของการศึกษา แนวปฏิบัติการพยาบาลควรได้รับการพัฒนาอย่างต่อเนื่องมีการฝึกทักษะและพัฒนาความรู้สำหรับผู้ใช้แนวปฏิบัติการพยาบาล นอกจากนั้นแนวปฏิบัติการพยาบาลควรได้รับความเห็นชอบจากทีมสหสาขาวิชาชีพ และควรมีการทำงานวิจัยเชิงผลลัพธ์ต่อไป

74 หน้า

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CHAPTER I
INTRODUCTION

Background and Significant of the Study

Diabetes mellitus, a chronic illness is a major global health problem. In 1995, the WHO estimated the number of diabetes patients as 135 million. And it is believed that this number might increase up to 299 million in 2025. In USA the number of diabetes patients is almost 21 millions and this number is continued to increase (Campos, 2007). According to the available statistics about the situation of diabetes mellitus Thailand, the number of diabetic patients is continue to increase 100,000 per year; from 33.3% in 1995 to 91.0% in 2004 (Viboonpolprasert, 2007). This number increased 4.4 percents in 1997 to 5.6 percent in 2004. Current situation of type 2 diabetic patients is increasing in the young patient because of improper health behavior. Out of 100 percent of diabetic patients, 99 percent of them in ASIAN region included Thailand has type 2 diabetes (Himatongkum, 2005). Chronic hyperglycemia in diabetic patients is associated with long microvascular and macrovascular complication and these are cause of high cost chronic diseases such as cardiovascular disease, cerebrovascular disease, End Stage Renal Disease (ESRD), hypertension, leading to morbidity and mortality rate. Diabetic patient's poor glycemic control is the cause of often emergency hospitalization particularly in hyperglycemia episode. Hyperglycemia in hospitalized patients is common episode and this is caused by stress, sepsis, stimulated counter-regulation hormone released for response critically illness and in some patients this is the result of medication such as glucocorticoid, vasopressor (Clement et al., 2004). Increase of blood glucose level in critically ill patients induces the risk of consequence of morbidity such as increased infarct size in myocardial infarction and stroke leading to poor outcome (Lewis, Kane-Gill, Bobek, & Dasta, 2004). Then hyperglycemia in hospitalization leads to long length of stay, increases required critical care setting and mortality rate (Clement et al., 2004). Controlling blood glucose near - normoglycemia is significant for reduced

complication from hyperglycemia such as infection, length of stay, morbidity and mortality. It is reported in several studies that insulin therapy for glycemic control can improve outcome of care in hospitalized patients such as reduced mortality in critical illness 43%, in hospitalized 34%, reduced renal failure for dialysis 41%, sepsis 46%, and reduced mortality rate in nurological 44% (Berghe et al., 2001). The meta analysis from Pittas and colleague (2004) reported that insulin therapy in critical ill patients can reduce mortality rate up to 15%. Then normoglycemic control in diabetes patients is important for patients in general ward, surgical ward and critical care setting (Clement et al., 2004), but intensive insulin is associated with important complications such as hypoglycemia episode. Hypoglycemia in type 2 during hospitalization who critical ill, older age and have co-morbidity such as liver failure and renal failure, the deteriorate organ in advanced age or poly pharmacy, or effected from some medication may blunt the autonomic symptoms response to hypoglycemia which may be delay diagnosis and serious effect consequence.

Hypoglycemia episode among diabetic patients who receive insulin therapy is the most common and has serious adverse effect (Leckie, Grant, Ritchie, & Frier, 2005; Miller et al., 2001). It is important barrier of effective glycemic control and indicators of quality of care in hospitalization (Wexler et al., 2007). Prevalence of hypoglycemia in type 2 diabetic patients is higher 70-80% (Johnson, Koepsell, & Reiber, 2002). Hypoglycemia affects on importance organs such as brain and heart. When hypoglycemia is not resolved and develops to severe hypoglycemia it may cause serious brain dysfunction and may associate with fatal vascular events such as myocardial infarction stroke and cardiac arrhythmias (Hsiao & Chien, 2006). Furthermore hypoglycemia is also cause of the release of counter-regulation hormones, such as glucagon, epinephrine, norepinephrin, cortisol, and growth hormone (Chang, Tseng, & Wang, 2007). The catecholamine release is related to the nadir plasma glucose concentration. The increase of heart rate, platelet aggregation and vasoconstriction may decrease coronary blood supply and increase myocardial oxygen demand affected to transient myocardial ischemia and shows increase episode of chest pain and ECG abnormalities (Desouza, Salazar, Cheong, Murgo, & Fonseca, 2003). Then hypoglycemia episode is important because it affects to physiology, economy and quality of life of diabetic patients.

Severity of hypoglycemia is divided in 3 levels: mild, moderate and severe hypoglycemia. Mild to moderate hypoglycemia defines to blood glucose level less than 70 mg/dl which may have no symptoms or few and patients can self-treat. Severe hypoglycemia means blood glucose level less than 50 mg/dl and this may decrease of conscious level in which patients need assistance from other people. The impact of lower blood glucose level induces signs and symptoms of hypoglycemia. Types of symptoms of hypoglycemia can be divided into two categories: autonomic symptoms or neurogenic symptoms and neuroglycopenic symptoms. An autonomic symptom is shown when the plasma glucose concentrations falls below 70 mg/dl. When this thing happens the brain is activated and releases neuroendocrine hormone (counter-regulatory or anti-insulin hormones) (Briscoe & Davis, 2006). This is compensated by release of hormone which affects to increase blood glucose level. Furthermore it stimulates the autonomic nervous system to present autonomic symptom. The autonomic symptom includes shaking, trembling, anxiety, nervousness, palpitations, humidity, sweating, dry mouth, hunger, pallor, pupil dilation. If the hypoglycemia is not resolved and it develops to the brain glucose deprivation associated with neuroglycopenic symptoms such as abnormal mentality, irritability, confusion, difficulty in thinking, difficulty in speaking, ataxia, paresthesias, headache, stupor, seizure, coma and death (Briscoe & Davis, 2006).

Hypoglycemia episode in diabetic patients during hospitalization is associated with mismatch between caloric intake and insulin supplementation (Campbell et al., 2004). The triggering events of hypoglycemia in hospitalized patients who received antihyperglycemic therapy are the transport off ward causing meal delay, new noting by mouth status for procedure or diagnosis, sudden decrease of dose of corticosteroids, emesis, decrease of caloric intake, missed or delayed meal, decrease rate of dextrose intravenous, decrease of recognized signs and symptoms of hypoglycemia, interruption of enteral or parenteral nutrition (Briscoe & Davis, 2006). Furthermore there are other risk factors such as advanced age, congestive heart failure, renal failure, liver failure, malignancy, sepsis, infection (Braithwaite et al., 2004; Clement et al., 2004).

The response of counter-regulation hormone during critical ill is associated with elevated blood glucose level concentration. The hospitalized patients who have

hyperglycemia during critical ill receive intensive insulin therapy for improving outcome, but the intensive insulin therapy adds the patient's characteristic of risk factors, process or routine of care associated with highest rate of hypoglycemia episode in diabetes patients during hospitalization. The serious outcome of hypoglycemia episode is the effect on morbidity and mortality rate of diabetes patients.

Hypoglycemia episode in hospitalization is an important clinical risk. The Bangkok Metropolitan Administration Medical Collage and Vajira Hospital recognize an importance of this clinical risk management by development of care map for surveillance hypoglycemia in hospitalized, which collaborate with multidisciplinary inpatients care team which included physicians, nurses, pharmacist and dietitians. But the problem of these is still routine care by nurses, incomplete and inactive pattern of care management. In the part of team collaboration, the lack of learning, work division, collaboration, actual problem analysis, and continuing care between multidisciplinary team is found. It results in frequency of hypoglycemia in patients who receive insulin therapy. Risk management of these problems begins with situation analysis, finding of the related evidences and inclusion of developing clinical nursing practice guideline for management and prevention hypoglycemia among type 2 diabetic patients who receive insulin therapy during hospitalization for safety and effectiveness of treatment.

Main Issue

Hypoglycemia episode in type 2 diabetic patients who receive insulin therapy during hospitalization is an important clinical risk. It can cause severe hypoglycemia which may affect morbidity and mortality rate. Hypoglycemia episode inpatients hospitalization has several causes either from patient's characteristic, routine or process of care, internal factors or external factors. Assessment, detection and prevention are important for inpatients' health care team and appropriated management. The development of a clinical nursing practice guideline for diabetic inpatients on evidence base is a part of prevention of these clinical risks and improves quality of care in diabetic patients. Furthermore, the type 2 diabetic during hospitalization receives insulin therapy safety and effectively.

Purpose of the Study

The objective of this study is to develop a clinical nursing practice guideline for management of hypoglycemia associated with insulin therapy in type 2 diabetic patients during hospitalization.

Benefits and Expected Outcome

1. Achieve safety and effectiveness of cure for the type 2 diabetic inpatients who receive insulin therapy.

2. Obtain standard of nursing care, assessment and appropriate management for the type 2 diabetic patients who receive insulin therapy.

3. Develop the standard and quality of nursing care in type 2 diabetic patients during hospitalization by using evidence-based practice.

CHAPTER II
LITERATURE REVIEW

Review of Existing Literature Related to Issues of Concern

The literature review is related to hypoglycemia episode in the type 2 diabetic inpatients who receive insulin therapy. The literature review covers following issues:

1. Hypoglycemia in type 2 diabetic patients
2. Factors influencing hypoglycemia in type 2 diabetic patients
3. Physical reactions to hypoglycemia in type 2 diabetic patients
4. The types of insulin
5. Nursing management for hypoglycemia in type 2 diabetic inpatients

1. Hypoglycemia in type 2 diabetic inpatients

The etiology of type 2 diabetes mellitus is insulin deficiency as β-cell dysfunction and insulin resistance that yield hyperglycemia. The hyperglycemia is cause of coronary artery disease (CAD), cerebrovascular, nephropathy, lower-extremity amputation and infection which enforce the patients to be hospitalized (Clement et al., 2004). The patients with type 2 diabetes mellitus have more chances of hospitalization in intensive care unit (ICU) than the ones who do not have diabetes counterparts as a result of several organs that affected as a result of poor diabetic control and the metabolic syndrome often present in these patients (Langdon & Shrive, 2004). They usually have longer length of stay in hospital. The critically ill diabetic patients are hospitalized patients who generally have poor glycemic control during admission because of many factors which include infection, fever, corticosteroid used, surgical wound and stress from admission (Cohen, Sedhom, Salifu, & Friedman, 2007). Hypoglycemia episode is usually found in the diabetes mellitus patients who have intensive glucose control. The more intensive glucose control in type 2 diabetes mellitus patients, the more risk of hypoglycemia increase is found (Miller et al., 2001).

Hypoglycemia not only has the impact on the type 2 diabetes mellitus patients but also it is a significant obstacle to control diabetic progress (Davis & Alonso, 2004).

Hypoglycemia episode in diabetic patients occurs more from the higher utilization of blood glucose than the intrinsic glucose. The physiopathology which is a response to lower blood glucose is a mechanism to prevent hypoglycemia episode. This mechanism normally prevents or rapidly corrects hypoglycemia. This begins from a decrease in pancreatic islet β-cell insulin secretion and is followed by counter-regulation hormone released for endogenous glucose production to elevate blood glucose (Banarer & Cryer, 2004). Normal blood glucose after digestive absorption in the patients without diabetes is about 72-108 mg/dl (4.0-6.0 mmol/L). Average of blood glucose level is about 81 mg/dl (4.5 mmol/L). The release of counter-regulation hormone starts when blood glucose level is lower than 65-70 mg/dl (3.6-3.9 mmol/L). Decreased blood glucose level affects to have signs and symptoms of hypoglycemia. Symptoms of hypoglycemia occur when blood glucose level is less than 70 mg/dl. The brain glucose deprivation is found when blood glucose is decreased to about 50-55 mg/dl (2.8-3.0 mmol/L). The patients with advanced type 2 diabetes mellitus may have more insulin deficiency. It causes the loss of glucagon that stimulates physical reaction to prevent hypoglycemia. Because of this reason, the patients with advanced type 2 diabetes mellitus easily gain iatrogenic hypoglycemia which is typically found clinical problem (Cryer, Davis, & Shamoon, 2003; Murata, Duckworth, Hoffman, Wendel, & Shah, 2004).

Iatrogenic hypoglycemia in advanced type 2 diabetic inpatients is the result of interplay of relative or absolute therapeutic insulin excess and compromised physiological defenses against falling plasma glucose concentrations (Cryer, 2002; Cryer, Irene, & Karl, 2007). The prevalence of iatrogenic of hypoglycemia episode in type 1 diabetic patients is found more than it is found in type 2 patients. However the number of type 2 diabetic patients is around 20 times more than that of type 1 patients. So we find that there are many episodes of iatrogenic hypoglycemia in type 2 diabetic patients. Frequency of iatrogenic hypoglycemia in type 2 diabetic patients is equaled to the one in type 1 diabetic patients (Cryer & Karl, 2007). The patients with advanced type 2 diabetic or prolonged disease make physical dysfunction to prevent hypoglycemia by suppressing insulin secretion and stimuli glucagon release blood

mechanisms increases glucose level. Furthermore, the advanced type 2 diabetic and prolonged disease have impact on declining response of sympathoadrenal, thus there is no signs and symptoms of hypoglycemia. Then there is increase in hypoglycemia unawareness which causes the development of severe hypoglycemia. And it is also a cause of hypoglycemia association autonomic failure (HAAF) (Cryer & Karl, 2007). In the same way frequent mild hypoglycemia in type 2 diabetic patients generate physical changes that cause hypoglycemic response failure which leads to have hypoglycemia unawareness and severe hypoglycemia including hypoglycemia association autonomic failure (HAAF) (Cryer & Childs, 2002; Miller et al., 2001).

2. Factors influencing hypoglycemia in type 2 diabetic patients

Hypoglycemia episode in type 2 diabetic in hospitalized patients comes from several factors such as, causative factors and predisposing factors. Causative factors include the imbalance between insulin and glucose level in blood circulation. The insulin excess must be maintained from time to time during treatment of diabetic with insulin or with an insulin secretagogue such as a sulfonylurea or glinide, because of the pharmacokinetic imperfections of these therapies. Predisposing factors consist of underlying diseases, degenerative changes of organ, reactions to medications and treatment in hospital (Zammitt & Frier, 2005).

2.1 Causative factors

The main causes of hypoglycemia episode in the type 2 diabetic patients who receive insulin therapy during admission are imbalance of insulin and glucose. The excess of insulin can be maintained by insulin therapy, insulin secretagogue, and by decrease in glucose such as; decrease of exogenous intake and failure of defense mechanism for preventing hypoglycemia by the counter-regulation hormone.

