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Diabetes Care Program of Nova Scotia

NOVA SCOTIA

DIABETES CARE PROGRAM OF NOVA SCOTIA

INSULIN DOSE ADJUSTMENT POLICIES & GUIDELINES MANUAL, 2016

Published by:

Diabetes Care Program of Nova Scotia
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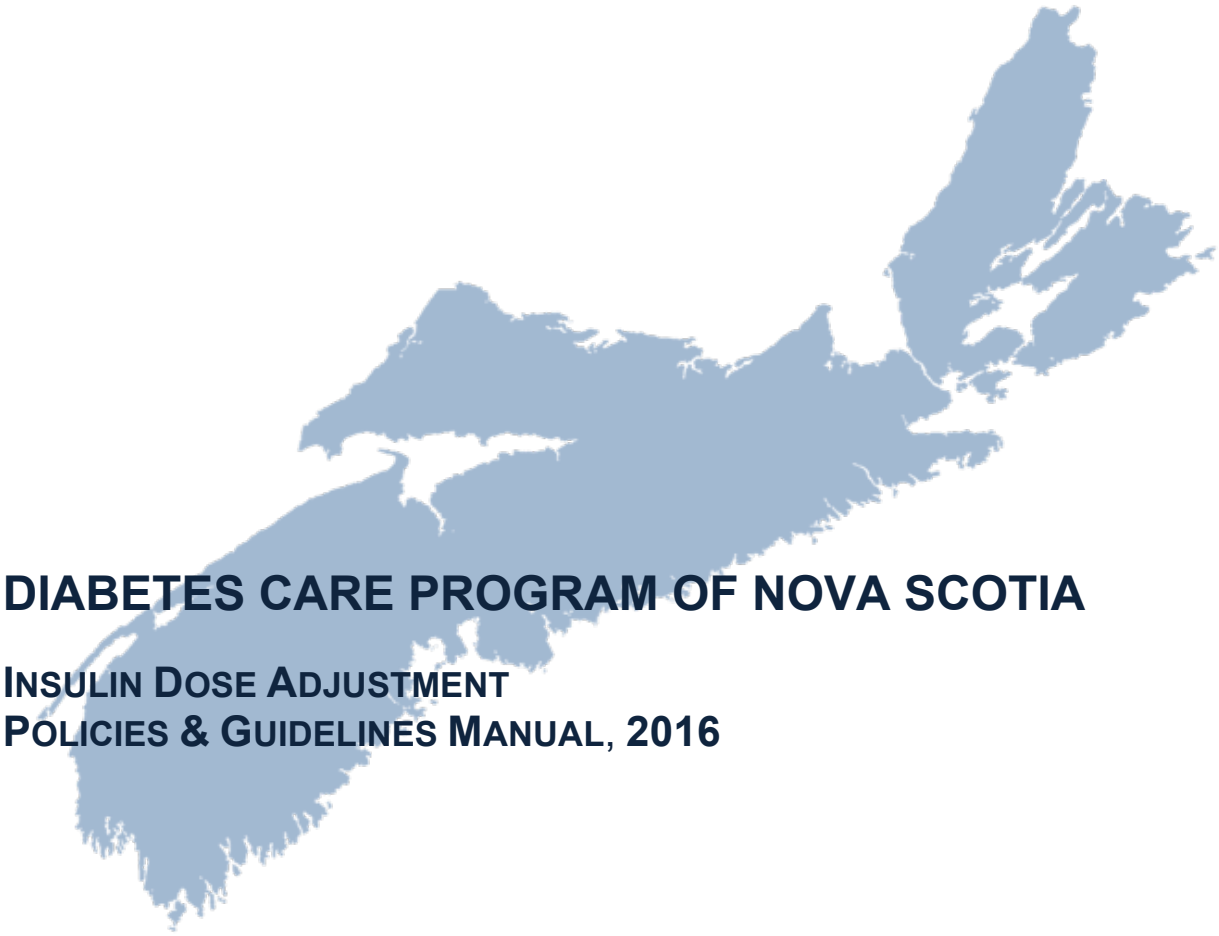

DIABETES CARE PROGRAM OF NOVA SCOTIA

INSULIN DOSE ADJUSTMENT
POLICIES & GUIDELINES MANUAL, 2016

25 yrs Partnerships, Quality, and Innovation (since 1991)
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nova scotia health authority

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ABOUT THE DIABETES CARE PROGRAM OF NOVA SCOTIA (DCPNS)

The Diabetes Care Program of Nova Scotia (DCPNS) is funded by the Nova Scotia Department of Health and Wellness (DHW) and acts in an advisory capacity to the health system. This program is committed to on-going improvement of the health care system and to the promotion of uniform standards throughout the province. To achieve this end, we bring together experts/working groups to advise the system, recommend service delivery models, establish and monitor approved standards, guide policy, facilitate knowledge transfer/translation and networking in support of best/promising practices, and ultimately improve care and outcomes at the local, regional, and provincial levels.

OUR MISSION

To improve, through leadership and partnerships, the health of Nova Scotians living with, affected by, or at risk of developing diabetes.

OUR VISION

The DCPNS is a trusted and respected program that values partnerships and supports integrated approaches to the prevention and management of diabetes.

WE ENVISION A NOVA SCOTIA WHERE:

- There are fewer cases of diabetes.
- Complication rates for those with diabetes are reduced.
- All Nova Scotians with diabetes have access to resources needed to live well.

ACKNOWLEDGEMENTS

ADDITIONAL THANKS

The DCPNS would like to acknowledge and thank the members of the DCPNS Delegated Medical Function (DMF) Committee and the Medical Advisors who have offered their support and guidance to both the content and exam review. With a truly collaborative partnership process, we were very pleased to have reviewers from New Brunswick and Prince Edward Island assist us throughout our revision. The successful completion of these guidelines reflects many hours of work and commitment to quality diabetes care in the Atlantic Provinces.

Members of the Delegated Medical Function Committee (2014-2015)

- Carrie Haggett, RN BScN CDE, Chair
- Peggy Dunbar, MEd PDt CDE, Co-Chair
- Bev Harris, PDt CDE
- Lois Ferguson, RN CDE
- Catherine Splane, RN BComm CDE
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- Kim Kelly, BSc. Pharm
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  Medical Director PEI Provincial Diabetes Program
- Tom Ransom, MD FRCPC, Adult Division of Endocrinology
  QEII Health Sciences Centre, Halifax, NS

Administrative Support and Editing

A heartfelt thanks to Andrea Estensen and Barb Patterson, DCPNS Coordinator of Administrative Services, for their formatting and editorial contributions.

TABLE OF CONTENTS

INTRODUCTION

This manual has been developed by the Diabetes Care Program of Nova Scotia (DCPNS) to assist and facilitate the adoption of insulin dose adjustment as a delegated medical function (DMF) in Nova Scotia Diabetes Centres (DCs), and Diabetes Programs in our partner provinces Prince Edward Island, New Brunswick, and the Western Region of Newfoundland. It has been developed to provide standardized policies and guidelines for use by the Nova Scotia Health Authority (NSHA) and the IWK. It provides diabetes educators (nurses and dietitians) with policies, procedures, and guidelines to assist them in reaching and maintaining an expected level of competence in performing insulin dose adjustment as a DMF.

The College of Physicians and Surgeons of Nova Scotia and the College of Registered Nurses of Nova Scotia Guidelines for Delegated Medical Functions & Medical Directives[1] was used as the framework for the initial edition (2005) of this document.

Current diabetes management focuses on optimal metabolic control.[2,3,4,5] Achieving the best possible glycemic control requires the active participation of the person with diabetes in making adjustments to his/her meal plan, physical activity routine, and insulin doses. This requires knowledge and skill acquisition and the motivation to carry out self-care practices. The diabetes educator, who is certified in insulin dose adjustment, can teach and assist clients to safely and competently adjust their insulin doses to achieve the most appropriate glycemic targets as per the Canadian Diabetes Association Clinical Practice Guidelines.[5] The diabetes educator's ability to adjust insulin is a considerable asset to both the client and referring physician.

It is expected that the diabetes educator will master insulin dose adjustments for adults prior to proceeding to dose adjustments for specialty populations. Only diabetes educators involved with the care/education of clients in the specialty areas (i.e., pregnancy, children/adolescents, and pump therapy) will be expected to make dose adjustment recommendations for these populations. As a prerequisite to adjusting insulin for pump therapy, it is recommended that the diabetes educator be certified as a pump trainer as well as certified in insulin dose adjustment.

This is a living document. New reference tables will be generated in keeping with new and evolving therapies/practices.

REFERENCES:

1. College of Physicians and Surgeons of Nova Scotia and College of Registered Nurses of Nova Scotia. *Guidelines for Delegated Medical Functions & Medical Directives*. Halifax, NS: Author; 2005.
2. The Diabetes Control and Complications Trial Research Group. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin dependent diabetes mellitus. *New England Journal of Medicine*. 1993;329:977-986.
3. UK Prospective Diabetes Study (UKPDS) Group. Intensive blood glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). *Lancet*. 1998;352:837-853.
4. Intensive Diabetes Treatment and Cardiovascular Disease in Patients with Type 1 Diabetes. The Diabetes Control and Complications Trial/Epidemiology of Diabetes Interventions and Complications (DCCT/EDIC) Study Research Group. *New England Journal of Medicine. 2005;353;25:2643-2653.*
5. Canadian Diabetes Association Clinical Practice Guidelines Expert Committee. Canadian Diabetes Association 2013 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. *Can J Diabetes*. 2013;37(suppl 1):S1-S212.

Please note: references are provided in each section and are not sequential throughout the document.
Please note: reference to any specific pharmaceutical products within this document does not imply endorsement.

SECTION 1

DELEGATED MEDICAL FUNCTION (DMF)

POLICY

INSULIN DOSE ADJUSTMENT AS A DELEGATED MEDICAL FUNCTION (DMF)

DIABETES CARE PROGRAM OF NOVA SCOTIA

Nova Scotia Health Authority (NSHA) Zone/IWK: _____ Facility: _____

Approved by (name): _____ Title: _____

Signature: _____ Approval date: _____

- Adjustment of insulin doses is a DMF performed by a diabetes educator (nurse or dietitian) who is certified in insulin dose adjustment.
- Only diabetes educators employed in Nova Scotia Diabetes Centres (DCs) will be certified for this procedure.
- Diabetes educators will be required to complete a certification process as evidence of their competency to adjust insulin doses as a DMF (*see Criteria for Certification on page 5*).
- Certification may be granted for diabetes educators to provide adult and specialty insulin dose adjustments.

As a prerequisite for becoming certified in insulin dose adjustment, it is expected that the diabetes educator will be competent in basic diabetes management and education skills, including insulin therapy.

- Insulin dose adjustments will be made according to guidelines outlined in the *DCPNS Insulin Dose Adjustment Policies & Guidelines Manual, 2016.*
- The diabetes educator, certified in insulin dose adjustment, will follow the established process and guidelines for insulin dose adjustment as approved by the NSHA zone/IWK and facility.

CRITERIA FOR CERTIFICATON

- At least six (6) to 12 months (minimum 800 hours) of clinical experience in direct diabetes education and management within the last 3 years.
- Certified Diabetes Educator* (CDE®) designation is recommended.
- Supervised/mentored clinical practice by the medical advisor or designate** (e.g., diabetes educator [nurse or dietitian] certified in insulin dose adjustment).
- Completion of case studies and answers reviewed by the Medical Advisor or designate.
- Completion of the Initial Competency Skills Checklist(s) (see pages 8 to 10).
- Completion of a written exam with a passing grade of 80% corrected by the medical advisor or designate.
- Initial certification will be documented on the Certificate of Competence and provided by the DCPNS to educators in Nova Scotia.
- The NSHA Zone/IWK and/or facility must maintain a record of the following:
  - Names of diabetes educators certified for insulin dose adjustment.
  - Dates of certification and re-certification.

***Certified Diabetes Educator (CDE®)**. Certification in diabetes education is provided by the Canadian Diabetes Educator Certification Board. This certification process is a designation to include all diabetes educators. Certification is a voluntary process that allows for identification of the health care professionals who are trained, experienced, and competent in diabetes education. In order to qualify for the CDE® examination, the diabetes educator must "…be registered with a regulatory body in Canada as a health professional and have obtained a minimum of 800 hours practice in diabetes education. The minimum of 800 hours of practice in diabetes education must be completed in a 3-year period immediately prior to the application deadline. All of the above must be attained while the individual is registered with a regulatory body in Canada as a health care professional." Therefore, in meeting the eligibility criteria for the CDE® process, the candidate has established direct clinical practice exposure and has broader diabetes knowledge in preparation for insulin dose adjustment as a DMF.
Source: Canadian Diabetes Educator Certification Board (www.cdecb.ca). Accessed December 2015.

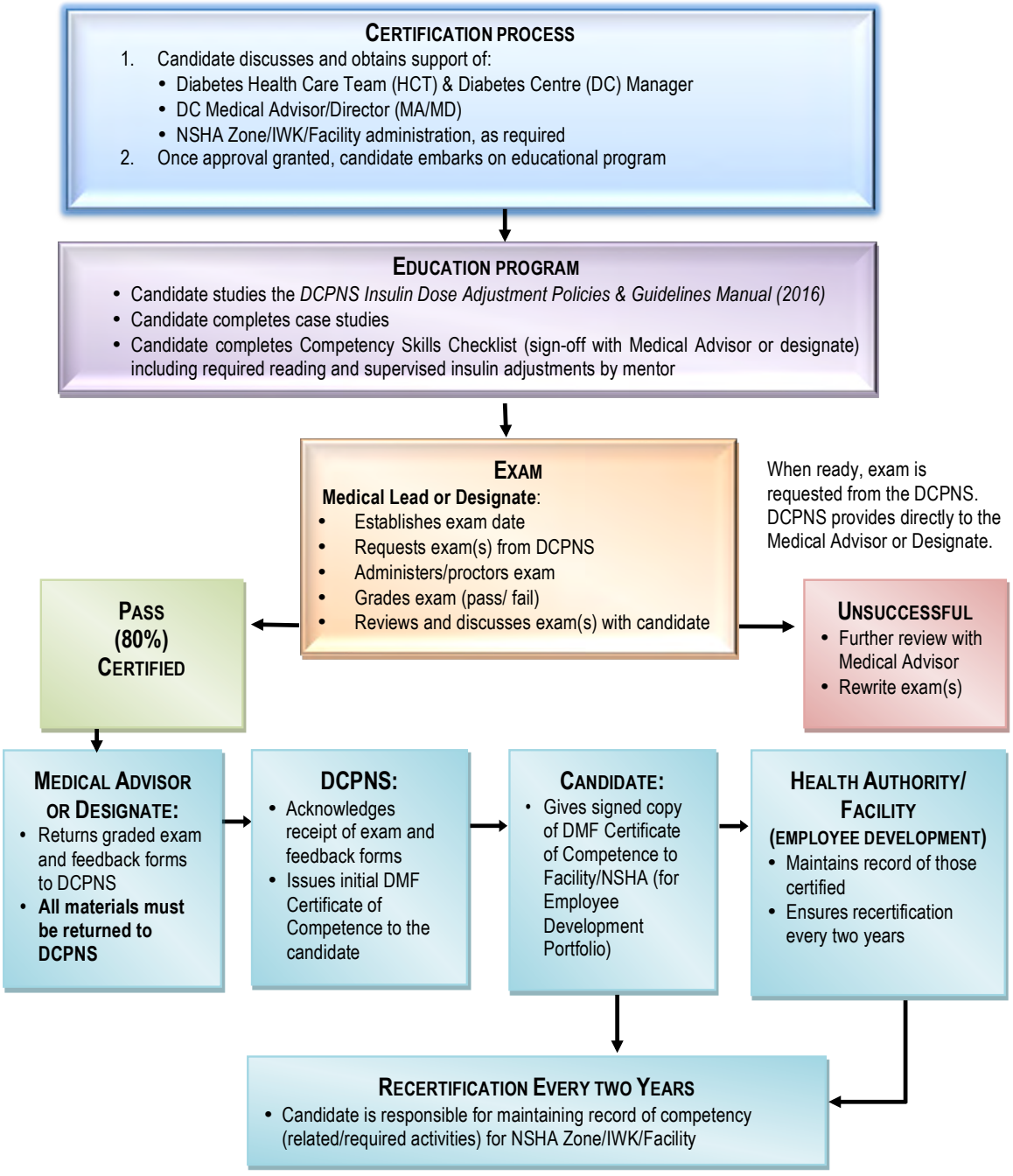
** **Designate** *(for exam purposes)***:** A diabetes educator (nurse or dietitian) previously certified in insulin dose adjustment with demonstrated competency and confidence who is formally (in writing) appointed by the Diabetes Centre Medical Advisor/Director to oversee the preparation and examination for insulin dose adjustment.