2.1.1 Exogenous insulin excess

Exogenous insulin excess refers to insulin for supplementation. According to United Kingdom Prospective Diabetic Study (UKPDS), the reason for using insulin injection in type 2 diabetic patients is constant decrease of β-cell function. In general, 50% of β-cell can work properly. When diabetic control medicine treatment fails, insulin injection is a treatment of choice to successfully control blood glucose of the patients. In addition, insulin injection is used in type 2

diabetic patients who do not respond to oral hypoglycemic agent (OHA) treatment; especially when they are hospitalized and usually in critical condition from severe uncontrolled diabetes in which the blood glucose is severely high that can cause morbidity and mortality. For instance, the patients may die after having stroke or having myocardial infarction. Severe high blood glucose also increases the chances of stroke and myocardial infarction. Control of blood glucose by insulin injection in critical ill patients decreases immediate mortality rate for 15% (Pittas, Siegel, & Lau, 2004). Although, the benefit of insulin injection is noted but there are significant complications such as hypoglycemia episode that is an obstacle of diabetic control (Guven, Bayram, Guven, & Kelestimur, 2000; Hasssan, 2007).

Hypoglycemia episode in type 2 diabetic patients who received insulin therapy has many relevant factors such as dose, type, time period of injection, change of diet habit or the decrease of insulin elimination causing renal failure and especially the change of counter-regulation hormone. In particular, type 2 diabetic elder patients who have prolonged diabetes mellitus with long-term insulin injection lose perception of symptom of hypoglycemia, thus risk of severe hypoglycemia occur due to hypoglycemic unawareness. The Joint Commission on Accreditation of Healthcare Organization (JACHO) voted that insulin is a high-risk drug which requires drug administration safety by good drug administration to reduce medication error such as no abbreviation in medication order. From several studies, it is found that hypoglycemia episode is common in insulin treatment. And oral hypoglycemic agent such as sulfonylurea respectively is frequently found in hospitalized type 2 diabetic patients (Ben-Ami, Nagachandran, Mendelspn, & Edoute, 1999)

2.1.2 Insulin secretagogue:

Insulin secretagogue refers to received oral hypoglycemic agent such as sulfonylurea. The major complications which may occur in sulfonylurea are hypoglycemia episode and increase of body weight (Oiknine & Mooradian, 2003). These drugs arise directly to β-cell in pancreas to release insulin. Severe hypoglycemia is found in the type 2 diabetic patients and elder patients with liver and renal failure including degenerative changes of liver and kidney and in the patients who use the medications mentioned above because these drugs are metabolized at liver and eliminated through kidney. The group of sulfonylurea such as glyburide

(glibenclamide) shows that it most common cause of more hypoglycemia than other secretatogues and it is also cause of more hypoglycemia than other sulfonylurea. In the previous researches any difference is not found in the risk for hypoglycemia of glyburide compared with insulin therapy (Gangji, Cukierman, & Gerstein, 2007). Other medicines such as chlorpropramide, glipizide, glicazide and glimerpiride show less evidences of hypoglycemia (Sriussadaporn & Nitiyanant, 2005). In general, the drug group sulfonylurea is metabolized in liver but in case of the patients who have moderate to sever liver failure the drug is metabolized and eliminated out in kidney instead. The effects of these kinds of medicines are long (Cheng & Fantus, 2005) because they cause hypoglycemia as well as undesired complications. Therefore, in type 2 diabetic patients who have impairment of liver and kidney functions with decreased creatinine clearance and other medications used may have the combined reactions leading to hypoglycemia (Inzucchi, 2002).

The type 2 diabetic patients who cannot control blood glucose receive insulin injection combined with one or more than one groups of oral hypoglycemic agent for instance, administration of insulin injection combined with oral hypoglycemic agents such as sulfonylurea, metformin, α-glucosidase inhibitor and thiazolidinedione (Sriussadaporn & Nitiyanant, 2005).

2.1.3 Decrease of exogenous glucose

Decrease of exogenous glucose refers to poor nutrition such as the reduction of diet consumption, fasting before operation, refusal of diet consumption, uncertain meal, decreased fluid with glucose intake, vomiting and guarding of tube-feeding or intravenous nutrition (Clement, et al., 2004). From the study of Varghese and associates (2007), it is found that the main cause of hypoglycemia in hospitalized diabetic patients (40%) is reduction of diet consumption.

2.1.4 Decreased endogenous glucose production

Decrease endogenous glucose production refers to the failure of counter-regulation hormone which is a physical mechanism response to prevent hypoglycemia. The failure of counter-regulation hormone in type 2 diabetic patients offers progressive severity of the disease. Prolonged diabetes, insulin treatment, strict metabolic control, and a history of hypoglycemia unawareness are also causes of counter-regulation hormone failure. It can be explained by glucagon which is the first

hormone gain dysfunction that can be found in the patients who have been diagnosed with diabetes for 5 years. The patients who have been diagnosed with diabetes for 10 years have epinephrine hormone dysfunction that means loss of physical reaction to hypoglycemia. Therefore, the type 2 diabetic patients have high risk to have hypoglycemia.

2.2 Predisposing factors

Predisposing factors of hypoglycemia in type 2 diabetic hospitalized patients are advanced age, underlying diseases such as liver disease, kidney disease, particular drugs and other health conditions.

2.2.1 Advanced age

Several other factors contribute to a high prevalence of type 2 diabetic older patients. For example normal aging is characterized by progressive alterations in all aspects of glucose metabolism (Oiknine & Mooradian, 2003), including insulin secretion, insulin action, and hepatic glucose production (Meneilly, 2006). Furthermore behavioral change on diet consumption, decrease of oxidative enzyme that may disturb the metabolism, elimination of insulin and oral hypoglycemic agent are cause of hypoglycemia. Degenerative changes of organs in older patients causing failure of vital organs such as liver, kidney, changes of counter-regulation hormone and change of hypoglycemic awareness due to lacking the sign of adrenergic dysfunction. Hence, hypoglycemia from insulin injection is a significant complication in elderly patients and an obstacle to control blood glucose within normal limit. From the study of Chelliah and Burge (2004), it is found that risk factors of hypoglycemia in diabetic elderly patients are combination of medicines, a history of admission, hypoglycemic agents used (Sulfonylurea and/or insulin), poor nutrition, underlying diseases such as liver and kidney diseases or coronary artery disease (CAD), loss of normal counter-regulation hormone, endocrine dysfunction such as thyroid glands, adrenal gland, pituitary gland, and hypoglycemia unawareness. In addition, Amiel and associates (2008) conducted the study and revealed that additional factors to increase hypoglycemia in elderly patients are the use of aspirin, allopurinol, warfarin, sulfonamide, trimethoprin, fibrates combined with drugs in the group of sulfonylurea and insulin stimulator agent e.g. non-steroidal inflammatory agent (NSAID). Hypoglycemia in diabetic elderly patients is frequently found during admission. It is a

predictor of mortality in 3-6 months according to risk factors for instance, infection, cancer, decreased blood albumin, female, high creatinine and alkaline levels.

2.2.2 Kidney disease

In the patients with kidney disease, particularly with end stage of kidney disease insulin elimination is decreased (Edelman & Morello, 2005). The insulin elimination is declined when kidney infiltration rate is less than 40 ml/minute and is maintained at 15-20 ml/minute. It causes the failure of insulin elimination (Mak, 2000). The study of Haviv and colleague (2000) showed hypoglycemia as the cause of mortality in the hospitalized patients with end stage of kidney disease.

There are many factors of hypoglycemia in the patients with end stage kidney disease such as decreased elimination of insulin, oral hypoglycemia agent, some medicines, and poorer function of counter-regulation hormone, acidosis and some hemodialysis solvents.

End stage of kidney disease is a cause of waste accumulation in human body and prohibition of insulin elimination that leads to have the decreased elimination of insulin and hypoglycemic agents. Prolonged half-life of oral hypoglycemic agent such as sulfonylurea increases risk of hypoglycemia in diabetic patients with end stage of kidney disease.

For end stage of kidney disease, abnormal glucose reduction, and impairment of counter-regulation hormones e.g. glucagon and catecholamine are found and they are causes of hypoglycemia. No catecholamine offers any neurogenic symptoms so the patients have neuroglycopenic symptoms without neurogenic symptoms as a warning. In addition, the use of some drugs such as octreotide has an endocrinology effect to stop the release of glucagon hormone and growth hormone that causes the lack of hyperglycemic hormones while having hypoglycemia. Hence, octreotide in the patients with end stage of kidney disease is a predictive index of hypoglycemia (Vriesendrop et al., 2006).

Acidosis on the patients with end stage kidney disease suppresses glucose production from liver and kidney to respond to hypoglycemia. It is a cause of hypoglycemia.

Some medicines such as antiarrhymic drug, β-blocker, warfarin, salicylate, sulfonamide and propanolol in the patients with end stage kidney disease may be predisposing factors of hypoglycemia.

Other stimuli consist of severe sepsis, chronic malnutrition (especially in the patients with end stage of kidney disease), and congestive heart failure (Clement et al., 2004).

2.2.3 Liver disease

Liver (20%) is responsible to eliminate and synthesize glucose in blood circulation. Fifty percent of insulin is released by liver. Therefore, the patients with hepatocellular carcinoma, severe fluminant hepatitis or poisonous hepatitis, and liver failure may have hypoglycemia when they receive some hypoglycemic agents such as tolbutamide, glyburide and glipizide (Guettier & Gorden, 2006).

2.2.4 Use of some drugs

Use of some drugs may be a predisposing factor of hypoglycemia.

1) Glucocorticoid can cause hyperglycemia because glucocorticoid controls metabolism of carbohydrates, protein and fat. Rapid reduction of glucocorticoid may lead to have hypoglycemia.

2) Drug-drug interaction or drug-induced hypoglycemia includes the following details:

- Pantamidine affects to pancreas cells.
- Triazole antifungal enhances better function of sulfonylurea.
- β-Adrenergic antagonists prohibit glucose reduction and cover signs and symptoms of hypoglycemia in the result to have the decrease of hypoglycemic awareness and cause severe hypoglycemia.
- Antifailure agent e.g. vasodilator; angiotensin-converting enzyme inhibitor (ACE inhibitor) that may affect to increase insulin sensitivity, particularly skeletal muscle. In addition, inotropics agent e.g. dopamine and dobutamine may cause hypoglycemia.
- Chloramphenical prohibits the metabolism of sulfonylurea.
- Chloroquine comes with uncertain cause of hypoglycemia but the incidences of death from overdose of chloroquine are reported.

- Disopyramide shows uncertain cause of hypoglycemia but the drug affects to endogenous insulin.
- Salicylates increases endogenous insulin and insulin sensitivity.
- Fluroquinolone group shows uncertain cause of hypoglycemia but the evidence of hypoglycemia in elderly patients who receive hypoglycemic agent and gatifloxacin is reported (Graumlich et al., 2005).
- Monoamine oxidase inhibitors may increase insulin release and reduce sympathetics reaction during hypoglycemia.
- Sulfonamides reduce the elimination of sulfonylurea.
- Doxycycline shows no obvious cause of hypoglycemia but there are evidences of hypoglycemia in elderly type 2 diabetic patients who received doxycycline for 5 days after the use of drug (Odeh & Oliven, 2000). Hypoglycemia may come from doxycycline damages liver and disturbs glucose production of liver by the decrease of epinephrine hormone release. Liver damage reduces glucose production and when it is combined with long half-life insulin injection it causes hypoglycemia.

2.2.5 Other causes

Other causes of hypoglycemia include severe infection, prolonged diabetes, increased insulin sensitivity, underlying diseases e.g. coronary artery disease (CAD), endocrinology diseases (Thyroid, Pituitary, and Adrenal glands), and loss of counter-regulation hormones and history of hypoglycemia unawareness.

3. Physical reactions to hypoglycemia in type 2 diabetic patients

3.1 Autonomic or neurogenic symptoms

Autonomic or neurogenic symptoms are from glucose receptor in brain that has reaction to hypoglycemia by sending neurotransmission to stimuli autonomic nervous system at medulla of adrenal gland to increase catecholamine. Epinephrine hormone is more released than norepinephrine. Catecholamine affects to have adrenergic symptoms e.g. palpitation, arrhythmia, high systolic pressure, hand tremor, anxiety, burning sensation, and nausea. Parasympathetic system releases more acetylcholine that generates cholinergic symptoms such as sweating, paresthesia and hunger.

Clinical symptoms as mentioned occur when blood glucose is 50-55 mg/dl as well as an alarm to warn about the occurrence of hypoglycemia. Adrenergic symptoms are predisposing factors to have arrhythmia or acute myocardial infarction in CAD patients (Sriussadaporn & Nitiyanant, 2005).

3.2 Neuroglycopenic symptoms

The etiology of neuroglycopenic glucose involves with acute cerebral dysfunction due to reduced blood glucose to brain affecting to neurological systems with various signs and symptoms. Blood glucose < 45-55 mg/dl generates neuroglycopenic glucose. The symptoms are fatigue, burning sensation with cold sweating skin, hypothermia, dizziness, headache, perception impairment, stupor, slow physical response, confusion, loss of concentration, ECG changed, blurred vision and slurred speech. If plasma glucose is less than 40 mg/dl, the patients will have drowsiness, forgetfulness, and behavioral changes. If plasma glucose goes lower than 30 mg/dl, the patients will lose conscious and have convulsion. Long period and repetition of low plasma glucose < 30 mg/dl generate permanent brain damage and death of the patients (Sriussadaporn & Nitiyanant, 2005). However, signs and symptoms of hypoglycemia may be similar to those of hyperglycemia. Single sign or symptom cannot indicate hypoglycemia and/or hyperglycemia. Hypoglycemia shows uncertain signs and symptoms which include sweating and/or palpitation which we feel from exercise. Similar signs and symptoms may cause the misinterpretation and the patients may jump to the conclusion of hypoglycemia.

Signs and symptoms of hypoglycemia in elderly patients are different from those in young patients. In elderly patients, it is risk that autonomic symptoms are changed to become neuroglycopenic symptoms because the elders have cognitive dysfunction causing the missed opportunity for receiving appropriate treatment. Hypoglycemia in elderly diabetic patients is commonly indefinite which could be weakness, sleepiness, faintness and unsteadiness. Missed diagnosis from clinical symptoms in elderly patients is probably transient cerebral ischemia, vertebrobasilar insufficiency, vasovagal attacks and cardiac dysrhythmia.

According to the loss of thirst mechanism, hypoglycemia can occur without symptoms of thirst or polydipsia. In elderly patients, signs or symptoms of

hyperglycemia mostly are not found. They may come to hospital with other chief complaints for instance, complications: stroke and acute myocardial infarction.

Several causes yield the loss of hypoglycemic perception in type 2 diabetic patients, which include depression, cognitive impairment, and history of stroke, complications, and old age. Elderly patients also have limit of perception and may receive β-blocker agent that may block signs or symptoms of neurogenic or autonomic symptoms promoting hypoglycemia unawareness. In the mean time, missed diagnosis of neuroglycopenic symptom may seem to be symptom of stroke (Murata et al., 2001).

4. The types of insulin

4.1 Action of insulin injection

There are many types of insulin injection that can be categorized into 2 types by sources and production process and insulin action.

4.1.1 Insulin categorized by sources and production process

- Conventional insulin is the insulin from pork or cow pancreas which has slightly different molecular structure from human insulin. This insulin is popular for long time.

- Synthetic insulin has the same molecular structure of human insulin that is synthesized by genetic-engineering technique. It is popular because it has fewer antibodies.

- Insulin analog is the synthetic human insulin which changes molecular structure to have pharmaceutical qualifications accordingly.