CERTIFICATION FLOW CHART

CRITERIA FOR INSULIN DOSE ADJUSTMENT CERTIFICATION

Insulin dose adjustment certification is a required qualification for some positions within the Nova Scotia Health Authority and the IWK Health Centre. Criteria for certification, include:

- At least six (6) to 12 months (minimum 800 hours) in direct diabetes education and management.
- Certified Diabetes Educator (CDE) designation is recommended.
- Supervised/mentored clinical practice by Medical Advisor/Director or designate. See full criteria for certification, page 5.



ADULT INITIAL CERTIFICATION
COMPETENCY SKILLS CHECKLIST

Nova Scotia Health Authority (NSHA) Zone/IWK: _____ Facility: _____

RN/PDt: _____

Medical Advisor (or Designate) Name/Initial: _____

The Medical Advisor (or designate) signs off topics as competency skills mastered.

Insulin Dose Adjustment (Adults)	DATE & SIGNATURE (MEDICAL ADVISOR/ DESIGNATE)	COMMENTS
Discusses policies and guidelines of insulin dose adjustment		
Obtains written/verbal physician directive for insulin dose adjustment		
Describes time action of insulin products		
Describes various insulin regimens for adults with type 1 & type 2 diabetes		
Identifies targets for glycemic control		
Describes potential risks of insulin dose adjustment		
Identifies variables that influence glycemic control, including frailty		
Correctly assesses SMBG records		
Discusses concepts of combination therapy		
Adjusts insulin correctly based on patterns of high blood glucose (hyperglycemia)		
Describes appropriate use of insulin with non-insulin therapies (including cautions and limitations)	.	
Adjusts insulin correctly for patterns of low blood glucose (hypoglycemia)		
Describes concepts of supplemental dose adjustment: • Compensatory • Anticipatory		
Constructs a variable insulin dose algorithm		

Competency Skills Checklist (cont)

Insulin Dose Adjustment (Adults)	DATE & SIGNATURE (MEDICAL ADVISOR/DESIGNATE)	COMMENTS
Discusses concepts of intensive insulin therapy		
Discusses concepts of an MDI (basal/bolus) regimen		
Calculates insulin-to-CHO ratios		
Adjusts insulin correctly for illness/DKA		
Adjusts insulin correctly for exercise		
Adjusts insulin correctly for travel		
Adjusts insulin correctly for shift work		
Ensures appropriate follow-up (phone, visit, etc.)		
Appropriately documents actions		
Has completed self-directed reading/learning		
Discussed/reviewed case studies		
Passed written exam (80%)		

SPECIALTY AREAS INITIAL CERTIFICATION COMPETENCY SKILLS CHECKLIST

Nova Scotia Health Authority (NSHA) Zone/IWK: _____ Facility: _____

RN/PDt: _____

Medical Advisor (or Designate) Name/Initial: _____

The Medical Advisor (or designate) signs off topics as competency skills mastered.

Insulin Dose Adjustment (Specialty Areas)	DATE & SIGNATURE (MEDICAL ADVISOR/DESIGNATE)	COMMENTS
Adjusts insulin correctly for pregnancy		
Adjusts insulin correctly for children & adolescents		
Adjusts insulin correctly for pump therapy		
Ensures appropriate follow-up (phone, visit, etc.)		
Appropriately documents actions		
Has completed self-directed reading/ learning		
Discussed/reviewed case studies		
Passed written exam (80%)		

CRITERIA FOR RECERTIFICATION

- **Recertification is required every two years**. Certificate must be signed every two years based on demonstrated continued competence.
- The certificate is to be signed by the Medical Advisor or designate.*
- Recertification is the responsibility of the candidate and the NSHA Zone/IWK/facility and **not** the Diabetes Care Program of Nova Scotia.
- Continued competency will be evaluated by:
  - Assessment of competency to perform components of the Delegated Medical Function (DMF).
  - Documented evidence of continuous educational activities (such as attendance at workshops/conferences, literature reviews, etc.) to support maintenance of competency.
  - Chart review and/or case conference by the Medical Advisor or designate.*
- If competency is judged adequate, the candidate is recertified in Insulin Dose Adjustment.
- If competency is judged inadequate, the diabetes educator will be required to repeat the initial certification process (including supervised clinical practice and exam).

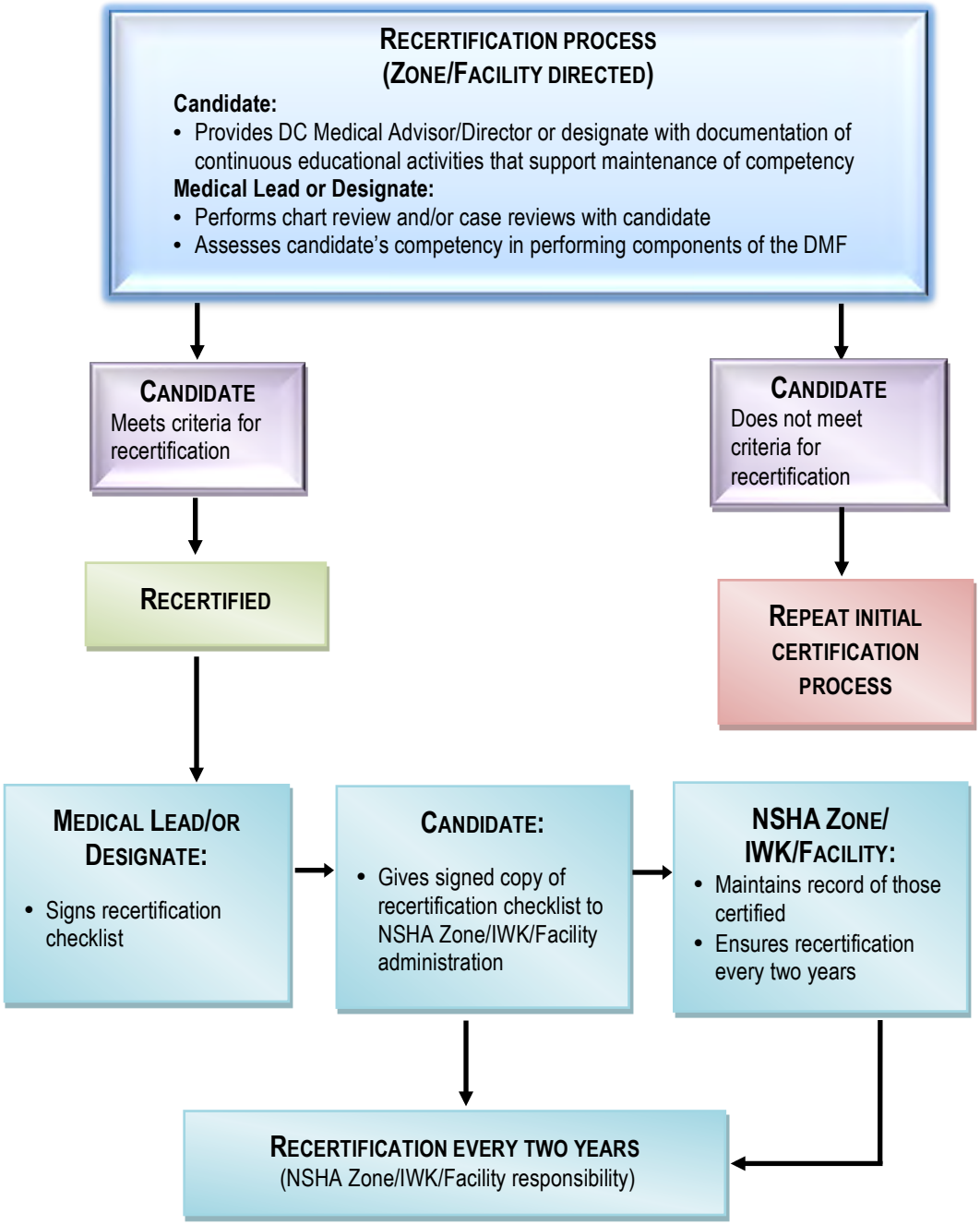
Note: *If not working in direct diabetes education for more than two years, the diabetes educator must recertify as per criteria for initial certification.*

* **Designate** *(for exam purposes)***:** A diabetes educator (nurse of dietitian) previously certified in insulin dose adjustment with demonstrated competency and confidence who is formally (in writing) appointed by the Diabetes Centre Medical Advisor/Director to oversee the preparation and examination for insulin dose adjustment.

RECERTIFICATION FLOW CHART

CRITERIA FOR INSULIN DOSE ADJUSTMENT RECERTIFICATION

- Previous certification in insulin dose adjustment and has been working in direct diabetes education for the past two years.



RECERTIFICATION COMPETENCY SKILLS CHECKLIST

ADULT AND/OR SPECIALTY AREAS

The use of this form is optional. A site-specific form developed by the facility or NSHA Zone/IWK may be preferred.

Nova Scotia Health Authority (NSHA) Zone/IWK: _____ Facility: _____

RN/PDt: _____

Medical Advisor (or Designate) Name/Initial: _____

Date of Initial Certification: _____ **Date of Recertification**: _____

Criteria for Recertification	**Date & Signature (Medical Advisor/Designate)**	
	Insulin Adjustment for Adults	**Specialty Areas** ❑ **Pregnancy** ❑ **Children & Adolescents** ❑ **Pump Therapy**
Candidate continues to meet all requirements of skills checklist as for Initial Certification in Insulin Dose Adjustment.*		
Candidate has provided documentation of continuous educational activities that support maintenance of competency.		
Chart reviews and/or case study reviews provide evidence of candidate's ongoing competency in the DMF for Insulin Dose Adjustment.		

***** For a complete list of required competencies see **Adult Initial Certification Competency Skills Checklist and/or Specialty Areas Initial Certification Competency Skills Checklist** pages 7 to 9.

POLICY

INSULIN THERAPY AND DOSE ADJUSTMENT

DIABETES CARE PROGRAM OF NOVA SCOTIA

Nova Scotia Health Authority (NSHA) ZONE/IWK: _____ Facility: _____

Approved by (name): _____ Title: _____

Signature: _____ Approval date: _____

1a. For initiation of insulin, referring physicians must indicate if the diabetes educator (nurse or dietitian) certified in insulin dose adjustment is to assist with insulin dose adjustment.

1.1 The referring physician must provide orders specifying type, time, and starting dose of insulin and authorization to make insulin dose adjustments. (*See sample Insulin Start Order Form; Section 5 - Documentation Forms, page 187.)*

1b. For re-referred or routine follow-up patients, insulin dose adjustment advice/guidance will be provided by the diabetes educator certified in insulin dose adjustment, unless otherwise specified by the referring physician.

1c. If diabetes educators are not to adjust insulin, the referring physician maintains responsibility for all changes in therapy.

2. Goals for blood glucose (BG) target range will comply with the current Canadian Diabetes Association (CDA) *Clinical Practice Guidelines* and will be individualized for each client.

3. Insulin adjustments will be made to optimize BG control and will be made on the basis of documented self-monitoring of blood glucose (SMBG) results and reported episodes of hypoglycemia and/or hyperglycemia following guidelines outlined in the *DCPNS Insulin Dose Adjustment Policies and Guidelines Manual, 2016*.

4. Initially, insulin will be adjusted on the basis of preprandial glucose results. However, when intensive insulin supplementation is desired and/or rapid-acting/short-acting insulin is used, insulin may be better adjusted according to both pre and postprandial BG results.

5. The diabetes educator and referring physician will communicate as needed to ensure the client is receiving optimal insulin doses.

6. If the diabetes educator feels that regimen changes are indicated, such as number of injections or type of insulin, this will be done in collaboration with the referring physician and client.

7. Insulin dose adjustments and follow-up plan will be documented on the client's chart and forwarded to the referring physician (according to individual clinic practice).

8. The diabetes educator will consult with the referring physician in the following situations:

- Difficult or complex circumstances (as perceived by the diabetes educator).
- If the client possibly requires a change in insulin type or regimen.
- If the client's glycemic control is not improving despite adjustments to insulin or other components of the treatment plan.

SELECTION OF CLIENTS FOR INSULIN DOSE ADJUSTMENT

All clients* using insulin who are willing and able will be taught insulin dose adjustment. Where possible, these individuals should also meet the following criteria:

- Have a referral to the Diabetes Centre authorizing insulin dose adjustment.
- Demonstrate the ability to perform regular, accurate SMBG and to record results.
- Demonstrate an interest in and ability to understand insulin dose adjustment.
- Have had and/or are willing to have a nutritional assessment and instruction with the diabetes educator (dietitian), including an introduction to or review of carbohydrate (CHO) counting.
- Willing to share and review SMBG results, and evaluates dose changes (by office visit, telephone, fax, or e-mail) as per client protocol.

If a client does not demonstrate the potential for, or interest in, safe dose adjustment (e.g., alcohol/substance abuse), the diabetes educator has the right to refuse insulin dose adjustment and refer the client back to the referring physician to assume responsibility for insulin dosing.

* Client refers to the person with diabetes requiring insulin. The person taught may be a parent/guardian, spouse/partner, or responsible caregiver in certain circumstances.

ADULT INSULIN DOSE ADJUSTMENT GUIDELINES

LEARNING OBJECTIVES

When criteria for certification in insulin dose adjustment (adult) has been met, the diabetes educator (nurse or dietitian) will be able to:

- Describe the time action of the available insulin products.
- Describe the different insulin regimens for adults with type 1 and type 2 diabetes.
- Discuss concepts of combination therapy.
- Describe the potential risks of insulin dose adjustment.
- Identify variables influencing glycemic control that must be assessed before insulin dose adjustment is performed.
- Define dawn phenomenon.
- Discuss indications, methods, and rationale for insulin dose adjustment based on patterns of high and low BG results.
- Discuss indications, methods, and rationale for supplemental dose adjustment.
- Construct an algorithm and describe its use in making compensatory insulin dose adjustments.
- Define intensive therapy, and describe key components of intensive regimens.
- Describe important points to consider when switching a client to an intensive (multiple daily injections or basal/bolus dose) regimen.
- Calculate insulin-to-CHO ratio and use this method to determine anticipatory insulin dose adjustments.
- Discuss indications, methods, and rationale for insulin dose adjustment for the following:
  - Illness and prevention/treatment of DKA
  - Physical activity/exercise
  - Travel
  - Shift work

SPECIALTY AREAS

(Prerequisite: Adult Insulin Dose Adjustment Certification)

LEARNING OBJECTIVES

When **specialty areas** criteria for certification in insulin dose adjustment has been met, the diabetes educator (nurse or dietitian) will be able to:

- Discuss concepts of insulin dose adjustment for pregnancy.
- Discuss concepts of insulin dose adjustment for children/adolescents.
- Discuss indications, methods, and rationale for insulin dose adjustment for pump therapy:
  - Adults
  - Children/adolescents

SECTION 2

ADULT INSULIN DOSE ADJUSTMENT GUIDELINES

INSULIN THERAPY

Insulin therapy is essential for the management of type 1 diabetes and may be needed by clients with type 2 diabetes. The effective use of insulin to obtain the best metabolic control requires an understanding of the duration of action of the various types of insulin and the relationship of blood glucose (BG) levels to exercise/physical activity, food intake, intercurrent illness, and certain medications. It also requires learning to adjust insulin dosages to achieve the individualized target goals established between the client and diabetes health care team (HCT) as per the *Canadian Diabetes Association Clinical Practice Guidelines*.[1] Insulin requirements are different for each person and can change with time.

It is the physician's responsibility to determine the initial insulin dose and regimen.

Insulin therapy is ideally started on an outpatient basis through the Diabetes Centre (DC) and involving the diabetes HCT. Education for the person starting insulin therapy should include insulin administration, time action profiles, self-monitoring of blood glucose (SMBG), interpretation of results, treatment of hypoglycemia, meal planning, CHO sources, problem solving, dose adjustments, activity, and sick day management. Active involvement of the client in self-care management with support and follow-up by the diabetes HCT are important components in assisting clients to achieve optimal diabetes management. Consistent meal/snack and physical activity routines are very important during insulin initiation and insulin adjustment (titration) to achieve desired glycemic control.

Before starting insulin therapy, determine if the person has an extended health insurance plan to cover the cost of insulin and supplies as well as BG monitoring strips for additional BG testing. Check periodically to see if newer insulin analogues are included in the Provincial Formulary.