4.1.2 Insulin categorized by action

- Short-acting insulin:

Short-acting insulin is commonly called Regular Insulin (RI) that has fast action but it doesn't last long. This insulin can be administrated via subcutaneous, muscular or intravenous approaches. After subcutaneous insulin is injected, its action begins within 30 minutes. Peak action lasts for 2-3 hours and total action is probably be 4-8 hours. Muscular insulin injection has its action within 10 minutes and it lasts for 1-2 hours. The action of intravenous insulin is within 2-3 minutes and it lasts for 10-20 minutes. As those qualifications, short-acting insulin is suitable for the ones who need rapidly reduced blood glucose for instance, the patients

who have ketoacidosis and hyperglycemic hyperosmolar non-ketotic syndrome (HHS), and they require immediate blood glucose control while having acute illness or operation or postprandial hyperglycemia. Short-acting insulin should be injected about 15-20 minutes before meal for the most effective action. The character of short-acting insulin is clear with mean pH. If it turns to be turbid, it may be expired so it should not be used. The samples of short-acting insulin are Humulin R, Actrapid HM (Sriussadaporn & Nitiyanant, 2005).

- Rapid-acting insulin:

Rapid-acting insulin shows its action within 5-15 minutes but peak action is in 1-2 hours. Its action lasts about 3-4 hours that is shorter than RI. Patients can have meal immediately after receiving rapid-acting insulin. However, due to rapid action of this kind of insulin and for the most effective use of rapid-acting insulin, it may be necessary to use intermediate-acting or long-acting insulin for maintaining basic insulin. This should be considered for the ones who really need it because rapid-acting insulin 4 times more expensive than RI. The patients who are suitable for rapid-acting insulin are: diabetic patients who require better blood glucose control and cannot wait for the action of RI. To solve ketoacidosis, rapid-acting insulin e.g. Lispro (Humalog) and Aspart (Novorapid) should be administrated by subcutaneous injection (Sriussadaporn & Nitiyanant, 2005).

- Intermediate-acting insulin:

Intermediate-acting insulin its action is delayed more than others as mentioned but its action lasts longer. Its purpose is to constantly control blood glucose for whole day which mimic to basal insulin secretion. This kind of insulin is cloudy fluid and should be administrated via subcutaneous only, no intravenous or muscular approaches. Intermediate-acting insulin begins its action within 2-4 hours. Its peak action is from 6-12 hours and lasts about 18-24 hours. This insulin may be required only once or twice daily. Samples of intermediate-acting insulin include Humulin N and Insulatard HM (Sriussadaporn & Nitiyanant, 2005).

- Long-acting insulin:

Long-acting insulin the beginning of its action is mostly delayed but its action is longer than intermediate-acting insulin. It lasts about 36 hours. The purpose to administrate long-acting insulin is to constantly control blood glucose for

whole day that also imitate basal insulin secretion. The character of long-acting insulin and intermediate-acting insulin are cloudy fluid. Long-acting insulin is not popular in Thailand because prolonged action of this insulin causes difficult dose adjustment.

- Constant long-acting insulin:

Constant long-acting insulin due to difficult dose adjustment of either long-acting insulin or intermediate-acting insulin, there is a production of new insulin with the molecules which can be absorbed and have constant long action with no peak action. At present, glargine (Lantus) is only insulin in the market. Premixed insulin is the insulin mixed from short-acting insulin and intermediate-acting insulin that offers rapid and prolonged action. Its fluid is cloudy fluid. The samples of premixed insulin which are synthetic insulin are Humulin 70/30 and Mixtrad HM (Sriussadaporn & Nitiyanant, 2005).

5. Nursing management for management of hypoglycemia in type 2 diabetic patients

Nursing management to monitor hypoglycemia in type 2 diabetic patients comprises with prevention of hypoglycemia and management of post episode of hypoglycemia.

5.1 Nursing management for prevention of hypoglycemia episode.

Nurses should assess the patients and mark “High risk hypoglycemia group”. The nursing care should cover the following topics:

1) Insulin administration

Hypoglycemia can come from imbalance of exogenous insulin and blood glucose. It is common to find hypoglycemia in diabetic patients who receive insulin treatment. To reduce the risk of hypoglycemia, nurses should focus with insulin administration in terms of efficiency and without any human error.

The most effective insulin administration is to give correct dose of insulin, appropriate timing with meal and correct approach including proper storage of insulin. For sliding scale insulin and basal bolus insulin, the patients should receive constant frequent checks on blood glucose more than other patients who use other kinds of insulin because there are evidences of hypoglycemia from sliding scale insulin. Assessment on the risk of hypoglycemia is useful for diabetic patients who

receive insulin treatment to intensively control blood glucose. To provide the most effective insulin administration, the nurses should have knowledge of types of insulin and their actions as follows (Table 1).

Table 1: Qualifications and actions of insulin

Insulin preparation	Trade name	Onset of action	Peak action	Duration of action
Rapid-acting				
Lispro	Humalog	5-15 mins	1-2 hours	4-6 hours
Aspart	Novorapid	20-30 mins	30-90 mins	1-2.5 hours
Short-acting				
Regular	Humulin R, Actrapid	30-60 mins	2-4 hours	6-10 hours
Intermediate-acting				
NPH	Humulin N,			
Lente	Insulatard	1-2 hours	4-8 hours	10-18
	Monotard			hours
Extended long - acting analogue (clear)				
Glargine	Lantus	1-2 hours	No peak	24 hours
Detemir	Levemir			
Combinations				
70/30 (70% NPH, 30% regular)	Humulin70/30	30-60 mins	Dual	
	Mixtard 30	15-30 mins	Dual	10-16
75/25 (75% protaminated lispro, 25% lispro)	Humalogmix 25	15-30 mins	Dual	hours
	Novomix 30	15-30 mins	Dual	
70/30 (70% protaminated aspart, 30% aspart)				

Source: Meneghini & Hirsch, 2006.

Insulin secretagogue administration such as sulfonylurea and meglitinides may be a cause of hypoglycemia episode. The reduction in occurrence of hypoglycemia episode in the patients who have received sulfonylurea consists of monitoring of blood glucose. In addition the type 2 diabetic patients with kidney disease should avoid some types of oral hypoglycemic agents such as chlorpropamide. Some oral hypoglycemic agent acts as insulin sensitizer such as thiazolidiones, biguanide and α-glucosidase inhibitors (acarbose, and miglitol). They do not increase insulin secretion, thus the hypoglycemia episode in the patients who have received this oral hypoglycemic group has hypoglycemia episode less than those who received sulfonylurea oral hypoglycemic group (David & Alonso, 2004). The health care team provider should assess nutritional status of type 2 diabetes patients. This assessment should comprise of evaluation of the patient's last meal, reduction of intravenous fluid intake, and NPO status.

2) Constant and proper blood glucose (BG) monitoring

Monitoring of blood glucose should be done 4 times per day (three times before meal and bedtime). Checking blood glucose (BG) at 03.00 am is useful for diabetic patients who have high blood glucose in the morning that can verify adequate or inadequate insulin injection at night. If hypoglycemia in the morning is at the highest level it means that the patients had inadequate food before bedtime. The type 2 diabetic patients who are fasting or have tube feeding should have blood glucose check at least every 6 hours.

3) Alarm system for response to divergence in the course of care

Divergence in course of care is the most common cause of hypoglycemia episode. For example decrease in oral intake such as patients are ordered not to receive anything from mouth for procedure, patients refuse to eat, and deviations from hospital routine occurred unexpectedly with lack of adjustment of antidiabetic medication, sudden decrease in corticosteroid, and delay in meal or miss the meal. That divergence in cause of care may affect to blood glucose level, thus nurses should pay attention and there should be clear communication for all diabetic patients regarding their oral intake, schedule in procedure or test by autonomic alerts for these divergences.

4) Monitoring oral intake

Nurse should assess oral intake regarding volume of each meal consumptions, problems and obstacles of less food consumptions, delayed meal and missed meal. Appropriate nutritional status in hospitalized patients is significant in all of diabetic patients. The starch and glucose is important for type 2 diabetic patients who receive insulin therapy. It should be given appropriately with dose of insulin. In addition, the diabetic inpatients should be assessed and managed on balance of meal and peak of insulin. If delayed meal or missed meal is the cause of hypoglycemia, portion of each snacks between meals should consists of carbohydrate 60-70 grams. Each snack should carry carbohydrate 15-30 grams.

5) Monitoring and assessing signs and symptoms of hypoglycemia

As mentioned above hypoglycemia episode is imbalance between insulin level and blood glucose level by hyperinsulinemia. The onset of hypoglycemia episode is often occurs due to insulin injection and oral hypoglycemic agent. It is possible that there are no or rare signs and symptoms of hypoglycemia in case of blood glucose level 60-70 mg/dl. If severe hypoglycemia (blood glucose level less than 40 mg/dl) is detected, it means that the patients may have neuroglycopenic symptoms.

Signs and symptoms of hypoglycemia are divided into 2 categories; they are adrenergic symptoms and neuroglycopenic symptoms. The adrenergic symptoms occur when blood glucose decreases immediately and it is seen before the onset of neuroglycopenic. The adrenergic symptoms are initial alarm of hypoglycemia. Neuroglycopenic symptoms are from the reduction of glucose in central nervous system. Therefore, health care provider team must be aware of adrenergic symptoms as an initial alarm of hypoglycemia which includes anxiety, frustration, dizziness, sweating, palpitation, arrhythmia, headache, and tremor.

Neuroglycopenic symptoms occur because of the combination of blood glucose and the limited glycogen in brain resulting in immediate dysfunction of central nervous system. In case there are no any adrenergic symptoms, or hypoglycemia is not resolved; continue decrease in blood glucose result in severe hypoglycemia. And that leads to have psychological changes, headache, discomfort,

less concentration, confusion, disorientation, frustration, drowsiness, slurred speech, uncontrolled behaviors and insomnia. Obvious dysfunctions of central nervous system consist of focal seizure, hemiplegia, patchy brain stem, and cerebella involvement mimicking basilar artery thrombosis. Characteristics of hypoglycemia in the medullary phase are deep coma, dilated pupils, shortness of breath, and tachycardia. When the blood glucose is about 10 mg/dl, hypotonicity is detected.

Assessment of signs and symptoms of hypoglycemia is significant and necessary, particularly in diabetic patients who have received insulin treatment or oral hypoglycemic agent. Early detection and investigation on hypoglycemia is very useful that can help the patient to have appropriate management. However, signs and symptoms of hypoglycemia in elderly patients are various and unspecific. In addition in is found that in the history of hypoglycemia, 40% of hypoglycemia patients experience recurrent episodes. There is possibility of autonomic system dysfunction and that lead to have Hypoglycemia Association Autonomic Failure (HAAF).

Table 2: Signs and symptoms of hypoglycemia

Autonomic symptoms		**Neuroglycopenic symptoms**	
Adrenergic symptoms	Cholinergic symptoms	Mild Neuroglycopenic symptoms	Severe Neuroglycopenic symptoms
- Palpitation - Tachycardia - Tremor - Anxiety - Nausea - Diastolic hypertension - Burning sensation	- Sweating - Numbness - Hungry	- Humid skin - Hypothermia - Weakness - Dizziness - Headache	- Loss of concentration - Stupor - Confusion - Behavioral changes - Blurred vision - Double vision - Hemiplegia - Slurred speech - Seizure - Unconscious,Coma

Source: Sriussadaporn & Nitiyanant, 2005.

6) Education for type 2 diabetic patients and families

Providing education about signs and symptoms of hypoglycemia is an important role of nurses. This knowledge should be provided to patients and their family members. Furthermore, knowledge of signs and symptoms of hypoglycemia helps the patients and their families for detecting initials of hypoglycemia episode and which enables the treatment of hypoglycemia immediately. The educator role is also a part of discharge planning.

5.2 Nursing management after hypoglycemia episode

Nursing management after hypoglycemia episode can be divided into 2 categories. They are: nursing management after mild to moderate hypoglycemia and nursing management after severe hypoglycemia.

Category 1: nursing management after mild to moderate hypoglycemia

Mild to moderate hypoglycemia refers to blood glucose less than 70 mg/dl (4.0 mmol/L) to 50 mg/dl (2.8 mmol/L) or ranged from 50-69 mg/dl (2.8 – 3.9 mmol/L). The two aspect of hypoglycemia which nursing management should pay attention are as follows:

1. Good conscious / Alert and able to eat and does not have NPO status

If signs and symptoms of mild to moderate hypoglycemia are detected such as sweating, hypothermia, and palpitation; nurses should assess vital signs, information about time and volume of last meal, and time of insulin injection. The existing nursing management for mild to moderate hypoglycemia is as follows:

1.1 Test blood glucose level.

1.2 Treat with 15 grams of fast-acting carbohydrate.

1.3 Repeat blood glucose test again in 15 minutes.

1.4 Treat again with another 15 grams fast-acting carbohydrate if blood glucose remains less than 70 mg/dl (4.0 mmol/L).

1.5 If next meal is more than 60 minutes away, provide a snack of 15 grams of starch and source of protein such as rice soup.

2. Unconscious or unable to eat or have NPO status

If signs and symptoms of mild to moderate hypoglycemia are detected, nurses should assess vital signs, information about time and volume of last meal, and time of insulin injection. The existing nursing management for mild to moderate hypoglycemia is as follows:

2.1 Test blood glucose level.

2.2 Treat with intravenous 50% dextrose 25 ml intravenous.

2.3 Repeat blood glucose test again in 15 minutes.

2.4 Treat again with of 50% of intravenous dextrose if blood glucose remains less than 70 mg/dl (< 4.0 mmol/L).

2.5 If next meal is more than 60 minutes away and if patients can to eat provide a snack of 15 grams of starch and source of protein such as rice soup.

Category 2: nursing management after severe hypoglycemia

Sever hypoglycemia refers to blood glucose level less than 50 mg/dl (2.8 mol/L). Nursing management for severe hypoglycemia can be divided into 2 categories. They are: diabetic patients with good conscious or alert, able to swallow or does not have NPO status and with unconscious or not able to swallow or have NPO status

1. Good conscious / Alert, able to swallow, and does not have NPO status

After signs and symptoms of severe hypoglycemia such as headache, confusion, and dizziness are detected; the nurse should assess vital signs, information about time and volume of last meal, time of insulin injection. The existing nursing management for severe hypoglycemia is as follows:

1.1 Test blood glucose level.

1.2 Treat with 20 grams fast-acting carbohydrate.

1.3 Continue 10% D/N/2 1,000 ml intravenous drip rate 100 ml/hr

1.4 Repeat blood glucose test again in 15 minutes.

1.5 Treat again with 15 grams fast-acting carbohydrate if blood glucose remains less than 70 mg/dl (< 4.0 mmol/L).

1.6 Keep checking every 2 hours until glucose level is more than 70 mg/dl or until the patients are able to eat normally, and then keep checking blood glucose before meal and bedtime or at every 6 hours.

1.7 If the next meal is more than 60 minutes away, provide a snack of 15 grams of starch and source of protein such as rice soup.

1.8 Continue intravenous dextrose about 24-72 hours in sulfonylurea induced hypoglycemia patients. And in insulin induced hypoglycemia patients the continuity of intravenous dextrose depend on type and action of that insulin.