TYPE 1 – ADULT – KEY POINTS

- Insulin therapy is the mainstay of glycemic control in type 1 diabetes.[1]
- The absolute insulin deficiency of established type 1 diabetes can only be treated effectively with Multiple Daily Injections (MDI) or continuous subcutaneous insulin infusion (CSII).[1]
- Insulin regimens should be tailored to the individual's treatment goals, lifestyle, diet, age, general health, motivation, hypoglycemia awareness status, and ability for self-management.[1]
- Rapid-acting insulin analogues, in combination with adequate basal insulin, should be considered over regular insulin to improve A1C while minimizing the occurrence of hypoglycemia and to achieve postprandial glucose targets.[1]
- As an alternative to intermediate-acting insulin, long-acting insulin analogues may be considered as the basal insulin to reduce the risk of hypoglycemia including nocturnal hypoglycemia.[1]
- The total daily insulin requirements are usually 0.2 to 1.0 units/kg of body weight/day, given in divided doses. In the absence of ketoacidosis (DKA), it is best to begin slowly by starting with 0.2 to 0.3 units/kg of body weight/day. In the presence of ketones, 0.5 units/kg may be recommended in the initial 24-hour calculated dose.
- Insulin requirements will be lower (0.2 to 0.6 units/kg of body weight/day) during the honeymoon phase. This is the period of remission early in the course of the disease that is characterized by residual endogenous insulin secretion and may last from weeks to months.[2]
- Initiation and advancement of insulin is guided by routine/regular meal/snack times, consistency in CHO (sources and amounts) and usual physical activity/exercise patterns as well as frequent self-monitoring of blood glucose (SMBG).

- Insulin requirements will fluctuate during illness and are often higher in the presence of intercurrent illness or other metabolic instability. This requires careful monitoring. *See Illness and Prevention/Treatment of DKA section, page 67.*
- All individuals with type 1 diabetes initiating insulin therapy should be counseled about:
  - the risk, prevention, and treatment of hypoglycemia.[1]
  - the risk, prevention, and treatment of DKA.
- Continuous glucose monitoring (CGM), sensor-augmented therapy, may be useful to identify periods of glucose variability.

TYPE 2 – ADULT – KEY POINTS

- Due to the progressive nature of type 2 diabetes, most people will eventually require insulin therapy in addition to non-insulin therapy (oral or injectables) to compensate for the diminishing supply of endogenous insulin. [3]
- Insulin requirements vary considerably and may range from as little as 5 to 10 units/day to more than 100 units/day. This is because of interpatient variability of insulin deficiency and insulin resistance.
- All individuals with type 2 diabetes initiating insulin therapy should be counseled about:
  - the recognition, treatment and prevention of hypoglycemia. [1]
  - sick day management
- In type 2 diabetes, long-acting insulin analogues are not recommended as the first line insulin therapy.[4] Long-acting insulin analogues may be considered in clients with type 2 diabetes who have a history of nocturnal hypoglycemia using human insulin.
- Before initiating a long-acting insulin analogue in a person with type 2 diabetes on a large dose of a single injection, it is important to try various insulin regimens using a combination of short-acting and intermediate-acting insulins. *See examples on pages 28 to 36.*
- Regardless of the insulin regimen chosen, the dose should be adjusted to achieve glycemic targets.[1]
- Initiation and advancement of insulin is guided by routine/regular meal/snack times, consistency in carbohydrate (CHO) (sources and amounts), and usual physical activity/exercise patterns as well as frequent SMBG.
- Testing will be more frequent during insulin initiation to assess the patterns and how the insulin is working. Advancing the insulin regimen is based on frequent SMBG and the appropriate reaction (increasing the dose, or adding additional injections).
- CGM, sensor-augmented therapy, may be useful to identify periods of glucose variability.[1]

ADDING INSULIN TO NON-INSULIN THERAPIES (*SEE PAGE 37 FOR COMBINATION THERAPY*):

- When insulin is added to non-insulin therapy, a single injection of intermediate-acting insulin may be used. This approach may result in better glycemic control with a smaller dose of insulin and may induce less weight gain and fewer hypoglycemic episodes than that seen when non-insulin therapies are stopped and insulin is used alone.[1]
- Since basal insulins (intermediate- and long-acting) do not control postprandial glucose levels, clients should be instructed to keep taking any other non-insulin therapies as recommended by the ordering physician. *See Section 4, Table 2A, page 183*.
- If daytime hypoglycemia occurs, the non-insulin therapy (secretagogues) may need to be reduced or discontinued or the insulin dose reduced.
- Sometimes sulfonylureas, DPP-4 inhibitors and GLP-1 agonists may be stopped when insulin needs change to a basal/bolus regimen.[5]

RECOMMENDED STARTING DOSES:

- If using intermediate-acting insulin, consider a starting dose of 10 units at bedtime[1] **or** consider a starting dose of 0.1 to 0.2 units/kg of body weight.[6] The bedtime (hs) starting dose is intended to target the fasting plasma glucose (FPG).
- If using a long-acting insulin analogue, consider a starting dose of 10 units once daily at bedtime.
- If using a premixed insulin, consider a dose of 5 to 10 units administered once or twice daily pre-breakfast and/or pre-supper.[1] Alternatively, based on general clinical experience, a starting dose of 0.1 to 0.2 units/kg of body weight can also be used to calculate pre-breakfast and/or pre-supper doses.

RECOMMENDED TARGETS FOR GLYCEMIC CONTROL*

	Glycated Hemoglobin (A1C)	Fasting Plasma Glucose (FPG) or Preprandial PG	2-hour Postprandial PG
Types 1 & 2 Diabetes	≤ 7.0 % (range ≤ 6.5-8.5%)	4.0 – 7.0 mmol/L	5.0 – 10.0 mmol/L (5.0 – 8.0 mmol/L, if A1C targets ≤ 7% not being met)

*Treatment goals and strategies must be tailored to the individual with diabetes, with consideration given to individual risk factors[1]. Glycemic targets for children ≤12 years of age and pregnant women differ from these targets[1]. *See Section 3 – Specialty Areas for further details*. Glycemic targets also differ for the frail elderly.[7]

TYPES OF INSULIN AVAILABLE IN CANADA

TYPES OF INSULIN			
Insulin Type (trade name)	**Onset**	**Peak**	**Duration**
Prandial (bolus) Insulins			
Rapid-acting (RA) insulin analogues (clear) Insulin aspart 100 units/ml (NovoRapid®) Insulin lispro 100 units/ml (Humalog®) Insulin lispro 200 units/ml (Humalog® Kwikpen®) Insulin glulisine 100 units/ml (Apidra®)	 10 to 15 minutes 10 to 15 minutes 10 to 15 minutes 10 to 15 minutes	 1 to 1.5 hours 1 to 2.0 hours 1 to 1.5 hours	 3.0 to 5.0 hours 3.5 to 4.75 hours 3.0 to 5.0 hours
Short-acting (SA) insulin (clear) Humulin® R Novolin® ge Toronto	30 minutes	2 to 3 hours	6.5 hours
Basal Insulins			
Intermediate-acting (IA) insulin (cloudy) Humulin® N Novolin® ge NPH	1 to 3 hour	5 to 8 hours	up to 18 hours* ** Intermediate-acting insulin duration of up to 24 hours in young children[8].*
Long-acting (LA) insulin analogues (clear) Insulin detemir 100 units/ml (Levemir®) Insulin glargine 100 units/ml (Lantus®) Insulin glargine 300 units/ml (Toujeo™ soloStar®)	 90 minutes 90 minutes up to 6 hours	 Not Applicable	 16 - 24 hours up to 24 hours up to 30 hours
Premixed Insulins			
Premixed regular (PMR) insulin – NPH (cloudy) Humulin® 30/70 Novolin® ge 30/70, 40/60, 50/50	A single vial or cartridge contains a fixed ratio of insulin (% of rapid-acting or short-acting insulin to % of intermediate-acting insulin).		
Premixed (PMA) insulin analogues (cloudy) Biphasic insulin aspart (NovoMix®30) Insulin lispro/lispro protamine (Humalog® Mix 25 and Mix 50)			

Note: Physicians should see the most current edition of *Compendium of Pharmaceuticals and Specialties* (Canadian Pharmacists Association; Ottawa, Ontario Canada) and product monographs for detailed information.

Adopted from: Canadian Diabetes Association Clinical Practice Guidelines Expert Committee. Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. *Can J Diabetes*. 2013;37(suppl 1):S57. 2015 update, table 1 accessed from CDA website December 2015.

ABBREVIATIONS USED THROUGHOUT THE MANUAL

Insulin Type (trade name)	Abbreviation
Prandial (bolus) Insulins	
Rapid-acting insulin analogues (clear) Insulin aspart (NovoRapid®) Insulin lispro (Humalog®) Insulin glulisine (Apidra®) Insulin lispro (Humalog® Kwikpen®)	RA
Short-acting insulins (clear) Humulin® R Novolin® ge Toronto	SA
Basal Insulins	
Intermediate-acting insulins(cloudy) Humulin®N Novolin® ge NPH	IA
Long-acting insulin analogues (clear) Insulin detemir (Levemir®) Insulin glargine (Lantus®) Insulin glargine 300 units/ml (Toujeo®)	LA
Premixed Insulins	
Premixed regular insulins – NPH (cloudy) Humulin® 30/70 Novolin® ge 30/70, 40/60, 50/50	PMR
Premixed insulin analogues (cloudy) Biphasic insulin aspart (NovoMix® 30) Insulin lispro/lispro protamine (Humalog® Mix25 and Mix50)	PMA

REFERENCES :

1. Canadian Diabetes Association Clinical Practice Guidelines Expert Committee. Canadian Diabetes Association 2013 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. *Can J Diabetes*. 2013;37(suppl 1)S1:212.
2. American Diabetes Association. *Practical Insulin: A Handbook for Prescribing Providers, Second Edition*. Alexandria, VA: Author; 2007.
3. American Diabetes Association. *Medical Management of Type 2 Diabetes, 7th edition*. Alexandria, VA: Author; 2012;79-80.
4. Dalhousie University Academic Detailing Service. *Diabetes 2010… Insulin Analogues & Self-Monitoring*. Halifax, NS: Dalhousie University; 2010.
5. American Diabetes Association. Standards of Medical Care in Diabetes -2015. *Diabetes Care*. 2015;38(suppl 2):S46.
6. Nathan DM, Buse J, Davidson MB. Management of hyperglycemia in type 2 diabetes: A consensus algorithm for the initiation and adjustment of therapy. *Diabetes Care*. 2006;29(8):1963-1972.
7. Diabetes Care Program of Nova Scotia. *Diabetes Guidelines for Elderly Residents in Long-Term Care (LTC) Facilities: Pocket Reference*. Halifax, NS: Diabetes Care Program of Nova Scotia; 2010. Available at: http://diabetescare.nshealth.ca/sites/default/files/files/LTCPocketReference.pdf. Accessed December 2015.

RECOMMENDED READING:

- Canadian Diabetes Association. *Building Competency in Diabetes Education: The Essentials 4th Edition*. Toronto, ON: Author; 2013.
- Walsh J, Roberts R, Varma C, Bailey T. *Using Insulin: Everything You Need for Success with Insulin*. San Diego, CA: Torrey Pines Press; 2003.

INSULIN REGIMENS

There are several insulin regimens currently in use. The starting dose and schedule of insulin administration is based on clinical assessment and the individual's meal times, exercise/physical activity, and work schedule. As much as possible, the individual's preferences should prevail in the choice of insulin regimen and delivery method.

- For individuals with type 1 diabetes, multiple daily injections (MDI) or basal/bolus regimens are required to best manage this type of diabetes.
- For individuals with type 2 diabetes, intermediate-acting insulin (NPH/N), acting as the basal insulin, is usually started at bedtime. This is titrated up to normalize the fasting plasma glucose (FPG). Depending on how the diabetes advances, 2, 3, 4 or more injections may be added accordingly to improve prandial values.

Most individuals will choose to use insulin pens for their injections (one pen per type of insulin), while others may choose to use a syringe to mix appropriate insulins (split mixed). For some, this practice of split mixed (two types of insulin in one syringe) will reduce the number of injections required at certain times of the day. For example, mixing the breakfast dose of rapid-acting or short-acting insulin with an intermediate-acting insulin in a single syringe would result in only one injection at breakfast.

Note: *Long-acting insulin analogues cannot be mixed with any other insulin.*

The following provides an overview of the various insulin regimens, starting with 4 or 5 injections per day (as the regimen most used in individuals with type 1 diabetes) followed by examples of 1, 2, and 3 injections per day (used with variable success in the type 2 population). Indications for use, as well as advantages and disadvantages of each regimen are provided along with examples and time action curves.

OVERVIEW OF INSULIN REGIMENS

Four or Five (4 or 5) Injections a Day

Indications:

- All adults with type 1 diabetes.
- All individuals with type 2 diabetes trying to obtain better glucose control when non-insulin therapy has failed and less frequent injections do not result in improved control.

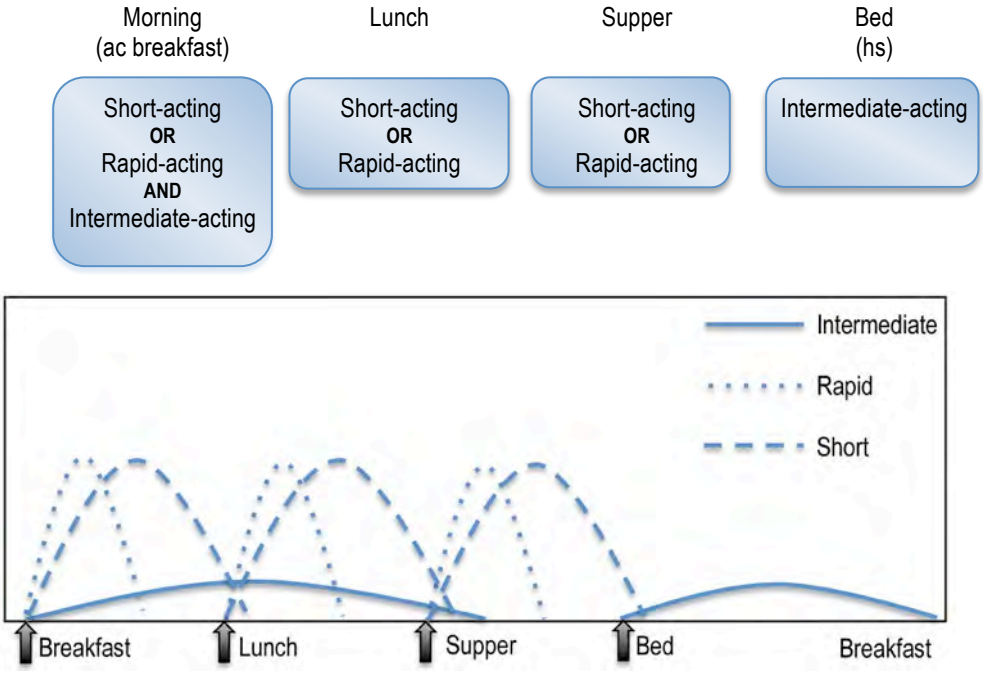
Advantages:

- Offers flexibility in meal size and timing.[1]
- Is easily understood by most clients because each period of the day has a defined insulin component.
- If using long-acting insulin analogue,* it is easily titrated to address fasting hyperglycemia with minimal risk of nocturnal hypoglycemia.

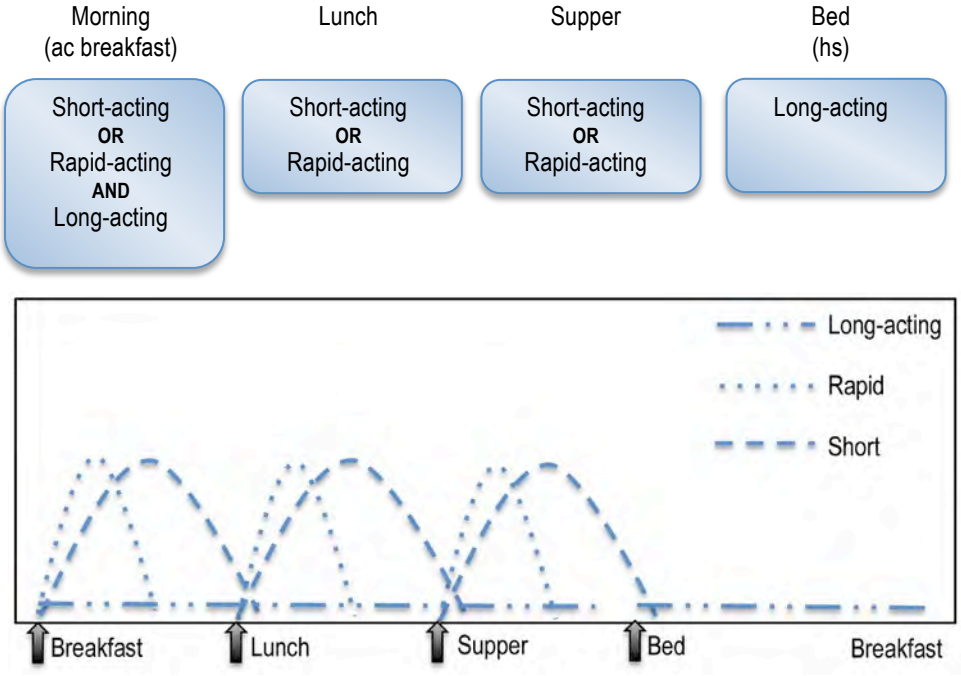
Note: If a syringe is being used to mix insulins, remind the client that the long-acting insulin analogues cannot be mixed with any other insulins.

*Insulin analogues are not recommended as first line insulin therapy for individuals with type 2 diabetes.

Example 1 — 4 to 5 injections per day

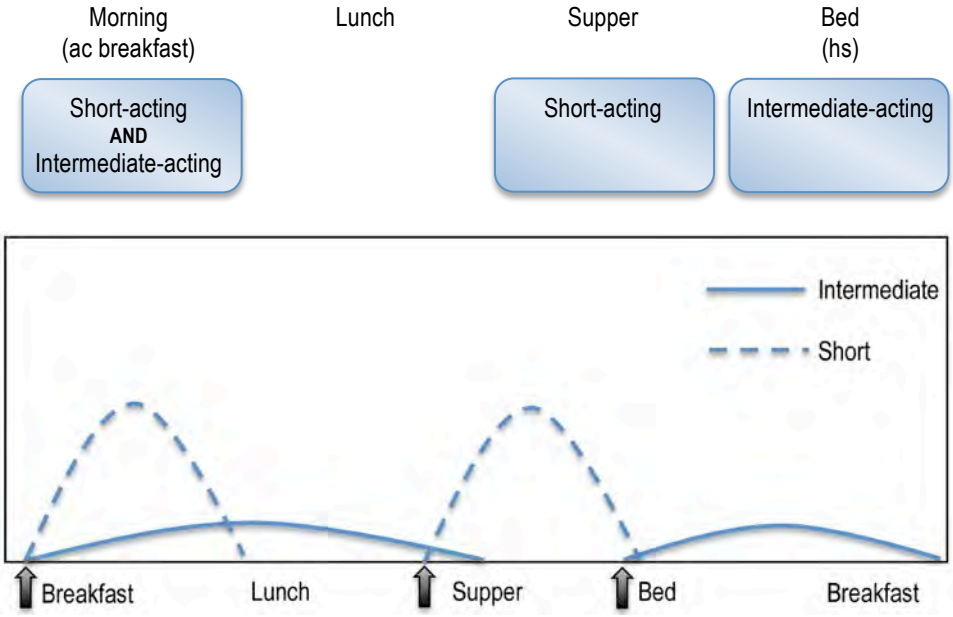


Example 2 — 4 to 5 injections per day



***Insulin analogues are not recommended as first line insulin therapy for individuals with type 2 diabetes.**

Example 3 — 4 to 5 injections per day



***Insulin analogues are not recommended as first line insulin therapy for individuals with type 2 diabetes.**

One (1) Injection a Day

Indications:

- Type 2 diabetes.
- Often in combination with non-insulin therapies.
- Not indicated for type 1 diabetes. May be effective for short periods of time during the honeymoon phase when residual insulin secretion is substantial, but is not recommended.

Advantages:

- Bedtime dosing may improve fasting BG control by suppressing nocturnal hepatic glucose production.

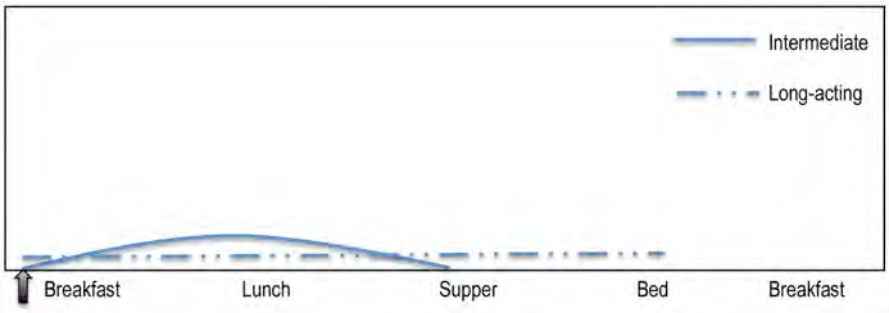
Disadvantages:

- Lack of flexibility dealing with before meal (prandial) or postprandial glucose.[1]

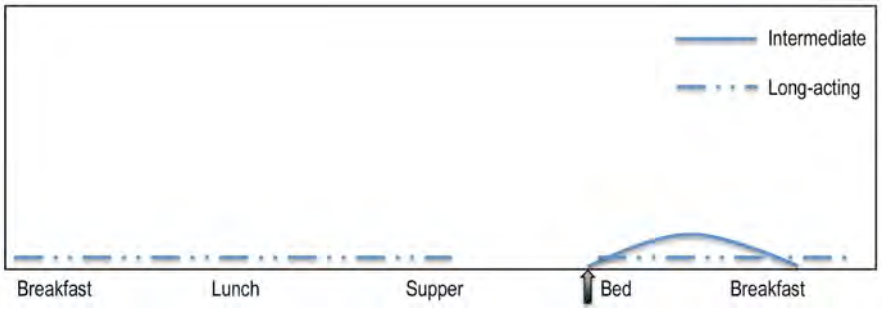
Examples

Morning (ac breakfast)	Lunch	Supper	Bed (hs)
Intermediate-acting **OR** Long-acting	**OR**		Intermediate-acting **OR** Long-acting

Morning dose



Bed dose



***Insulin analogues are not recommended as first line insulin therapy for individuals with type 2 diabetes.**

Two (2) Injections a Day

Indications:

- Type 2 diabetes.
- For clients with type 2 diabetes who are treated with one or more non-insulin therapies.
- To address late afternoon and early evening hypoglycemia for clients on bedtime (hs) insulin.
- For clients with type 2 diabetes who are changing from a single large dose to two injections a day.
- Adding a short- or rapid-acting insulin to an insulin analogue.

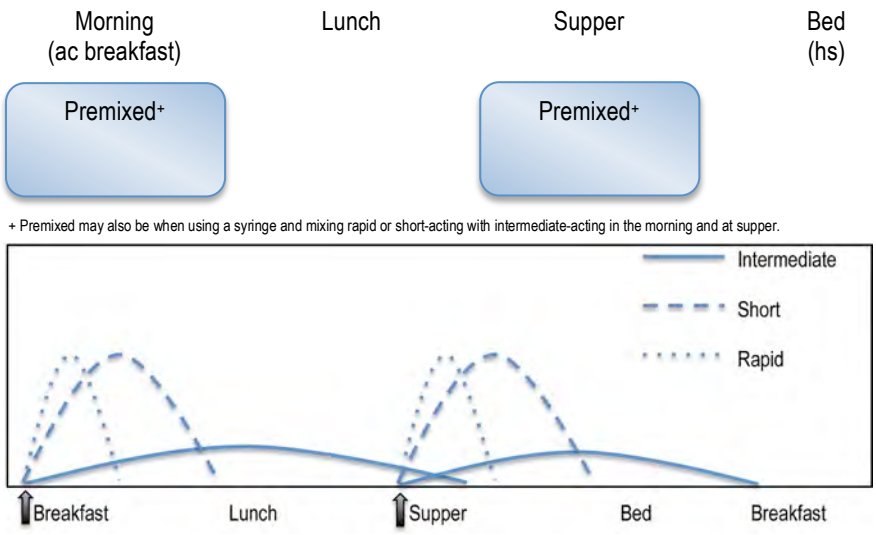
Advantages:

- Ability to try to gain better blood glucose control.
- Mealtime flexibility.

Disadvantages:

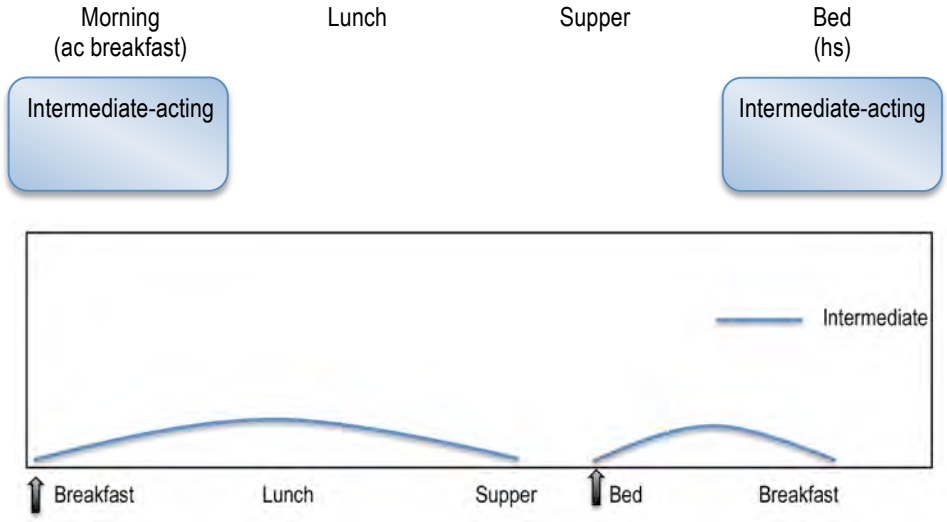
- Intermediate-acting insulin before supper may peak overnight causing nocturnal hypoglycemia and/or high fasting BG.[1]
- Inability to cover specific meal time excursions as demonstrated in examples 2 to 5.[1]

Example 1 — 2 injections per day

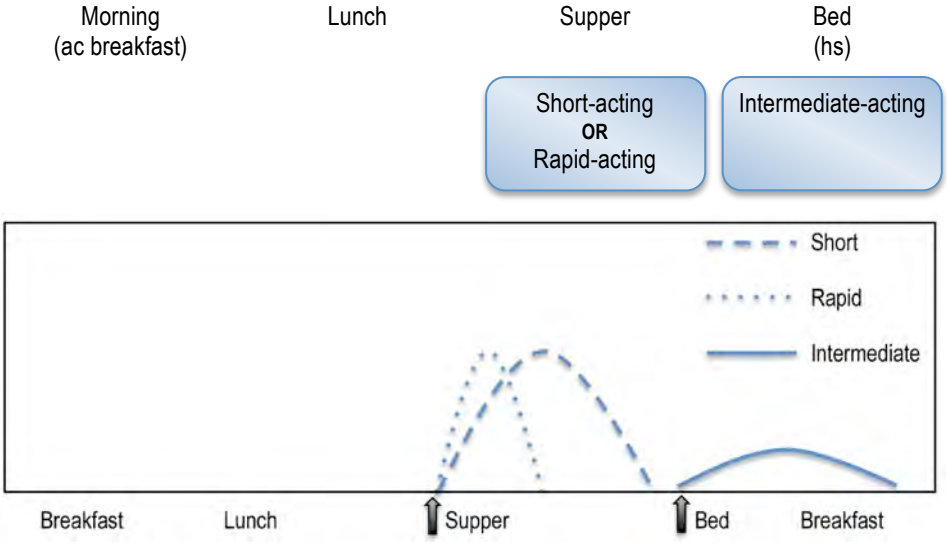


***Insulin analogues are not recommended as first line insulin therapy for individuals with type 2 diabetes.**

Example 2 — 2 injections per day

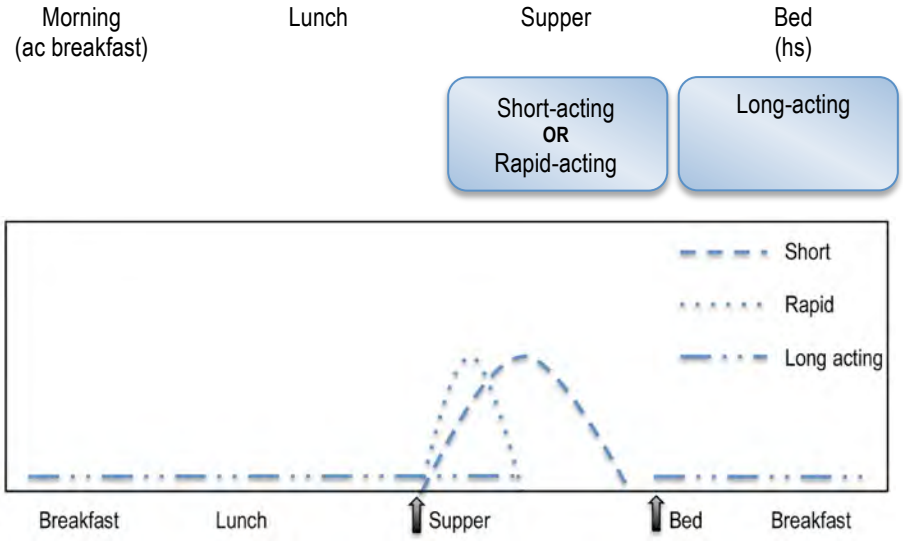


Example 3 — 2 injections per day

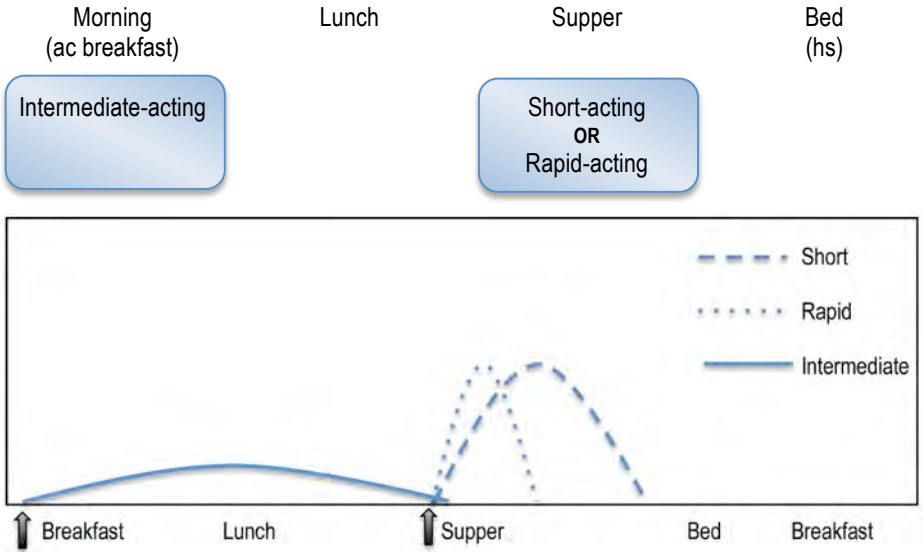


***Insulin analogues are not recommended as first line insulin therapy for individuals with type 2 diabetes.**

Example 4 — 2 injections per day



Example 5 — 2 injections per day



***Insulin analogues are not recommended as first line insulin therapy for individuals with type 2 diabetes.**

Three (3) Injections a Day

Indications:

- Type 2 diabetes.
- Generally, it is not possible to achieve near-normal glycemic levels in type 1 diabetes with three injections a day.