2. Unconsciousness, unable to swallow or have NPO status

If patient is unconscious; the nurses should assess vital signs, information about time and volume of last meal, time of insulin injection. The existing nursing management for severe hypoglycemia is as follows:

2.1 Test blood glucose level.

2.2 Give 50% intravenous dextrose 20-50 ml and then continue drip 10% D/N/2 1,000 ml intravenous rate 100 ml/hr.

2.3 Repeat blood glucose test again immediately.

2.4 Treat again with of 50% dextrose 20-50 ml intravenous if blood glucose remains less than 50 mg/dl (2.8 mmol/L), and re-treat until blood glucose level becomes more than 50 mg/dl

2.5 Keep checking every 2 hours until glucose level becomes more than 70 mg/dl or until the patients are able to eat normally, and then keep checking before meal and bedtime or at every 6 hours.

2.6 Continue intravenous dextrose about 24-72 hours in sulfonylurea induced hypoglycemia patients. And in the insulin induced hypoglycemia patients the continuity of intravenous dextrose depend on type and action of that insulin.

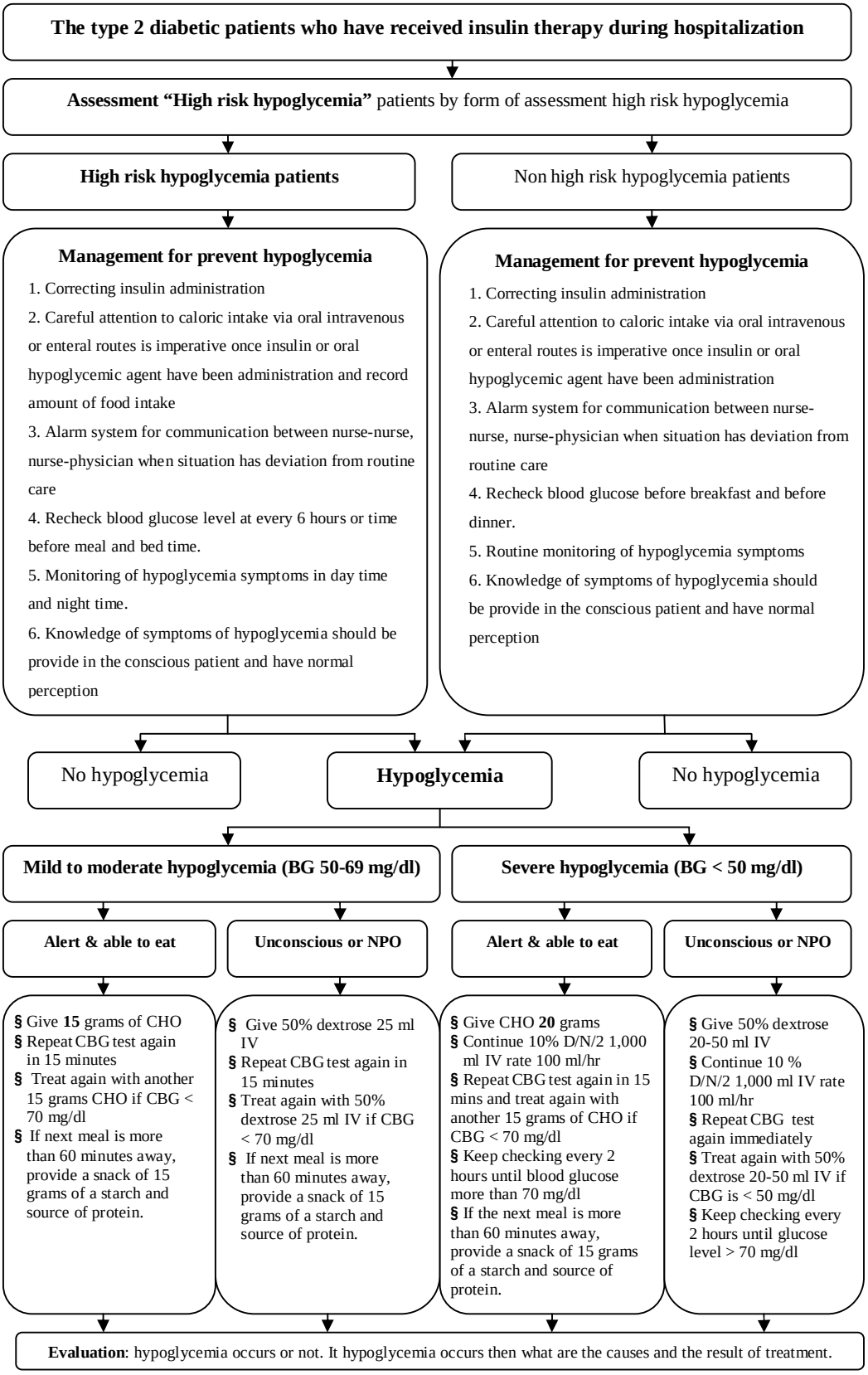

Figure 1: Nursing Management Guideline to Prevention and Manage Hypoglycemia

Conceptual Framework of the Study

Conceptual framework of this study emphasizes hypoglycemia episode which is caused by the imbalance of insulin and glucose in blood circulation (Cefalu & Cefalu, 2005). It is hyperinsulinemia combined with factors of caring and treatment management during hospitalization. Because of this reason, the type 2 diabetic patients are vulnerable to hypoglycemia episode during hospitalization. The hypoglycemia episode in type 2 diabetic patients during hospitalization includes intrinsic factors such as older age patients, causing deteriorate of organs, underlying diseases such as liver disease, kidney diseases, cancer, heart disease, and failure of counter-regulation hormone. Extrinsic factors consist of insulin injection and/or oral hypoglycemic agents such as sulfonylurea, process of treatment during admission for example as in NPO status for investigation and/or intervention, immediate decreased dose of corticosteriod, rapid delay of glucose intravenous intake, reduction of dietary consumption, uncertain meal time, and multiple drugs used with the combined actions occurred due to multiple complicated diseases. These factors as mentioned above cause the type 2 diabetic patients easily to have hypoglycemia during hospitalization. Hypoglycemia in type 2 diabetic patients can be found in critically ill or noncritically ill patients. The development of a clinical nursing practice guideline for management and prevention of hypoglycemia episode includes the assessment of risk factors and predisposing factors, and identification on the high risk hypoglycemia on type 2 diabetic inpatients that have high risk hypoglycemia. Nursing management to prevent hypoglycemia consists of proper insulin administration, constant proper blood glucose monitoring, monitoring of oral intake and periodic assessment on signs and symptoms of hypoglycemia. In the detection and prevention the nurses have important role. If hypoglycemia is detected, appropriate and proper nursing management should be provided for patients who have mild to severe hypoglycemia episode, see in Figure 2.

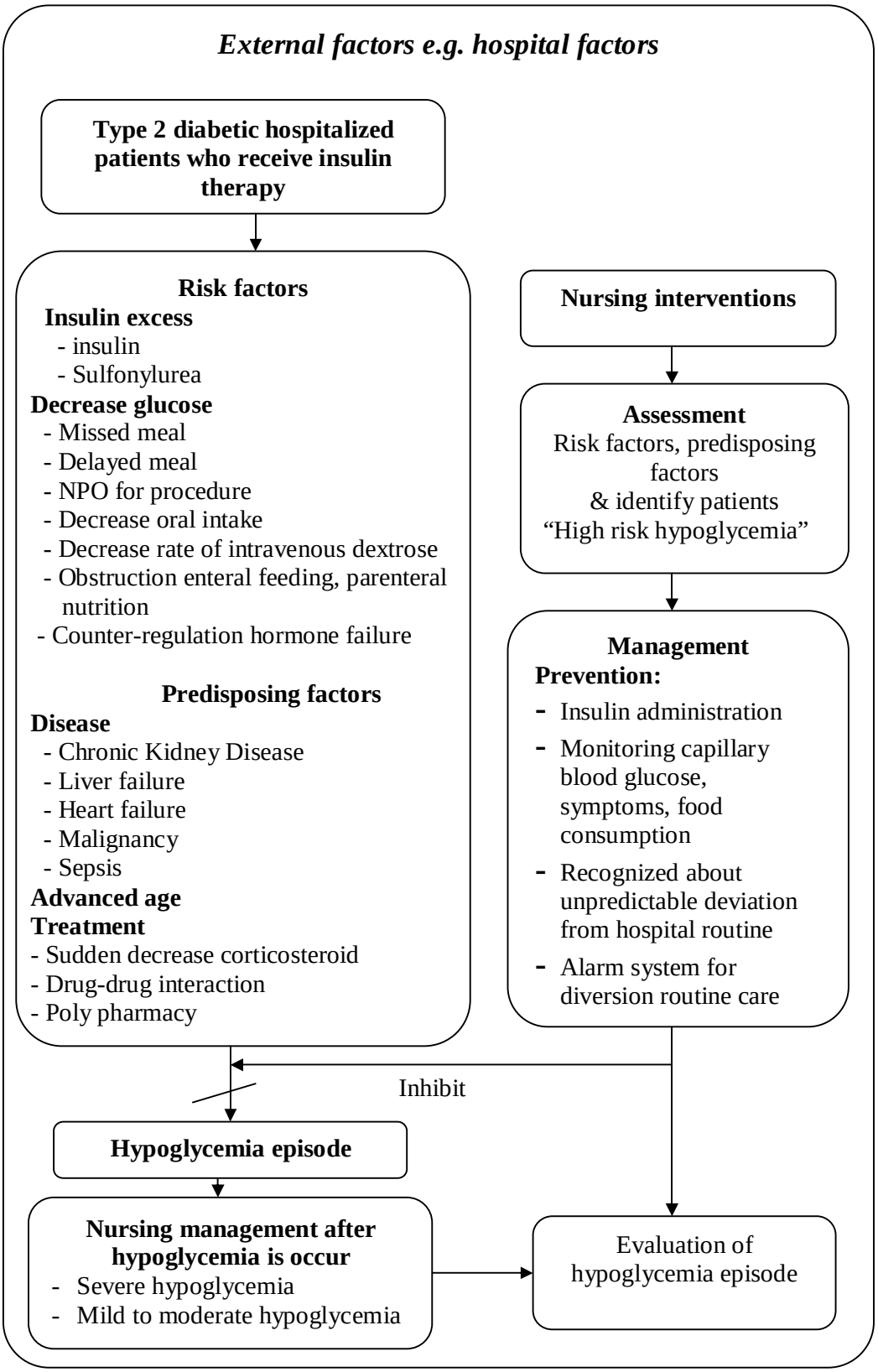

Figure 2: Conceptual Framework of the Study

CHAPTER III
METHODOLOGY

Selected Model for Implementation

In the development of a clinical nursing practice guideline for management of hypoglycemia associated with insulin therapy among the type 2 diabetic patients during hospitalization, the investigator selected the evidence-based practice model of Sister Maurita Soukup (Soukup, 2000) as a conceptual framework for the developing of a clinical nursing practice guideline, because of the effectiveness of this model in terms of practice and clear in terms of process. The steps for development of the clinical nursing practice guideline are related to process of situation analysis, related to clinical problems, analysis and synthesis evidence-based for creating clinical nursing practice guideline to resolve the clinical problems. The step of evidence-based practice model leads to relevance to resolve these steps. The evidence-based practice model is made up of the followings:

Phase 1: Evidence-triggered phase

Evidence-triggered phase is exploratory so identification of the clinical problem is required to be resolved. The clinical data of problem and information can be collected from working experience. These clinical problems and collection of data are acquired from 2 triggering. They are practice trigger and knowledge trigger.

- Practice trigger is data collection from clinical problems of nursing practice.
- Knowledge trigger is data collection from literature review, advance technology, and nursing practice quality improvement.

Phase 2: Evidence-support phase

Evidence-support phase is search for conduct with the objective of finding credible evidence-based practice from various sources related to the issues of the prevention and management of hypoglycemia episode in type 2 diabetic patients who receive insulin therapy during hospitalized. The information was analyzed and synthesized to create a clinical nursing practice guideline for effective nursing care.

Phase 3: Evidence-observed phase

Evidence-observed phase is making of a plan for trial implementation of this nursing practice guideline for management of hypoglycemia associated with insulin therapy among type 2 diabetic patients during hospitalization in order to assess the possibility of implementation in an actual situation in organization. The clinical nursing practice guideline is implemented by a pilot study.

Phase 4: Evidence-based phase

Evidence-based phase is the conduct of the clinical nursing practice guideline to analyze from actual practice and plan to revise until a suitable design and the better guideline for actual practice is obtained.

For the purpose of this study the investigator followed the procedure according to the conceptual framework as designed until phase 2. After development of a clinical nursing practice guideline it was examined for validity by 5 experts. According to the recommendation of each expert's opinion it was improved and revised for completion of the nursing practice guideline. In the phase 3 and 4 of the study, the investigator made plan for submitting this clinical nursing practice to actual work unit for the later time.

Process of Developing the Clinical nursing Practice Guideline

The detail of the process of developing a clinical nursing practice guideline for management hypoglycemia associated with insulin therapy among the type 2 diabetic patients during hospitalization is as follows:

Phase 1: Evidence-triggered phase

The exploration clinical problem that required solution by practice trigger and knowledge trigger is as follows:

1.1 Practice trigger

The details of working experience of nursing care related to issue of hypoglycemia in type 2 diabetic patients who received insulin therapy during hospitalization in medical unit in The Bangkok Metropolitan Administration Medical Collage and Vajira Hospital and in the Siriraj Hospital are as follows:

From working experience of nursing practice at The Bangkok Metropolitan Administration Medical Collage and Vajira Hospital and from the report of

Medication Patient Care Team (PCT), it is found that the incidences of hypoglycemia in diabetic patients in hospitals are the highest of the top five important clinical risks. In 2003 the endocrinology team developed care map for surveillance of hypoglycemia in hospitals. The aim of this team was the collaboration with multidisciplinary inpatients care team which consists of physicians, nurses, pharmacist and dietitians. The method of care map includes assessment of high risk patients, investigation by laboratory results, treatment of symptoms, collaborative prevention of hypoglycemia in the hospitalized patients and discharge planning. It is found that the incidences of hospitalized patients of hypoglycemia in DM, before development of care map were 5.01% from 1,233 diabetes patients. After using care map for surveillance, it is found that the rate of incidences of hospitalized patients of hypoglycemia in DM, decreased to 4.28% from 1,233 diabetes patients. However, although we have the methods of preventing hypoglycemia in hospitalized patients but incidences of hospitalized patients of hypoglycemia in DM are still found. And it is one of the top 5 of important clinical risk of Medicine department (Medical Patient Care Team in Bangkok Metropolitan Administration Medical Collage and Vajira Hospital, 2005). In the report of safety outcome in 2006 by Medical Patient Care Team, it is found that total reports of hypoglycemia are 41 times and asymptomatic hypoglycemia is 22 times annually. The consideration of nurse's role among method of care map found that still routine care by nurse, lack of awareness of detecting signs and symptoms of hypoglycemia in hospitalized patients, lack of response to predictors of hypoglycemia and lack of playing critical role in prompt in prevention and treatment. The consequences of hypoglycemia in diabetes mellitus in hospitalized patients are longer length of stay, high cost of care, possibility of risk of morbidity and mortality. Hypoglycemia episode in hospitalized patients is an important barrier of for maintaining of euglycemia and treatment for control blood glucose for reducing morbidity and mortality; and it is an important clinical risk in diabetic patients during hospitalization. Furthermore hypoglycemia episode in hospitalized patients has impact on hospital accreditation.