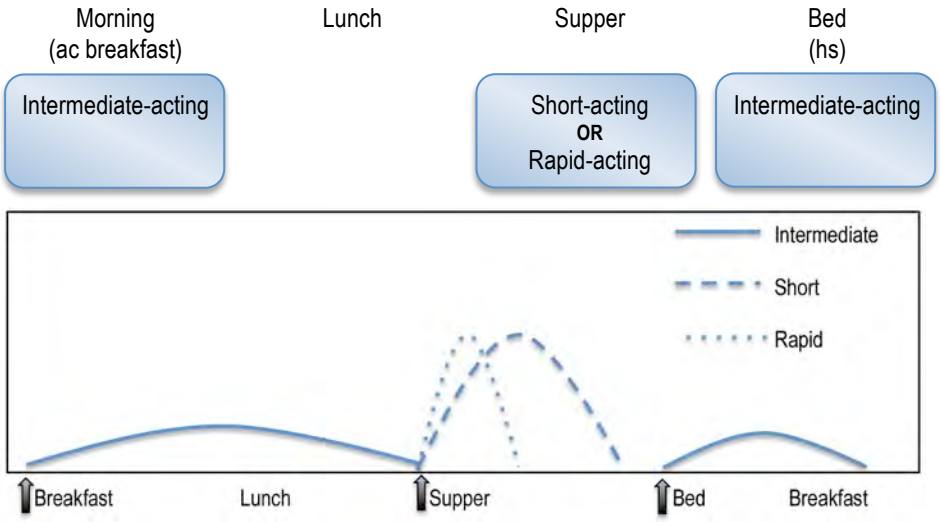
Advantages:

- Reduction in preprandial and postprandial hyperglycemia.
- Better glucose control overnight.[1]

Disadvantages:

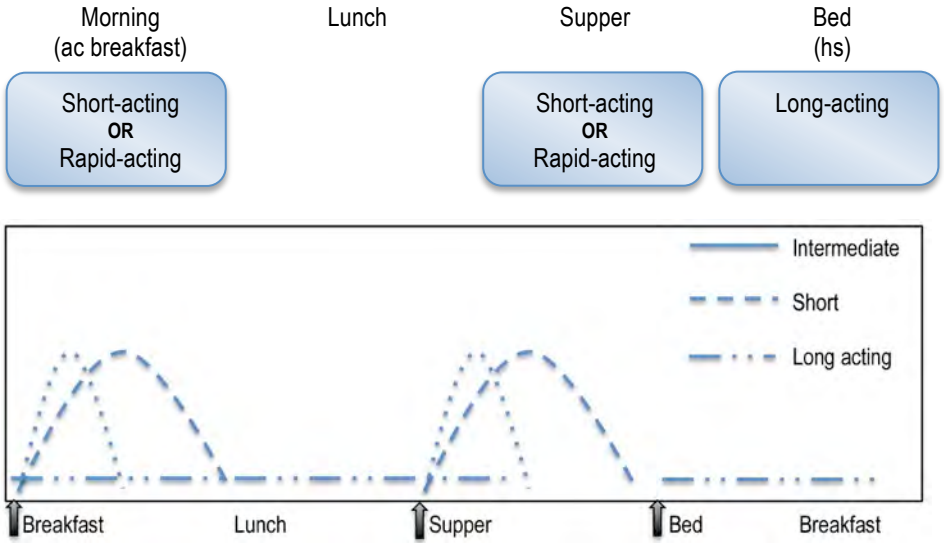
- If there is no insulin injected at noon then there is a lack of flexibility dealing with the effects of the noon meal, i.e., 2-hour pc lunch and ac supper.[1]

Example 1 — 3 injections per day

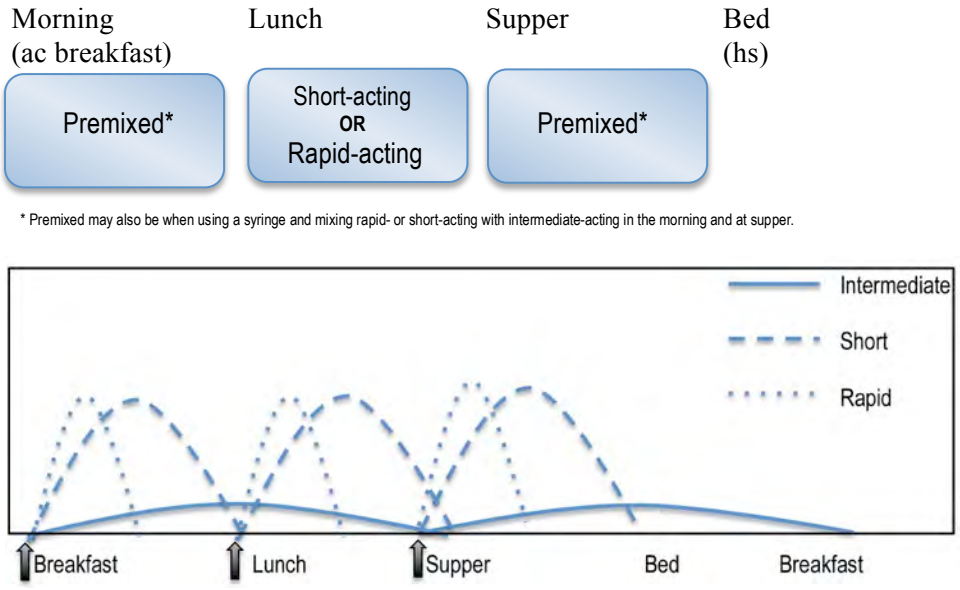


***Insulin analogues are not recommended as first line insulin therapy for individuals with type 2 diabetes.**

Example 2 — 3 injections per day



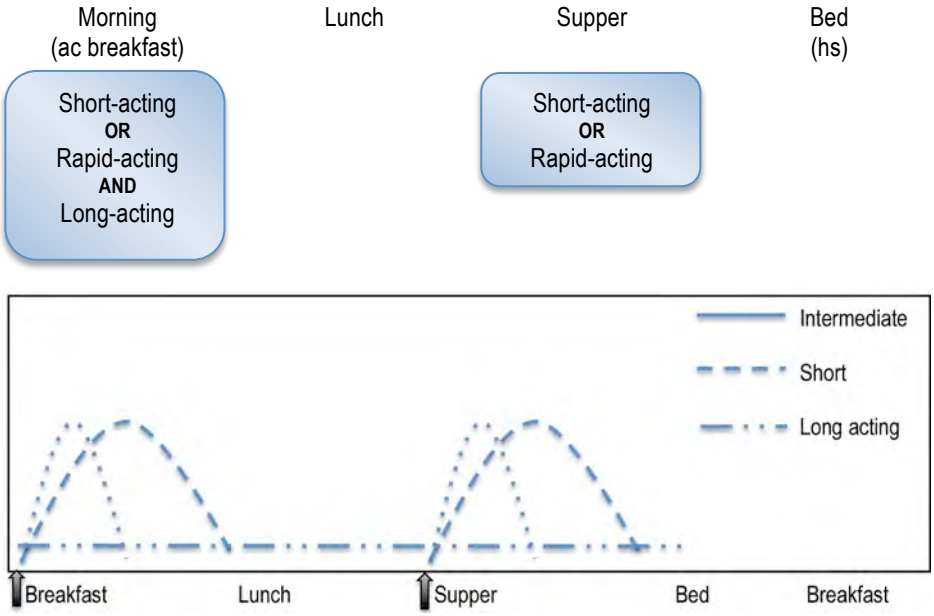
Example 3 — 3 injections per day



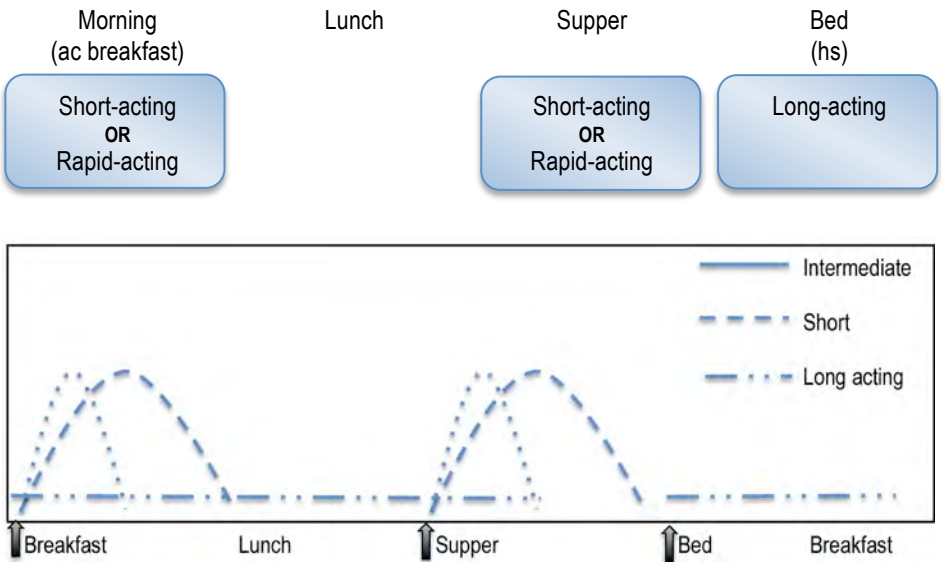
* Premixed may also be when using a syringe and mixing rapid- or short-acting with intermediate-acting in the morning and at supper.

***Insulin analogues are not recommended as first line insulin therapy for individuals with type 2 diabetes.**

Example 4 — 3 injections per day



Example 5 — 3 injections per day



***Insulin analogues are not recommended as first line insulin therapy for individuals with type 2 diabetes.**

COMBINATION THERAPY

Combination therapy involves the addition of insulin to non-insulin therapies.

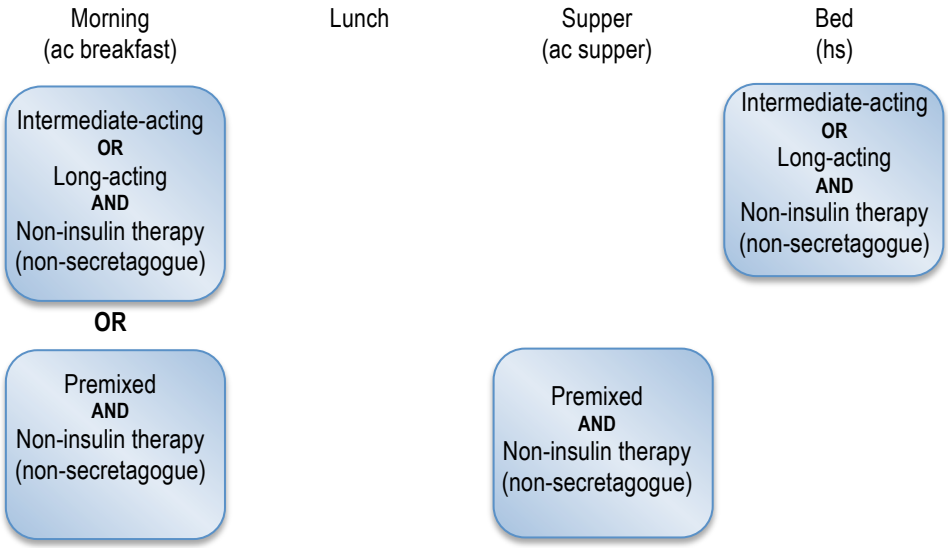
KEY POINTS

Individuals who might benefit from combination therapy are:

- Well-controlled type 2 diabetes clients on large doses of insulin (greater than 1 unit/kg of body weight).
- Individuals unable to achieve adequate control on non-insulin therapy alone.
- Benefits of combination therapy include:
  - Improved glycemic control with lower daily insulin requirements.[1-2]
  - Fewer insulin injections, at least initially. This often makes the transition and acceptance of insulin therapy easier for clients.
- The combination of non-insulin therapy and insulin has been shown to be an effective alternative for reaching blood glucose (BG) goals. Non-insulin therapy may help to control daytime BG levels, while bedtime insulin is used to suppress nocturnal hepatic glucose production and improve fasting BG levels.
- Non-insulin therapy, especially secretagogues, may need to be decreased during the day to prevent hypoglycemia when adding before meal (prandial) insulin.
- Combination therapy using metformin and insulin has been shown to result in less weight gain and fewer episodes of hypoglycemia than insulin alone or insulin in combination with secretagogues and is, therefore, the preferred combination (if there is no contraindication to metformin).[1-2]
- When insulin therapy is added to non-insulin therapy, the most widely-accepted insulin regimen is a single injection of intermediate-acting insulin with a starting dose of 10 units at bedtime.[2-4] However, it is also acceptable to have a starting dose of 0.1 to 0.2 units/kg of body weight[5] (e.g., for someone weighing 110 kg the starting dose could be 11 to 22 units). Before suggesting a dose, consider how elevated the BG levels are, and the symptoms, as well as the client's thoughts on hypoglycemia and starting insulin.
- If using premixed insulin in combination with non-insulin therapy, the recommended starting dose is 5 to 10 units administered once or twice daily pre-breakfast and/or pre-supper.[2] Alternatively, based on general clinical experience, a starting dose of 0.1 to 0.2 units/kg of body weight can also be used to calculate pre-breakfast and/or pre-supper doses.
- Dose adjustments of 2 units are made every three days to reach a target fasting BG. If fasting BG is greater than 10 mmol/L, larger increments (e.g., 4 units every three days) may be made.[5] (Alternatively, titrate insulin by 1 unit a day until target is reached.)[2]
- Special emphasis should be placed on increasing the bedtime insulin dose to normalize the fasting BG (versus adding additional insulin injections prior to achieving target fasting BG).[4]
- If BG levels remain elevated later in the day as compared to the fasting BG, a change in regimen to multiple doses of insulin needs to be considered.[6]
- The addition of non-insulin therapies to insulin therapy for the type 2 diabetes client with inadequate glycemic control, in spite of a large total daily insulin dose, may result in improved glycemic control. Be aware that insulin needs may decrease.
- Combining insulin with a thiazolidinedione (TZD) is not approved in Canada.[2] *See Section 4, Table 2A, page 183.*

Examples:

- Intermediate-acting insulin (morning or bedtime) plus non-insulin therapy.
- Long-acting* insulin analogue (morning or bedtime) plus non-insulin therapy.
- Premixed insulin (morning and/or supper) plus non-insulin therapy (e.g., non-secretagogues).



***Insulin analogues are not recommended as first line insulin therapy for individuals with type 2 diabetes.**

REFERENCES:

1. American Diabetes Association. *Medical Management of Type 2 Diabetes, 6th Edition.* Alexandria, VA: Author; 2008:73-75.
2. Canadian Diabetes Association Clinical Practice Guidelines Expert Committee. Canadian Diabetes Association 2013 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. *Can J Diabetes*. 2013;37(suppl 1).
3. Yki-Jarvinen H. Combination therapies with insulin in type 2 diabetes. *Diabetes Care*. 2001;24(4):758-767.
4. Holman RR, Thorne KI, Farmer AJ, et al. Addition of biphasic, prandial, or basal insulin to oral therapy in type 2 diabetes. *New England Journal of Medicine*. 2007;357(17)1716-1730.
5. Nathan DM, Buse JB, Davidson MB, et al. Management of hyperglycemia in type 2 diabetes: a consensus algorithm for the initiation and adjustment of therapy. *Diabetes Care*. 2006; 29:1963-1972.

RECOMMENDED READING:

- Canadian Agency for Drugs and Technologies in Health. *Optimal use recommendations for second and third-line therapy for patients with type 2 diabetes*. Ottawa: The Agency 2013. (CADTH optimal use report;vol.3, no.1d)
- Canadian Diabetes Association. *Building Competency in Diabetes Education: The Essentials 4th Edition*. Toronto, ON: Author; 2013.
- Inzucchi SE, Berggenstal RM, Buse JB et al. Management of hyperglycemia in type 2 diabetes: a patient-centered approach: position statement of the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). *Diabetes Care*. 2012 Jun;35(6):1364-79. Doi:10.2337/dc12-0413. Epub 2012 Apr 19.
- *Optimal Therapy Recommendations for Prescribing and Use of Insulin Analogues COMPUS*. May 2009 http://www.cadth.ca/media/pdf/compus_IA_OT_rec_report.pdf accessed December 2015.
- Walsh J, Roberts R, Varma C, Bailey T. *Using Insulin: Everything You Need for Success with Insulin*. San Diego, CA: Torrey Pines Press; 2006.

CASE STUDY - COMBINATION THERAPY

- In preparation for writing the DMF certification exam and using these guidelines in daily practice, the following case studies should be reviewed and discussed with your Medical Advisor or his/her designate.
- For each case study, read through the narrative and case study questions.
- To answer the questions, draw on your own knowledge and experience, see related section(s) in the manual, and see references and recommended readings.
- Read through the case study answer sheet, compare/contrast your answers, and review/discuss with your Medical Advisor or designate.

CASE STUDY 1: COMBINATION THERAPY

NARRATIVE:

Mrs. C. is a 60-year-old woman who has had type 2 diabetes for 10 years. She was originally started on Glucophage®, but glyburide was added two years ago because of persistent hyperglycemia. She follows her meal plan reasonably well, does housework daily, and goes bowling twice a week. She is starting to show proliferative retinopathy. She sees her ophthalmologist regularly, but she is very worried about losing her sight. She is having consistently elevated BG, especially ac breakfast. She was reluctant, but agreed to start insulin therapy. She was started on intermediate-acting insulin at bedtime and continued on her Glucophage® 1000 mg BID and Januvia® 100 mg daily. Glyburide was discontinued.

PHYSICAL AND LABORATORY FINDINGS:

- Present weight is 75 kg
- BMI is 28
- Most recent A1C is 8.2%
- Fasting BG is 13.8 mmol/L
- eGFR is 55 mL/min
- Blood pressure is 140/75 mm/Hg

CURRENT DIABETES MEDICATION:

- Intermediate-acting (IA) insulin 15 units at bedtime (75 kg x 0.2 units/kg = 15 units)
- Glucophage® 1000 mg BID
- Januvia® 100 mg daily

RECENT SMBG RESULTS:

DATE	BLOOD GLUCOSE					INSULIN				COMMENTS
	ac bkfst	ac lunch	ac supper	hs bed	other	B	L	S	hs bed	
May 1	11.0	7.0	5.4	6.8					IA 15 units	Bowling in afternoon.
May 2	10.6	8.2	6.8	8.7					IA 15 units	
May 3	11.9	6.4	7.8	7.3					IA 15 units	
May 4	12.1		7.5	7.0					IA 15 units	

CASE STUDY 1 COMBINATION THERAPY QUESTIONS:

1. What are the issues of most concern for this client?
2. What are the advantages of combination therapy for Mrs. C.?
3. What questions do you need to ask her today at her follow-up visit?
4. What recommendations for insulin adjustment would you make today? Include rationale.

CASE STUDY 1 ANSWER SHEET:

1. The areas of concern are:

- Poor glycemic control.
- Retinopathy; fear of losing sight.
- Reluctance to start insulin. Needs reinforcement and encouragement to understand importance of BG control to prevent further progression of retinopathy.
- Client's initial reluctance to give herself insulin; needs reassurance she can do this.

2. The advantages of combination therapy are as follows:

- Easier for her to accept insulin therapy with one injection a day; easier to learn.
- A pen device would be used which would be helpful if eyesight does deteriorate. She may be surprised at how convenient it is.
- Insulin at bedtime will target the fasting hyperglycemia.
- The combination of insulin and Glucophage® causes less weight gain than other combinations. She is already overweight. She can still tolerate biguanide and DPP-4 Inhibitor with a eGFR of 55mL/min.
- This combination therapy may cause fewer hypoglycemic episodes; she is moderately active, and we want to encourage continued exercise/physical activity. (If she had frequent lows, she might eat more [weight gain] or stop her exercise/physical activity routine.)

3. You need to ask the following questions:

- How is she getting along with insulin administration? Are there any concerns or problems?
- What exercise/physical activity has she done in the last few days?
- How well is she following her meal plan? Does she need time with the dietitian today?
- Any other causes of elevated results? Explore before adjusting insulin.

4. What recommendations would you make? Include rationale.

- Increase bedtime intermediate-acting insulin to 17 units. The first goal is to improve the fasting BG.
- Explore other exercise/physical activity possibilities; for example, a walk after breakfast.
- Continue to adjust the dose by 2 units every three to four days until fasting BG has improved. An alternative would be to increase the dosage of intermediate-acting insulin by 1 unit every night until her fasting BG is in target. Early in therapy, the focus should be on improving fasting BG. Involve Mrs. C. in problem solving and making decisions regarding insulin adjustments. The goal is to empower the client to self-manage and to safely self-adjust the dose to the best of her ability.

PATTERN MANAGEMENT

Pattern management is defined as making changes to an insulin dose based on two to three days' worth of consistently fluctuating (high or low) blood glucose (BG) results occurring at the same time each day when everything else is the same (e.g., activity, food and injection sites).

BASIC STEPS

- Set and clarify target BG goals with client.
- Ensure accuracy of SMBG results with periodic assessment of client's technique, lab/meter comparison, and A1C.
- Ensure a plan is in place for reasonably consistent carbohydrate (CHO) intake and physical activity levels while dose adjustments are being made.
- Have client monitor BG ac meals and at bedtime. Insulin adjustments are initially made on preprandial results. Test overnight (0300 hours) to assess changes to bedtime insulin or to rule out nocturnal hypoglycemia after exercise.
- When a short-acting insulin or rapid-acting insulin analogue is used, postprandial (2-hour pc) BG monitoring will help fine-tune mealtime insulin dose. (Note: 1-hour pc SMBG is used in relation to pre-conception and pregnancy care.)
- Fingertip testing (rather than alternate site testing) is preferred after meals, when medication action is peaking, after exercise/physical activity, and during hypoglycemia.[1]
- Assess patterns or trends of BG results over at least two to three days.
- Consider other factors that may be causing the pattern:
  - Food intake
  - Over-treatment of hypoglycemia
  - Activity level (e.g., seasonal)
  - Too much or too little insulin
  - Menstrual cycle
  - Timing of injections
  - Presence of illness/infection
  - Alcohol intake
  - Injection sites and rotation
  - Accuracy of meter and strips
  - Insulin storage
  - Improper use of insulin delivery device
  - Medications (i.e., niacin, steroids, chemotherapy, etc.)
- Identify the insulin that has the greatest effect on the BG pattern/trend.

If the diabetes educator certified in insulin dose adjustment feels changes in the insulin regimen are indicated, such as number of injections or type of insulin, this should be done in collaboration with the referring physician.

- Adjust appropriate insulin by 1 to 4 units or to a maximum of 10 to 15% of the total daily dose (TDD). Adjust insulin by smaller doses to avoid sudden changes in BG levels when BG is close to target. Adjust by larger increments when hyperglycemia is present.
- Usually change only one insulin at a time.
- If both hypoglycemia and hyperglycemia are present, adjust for hypoglycemia first. If all BG results are comparably elevated, usually start with adjusting for the fasting BG.
- In some cases, it may be appropriate to adjust more than one insulin dose simultaneously. E.g., if breakfast and supper BG levels are high at the same time, than the intermediate-acting insulin could be increased at breakfast and nighttime.

It is essential that individuals understand pattern management before progressing to more advanced insulin dose adjustment.

- Consider all BG results that may be affected by the dose adjustment.
- Leave the change for two to three days to see how the peaking insulin will affect the current patterns. If results remain very elevated during this time, the client should be instructed to contact the physician/diabetes educator.
- Arrange follow-up to review SMBG results in three to four days. Advise the client or family to call sooner if he/she is experiencing frequent hypoglycemic reactions or has other concerns. (According to local policy, telephone, fax, e-mail or office visits can be used to communicate results/ adjustments.)
- Most clients should be instructed in insulin dose adjustment.
- Discuss rationale for all dose adjustments, and use guided problem solving to promote understanding and support client learning.
- Continue dose adjustments until BG levels are in the target range.
- Follow-up intervals may lengthen as SMBG results reach target and/or the client becomes proficient at adjusting his/her own insulin.

REFERENCES:

1. Canadian Diabetes Association Clinical Practice Guidelines Expert Committee. Canadian Diabetes Association 2013 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. *Canadian Journal of Diabetes*. 2013;37(suppl 1):S1-212.

RECOMMENDED READING:

- Braithwaite S. Case Study: Five steps to freedom: dose titration for type 2 diabetes using basal-prandial-correction insulin therapy. *Clinical Diabetes*. 2005;23(1):39-43.
- Canadian Diabetes Association. *Building Competency in Diabetes Education: The Essentials 4th Edition*. Toronto, ON: Author; 2013.
- Walsh J, Roberts R, Varma C, Bailey T. *Using Insulin: Everything You Need for Success with Insulin*. San Diego, CA: Torrey Pines Press; 2003.
- Inzucchi, S., Berganstal, R.M., Buse, J.B., Diamant, M. ADA, Management of Hyperglycemia in Type 2 Diabetes: A patient centered approach. Position statement of the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). *Diabetes Care*, 2012;35,(6):1364-1379.
- Kramer C, Zinman B and Retnakaran R. Short term intensive insulin therapy in type 2 diabetes management. A systematic review and meta-analysis. *The Lancet* 2013; http://dx.doi.org/10.1016/S2213-8587(13)70006-8. Accessed December 2015.

SUPPLEMENTAL DOSE ADJUSTMENT

Supplements are temporary insulin adjustments to the rapid- or short-acting insulin dose to compensate for hyperglycemia or hypoglycemia:

Hyperglycemia – Usual insulin dose is increased.

Hypoglycemia – Usual insulin dose is decreased.

There are two types of supplemental adjustments:

Compensatory – Adjustment to correct for an immediate high or low BG result. Compensate.

Anticipatory – Adjustment in advance of planned exercise/physical activity or food intake. Anticipate.

COMPENSATORY DOSE ADJUSTMENTS

- A variable insulin dose algorithm can be developed to guide a client in making compensatory insulin dose adjustments. Clients should be involved in the development of the algorithm as it will not be the same for everyone.
- Algorithms should be developed after pattern management is established.

Tips For Constructing A Variable Insulin Dose Algorithm

- Consider the client's target range for BG control.
- Consider the client's willingness and ability to use a variable insulin dose algorithm.
- Ensure variable dose adjustments are made in conjunction with pattern management adjustments.
- Consider the client's sensitivity to rapid- or short-acting insulin. Sensitivity varies from person to person.
- Construct the algorithm conservatively; i.e., err on the side of hyperglycemia initially.
- Calculate the client's insulin sensitivity factor (ISF). *See Calculating the Insulin Sensitivity Factor (ISF) or Correction Factor, page 49.*
- The ISF (or Correction Factor) is defined as the glucose lowering effect of 1 unit of insulin over 2 to 4 hours.
- Usually an additional 1 unit of insulin is needed for every 2 mmol/L increase in BG. Algorithms may be designed to fit each individual's needs (i.e., in increments of 1 to 3 units or more). This can vary significantly based on type of diabetes, level of physical activity, or client's weight.
- In most cases, limit the total amount of additional rapid- or short-acting insulin to 5 or 6 units in the algorithm or not more than 10% TDD.
- Algorithms are usually applied at times when the client routinely takes rapid- or short-acting insulin (i.e., ac meals).
- Calculating an effective variable insulin dose algorithm is a process of trial and error and will take time.
- Evaluate for effectiveness and revise as necessary.

Calculating the Insulin Sensitivity Factor (ISF) or Correction Factor[1,2,3]

The ISF formula provides an estimated starting point only. It will need to be individualized and modified based on the client's results.

- The ISF formula provides an estimated starting point only. It will need to be individualized and modified based on the client's SMBG results and insulin dose records (past and present).
- ISF estimates the drop in BG (mmol/L) per unit of rapid- or short-acting insulin over 2 to 4 hours.
- ISF is calculated by dividing the TDD into 100 when using rapid-acting insulin or into 83 when using short-acting insulin.

ISF = $\frac{100}{TDD}$ (rapid-acting insulin) **ISF = $\frac{83}{TDD}$ (short-acting insulin)**

- It is possible to have more than one ISF; e.g., a higher sensitivity number overnight for clients with a history of hypoglycemia unawareness or nocturnal hypoglycemia, as well as setting higher BG target values overnight. Similarly, clients may have a lower ISF at breakfast due to dawn phenomenon.
- The lower the ISF number, the more insulin is given for a correction dose.
- Adjustments may be required during puberty, weight change, physical activity, and illness.

Example:

Sarah is a 24-year-old woman with type 1 diabetes. She takes the following:

Before breakfast:	Intermediate-acting insulin	10 units
	Rapid-acting insulin	6 units
Before lunch:	Rapid-acting insulin	5 units
Before supper:	Rapid-acting insulin	5 units
At bedtime:	Intermediate-acting insulin	8 units
TOTAL DAILY DOSE (TDD)		**34 units**

Her target BG is 4 to 7 mmol/L ac meals. Sarah's TDD is 34 units, and **she uses rapid-acting insulin**.

Sarah's ISF is $\frac{100}{34}$ = 2.9 mmol/L (3 mmol/L)

That is, 1 unit of rapid-acting insulin will lower her BG by approximately 3 mmol/L over 2 to 4 hours.

If Sarah was using short-acting insulin:

Sarah's ISF would be $\frac{83}{34}$ = 2.4 mmol/L (2 mmol/L)

That is, 1 unit of short-acting insulin would lower her BG by approximately 2 mmol/L over 2 to 4 hours.

Sarah's starting algorithm using rapid-acting (RA) insulin is below. Her variable insulin dose algorithm would need to be revised based on her SMBG results.

IA = Intermediate-acting RA = Rapid-acting

BG (mmol/L)	Basal Insulin	Bolus Insulin				Basal Insulin
		Breakfast (B)	Lunch (L)	Supper (S)	Snack/hs	
≤ 4.0		-1	-1	-1		
4.0 to 7.0 (Target)	IA 10 units (AM)	RA 6 units	RA 5 units	RA 5 units	RA*	IA 8 units (hs)
8.0 to 11.0		+1	+1	+1		
11.1 to 14.0		+2	+2	+2		
14.1 to 17.0		+3	+3	+3	1	*Check ketones*
17.1 to 20.0		+4	+4	+4	2	*Check ketones*
≥ 20.0		+4	+4	+4	2	*Check ketones*

* *Use of rapid-acting insulin at bedtime is not usually recommended because of the risk of nocturnal hypoglycemia. However, a conservative supplement for excessively elevated BG readings at bedtime is sometimes used.*

ANTICIPATORY DOSE ADJUSTMENTS

- CHO counting (calculating the insulin-to-CHO ratio) is the most common method used for making anticipatory dose adjustments for planned exercise/physical activity or food intake.
- Insulin-to-CHO ratios enable a person to adjust insulin doses according to how much CHO will be eaten. This allows for more flexible insulin therapy and is one of the many benefits of switching to multiple daily injections.
- It is important for the client to maintain a reasonably consistent CHO intake while determining the insulin-to-CHO ratio, as it will help to establish the ratio per meal more accurately.
- The usual insulin-to-CHO ratio in adults is 1 unit of insulin per 10 to 15 grams CHO, but must be individualized.[4]
- If short-acting insulin is used, CHO counting includes all CHO consumed within a meal period. A meal period includes meals plus any snacks before the next meal.[2,5]
- If rapid-acting insulin is used, CHO counting includes all CHO consumed at the meal. An injection before snacks may be required if the CHO content is significant. This is individualized.
- To match the insulin dose and CHO intake as accurately as possible, the insulin-to-CHO ratio is used for pre-meal times only.
- A wide range of insulin-to-CHO ratios is possible, depending on the client's sensitivity to insulin.

Insulin-to-CHO ratios vary from person to person and may differ from meal to meal in the same individual.

- Insulin-to-CHO ratio effectiveness is verified by 2-hour pc BG testing (or 1-hour pc testing during pregnancy or pre-conception).
- It is best to check the 2-hour pc meal for carbohydrate accuracy when the pre-meal glucose is at target.

Calculating the Insulin-to-CHO Ratio [2]

To calculate the insulin-to-CHO ratio, divide the total grams of CHO (minus fiber) in the meal by the number of units of insulin to be taken.

$$\frac{\text{\# grams of CHO/meal}}{\text{\# units of insulin}} = \text{Insulin-to-CHO Ratio}$$

Example:

Luke's breakfast has a total CHO content of 65 grams. He also has a morning snack containing 25 grams. He takes 6 units of short-acting insulin before breakfast. To determine the insulin-to-CHO ratio:

$$\frac{\text{\# grams of CHO/meal (plus snack)}}{\text{\# units of insulin}} = \frac{65 + 25}{6} = \frac{90}{6} = 15$$

Luke's insulin-to-CHO ratio is 1 unit of insulin to 15 grams of CHO.

This is confirmed by a 2-hour pc BG within target range.

Calculating the Insulin Dose Using CHO Counting [1,2]

To use the insulin-to-CHO ratio to determine an insulin dose, a rule of thumb is to assume 1 unit of insulin for every 10 to 15 grams of CHO; and use the following equation:

$$\frac{\text{\# grams of CHO/meal}}{\text{grams CHO per 1 unit insulin}} = \text{Insulin Dose}$$

Example:

Betty's breakfast has a total CHO content of 56 grams, including 5 grams of fiber. She does not have a morning snack. Using the insulin-to-CHO ratio of 1 unit of insulin/10 grams CHO, calculate the amount of insulin she needs to take to cover the CHO in her breakfast.

56 grams – 5 grams = 51 grams

$$\frac{\text{51 grams CHO/meal}}{\text{1 unit insulin/10 grams CHO}} = \frac{51}{10} = \text{5.1 units (5 units)}$$

Betty would take 5 units of rapid- or short-acting insulin to cover the CHO in her breakfast, which would be verified by BG in target range 2 hours pc or ac the next meal.

REFERENCES:

1. Walsh J, Roberts R, Varma C, Bailey T. *Using Insulin: Everything You Need for Success with Insulin*. San Diego, CA: Torrey Pines Press; 2003.
2. Canadian Diabetes Association, *Building Competency in Diabetes Education: Advancing Practice 3rd Edition*. Toronto, ON: Authors; 2014
3. Walsh J, Roberts R. *Pumping Insulin: Everything you need for success on an Insulin Pump + a new chapter on CGMs, 5th Edition*. San Diego, CA: Torrey Pines Press; 2013
4. American Association of Diabetes Educators. *A Core Curriculum for Diabetes Education, 5th edition*. Chicago, IL: Author; 2003.
5. Jones H, ed. *Guidelines for Insulin Dose Adjustments: Policies, Indications, Competencies*. Toronto, ON: Leadership Sinai Centre for Diabetes, Mount Sinai Hospital; 2004.