From the working experience in medication department of Siriraj hospital from September to November 2007, it is found that the characteristics of diabetic patients are similar in Bangkok Metropolitan Administration Medical Collage and Vajira Hospital. Furthermore, in this nursing practice the investigator emphasized study in

the population of diabetic patients who have co-morbidity and complexity and found that the diabetic patients who receive insulin therapy during hospitalization have occurrence of hypoglycemia episode and the consequences of hypoglycemia are dangerous. The data is as follows:

Case study

Personality data:

- Diabetes mellitus female, status: married, Age: 60 years old

Chief Complaint:

- Unconscious 4 hours before hospitalization

Diagnosis:

- Hypoglycemia, NSTEMI

Present illness:

- Underling case of coronary artery disease (triple vessel disease) for 10 years. S/P CABG at 2001, LVEF 49%, post CABG patient able to do normal work functional class I-II.
- 1 month before hospitalization, increase edema leg, no dyspnea, no paroxysmal nocturnal dyspnea (PND), function class of NYHA I-III, no chest pain.
- 3 days before hospitalization, having PND, no chest pain.
- 4 hours before hospitalization, to feel discomfort at

xiphoid refers to chest, no sweating, no palpitation, and injection 10 unite of Human N, before going to bed and no ingest dinner, and family member meet at 20:30 p.m., patient unconscious, and family member take her to hospital.

- 2 hours before hospitalization, patient unconscious and family members stimulate, patient feels cold and family members take her to hospital. .

Past history:

- Dyslipidemia about 4 years and poor control
- Hypertension about 4 years
- Chronic Kidney Disease, creatinine increase from 2 in February 2007 to 6 in June 2007.

Emergency room

The result of capillary blood glucose (CBG) = 36 mg/dl, and the patients receives 50% glucose intravenous, then she becomes alert, and chest X-ray examination meet cardiomegaly with pulmonary edema both lungs, ECG not ST-T change, cardiac enzyme; CKMB 12.2-6.56 (normal 0-5) Troponin T 1-1.13 (normal < 0.01).

Treatment

10% DNSS 1,000 ml intravenous rate 100 ml/hr, Lasix 250 mg intravenous, retain Foley's catheter, then patient dyspnea, she received intubation's tube and NTG 1:5 vein drip 3 microdrop/min, then the patient is referred to admission in medical unit. During hospitalization patient has poor control of blood glucose, CBG 66-559 mg/dl, received monitoring blood glucose before meal and bedtime, 4 times per day, received glycemic controlled by Mixtard 40 units subcutaneous before breakfast and before dinner, she has edema at leg, arm, patient is conscious, and have sepsis and chronic kidney disease received hemodialysis.

Table 3: Result of capillary blood glucose (particular the day of hypoglycemia)

Result of capillary blood glucose (mg/dl)				
Day/Time (before meal and bedtime)	**Breakfast**	**Lunch**	**Dinner**	**Bedtime**
12 September 2007	89	103	149	34

The result of capillary blood glucose in the day of adverse event is the blood glucose which started decreasing but insulin therapy was not adjusted. Until at 11:00 p.m. patient was unconscious and EKG showed cardiac arrest and received resuscitation for 30 minutes and then patient died.

The result of this case demonstrates that tight glycemic control may increase the risk of increasing hypoglycemia and cardiovascular events. The rapid hypoglycemia changes in blood glucose have shown to increase counter-regulation hormone such as epinephrine and norepinephrine, which may induce vasoconstriction, platelet aggregation, and thereby causing ischemia (Desouza, Salazar, Cheong, Murgo, & Fonseca, 2003). Furthermore, in this case the patient had cardiovascular condition

effect to left ventricular hypertrophy (LVH) and low of the left ventricular ejection fraction (LVEF) (only 37%). The result of LVH and low LVEF, induce that the patient had low cardiac output and decreased tissue perfusion. The decrease of tissue perfusion induces activation of rennin-angiotension – aldosterone system and the sympathetic nervous system is activated. The result of activation of sympathetic nervous system is induced vasoconstriction. The vasoconstriction has an effect on to increase of afterload, heart rate, and blood pressure. Because of this reason it increases cardiac workload and increases oxygen demand and it is cause of myocardial ischemia. In this case, the patient had hypoglycemia due to insulin therapy, it is cause of myocardial ischemia and may be cause of cardiac arrest and may be the one of reason of death.

From working experience, it is found that hypoglycemia episode is an important clinical risk, and this can occur particularly in diabetic patients who receive insulin therapy while there are critically ill. Although occurrence of hypoglycemia is rare, it is dangerous. And severity to diabetes mellitus may cause patient's death particularly in diabetes mellitus patients, who have co-morbidity such as cardiovascular, chronic kidney disease, stroke. The cardiovascular patients with diabetes mellitus, the physiology of diabetes mellitus may be asymptomatic of myocardial ischemia (no chest pain symptoms or silent myocardial ischemia). Asymptomatic of myocardial ischemia in diabetic patients, may be a cause of delay in diagnosis, and missed diagnosis. These are the reasons for present study for development of a clinical nursing practice guideline for prevention, detection and treatment of hypoglycemia in hospitalized patients. Knowledge trigger for development of clinical nursing practice guideline is as follows:

1.2 Knowledge trigger

From current knowledge and from development of care map for surveillance hypoglycemia in diabetic patients in hospital by endocrinology team, hypoglycemia in type 2 diabetic patients who received insulin therapy in hospitalization is predictable and preventable. From method of care map, the component of activity of surveillance including, activity by physician, pharmacist, dietitian, and nurse, then the component of a clinical nursing practice guideline is compound treatment, medication, diet, and monitoring and caring. There are several risk factors for the development of

hypoglycemia episode such as, the characteristic of type 2 diabetic patients, process of cure, internal and external risk factors. At present there is trustworthiness of evidence-based, and they can be guidance to develop guidelines for assessment, exploration, prevention, and suitable management. From all of these the type 2 diabetic inpatient would receive safety and effective treatment. Nurses should have knowledge and awareness of the predictors and they should have appropriate response to the predictor. Furthermore the role of nurses for management and prevention are appropriate monitoring of blood glucose, signs and symptoms of hypoglycemia and food consumption in type 2 diabetic in hospitalized patients.

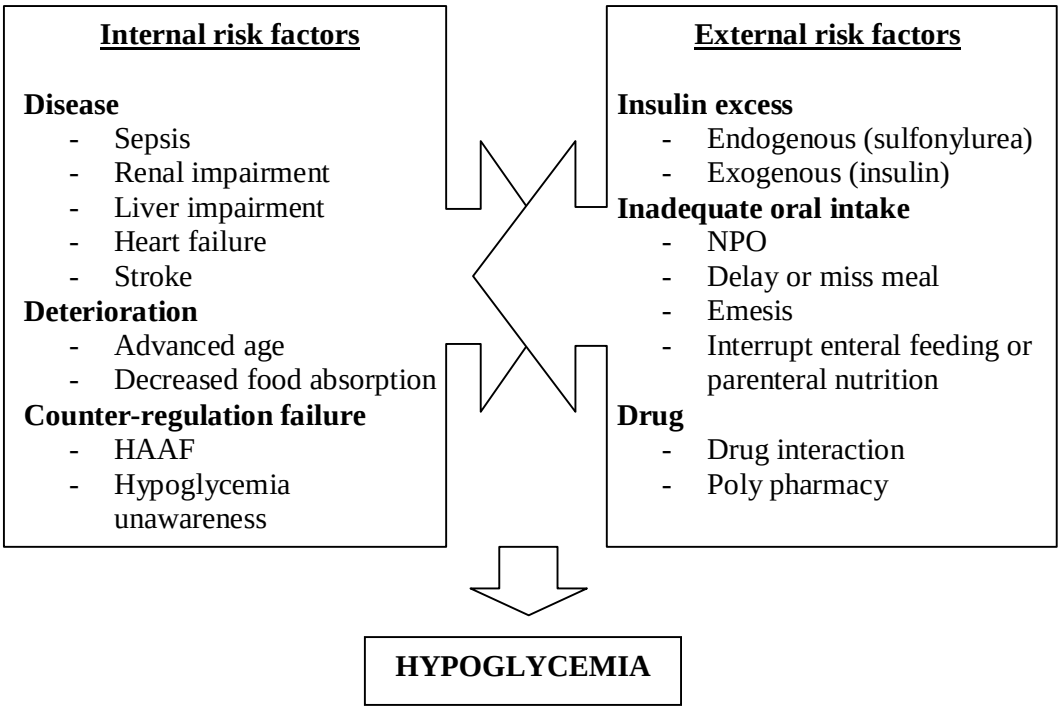

Figure 3: Risk Factors for Development of Hypoglycemia Hospitalization

Source : Briscoe & Davis, 2006; Tomky, 2005; Vriesendrorp et al., 2006

Current knowledge related to risk factors for the development of hypoglycemia demonstrates that hypoglycemia in type 2 diabetic patients during hospitalization is the result of internal factors and external factors. When these risk factors occur together, hypoglycemia may occur easily during hospitalization. Then the nurses have important role for managing the clinical risk, because nurses care inpatients around the clock, and they have role for inpatients' safety. The duties of nurses are: drug administration, reminding the patients for food intake, monitoring laboratory,

monitoring symptoms, and initial treatment. Nursing process is very important in managing clinical risk: begin assessment, prevention, management, and evaluation.

Phase 2: Evidence - supported phase

This phase reviews and finds out credible evidence-based from many sources: relevant issue of insulin therapy and hypoglycemia during hospitalization. Credible evidence-based are analysis and synthesis of the appropriate data conducted to create new innovation for guiding effective nursing practice and this can resolve actual problem. The methods are as follows:

1. Selection criteria

The investigator used PICO framework as the criteria for selecting appropriate evidences (Melnyk & Fineout-Overholt, 2005). They are related to issue of insulin therapy and type 2 diabetic inpatients. The detail this framework can be explained as follows:

P (Population) : The type 2 diabetic patients who have received insulin therapy during hospitalization

I (Intervention) : Management and prevention of hypoglycemia episode during hospitalization

C (Comparison) : No comparison

O (Outcome) : The type 2 diabetic patients are safe from hypoglycemia episode during hospitalization.

Inclusion criteria

The investigator's criteria for selecting evidences are as follows:

1. The evidence published during 2000-2007 both in Thai and in English.
2. The populations are adult type 2 diabetic inpatients.
3. Use the evidence of all levels (I-VII) according to the classification of Melnyk & Fineout-Overholt. (2005)

2. Key words for searching

- Hypoglycemia and hospitalized patients
- Hypoglycemia and insulin
- Hypoglycemia and prevention
- Hypoglycemia and management

- Insulin therapy and type 2 diabetic patients
- Hypoglycemia and nursing management

3. Sources of evidence search

- Search from databases includes: Blackwell Synergy, CINAHL, HighWire, OVID, PubMed, ScienceDirect, ProQuest, and ISI Web of Science
- Search from reference list and hand search
- Search for standard practice guidelines from www.guidelines.gov

4. Criteria for evaluation level of evidence

In this study the investigator uses criteria of Melnyk and Fineout - Overholt (2005) for evaluating levels of evidence. All of the levels are shown in table 4.

Table 4: Levels of evidence

Level of evidence	Source of evidence
Level I	Evidence from a systematic review or meta-analysis of all relevant randomized controlled trials (RCTs), or evidence-based clinical practice guidelines based on systematic review of RCTs
Level II	Evidence obtained from at least one well - designed RCT
Level III	Evidence obtained from well-designed controlled trials without randomization
Level IV	Evidence from well-designed case-control and cohort study
Level V	Evidence from systematic review of descriptive and qualitative studies
Level VI	Evidence from single descriptive or qualitative studies
Level VII	Evidence from the opinion of authorities and / or reports of the committee of experts

5. Result of searching

The investigator searched the evidences for developing a clinical nursing practice guideline. In this study the investigator used 5 studies of evidences: 4 studies were research and 1 study was the opinions of experts. The data of searching evidences, sources, key words and number of evidences are shown in figure 4 and in table 5.

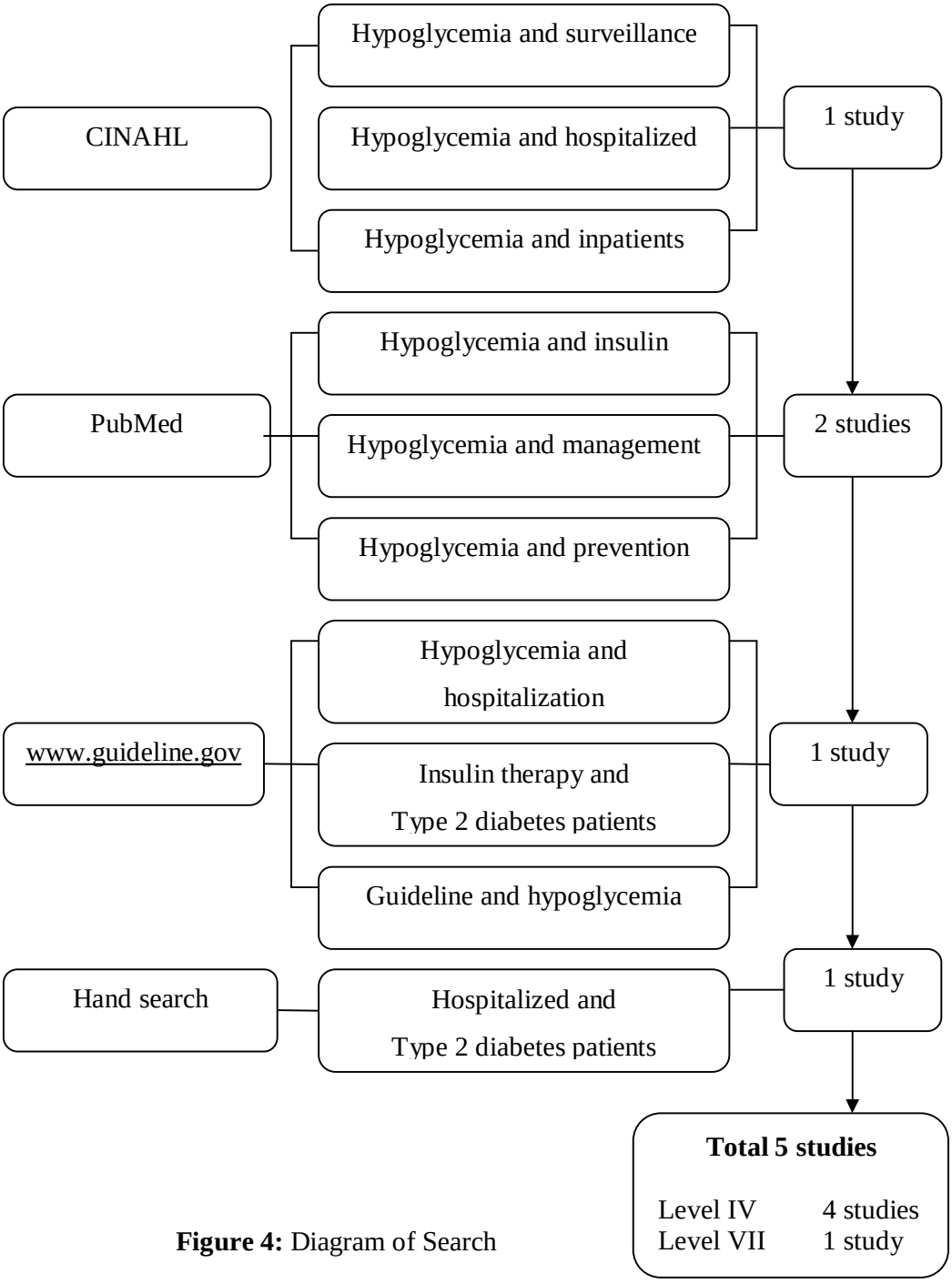

Figure 4: Diagram of Search

Table 5: Summary and division of the levels of evidences

Database	Title	Research design	Level of evidence
CINAHL	Causes of hyperglycemia and hypoglycemia in adult inpatients	Prospective	IV
PubMed	Hypoglycemia in hospitalized patients treated with antihyperglycemic agents	Prospective	IV
PubMed	A quality improvement project for better glycemic control in hospitalized patients with diabetes	Prospective	IV
Hand search	Effectiveness of surveillance system in prevention of hospital hypoglycemia	A prospective intervention study	IV
www.guideline.gov	Best practice guideline for the subcutaneous administration of insulin in adults with type 2 diabetes	Experts' opinion	VII