RECOMMENDED READING:

- Pearson J, Bergenstal R. Fine-tuning control: pattern management versus supplementation. *Diabetes Spectrum*. 2001;14(2):75-78.
- Nathan D, Buse J, Davidson M, et al. Medical management of hyperglycemia in type 2 diabetes: a consensus algorithm for the initiation and adjustment of therapy. *Diabetes Care*. 2009,Vol 32 no.1,193-203.
- Home P, Riddle M, Cefalu WT, et al. Insulin therapy in people with type 2 diabetes: opportunities and challenges. *Diabetes Care*. 2014; 37(6);1499-1508.

CHANGING TO INTENSIVE DIABETES THERAPY

Intensive insulin therapy is the matching of insulin dosing to food, activity and life events with individual adjustments to insulin regimens.[1]

KEY POINTS

- Intensive diabetes therapy includes a basal/bolus insulin regimen of multiple daily injections (MDI). The Diabetes Control and Complications Trial (DCCT), along with the follow-up study Epidemiology of Diabetes Interventions and Complications (EDIC), clearly demonstrated that successful intensive diabetes therapy substantially reduced the development and/or progression of long-term microvascular complications in type 1 diabetes.[2,3] The United Kingdom Prospective Diabetes Study (UKPDS) showed a 25% risk reduction in microvascular endpoints with more intensive therapy for type 2 diabetes.[4]
- Safe and effective implementation of intensified diabetes therapy requires that the client is willing and able to actively participate in treatment and problem solving and that there is a trained and motivated diabetes health care team (HCT) to provide the client with the necessary education, skills, and support needed.
- The benefit of intensive control is likely to be minimal for the frail elderly.[5]
- Key elements of intensive diabetes therapy include the following:
  - The use of four or more daily insulin injections or insulin pump therapy (basal-bolus regimen)
  - Frequent SMBG up to 3 to 4 times a day
  - Individualized target BG levels
  - Careful balance of food intake, activity, and insulin dose
  - Self-adjustments of food intake, insulin dose, and use of insulin
  - Frequent contact with the diabetes HCT concerning diabetes management (initially)
  - Education on how to do intensive therapy
  - Psychological support
  - Development of mutually negotiated goals for health and diabetes self-care
  - Regular objective assessment of A1C, SMBG records, and frequency/severity of hypoglycemia and adjustment of goals/plan based on this information
- With intensive MDI regimens, the insulin dose is divided into basal and bolus injections. Generally, 40 to 60% of the TDD provides the basal insulin, and the remainder is divided into bolus doses to match food intake.[5]
- When switching to MDI, it is imperative to review the client's previous experience/history with response to insulin (i.e., insulin sensitivity), as any change in insulin therapy must be individualized. *See Supplemental Dose Adjustment, page 48*.
- When switching from intermediate-acting insulin once daily to a long-acting insulin analogue, the number of units of insulin should remain the same.
- When switching from intermediate-acting insulin twice daily to a long-acting insulin analogue, the number of units should be decreased by 20%.
- Increased frequency of SMBG ac and 2-hour pc meals for the first one to two weeks is recommended when switching to MDI regimens.

- A continuous glucose monitoring (CGM) system can be used as a clinical tool to fine-tune insulin therapy in select clients. Potential benefits of CGM include the identification of hypoglycemic unawareness or overnight hypoglycemia as well as the ability to discern the glycemic effect of meals, exercise/physical activity, insulin, medications, and stress. This information can then be used for individual analysis, interpretation, and regimen changes to help improve and/or maintain optimal glycemic control.

CALCULATING BASAL AND BOLUS REQUIREMENTS

Step 1: Calculate the TDD of insulin

These formulas provide an estimate of the starting insulin requirements only. They will need to be individualized and modified based on SMBG results.

- Add the sum of all current insulin doses and reduce by 10 to 25%.

Current TDD - 10 to 25% = <u>New TDD</u> (usual reduction is 20%)

OR

- Reduce basal by 10 to 25% and boluses by 10 to 25% if not using insulin-to-CHO ratios.

Step 2: Calculate basal insulin requirements

- Basal requirement = 40 to 60% of new TDD which can be given as:
  - Intermediate-acting insulin divided into ac breakfast and bedtime or bedtime only.
  - Long-acting insulin analogue (glargine; detemir) once a day.
  - Basal (units/hour) with Continuous Subcutaneous Insulin Infusion (CSII).

Increased frequency of SMBG ac meals, and 2-hours pc for the first 1 to 2 weeks is recommended when switching to MDI regimens.

(If there is a fear of hypoglycemia or actual hypoglycemic events err on the side of caution and use 40%. If BG levels are elevated, use 60%.)

Step 3: Calculate bolus (meal) requirements

- Total bolus (meal) requirements = TDD - basal insulin

There are several ways to determine pre-meal boluses of rapid- or short-acting insulin such as the following: (A or B or C)

A) Determined as a percentage of the TDD depending on the meal size/composition.
   - 15 to 25% TDD ac breakfast
   - 10 to 20% TDD ac lunch
   - 15 to 20% TDD ac supper

Based on the formula used, there may be some slight variation in individual doses when switching to MDI. Again, doses will be fine-tuned based on SMBG results.

B) Determined as a percentage of the total **<u>meal</u>** doses (TMD)
   - 35% TMD ac breakfast
   - 30% TMD ac lunch
   - 35% TMD ac supper

C) Determined by calculating the insulin-to-CHO ratio for each meal using CHO counting. The usual adult insulin-to-CHO ratio is 1 unit of insulin to 10 to 15 grams of CHO, but it must be individualized. *See Calculating the Insulin-to-CHO Ratio, page 51.*

Example:

Client's current dose is: Intermediate-acting 30 units and short-acting 10 units ac breakfast.
Intermediate-acting 20 units and short-acting 8 units ac supper.
Fear of hypoglycemia exists.

Step 1: **Current TDD = 30 + 10 + 20 + 8** **= 68 units**

Current TDD – 20% = New TDD
= 68 – [(68 x 0.20) = 13.6 (14 units)]
= 68 – 14

New TDD **= 54 units**

Step 2: **Basal requirements** = 40 to 60% of New TDD
= 0.40 x 54 = 21.6 (22 units)

Basal requirements **= 22 units**

Step 3: **Bolus (meal) requirements** = TDD – Basal insulin
= 54 – 22

= 32 units

A) **Determined as percentage of TDD**

25% TDD ac breakfast	= 0.25 x 54	= 14 units ac breakfast
15% TDD ac lunch	= 0.15 x 54	= 8 units ac lunch
20% TDD ac supper	= 0.20 x 54	= 11 units ac supper
	Total Bolus	**= 33 units**

OR

B) **Determined as percentage TMD**

35% TMD ac breakfast	= 0.35 x 32	= 11 units ac breakfast
30% TMD ac lunch	= 0.30 x 32	= 10 units ac lunch
35% TMD ac supper	= 0.35 x 32	= 11 units ac supper
	Total Bolus	**= 32 units**

OR

C) **Determined by calculating insulin-to-CHO ratio**.

REFERENCES:

1. Canadian Diabetes Association *Building Competency in Diabetes Education: Advancing Practice 3rd Edition*. Toronto, ON: Author; 2014.
2. The Diabetes Control and Complications Trial Research Group. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin dependent diabetes mellitus. *New England Journal of Medicine*. 1993;329:977-986.
3. The Epidemiology of Diabetes Interventions and Complications (EDIC). *New England Journal of Medicine*. 2005;353(23)353(25).
4. UK Prospective Diabetes Study (UKPDS) Group. Intensive blood glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). *Lancet*. 1998;352:837-853.
5. Canadian Diabetes Association Clinical Practice Guidelines Expert Committee. Canadian Diabetes Association 2013 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. *Canadian Journal of Diabetes*. 2013;37(suppl 1):S1-212.

RECOMMENDED READING:

- Canadian Diabetes Association. *Building Competency in Diabetes Education: The Essentials 4th Edition*. Toronto, ON: Author; 2013.
- Optimal Therapy Recommendations for the Prescribing and Use of Insulin Analogues. COMPUS May 2009. https://www.cadth.ca/media/pdf/compus_IA_OT_rec_report.pdf. Accessed December 2015.
- Walsh J, Roberts R, Varma C, Bailey T. *Using Insulin: Everything You Need for Success with Insulin*. San Diego, CA: Torrey Pines Press; 2003.

CASE STUDIES - CHANGING TO INTENSIVE DIABETES THERAPY

- In preparation for writing the DMF certification exam and using these guidelines in daily practice, the following case studies should be reviewed and discussed with your Medical Advisor or his/her designate.
- For each case study, read through the narrative and case study questions.
- To answer the questions, draw on your own knowledge and experience, see related section(s) in the manual, and see references and recommended readings.
- Read through the case study answer sheet, compare/contrast your answers, and review/discuss with your Medical Advisor or designate.

CASE STUDY 1: CHANGING TO INTENSIVE DIABETES THERAPY

NARRATIVE:

Jamie C. is a 32-year-old male who has had type 1 diabetes for 20 years. His last visit to a DC was 8 years ago. He has not seen an endocrinologist since he last attended a pediatric facility 14 years ago. Recently, Jamie has been diagnosed with hypertension, renal disease, and dyslipidemia. Upon referral to the endocrinologist, his history reveals that Jamie usually feels his hypoglycemic episodes; and he has become increasingly concerned about his ac breakfast values (variable lows and highs; a possible indication of nocturnal hypoglycemia). He did require paramedic intervention for a severe hypoglycemic episode after supper in the past year. His wife is supportive of measures to improve diabetes management.

PHYSICAL AND LABORATORY FINDINGS:

- Present weight is 85.1 kg
- Most recent A1C is 8.6%
- Blood pressure is 110/70 mm/Hg

CURRENT DIABETES MEDICATION:

- Intermediate-acting insulin 26 units; short-acting insulin 16 units ac breakfast
- Intermediate-acting insulin 15 units; short-acting insulin 14 units ac supper

RECENT SMBG RESULTS:

DATE	BLOOD GLUCOSE					INSULIN				COMMENTS
	ac bkfst	ac lunch	ac supper	hs bed	other	B	L	S	hs bed	
April 10	3.0	4.1	12.1	2.0		IA 26 units SA 16 units		IA 15 units SA 14 units		
April 11	17.9	9.4	6.3	3.1						
April 12	4.0	17.6	2.0	21.1						
April 13	14.0	20.2	3.2	7.0						

CASE STUDY 1 CHANGING TO INTENSIVE DIABETES THERAPY QUESTIONS:

1. The attending endocrinologist/internist orders a more intensive (MDI) regimen for Jamie using a long-acting analogue and a rapid-acting analogue. What would you need to discuss and/or review with Jamie to prepare him for a more intensive insulin regimen?

2. What would be important to consider for Jamie before switching to MDI?

3. Jamie is now ready to switch to MDI following adequate preparation by his diabetes HCT.
   a) Briefly define the terms basal and bolus (meal) insulin requirements in intensive insulin regimens.
   b) For each step, provide the rationale for the method used as well as the calculation.

      Step 1: Determine the TDD to be used.

      Step 2: Provide the calculations and rationale in determining basal insulin requirements.

      Step 3: Determine the pre-meal doses by using the insulin-to-CHO ratio method. The following CHO composition for each meal/snack has been calculated from Jamie's meal plan:

Breakfast	**Lunch**	**Supper**	**Bedtime Snack (hs)**
135 grams	120 grams	150 grams	30 grams

   c) What recommendations would you give Jamie as he begins his MDI regimen?

4. In the future, an insulin algorithm may be developed (this will assist Jamie to further enhance his glycemic control).
   a) What should be considered before proceeding?
   b) Construct an algorithm for Jamie. Show appropriate calculations.

CASE STUDY 1 ANSWER SHEET:

1. In preparation, Jamie must be aware of the rationale for promoting intensive therapy. Discuss the following key points:

- A MDI regimen is designed to help achieve normal or near-normal BG levels by attempting to mimic physiologic insulin.
- What the key elements of MDI are and if he has any concerns/questions.
- Intensive diabetes therapy, resulting in improved control, substantially reduces (39% to 76%) the development and/or progression of long-term microvascular complications in type 1 diabetes. It is especially important for Jamie who has recently learned that he has developed renal disease. MDI may slow progression.
- Jamie will be able to be an active participant in the planning and implementation of his MDI regimen.
- His wife is supportive.

2. Important considerations include:

- Does Jamie have extended health insurance for the increased cost of insulin analogues and BG monitoring strips for the additional SMBG? (*See section 4, Table 1A, page 177*.)
- Current knowledge/understanding of insulin, time action, injection sites, rotation of sites, etc.
- Frequency/severity of hypoglycemia - signs and symptoms, causes, and treatment.
- Present frequency of SMBG and record keeping.
- Individualized target BG levels.
- Motivation and willingness to follow through and work with the diabetes HCT.
- Frequency of contact between Jamie and the diabetes HCT.
- Cognitive and/or physical challenges.
- Psychological/socio-economic supports needed.
- Education re: effective intensive therapy (e.g., CHO counting, insulin-to-CHO ratio, etc.).
- Regular objective assessment of A1C and SMBG records.
- Time required for adequate preparation.
- Meal plan review for health concerns.

3a. Basal dose insulin refers to the intermediate-acting insulin BID or long-acting insulin analogue given as one dose (usually at bedtime) or BID. This helps to sustain optimal glycemic control in conjunction with the insulin dosing associated with the meal period.

Bolus (meal) requirements see the amount of rapid- or short-acting insulin given as a pre-meal bolus to cover the CHO content of the meal.

3b. Calculating the doses (*see page 51*):

Step 1: Current TDD - 10 to 25% = new TDD **71 units - 15% = 60 units**

Fifteen percent (15%) was chosen because of his history of hypoglycemia and current SMBG report, which had an equal number of high and low BG results.

Step 2: Basal requirement = 40 to 60% of the new TDD **60 units x 0.50 = 30 units**

Fifty percent (50%) was chosen, as it is a safe mid-range and considers recent BG results and episodes of hypoglycemia.

Step 3: Bolus/ mealtime requirements**:**
The usual insulin-to-CHO ratio is 1 unit of insulin to 10 to 15 grams of CHO.
The ratio of 1 unit/15 grams of CHO will be used to err on the side of caution and prevent hypoglycemia.

B: $\frac{135}{15}$ = 9 units **L: $\frac{120}{15}$ = 8 units** **S: $\frac{150}{15}$ = 10 units** **hs: $\frac{30}{15}$ = 2 units**

NOTE: *Insulin-to-CHO ratio should always be fine-tuned using 2-hour pc meal testing and discussed with the physician/diabetes HCT. Insulin-to-CHO ratio varies from person to person and may differ from meal to meal in the same individual.*

Jamie's new MDI regimen and starting insulin doses are:

B: RA = 9 units L: RA = 8 units S: RA = 10 units hs: LA = 30 units

RA = 2 units

3c. Recommendations as Jamie starts to use his new dose are:

- Increase frequency of SMBG ac meals and 2-hours pc for the first one to two weeks.
- Phone/fax/e-mail (as per NSHA Zone/IWK/facility policy) SMBG and CHO counting records to be reviewed by the diabetes heatlh care team.
- Dietitian and nurse will reinforce tight adherence to meal plan (structure before flexibility) to assess effective CHO counting methods employed.
- Explain to Jamie that these formulas provide a starting point for insulin requirements for a MDI regimen. They will need to be individualized and modified based on his SMBG results.
- Involve Jamie in problem solving to support learning and self-care practices.

4a. Important points to consider before proceeding with use of an algorithm include:

- Wait until pattern management is established.
- Wait until ISF is known or calculated.
- Ensure Jamie is able to comprehend and implement appropriately (e.g., applied usually when he routinely takes his rapid- or short-acting insulin).
- Continue reinforcement on the basics of pattern management and CHO counting.

4b. To construct an insulin algorithm for Jamie, first calculate the ISF.

ISF Formula: $\frac{100}{59}$ = 1.69 mmol/L (2 mmol/L)

- Therefore, Jamie's ISF is 1 unit rapid-acting insulin to lower the BG by 2 mmol/L. Jamie's algorithm would require modification/adjustment based on his SMBG results.
- Construct the algorithm conservatively (i.e., err on the side of hyperglycemic initially).
- Remember that the lower the ISF number, the more insulin is given for a corrective dose. Jamie's recent SMBG results revealed hypoglycemia once or more a day. Therefore, it is important <u>not</u> to be aggressive with corrective doses for hyperglycemia; hence the 3 mmol/L range algorithm (see below).
- The BG ranges in an algorithm do not have to match the ISF number.