6. Assessment of evidences for implementation of feasibility

For the study of the concept of assessment of the feasibility of evidence-base for development of a nursing practice guideline for management of hypoglycemia associated with insulin therapy among the type 2 diabetic patients during hospitalization, the investigator applied the concept of Polit & Beck, 2004 (Polit & Beck, 2004). They are as follows:

Clinical relevance

All five of the evidences for the development of clinical nursing practice guideline are of clinical relevance and can be utilized. All of these help the nurses for decision making in nursing process. Five of evidences can be utilized in patient's

assessment, management for prevention and treatment of hypoglycemia and evaluation of hypoglycemia episode.

Scientific merits

All of these five studies are reliable, because they are conducted by physicians, nurses or members of related healthcare teams and passed the inspection of qualified experts. Four studies are of level IV and one study is of level 7 (Melnyk & Fineout-Overhort, 2005). These evidences-based have been published in well-known journals.

Implementation potential

1. Transferability of the finding

These evidences are suitable for the trial implementation which is considerate in term of similarity of the service recipient's patients in the work unit, sample group and philosophy in caring. The diabetes mellitus patients associated insulin therapy during hospitalization obtains the benefit from the implementation.

2. Feasibility of the finding

These evidences are for ensuring the privilege of implementation by nurses. Furthermore the organization may consider it respectful and collaborate it because of having no conflict and no interruption in routine work. The methods of nursing practice are not difficult and complex. They can be easily implemented.

3. Cost-benefit ratio

The risk of implementation does not occur. In addition the chances of obtaining benefits are more than that of former nursing practices.

7. Summary of the results of analysis and synthesis of research and evidence-based practice

The analysis and synthesis of the evidence-based practice yielded the three main issues for management and prevention of hypoglycemia episode in type 2 diabetic patients during hospitalization including: the concept of assessment of risk factors and predisposing factors, nursing management, and nursing evaluation. They are as following:

7.1 Assessment

The assessment of risk factors and predisposing factors such as assessment of history of illness, food intake or nutritional status and current medication are as follows:

7.1.1 History of illness

History of illness includes: history of past illness such as diabetes mellitus, history of hypoglycemia, chronic kidney disease, liver disease, coronary artery disease, cerebrovascular disease and condition of present illness such as sepsis, myocardial infarction, stroke and receiving oral hypoglycemia agent such as glibenclamide (Swangjit Sura-amornkul, Petcharaphan Tiyamani, Petch Rawdaree, 2005; Varghese et al., 2007).

7.1.2 Food intake

The most common risk factors of hypoglycemia episode in diabetic patients during hospitalization are related to decrease of oral intake (Varghese et al., 2007). The decrease in oral intake in diabetic patients during hospitalized includes; missed meal, delayed meal, noting per oral (NPO) for procedure, and during critically ill period (Briscoe & Davis, 2006), as medication may not readjust when oral intakes patients' decline or when they move out from wards for various tests (Vriesendorp et al., 2006). Time of food intake must be appropriate with duration of action of insulin therapy. The diabetic inpatients should receive assessment of nutrition status or dietary intake and assessment of problem of nutritional status for prevention of hypoglycemia episode.

7.1.3 Current medication

Current medication for treatment of diabetic inpatients is important, particularly antihyperglycemic drugs such as insulin therapy and / or secretagogue insulin such as sulfonylurea. Medication during hospitalization such as insulin therapy 4 times per day, sliding scale insulin with basal insulin dosing therapy is important predictors of hypoglycemia during hospitalization. The oral hypoglycemic agent (OHA) such as glyburide (glibenclamide) is easy to cause hypoglycemia when it is used in the chronic kidney disease patients. In addition, sudden decrease in corticosteroid is one of the causes of hypoglycemia and some medications such as salicylate promote the action of oral hypoglycemic agent. In addition in the diabetic

patients who receive β-blocker the symptoms of hypoglycemia are reduced. Nurses should pay attention to some medications such as ACE inhibitor, doxycycline, gatifloxacin which have incident report risk of hypoglycemia (Briscoe & David, 2006; K. Akram, et al., 2006; Murata, et al., 2004; Tomky, 2005).

Additional risk factors are removal of the patients out of ward after receiving short acting insulin, hormone deficiency such as growth hormone, cortisol or both, emesis, decrease rate of dextrose intravenous (Tomky, 2005), decrease absorption, change of process of elimination (Davis & Alonso, 2004). Additional history of nocturnal hypoglycemia is one of the risks of hypoglycemia during hospitalization.

7.2 Nursing management

The nursing management of a clinical nursing practice guideline include: nursing management for management and prevention hypoglycemia episode and nursing management after hypoglycemia episode. They are as follows:

7.2.1 Nursing management for prevention hypoglycemia episode in type 2 diabetic hospitalized patients

1) Correct insulin administrations, alertness for duration of action of each type of insulin and time of injection and meal should be strictly followed (Appendix B) (Gilman, 2001).

2) The time of monitoring of blood glucose should be appropriate as following: monitor the diabetic patients who can take their mean by themselves, monitor blood glucose pre meal and bedtime (four times per day), and monitor every 6 hours in the diabetic patients who has NPO status or enteral tube feeding (Lien, Bethel, & Feinglos, 2004; Smith, Winterstein, Johns, Rosenberg, & Sauer, 2005).

3) The diabetic patients who have noting per oral status (NPO status) for procedure or investigation are plan or emergency case, insulin therapy before moving for further test should be held for them. The insulin administration should be given after the diabetic patients come back to ward or according to the prescription of the physician (Virani et al., 2004).

4) Time of eating for the diabetic patients who received insulin therapy, must be related with the time of insulin injection. However, if there is

decrease in food intake, delayed meal, missed meal, this should be reported to the physician for consideration of dosage of insulin therapy.

5) The symptoms of hypoglycemia in the day time and the night time should be monitored. Particularly in the diabetic patients who received Intermediate-acting insulin before dinner and blood glucose before bedtime should be rechecked if it is less than 126 mg/dl provided 15 grams of starch and a protein source. The symptoms of hypoglycemia should be detected as autonomic symptoms such as sweating, hungry and palpitation (Virani et al., 2004).

6) In the diabetic patients who are good conscious and have normal of perception, the knowledge of particular symptoms of hypoglycemia should be provided. The aim of this education is that patients' report symptoms of hypoglycemia are quicker and they can help resolve hypoglycemia episode faster (Virani et al., 2004).

7.2.2 Nursing management for treatment hypoglycemia episode

Nursing management for treatment hypoglycemia episode is composed of 2 parts including treatment of mild to moderate hypoglycemia and treatment of severe hypoglycemia. The details are as follows:

1. Nursing management for treatment of mild to moderate hypoglycemia episode

Nursing management for treatment of mild to moderate hypoglycemia can be divide 2 categories. First conscious / alert status, the patients do not have NPO status and they are able to swallow. The second is unconscious status or NPO status or unable to swallow status.

1) Good conscious / alert, able to swallow, and does not have NPO status

1. Check blood glucose level.
2. If capillary blood glucose is between 50 - 69 mg/dl (< 4.0 mmol/L) treat with 15 gm of fast-acting carbohydrate.
3. Repeat capillary blood glucose in 15 minutes.
4. Treat again with another 15 gm fast-acting carbohydrate if blood glucose remains less than 70 mg/dl.

5. If the next meal is more than 60 minutes away, a snack of 15 grams of a starch and include a protein source should be given.

2) Unconscious and / or NPO status or unable to swallow status

1. Check blood glucose level.
2. If blood glucose is between 50-69 mg/dl (< 4 mmol/L) give 50% dextrose 25 ml intravenous.
3. Recheck blood glucose again in 15 minutes.
4. Treat again with 50% dextrose 25 ml intravenous if blood glucose is less than 70 mg/dl (< 4mmol/L).
5. If next meal is more than 60 minutes away and if patients can to eat provide a snack of 15 grams of starch and source of protein such as rice soup.

2. Nursing management for treatment of severe hypoglycemia episode.

Nursing management for treatment of severe hypoglycemia episode can be divided in 2 categories. First conscious / alert status, patients do not have NPO status and they have able to swallow status. The second is unconscious or NPO status or unable to swallow status.

1) Good conscious, able to swallow, and does not have NPO status

1. Test blood glucose level.
2. Treat with 20 grams fast-acting carbohydrate.
3. Continue 10% D/N/2 1,000 ml intravenous drip rate 100 ml/hr.
4. Repeat blood glucose test again in 15 minutes.
5. Treat again with 15 grams fast-acting carbohydrate if blood glucose remains less than 70 mg/dl (< 4.0 mmol/L).
6. Keep checking every 2 hours until glucose level is more than 70 mg/dl or until the patients are able to eat normally, and then keep checking blood glucose before meal and bedtime or at every 6 hours.

7. If the next meal is more than 60 minutes away, provide a snack of 15 grams of starch and source of protein such as rice soup.

8. Continue intravenous dextrose drip about 24-72 hours in sulfonylurea induced hypoglycemia patients. And in the insulin induced hypoglycemia patients the continuity of intravenous dextrose depend on type and action of that insulin.

2) Unconsciousness, unable to swallow or have NPO status

If patient is unconscious; the nurses should assess vital signs, information about time and volume of last meal, time of insulin injection. The existing nursing management for severe hypoglycemia is as follows:

1. Test blood glucose level.

2. Give 50% intravenous dextrose 20-50 ml and then continue 10% D/N/2 1,000 ml intravenous drip rate 100 ml/hr.

3. Repeat blood glucose test again immediately.

4. Treat again with of 50% intravenous dextrose 20-50 ml if blood glucose remains less than 50 mg/dl (4.0 mmol/L), and re-treat until blood glucose level becomes more than 50 mg/dl.

5. Keep checking every 2 hours until glucose level becomes more than 70 mg/dl or until the patients are able to eat normally, and then keep checking before meal and bed time or at every 6 hours.

6. Continue intravenous dextrose about 24-72 hours in sulfonylurea induced hypoglycemia patients. And in the insulin induced hypoglycemia patients the continuity of intravenous dextrose depend on type and action of that insulin.

7.3 Nursing evaluation

Nursing evaluation of this stage is evaluating the episode of hypoglycemia in diabetes patients. If hypoglycemia occurs, what are the causes and what are the results of hypoglycemia resolution.

Recommendation from experts

After development of a clinical nursing practice guideline for management of hypoglycemia associated with insulin therapy among the type 2 diabetic patients during hospitalization, the investigator presented this guideline for examination to the five professional experts. They are including: 2 physicians who have diploma of board of endocrinology, 1 advanced practice nurse (APN) specialist of diabetes mellitus patients, 1 nurse teacher of school of nursing, and 1 senior nurse who has long time of experience of nursing care on the diabetic patients and one of development of care map for surveillance hypoglycemia in DM in hospital (Appendix E) for validity for the suitable to utilization. The recommendations obtained from the five of experts as follows:

1. The prevention and continuous monitoring are important role of nurses. They include assessment of high risk hypoglycemia among diabetic inpatient, monitoring of blood glucose, symptoms, and food intake. In this role nurses should clarify and should create strategy or system for prevention of hypoglycemia in hospital.

2. In the monitoring of blood glucose level in severe hypoglycemia patients, particularly unconscious status patients, blood glucose should be rechecked immediately after giving 50% dextrose intravenous push. The patients must be re-treated with glucose until blood glucose level becomes more than 50 mg/dl, and then 10% D/N/2 1,000 ml intravenous drip rate 100 ml/hr should be continued. Furthermore, the monitoring of blood glucose level after continuous drip 10% D/N/2 1,000 ml should be monitored at every 2 hours until blood glucose level becomes more than 70 mg/dl (> 4.0 mmol/L) or in conscious patients, it should be done until they are able to consume food normally. In addition the monitoring of blood glucose level should be done at the same time in situation for prevention of hypoglycemia in hospital such as 4 times per day (before meal and bedtime) or in the NPO or enteral tube feeding rechecks of blood glucose at every 6 hours should be done.

3. In severe hypoglycemia patients, resolution by continuous intravenous dextrose drip should be provided. If sulfonylurea – induces hypoglycemia, intravenous dextrose should be continued for an average of 24-72 hours. In the insulin-induced

hypoglycemia patients continuity of dextrose intravenous depends on types and action of that insulin.

4. The nursing management of the high risk hypoglycemia patients and non-high risk hypoglycemia patients should be different in contents.

5. The result of synthesis and analysis of evidence-based should be carefully conducted to create nursing practice guideline, for the effectiveness and covering of this guideline.

6. The documentation of nurse, about food intake (see APPENDIX B), in terms of decrease in food consumption such as amount of food intake, its fraction, percentage and amount of a mouthful should be provided. The detailed explanation of food intake should be obtained to prevent hypoglycemia in the future.

7. If hypoglycemia in hospitalized patients occurs, the causes of this should be investigated and explained.

8. As glucagon is not available and is not used in Thailand, the resolution of hypoglycemia should be suitable in phenomenal environment of hospitals in Thailand.

9. The monitoring of blood glucose level helps to explain the fluctuation of blood glucose level at that time however it is not the best treatment. The continuous use of intravenous dextrose drip after severe hypoglycemia occurrence is more important than the fear of volume overload because of the lower blood glucose in severe hypoglycemia group which is harmful for patients.

The investigator used all suggestions of five experts, to revise and improve this clinical nursing practice guideline for complete coverage of guideline, and for the suitability in actual work units.

In the assessment of potential implementation of this clinical nursing practice guideline the investigator has applied the criteria of assessment of Polit and Beck (2004). The details are as follows:

Transferability of the findings

The clinical nursing practice guideline for management of hypoglycemia associated with insulin therapy among the type 2 diabetic patients during hospitalization is established and can be utilized because it is developed from empirical evidences which are similar to in characteristics of population and similar in target of management.

Feasibility of implementation

The clinical nursing practice guideline can be utilized because it has the assessment, management and prevention of hypoglycemia in which the nurses have important roles for providing services to diabetic hospitalized patients. In addition this guideline has handbook for nurses. This handbook contains the detail of knowledge related to specific areas in caring of the type 2 diabetic inpatients who receive insulin therapy during hospitalization. Because of these factors this guideline can be utilized.

Cost-benefit ratio of innovation

In the clinical nursing practice guideline for management of hypoglycemia associated with insulin therapy among the type 2 diabetic patients during hospitalization, there is strategy for nurses for prevention and immediate treatment. The hypoglycemia episode in hospital can predicted and prevented. The health care providers do not delay hypoglycemia treatment. Because of these the benefits are greater than the risks of its utilization.

The thematic paper was developed only in 2 phases. There is no any implementation. However, the investigator has plans to conduct a pilot study on the type 2 diabetic patients who receive insulin therapy during hospitalization in the Medicine Department of Bangkok Metropolitan Administration Medical Collage and Vajira Hospital in future. Therefore, phase 3 and 4 are determined as follow:

Phase 3: Evidence-observed phase

In this phase, a clinical nursing practice guideline is presented for implementation in actual situation by appropriate methods and this guideline can be measured. This clinical nursing practice guideline will be conducted as a pilot study by submitting the clinical nursing practice guideline for management of hypoglycemia in type 2 diabetic patients who have received insulin therapy during hospitalization to actual implementation with patients in work units. The implementation in actual situation aims to confirm that this clinical nursing practice guideline can be utilized in actual work units.

Phase 4: Evidence-based Phase

In this phase, the data and information from evidence-supported phase and evidence-observed phase are carefully analyzed. Then clinical nursing practice guideline is revised until suitable design has been obtained for actual work unit. Then the implementation was announced and developed in order to attain long-term solution and to disseminate usage while creating a network and promote the implementation of this clinical nursing practice guideline in other work units that provide care for type 2 diabetic patients who receive insulin therapy for controlling blood glucose during hospitalized. The practice guideline is as follows:

1. The entirely revised version of the clinical nursing practice guideline for management of hypoglycemia associated with insulin therapy in type 2 diabetic patients during hospitalization will be presented to administrators such as head nurse in the medicine department and to the Medical Patient Care Team (PCT) for improving a quality of care in the diabetic hospitalized patients.

2. The development of a clinical nursing practice guideline for management of hypoglycemia associated with insulin therapy in type 2 diabetic patients during hospitalization will be presented at an academic conference in the hospital.

3. The clinical nursing practice guideline for management of hypoglycemia associated with insulin therapy among the type 2 diabetic patients during hospitalization will be submitted for trial implementation in other related work units such as other medicine department units and surgical departments in the hospitals which provide nursing care on the type 2 diabetic patients who receive insulin therapy during hospitalization.

4. The clinical nursing practice guideline will be implemented in order to affect changes in the work units and in the organizations by presenting it to high level administrators for approval of implementation and dissemination in order to urge changes and announcement of implementation by integrating this guideline as a part of Continuous Quality Improvement (CQI).

CHAPTER IV
CONCLUSION AND RECOMMENDATION

Conclusion

This thematic paper aims to develop a clinical nursing practice guideline for management of hypoglycemia in type 2 diabetic patients who receive insulin therapy during hospitalization. Because hypoglycemia is a commonly occurring iatrogenic event in hospitalized patients, nurses play an importance role in its detection, treatment, and prevention. This clinical nursing practice guideline will be utilized for improving the quality of nursing care for awareness of hypoglycemia by assessment of patient risk factors, signs, symptoms, bedside monitoring of blood glucose, and appropriate management for resolution of hypoglycemia episode. Furthermore, hypoglycemia is an important clinical risk in the hospital and it is related to high cost of care, long length of stay, and disability or mortality. It is hoped that the outcomes of nursing care by using this clinical nursing guideline will be high level of safety and effectiveness of cure for the type 2 diabetic patients in the hospital. In this study the investigator has used models of evidence – base practice model (Soukup, 2000) for the development of this clinical nursing practice guideline. The detail of this framework is composed of 4 phases. They are as follows:

Phase 1: Phase one is exploration and identification of clinical problems. It was found that hypoglycemia episode in type 2 diabetic patients who receive insulin therapy during hospitalization is an important clinical risk. The benefit of intensive insulin therapy on type 2 diabetic inpatients is the decrease is the rate of morbidity and mortality. Hypoglycemia episode is a significant barrier of treatment for reducing morbidity, mortality and barrier to improve outcomes.

Phase 2: In this phase relevant evidence were found out by searching from many sources. PICO framework was used for the criteria of selecting appropriate evidences by the investigator (Melnyk & Fineout-Overholt, 2005). There are five studies of evidence in present research and all of these are clinically relevant. And

they can be utilized for prevention and management of the hypoglycemia in type 2 diabetic patients who receive insulin therapy during hospitalization. The investigator used criteria of Melynk and Fineout - Overholt (2005) for evaluation of level of evidences-based. Five studies were used for evidence base: four studies are retrospective and prospective researches (level IV) and one study is nursing best practice by expert (level VII). From the above mentioned evidences the main concepts of established clinical nursing practice guideline can be summarized in three: assessment of high risk hypoglycemia patients, nursing management for prevention and nursing management for treatment of hypoglycemia in hospitalized patients and finally the evaluation of hypoglycemia episode during hospitalization. Then the draft of a clinical nursing practice guideline is examined for validity and reliability by 5 experts. The recommendations of five experts were applied to improve this clinical nursing practice guideline for suitability and completion of this guideline which can be utilized in work units. The summary of expert's recommendations is as follow:

1. The prevention and continuous monitoring is an important role of nurses. This includes assessment of high risk hypoglycemia among type 2 diabetic inpatient, monitoring of blood glucose, symptoms, and food intake. In this role nurses should have clear idea and they should create strategy or system for prevention of hypoglycemia in hospital.

2. In the monitoring of blood glucose level in severe hypoglycemia patients, particularly unconscious status patients, blood glucose should be rechecked immediately after giving 50% dextrose intravenous push. Particularly, the severe hypoglycemia patients and hypoglycemia patients with unconscious status must be re-treated with glucose until blood glucose level becomes more than 50 mg/dl, and then continuous drip 10% D/N/2 1,000 ml intravenous rate 100 ml/hr should be provided. Furthermore, the monitoring of blood glucose level after continuous drip 10% D/N/2 1,000 ml should be monitored at every 2 hours until blood glucose level becomes more than 70 mg/dl (> 4.0 mmol/L) or in conscious patients, it should be done until they are able to consume food normally. In addition the monitoring of blood glucose level should be done at the same time in situation for prevention of hypoglycemia in hospital such as 4 times per day (three times before meal and once at bedtime) or in

the NPO or enteral tube feeding recheck of blood glucose should be done at every 6 hours.

3. In severe hypoglycemia patients, resolution by continuous intravenous dextrose drip should be provided. If sulfonylurea – induces hypoglycemia, intravenous dextrose should be continued for an average of 24-72 hours. In the insulin-induced hypoglycemia patients continuity of dextrose intravenous depends on types and action of that insulin.

4. In addition the monitoring of blood glucose after treatment with carbohydrate or glucose should be rechecked at every 2 hours until blood glucose becomes > 70 mg/dl.

5. The nursing management of the high risk hypoglycemia patients and non high risk hypoglycemia patients should be different in content.

6. The result of synthesis and analysis of evidence-based should be carefully to conduct to create nursing practice guideline, for the effectiveness and for covering of this guideline.

7. The documentation of nurse, about food intake (see APPENDIX B), in terms of decrease in food consumption such as amount of food intake, its fraction, percentage and amount of a mouthful should be provided. The detailed explanation of food intake should be obtained to prevent hypoglycemia in the future.

8. If hypoglycemia in hospitalized patients occurs, its causes should be investigated and explained.

9. As glucagon is not available and is not used in Thailand, the resolution of hypoglycemia should be suitable in phenomenal environment of hospitals in Thailand.

10. The monitoring of blood glucose level helps to explain the fluctuation of blood glucose level at that time however it is not the best treatment. The continuous use of intravenous dextrose drip after severe hypoglycemia occurrence is more important than the fear of volume overload because of the lower blood glucose in severe hypoglycemia group which is harmful for patients.

Phase 3 and phase 4: In phase 3 and 4 the investigator is planning for the trial implementation of nursing practice guideline for surveillance hypoglycemia associated with insulin therapy among the type 2 diabetic patients during hospitalization in order

to assess the possibility of implementation in actual situation. In addition phase 4 involves evaluation of result in order to revise this nursing practice guideline after pilot study for its improvement aiming at the suitability in actual situation.

Recommendation

Though in this study, this clinical nursing practice guideline is not actual implementation, however the investigator plans to submit the nursing practice guideline for implementation with actual patients in a work unit later time. The investigator suggestions for the clinical nursing practice guideline are as follows:

1. The clinical nursing practice should be submitted for pilot study in actual work unit. In addition the information of obstacles from the clinical trial should be applied to improve and revise this guideline for making it complete and suitable in the real phenomenal work unit.

2. Training to the staff nurse for promotion and presentation of this clinical nursing practice guideline for management of hypoglycemia associated with insulin therapy among the type 2 diabetes mellitus during hospitalization should be provided for the utilization of this guideline.

3. The clinical nursing practice guideline should be continually improved and revised following the new evidences and for the matching with environment and format of the service of the work unit.

4. The nursing practice guideline should be disseminated to the other medicine department work units which provide nursing care on the type 2 diabetic hospitalized patients who have glycemic control by insulin.

5. The effectiveness of implementation the nursing practice guideline should be comparative studied on the safety from hypoglycemia of the type 2 diabetes patients who receive routine nursing care and the new innovation by outcome research should be followed.

6. The hospital should have policy and protocol on hypoglycemia treatment for nurses to support this clinical nursing practice guideline.

7. Further researches should be conducted focusing on the predicting risk factors for the development of hypoglycemia in critical ill and non-critical ill type 2 diabetes

mellitus patients during hospitalization, focusing intervention to improve treatment and focusing prevention of hypoglycemia in hospitalized patients.

REFERENCES

Amiel, S. A., Dixon, T., Mannt, R., & Jameson, K. (2008). Hypoglycemia in type 2 diabetes. *Diabetic Medicine,* 1-10.

Anthony, M. (2007). Treatment of hypoglycemia in hospitalized adults: A descriptive study. *The Diabetes Educator, 33,* 709-715.

Banarer, S., & Cryer, P. E. (2004). Hypoglycemia in type 2 diabetes. *The Medical Clinics of North America, 88,* 1107-1116.

Ben-Ami, H., Nagachandran, P., Mendelson, A., & Edoute, Y. (1999). Drug-induced hypoglycemic coma in 102 diabetic patients. *Archive of Internal Medicine, 159,* 281-284.

Briscoe, V. J., & Davis, S. N. (2006). Hypoglycemia in type 1 and type 2 diabetes: Physiology, pathophysiology, and management. *Clinical Diabetes, 24*(3), 115-121.

Campbell, K. B., & Braithwaite, S. S. (2004). Hospital management of hyperglycemia. *Clinical Diabetes, 22*(2).

Carroll, M. F., Burge, M. R., & Schade, D. S. (2003). Severe hypoglycemia in adults. *Endocrine & Metabolic disorders, 4,* 149-157.

Cefalu, C. A., & Cefalu, W. T. (2005). Controlling hypoglycemia in type 2 diabetes: Which agent for which patient? At each new stage of treatment, choices can be made to reduce risk. *The Journal of Family Practice, 54*(10), 855-862.

Chelliah, A., & Burge, M. R. (2004). Hypoglycemia in elderly patients with diabetes mellitus causes and strategies for prevention. *Drugs Aging, 21*(8), 511-530.

Cheng, A. Y. Y., & Fantus, I. G. (2005). Oral antihyperglycemic therapy for type 2 diabetes mellitus. *Canadian Medical Association Journal, 172*(2), 213-226.

Clement, S., Braithwaite, S. S., Magee, M. F., Ahmann, A., Smith, E. P., Schafer, R. G., et al. (2004). Management of diabetes and hyperglycemia in hospital. *Diabetes Care, 27*(2), 553-589.

Cohen, L. S., Sedhorn, L., Salifu, M., & Friedman, E. A. (2007). Inpatient diabetes management: Examining morning practice in an acute care setting. *The Diabetes Educator, 33*, 483-492.

Cox, D. J., Gonder-Frederick, L., Ritterband, L., Clarke, W., & Kovatchev, B. P. (2007). Prediction of severe hypoglycemia. *Diabetes Care, 30*, 1370-1373.

Cryer, P. E. (2002). Hypoglycemia: The limiting factor in the glycaemic management of type I and type II diabetes. *Diabetologia, 45*, 937-948.

Cryer, P. E., & Childs, B. P. (2002). Negotiating the barrier of hypoglycemia in diabetes. *Diabetes Spectrum, 15*, 20-27.

Cryer, P. E., Davis, S. N., & Shamoon, H. (2003). Hypoglycemia in diabetes. *Diabetes Care, 26*(6), 1902-1912.

Cryer, P. E., E., I., & Karl, M. M. (2007). Insulin therapy and hypoglycemia in type 2 diabetes mellitus. *Insulin, 2*, 127-133.

Cryer, P. E. Hypolycemia. In: Braunwald Fauci, Kasper, Hauser, Longo, Jameson. Editors. Harrison's principles of international medicine. 15 th ed. International edition 2001. p 2138-2143.

Cryer, P. E. Glucose homeostasis and hypoglycemia. In: Kronenber HM, Melmed S, Polongsky KS, Larsen PR. Williams. Textbook of endocrinology. 11 th editors. Philddelphia WB Saunders; 2008. p 1503-1533.

Davis, S., & Alonso, M. D. (2004). Hypoglycemia as a barrier to glycemic control. *Journal of Diabetes and its Complications, 18*, 60-68.

Desouza, C., Salzar, H., Cheong, B., Murgo, J., & Fonseca, V. (2003). Association of hypoglycemia and cardiac ischemia: A study based on continuous monitoring *Diabetes Care, 26*(5), 1485-1489.

Edelman, S. V., & Morello, C. M. (2005). Strategies for insulin therapy in type 2 diabetes. *Southern Medical Journal, 98*(3), 363-371.

Gangji, A. S., Cukierman, T., & Gerstein, H. C. (2007). A systematic review and meta-analysis of hypoglycemia and cardiovascular events: A comparison of glyburide with other secretagogues and with insulin. *Diabetes Care, 30*(2), 389-394.

Gilman, J. A. (2001). A quality improvement project for better glycemic control in hospitalized patients with diabetes. *The Diabetes Educator, 27*(4), 541-546.

Graumlich, J. F., Habis, S., Avelino, R. R., Salverson, S. M., Gaddamanugu, M., Jamma, K., et al. (2005). Hypoglycemia in inpatients after gatifloxacin or levofloxacin therapy: nested case-control study. *Pharmacotherapy*. *25*(10), 1296–1302.

Guettier, J.M., & Gorden, P. (2006). Hypoglycemia. *Endocrinology and Metabolism Clinics of North America, 35*, 753-766.

Guven, M., Bayram, F., Guven, K., & Kelestimur, F. (2000). Evaluation of patients admitted with hypoglycemia to a teaching hospital in Central Anatolia. *Postgraduate Medical Journal, 76*, 150-152.

Hasssan, E. (2007). Hyperglycemia management in the hospital setting. *American Journal Health System Pharmacy, 64*, S9-S14.

Haviv, Y. S., Sharkia, M., & Safadi, R. (2000). Hypoglycemia in patients with renal failure. *Renal Failure, 22*(2), 219-223.

Hellman, R. (2001). Improving patient safety in diabetes care: the importance of reducing medical errors. *Clinical Diabetes, 19*(4), 190-192.

Hsiao, Y.C., & Chien, M.N. (2006). Severe hypoglycemia in type 2 diabetes: A hospital-based retrospective study. *Journal Internal Medicine Taiwan, 17*, 73-77.

Inzucchi, S. E. (2002). Oral antihyperglycemic therapy for type 2 diabetes. *Journal of American Medical Association, 287*(3), 360-372.

Kagansky, N., Levy, S., Rimon, E., Cojocaru, L., Fridman, A., Ozer, Z., et al. (2003). Hypoglycemia as a predictor of mortality in hospitalized elderly patients. *Archive of Internal Medicine, 163*, 1825-1829.

Krinsley, J. S., & Grover, A. (2007). Severe hypoglycemia in critically ill patients: Risk factors and outcomes. *Critical Care Medicine, 35*(10), 2262-2267.

Langdon, C. D., & Shriver, R. L. (2004). Clinical Issues in the Care of Critical ill Diabetes Patients. *Critical Care Nursing Quarterly, 27*(2), 162-171.

Lewis, K. S., Kane-Gill, S. L., Bobek, M. B., & Dasta, J. F. (2004). Intensive insulin therapy for critically ill patients. *The Annals of Pharmacotherapy, 38*, 1243-1251.

Lien, L. F., Bethel, M. A., & Feinglos, M. N. (2004). In-hospital management of type 2 diabetes mellitus. *The Medical Clinics of North America, 88*, 1085-1105.

Mak, R. H. K. (2000). Impact of end-stage renal disease and dialysis on glycemic control. *Seminars in Dialysis, 13*(1), 4-8.

McAulay, V., Deary, I. J., & Frier, B. M. (2001). Symptoms of hypoglycaemia in people with diabetes. *Diabetic Medicine, 18*, 690-705.

Mehmet, S., Quan, G., Thomas, S., & Goldsmith, D. (2001). Important causes of hypoglycemia in patients with diabetes on peritoneal dialysis. *Diabetic Medicine, 18*, 679-682.

Melnyk, B. M., & Fineout-Overholt, E. (2005). *Evidence-base practice in nursing & healthcare: A guide to best practice*. Philadelphia: Lippincott William & Wilkins.

Meneghini, L., & Hirsch, I. B. (2006). Pharmacotherapies for diabetes management: An update for the practicing clinician. *Thoracic and cardiovascular surgery, 18*, 379-389.

Meneilly, G. S. (2006). Diabetes in the elderly. *The Medical Clinics of North America, 90*, 909-923.

Miller, C. D., Phillip, L. S., Ziemer, D. C., Gallina, D. L., Cook, C. B., & El-Kebbi, I. M. (2001). Hypoglycemia in patients with type 2 diabetes mellitus. *Archive of Internal Medicine, 161*, 1653-1659.

Murata, G. H., Duckworth, W. C., Hoffman, R. M., Wendel, C. S., & Shah, M. J. M. J. H. (2004). Hypoglycemia in type 2 diabetes: a critical review. *Biomedicine & Pharmacotherapy, 58*, 551-559.

Odeh, M., & Oliven, A. (2000). Doxycycline-induced hypoglycemia. *Journal Clinical Pharmacol, 40*, 1173-1174.

Oiknine, R., & Mooradian, A. D. (2003). Drug therapy of diabetes in the elderly. *Biomedicine & Pharmacotherapy, 57*, 231-239.

Paparella, S., & Valley, H. (2006). Avoiding errors with insulin therapy. *Journal of Emergency Nursing, 32*(4), 325-328.

Pittas, A. G., Siegel, R. D., & Lau, J. (2004). Insulin therapy of critically ill hospitalized patients. *Achieve of Internal Medicine, 164*, 2005-2011.

Polit, D. F., & Beck, C. T. (2004). *Nursing research: Principle and methods* (7th ed.). Philadelphia: Lippincott William & Wilkins.

Smith, W. D., Winterstein, A. G., Johns, T., Rosenberg, E., & Sauer, B. C. (2005). Causes of hyperglycemia and hypoglycemia in adult inpatients. *American Journal Health System Pharmacy, 62*, 714-719.

Swift, C. S., & Boucher, J. L. (2005). Nutrition care for hospitalized individuals with diabetes. *Diabetes Spectrum, 18*(1), 34-38.

Tomky, D. (2005). Detection, prevention, and treatment of hypoglycemia in the hospital. *Diabetes Spectrum, 18*, 39-44.

Verghese, P., Gleason, V., Sorokin, R., Senholzi, C., Jabbour, S., & Gottlieb, J. E. (2007). Hypoglycemia in hospitalized patients treated with antihyperglycemic agents. *Society of Hospital Medicine, 2*, 234-240.

Virani, T., Santos, J., McConnell, H., Schouten, J. M., Lappan-Gracon, S., Scott, C., et al. (2004). Best practice guideline for the subcutaneous administration of insulin in adults with type 2 diabetes. Retrieved June, 2004, from http: //*www.rnao.org/bestpractices*, 1-121.

Vriesendorp, T. M., Santen, S. V., DeVries, J. H., Jonge, E. D., Rosendaal, F. R., Schultz, M. J., et al. (2006). Predisposing factors for hypoglycemia in the intensive care unit. *Critical Care Medicine, 34*(1), 96-101.

Wexler, D. J., Meigs, J. B., Cagliero, E., Nathan, D. M., & Grant, R. W. (2007). Prevalence of hyper-and hypoglycemia among inpatients with diabetes. *Diabetes Care, 30*(2), 367-369.

White, J. R., Jr, Davis, S. N., Cooppan, R., Davidson, M. B., Mulcahy, K., et al. (2003). Clarifying the role of insulin in type 2 diabetes management. *Clinical Diabetes, 21*(1), 14-21.

Yale, J. F., Begg, I., Gerstein, H., Houlden, R., & Jones, H. (2001). 2001 Canadian diabetes association clinical practice guidelines for the prevention and management of hypoglycemia in diabetes. *Canadian Journal of Diabetes, 26*(1), 22-35.

Zammitt, N. N., & Frier, B. M. (2005). Hypoglycemia in type 2 diabetes pathophysiology, frequency, and effects of different treatment modalityes. *Diabetes Care, 28*(12), 2498-2961.

เทพ หิมะทองคำ และคณะ (2548). *ความรู้เรื่องเบาหวานฉบับสมบูรณ์*. กรุงเทพมหานคร: บริษัท จูน พลับบลิชชิ่ง.

สว่างจิต สุรอมรกุล เพชรพรรณ ติยะมณี และเพชร รอดอารีย์ (2548). ประสิทธิผลของระบบการเฝ้าระวังเพื่อป้องกันภาวะน้ำตาลต่ำในเลือดในโรงพยาบาล. *วชิรเวชสาร*, 49(1), 59-67.

สุทิน ศรีอัษฎาพร และ วรรณี นิธิยานันท์ (2548). *โรคเบาหวาน*. กรุงเทพมหานคร: เรือนแก้วการพิมพ์.

สุวิทย์ วิบูรณ์ผลประเสริฐ (2550). *การสาธารณสุขไทย*. กรุงเทพมหานคร. โรงพิมพ์องค์การสงเคราะห์ทหารผ่านศึก.

APPENDIX A

A CLINICAL NURSING PRACTICE GUIDELINE

แนวปฏิบัติการพยาบาล เพื่อการจัดการภาวะน้ำตาลในเลือดต่ำ ในผู้ป่วยเบาหวานชนิดที่2 ที่ได้รับการรักษาด้วยอินซูลิน ขณะเข้ารับการรักษาในโรงพยาบาล

วัตถุประสงค์

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คำจำกัดความ

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กลุ่มผู้ป่วยที่ใช้แนวปฏิบัติการพยาบาล

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ประโยชน์ที่คาดว่าจะได้รับ

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เกณฑ์การประเมินผล

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แนวปฏิบัติการพยาบาลเพื่อการป้องกัน และจัดการภาวะน้ำตาลในเลือดต่ำ

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การประเมินผล

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APPENDIX B

แบบบันทึกทางการพยาบาล

เพื่อการประเมินผู้ป่วยที่มีความเสี่ยงสูงต่อการเกิดน้ำตาลในเลือดต่ำสำหรับผู้ป่วยที่ได้รับอินซูลิน

ชื่อผู้ป่วย .....Ward

.....HN.....

Diagnosis.....Chief complaint.....

ประเมินผู้ป่วยเบาหวานที่ได้รับอินซูลิน เพื่อระบุตัวผู้ป่วย “High risk hypoglycemia”	
ปัจจัยเสี่ยง	**ภาวะเจ็บป่วยรุนแรงเฉียบพลัน**
…….. …….. …….. …….. …….. **หมายเหตุ** ……..	…….. …….. …….. …….. **หมายเหตุ** ……..
โทรรายงาน.....…….……	
โทรรายงาน.....……..	
โทรรายงาน.....…….……	
โทรรายงาน.....…….……	

แบบบันทึกทางการพยาบาล การได้รับอินซูลิน

ชื่อผู้ป่วย .....Ward……..HN……

Nutritional / Prandial insulin		**Basal insulin**		
.....	.....	.....	.....	....
....	....	....	....	....
.....	.....	.....	.....	....
.....				

วันที่ /เวลา	**ก่อน.....**		**ก่อน .....**		**ก่อน.....**		**ก่อน.....**		**หมายเหตุ**

แบบบันทึกทางการพยาบาลการได้รับอาหารสำหรับผู้ป่วยเบาหวานที่ได้รับอินซูลิน

ชื่อ-นามสกุลผู้ป่วย.....อายุ.....ห้อง/เตียง.....HN……..

ชนิด...../.....			
ชนิด ……			**อาการ**
วันที่ / เดือน ……	**ปริมาณ**.....	**การเปลี่ยนแปลง**	....
	มื้อ.....	.... เหตุผล.....	..... …… ……
	มื้อ.....	.... เหตุผล.....	..... …… ……
	มื้อ.....	.... เหตุผล.....	..... …… ……
	.มื้อ.....	.... เหตุผล.....	…… ……

แบบบันทึกทางการพยาบาล การจัดการภาวะน้ำตาลในเลือดต่ำ

(Hypoglycemia management)

ชื่อ.....**สกุล** .....**อายุ**.....**ward**.....**HN**……..

วันที่ .....**เวลา**.....

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APPENDIX C

คู่มือสำหรับพยาบาลในการดูแลผู้ป่วยเบาหวานที่ได้รับอินซูลิน

การประเมินผู้ป่วยเบาหวานที่ได้รับอินซูลิน

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การบริหารการให้อินซูลิน (Insulin administration)

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การรับประทานอาหารสำหรับผู้ป่วยที่ได้รับยาฉีดอินซูลิน และความต้องการพลังงานสำหรับผู้ป่วยเบาหวาน

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การประเมินอาการและอาการแสดงของภาวะน้ำตาลในเลือดต่ำ

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การจัดการทางการพยาบาล ภายหลังเกิดภาวะน้ำตาลในเลือดต่ำ

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APPENDIX D

ตารางการวิเคราะห์และสังเคราะห์งานวิจัย

หัวข้อ	รายละเอียด
ชื่อผู้แต่ง / ปีที่พิมพ์	…… ……
เรื่อง/แหล่งตีพิมพ์	…… ……
วัตถุประสงค์การวิจัย	…… ……
กลุ่มตัวอย่างที่ใช้ในการวิจัย	…… ……
Setting ของงานวิจัย	…… ……
ระเบียบวิธีวิจัย/ ระดับของงานวิจัย	…… ……
เครื่องมือที่ใช้ในการวิจัย	…… ……
ผลการวิจัย	…… ……
การประเมินความเป็นไปได้ ในการนำไปใช้	…… ……
การสรุปเพื่อนำไปใช้	…… ……

APPENDIX E

LIST OF EXPERTS

รายนามผู้เชี่ยวชาญในการตรวจสอบแนวปฏิบัติ

1. ผู้ช่วยศาสตราจารย์ นายแพทย์ธวัชชัย พีรพัฒน์ดิษฐ์ พบ. วุฒิบัติอายุรศาสตร์ต่อมไร้ท่อ รองคณบดีฝ่ายทรัพยากรบุคคล หัวหน้าสาขาต่อมไร้ท่อ และอาจารย์ประจำคณะแพทยศาสตร์ศิริราชพยาบาล มหาวิทยาลัยมหิดล
2. แพทย์หญิงสว่างจิต สุรอมรกุล พบ. วุฒิบัติอายุรศาสตร์ต่อมไร้ท่อ นายแพทย์ 8 วช. ภาควิชาอายุรศาสตร์ วิทยาลัยแพทยศาสตร์กรุงเทพมหานครและวชิรพยาบาล
3. ผู้ช่วยศาสตราจารย์ ดร. ชูชื่น ชีวพูนผล พย.ด อาจารย์ประจำภาควิชาการพยาบาลอายุรศาสตร์ คณะพยาบาลศาสตร์ มหาวิทยาลัยมหิดล
4. นางสาวอุระณี รัตนพิทักษ์ พย.ม. พยาบาลผู้ปฏิบัติการพยาบาลขั้นสูง กลุ่มผู้ป่วยเบาหวาน และพยาบาลผู้ชำนาญการปฏิบัติงานประจำคลินิกเบาหวาน คณะแพทยศาสตร์ ศิริราชพยาบาล มหาวิทยาลัยมหิดล
5. นางเพ็ชรพรรณ ติยะมณี พย.บ พยาบาลผู้มีประสบการณ์สูงในการดูแลผู้ป่วยเบาหวาน วิทยาลัยแพทยศาสตร์กรุงเทพมหานครและวชิรพยาบาล

BIOGRAPHY

NAME Miss Naphassawan Dermkhuntod

DATE OF BIRTH 22 March 1976

PLACE OF BIRTH Nakhonsawan, Thailand

INSTITUTIONS ATTENDED The College of Nursing
Kuakarun, 1999:
Bachelor of Nursing
Mahidol University, 2008:
Master of Nursing Science
(Adult Nursing)

POSITION & OFFICE Bangkok Metropolitan Administration
Medical Collage and Vajira
Hospital, Thailand
Position: Nurse
Tel. 02-2443504
E-mail:tong.naphat@hotmail.com

HOME ADDRESS 681 Samsen road Vajira Dusit
Bangkok, Thailand
Tel. 083-2953078