Glucose	Bkfst	Lunch	Snack	Supper	hs bed	
< 4.0	-1	-1		-1		
4.0-7.0 (Target)	RA 9 units	RA 8 units		RA 10 units	RA 2 units LA 30 units	
7.1-10.0	+1	+1		+1		
10.1-13.0	+2	+2		+2		
13.1-16.0	+3	+3		+3		*Check ketones & 3 a.m. BG check*
16.1-19.0	+4	+4		+4	RA 2	*Check ketones & 3 a.m. BG check*
> 19	+5	+5		+5	RA 3	*Check ketones & 3 a.m. BG check*

CASE STUDY 2: CHANGING TO INTENSIVE DIABETES THERAPY

NARRATIVE:

Joan is a 49-year-old teacher. She was diagnosed with type 2 diabetes 8 years ago; and at the time of diagnosis, was overweight and inactive. Joan was started on Glucophage® and attended Diabetes Centre classes. She was determined to do well with her diabetes management. Joan has followed her meal plan and exercise program and has lost 10 lbs.

Two years ago, Joan's BG began to climb despite her efforts, and her A1C rose to 9.2%. Bedtime intermediate-acting insulin (NPH) was added. Recently, Joan noticed her BG levels rising again, and she has been feeling more tired than usual, especially after lunch and in the evenings. She is not really sure what her BG targets should be before aqua aerobics class but she feels that they could be better. Her next regular appointment at the DC is next week.

PHYSICAL AND LABORATORY FINDINGS:

- Present weight is 73 kg
- Most recent A1C is 8.0%
- Fasting BG is 10.2 mmol/L
- eGFR is 50

CURRENT DIABETES MEDICATION:

- Glucophage® 1000 mg BID
- Trajenta® 5 mg once daily
- Novolin® NPH 45 units hs

RECENT SMBG RESULTS:

DATE	BLOOD GLUCOSE					INSULIN				COMMENTS
	ac bkfst	ac lunch	ac supper	hs bed	other	B	L	S	hs bed	
Feb. 20	8.9		11.5	9.8					IA 45 units	Aqua Aerobics 7 to 8 p.m.
Feb. 21	9.4	8.7	9.7						IA 45 units	
Feb. 22	10.1		10.3	7.8					IA 45 units	Aqua Aerobics 7 to 8 p.m.
Feb. 23	8.5	10.4		12.0					IA 45 units	

CASE STUDY 2 CHANGING TO INTENSIVE DIABETES THERAPY QUESTIONS:

1. Using the information provided, what will you review with Joan when she comes in for her appointment?
2. Why would introducing an MDI regimen be appropriate and beneficial at this time?
3. What new information/skills would Joan need to know/learn to make the most of MDI?
4. Work out her starting MDI doses, show calculations, and provide rationale for each. What about her present non-insulin therapy?
5. What recommendations would you give Joan as she begins her new MDI regimen?

CASE STUDY 2 ANSWER SHEET:

1. At Joan's appointment, discuss the following:

- Recent lab and SMBG results and her symptoms of hyperglycemia.
- Discuss her targets for her BG values when she is physically active.
- Present meal plan and physical activity routine. Are there areas that need increased effort or fine-tuning?
- Natural progression of type 2 diabetes and the importance of adding multiple therapies early to prevent long-term complications.
- Concept of adding mealtime insulin and going to MDI regimen and the rationale for more intensive diabetes therapy.
- Decreasing the Glucophage® because of her eGFR level but keeping the DPP-4 inhibitor as it is still indicated with an eGFR of 50.

2. Explain the following advantages of moving to MDI at this time:

- She is young and has demonstrated an interest in managing her diabetes as well as she can.
- She has the capacity and motivation to take responsibility for managing MDI well.
- She has a good medical plan (teacher).
- MDI would give her more flexibility now and in the future.
- Increased energy.

3. Joan would require the following:

- Instruction in CHO counting and developing an insulin-to-CHO ratio.
- Information related to an MDI regimen, mealtime insulin, etc.
- Increase in SMBG – adding 2 hour pc meal checks, at least initially and then periodically.
- A review of hypoglycemia – signs, symptoms, and treatment.
- Instruction to self-adjust insulin, starting with pattern management and eventually, variable dose scales.
- Check her eGFR levels again.

4. Starting Doses:

Step 1: Current TDD - 10 to 25% = new TDD 45 units - 10% (45 x 0.10 = 4.5) = 5 units
45 units - 5 units = new TDD (40 units)

Ten percent (10 %) reduction was chosen because SMBG and A1C are elevated, and she is symptomatic. Therefore, we do not want to reduce dose significantly.

Step 2: Basal requirement = 40 to 60% of the new TDD **40 units x 0.50 = 20 units**

Fifty percent (50%) was chosen, as it is a safe mid-range and a 50% split of basal/bolus doses is a reasonable starting point for MDI. Even though the morning BG values were consistently elevated, adding a rapid-acting insulin at supper should help lower her bedtime BG levels which will impact her breakfast BG levels.

Step 3: Bolus (meal) requirements = TDD - Basal dose **40 units - 20 units = 20 units**

15% TDD = 40 x 0.15 = 6 units ac breakfast
15% TDD = 40 x 0.15 = 6 units ac lunch
20% TDD = 40 x 0.20 = 8 units ac supper

NOTE: *This was used to calculate meal doses because Joan is not presently CHO counting but does keep meal content quite consistent day to day*.

Glucophage® still has a place in Joan's regimen as an insulin sensitizer and to promote less weight gain when combined with insulin. However, reduce to 500 mg BID because eGFR is 50.

Joan's new MDI regimen and starting insulin doses are:

Breakfast	**Lunch**	**Supper**	**Bedtime**
RA = 6 units Glucophage® 500 mg Trajenta® 5 mg	RA = 6 units	RA = 8 units Glucophage® 500 mg	IA = 20 units

5. Recommendations include:

- Explain that this new insulin regimen should help to improve her overall BG control, but the insulin doses will need to be fine-tuned based on her SMBG results.
- Increase SMBG to ac and 2-hour pc meals and hs.
- Contact DC in 3 days for a review of BG levels and food intake by the diabetes HCT.
- Doses will be adjusted as necessary. Explain rationale to Joan and eventually have her suggest adjustments to increase self-management skills.
- Schedule a follow-up appointmet for instruction on CHO counting.
- Keep present meal plan and activity level reasonably consistent until new doses are established and BG levels are within target. Later, discuss further changes such as increasing physical activity, insulin-to-CHO ratios, etc.
- Lowered Glucophage® due to eGFR. This needs to be watched.

INSULIN DOSE ADJUSTMENT FOR ILLNESS AND PREVENTION/TREATMENT OF DKA

KEY POINTS

- The objective of sick day management in insulin-managed diabetes is to minimize metabolic imbalance, avoid severe hypoglycemia, and prevent hyperglycemia and ketosis leading to the development of diabetic ketoacidosis (DKA).
- DKA and Hyperosmolar hyperglycemic state (HHS) are diabetes emergencies with similar qualities. [1]
- Illness and infection allow the body to release counterregulatory hormones that oppose the action of insulin. This allows the circulating levels of glucose to rise quickly along with an increase in circulating fat cells. With lower insulin levels, higher glucose levels, and increasing fat cells the blood becomes more acidic and ketone bodies increase.
- Ketone testing is recommended for all people with type 1 diabetes during periods of acute illness accompanied by elevated BG, when preprandial BG levels remain elevated (> 14 mmol/L), or when symptoms of DKA such as nausea, vomiting, or abdominal pain are present. Ketone testing should also be considered in those with type 2 diabetes when the above conditions are present, as DKA can also occur in these individuals.[1,2]
- Clients will vary in their ability to manage illness at home. Assessment of physical and cognitive abilities, as well as family support, is important before safely implementing home illness management. If the client has appropriate physical and cognitive abilities, illness management guidelines and insulin adjustment recommendations can be made over the phone by the diabetes educator (nurse or dietitian) certified in insulin dose adjustment.
- Insulin should never be omitted during sick days.
- Continue usual dose of intermediate- or long-acting insulin in most cases.
- Supplemental insulin (rapid- or short-acting) may be needed for hyperglycemia and ketosis. In general, ketones are markers of insulin deficiency and indicate the need for supplemental insulin. However, if BG remains elevated – with or without ketones – additional doses of insulin should be given. *See Table 2-1, page 68*.
- Supplemental rapid- or short-acting insulin can be safely given every three to four hours, without discussion with a physician.
- Usually, additional rapid- or short-acting insulin is required; however, in the face of hypoglycemia, a reduction in dose may be advised. *See Table 2-1, page 68*.
- BG and ketones should be monitored every two to four hours around the clock (including usual SMBG times, ac meals, and bedtime snack, even if not eating) as long as significant hyperglycemia and/or ketonuria/ketonemia persist.
- The usual target ranges for BG control may be relaxed during a brief illness. Often the goal of management will be to keep BG < 14 mmol/L[1] and urinary ketones to negative (blood ketone 0.6 or less). *See Table 2-1*, *page 68.*
- If a client has difficulty eating solids during illness, 10 to 15 grams of carbohydrate (CHO) (liquid or soft foods) should be taken every one to two hours (to prevent starvation ketosis and hypoglycemia).
- Extra fluids (e.g., water, clear broth, sugar-free soft drinks, etc.) should be taken to prevent dehydration and facilitate excretion of ketones in the urine. The body needs at least 2200 ml (9 cups) of fluid daily to prevent dehydration. As a rule of thumb, 250 ml (1 cup) an hour while awake can be recommended during times of illness.

- Communication with the physician, as well as the diabetes educator, is recommended when the client:
  - Is unable to tolerate fluids.
  - Has recurrent vomiting (more than once in four hours).
  - Has recurrent diarrhea (more than five times in one day).
  - Has taken extra insulin (two additional doses) as recommended, but hyperglycemia and ketones do not improve.
  - Has an illness that is very severe, worsens, or lasts longer than 12 to 24 hours.
  - Is unable to keep BG above 6 mmol/L.
  - Shows signs or symptoms of DKA, dehydration, or any other serious problem.
  - Has any questions/concerns about sick day management.

These are guidelines only; adjustments should be based on clinical assessment, individual response, and previous experience during sick days.

- The total daily dose (TDD) formula is used to decide how much extra insulin is needed in addition to usual dose. TDD equals the sum of all insulin taken each day. Supplemental insulin is calculated as a percentage of the TDD. *See Table 2-1* below.
- Teach the client to calculate supplemental insulin dose increases by 10% and 15 of TDD and decreases in insulin doses by 10 to 30% of TDD.
- To prevent hypoglycemia, use caution when increasing insulin as illness resolves.

Table 2-1: Insulin Adjustment Guidelines for Sick Days

Use the chart below to find out how much extra rapid-acting insulin is needed based on the BG and ketone measurements.

Ketones		BG (mmol/L)	Extra Insulin Required (rapid-acting)
Blood	Urine		
		< 6.0	Reduce usual dose 5 to 10%
< 1.5	Negative/ Small	6 to 20	Usual doses and at usual times with corrections
1.5 to 3.0	Positive/ Moderate	≥ 14	10% of your TDD in addition to usual dose. If this doesn't work within 2 to 3 hours, try 10 - 15% of your TDD or, if on an insulin pump, use 1.5 times usual correction and seek medical attention.
< 1.5	Negative/ Small	> 20	10% of your TDD in addition to usual dose. If this doesn't work within 2 to 3 hours, try 10 - 15% of your TDD or if on an insulin pump, use 1.5 times usual correction and seek medical attention.
> 3.0	Large	> 20	15% of your TDD in addition to usual dose and/or consult with your HCT. If not improving, seek medical help.

Adapted from: Diabetes Care Program of Nova Scotia. *Moving on…with Diabetes: A Youth in Transition Handbook*. Halifax, NS: Author; 2013.[3]

Example:

Kevin has been ill with the flu and has been testing his BG and urine for ketones every 4 hours. Kevin takes the following:

Before breakfast	Intermediate-acting insulin	30 units
	Short-acting insulin	10 units
Before supper	Short-acting insulin	8 units
At bedtime	Intermediate-acting insulin	20 units
		TDD 68 units

At supper today, his BG is 18.1 mmol/L and ketones in his urine are positive.

He would take an additional 10% of his TDD (units of his short-acting insulin in addition to usual supper dose).

10% of 68
= 0.10 x 68
= 6.8 (7 units)

Kevin would take 15 units of short-acting insulin before supper. He should continue his BG and ketone testing every two to three hours and maintain increased fluid intake. The physician or diabetes educator should be notified of the situation.

BLOOD KETONE TESTING

- Urine ketone test strips remain the most commonly used method for ketone testing. However, this method is prone to false-positive and false-negative results in certain circumstances and may provide a less accurate indication of ketoacidosis status.
- Blood 3 beta-hydroxybutyrate (3HB) measurements may have advantages over urine ketone testing in indicating the presence and severity of DKA. The reason is that 3HB may represent the largest portion of ketone production but is not measured in the urine.
- Blood 3HB reflects current ketonuria while urine lags behind because of what is left in the bladder from the last void therefore, ketones are detected in the blood earlier than in urine providing an early warning of impending DKA.[1,2]
- The Precision Neo™ Blood Ketone Monitoring System (Abbott) measures 3HB levels on a finger stick blood specimen (1.5 uL) within 10 seconds with a detection range of 0 to 6.0 mmol/L. It uses a specific reagent strip for 3HB testing and another for glucose.

REFERENCES:

1. Canadian Diabetes Association Clinical Practice Guidelines Expert Committee. Canadian Diabetes Association 2013 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. *Can J Diabetes*. 2013;37(suppl 1):S1-S212.
2. Walsh J, Roberts R. *Pumping Insulin: Everything You Need for Success on an Insulin Pump + a new chapter on CGMs, 5th edition*. San Diego, CA: Torrey Pines Press; 2013.
3. Diabetes Care Program of Nova Scotia. *Moving on… with Diabetes: A Youth in Transition Handbook*. Halifax, N.S: Author; 2013

RECOMMENDED READING:

- Canadian Diabetes Association. *Building Competency in Diabetes Education: Advancing Practice, 3rd Edition.* Toronto, ON: Author; 2014.
- Canadian Diabetes Association. *Building Competency in Diabetes Education: The Essentials, 4th edition*. Toronto, ON: Author; 2013.
- International Society for Pediatric and Adolescent Diabetes (ISPAD). ISPAD Clinical Practice Consensus Guidelines 2014. *Pediatric Diabetes*. 2014;15(Suppl 20):Si-S290. Available at: http://www.ispad.org/?page=ISPADClinicalPract. Accessed December 2015.

CASE STUDIES – ILLNESS AND PREVENTION/TREATMENT OF DKA

- In preparation for writing the DMF certification exam and using these guidelines in daily practice, the following case studies should be reviewed and discussed with your Medical Advisor or his/her designate.
- For each case study, read through the narrative and case study questions.
- To answer the questions, draw on your own knowledge and experience, see related section(s) in the manual, and see references and recommended readings.
- Read through the case study answer sheet, compare/contrast your answers, and review/discuss with your Medical Advisor or designate.

CASE STUDY 1: PREVENTION/TREATMENT OF DKA

NARRATIVE:

Jason is an 18-year-old, first-year university student living in residence. He is living away from home for the first time. He has met a few people on his floor who play the same online games as he does. Jason and a few of his friends agreed to play in an online tournament that will last all weekend. His team's games are scheduled back to back on the first night. They played all night. He felt fine but missed his bedtime intermediate-acting (basal) insulin. He did not feel this was a problem, as it had happened in the past and he was ok. He checked his BG during the night and took some rapid-acting (bolus) insulin with a snack, and slept for a while. The guys on the floor woke him at noon. Jason felt vaguely uncomfortable, stressed even, but thought it was likely nerves. He took a shower and had a bite to eat.

His games are scheduled for the evening of the second day. He has to make frequent trips to the washroom and tries to stop drinking but can't. He blames his bathroom breaks for his inability to pick up his game. He did not play well. He has now missed two night doses and one morning dose of his intermediate acting insulin.

It was after midnight when one of the guys said, "You're hyperventilating man! It's only a game." Jason knew something was wrong. His BG was elevated. He did not have any ketone test strips, so he asked one of the guys to drive him to the ER. He was admitted to ICU for management of DKA.

PHYSICAL AND LABORATORY FINDINGS:

- Present weight is 70 kg
- BMI is 24
- Present BG is 30 mmol/L
- Blood ketones 3.0 mmol/L
- pH is 7.25
- A1C is 9.2%

CURRENT DIABETES MEDICATION:

- Intermediate-acting (basal) insulin 18 units ac breakfast
- Rapid-acting (bolus) insulin 8 units ac breakfast
- Rapid-acting (bolus) insulin 8 units ac lunch
- Rapid-acting (bolus) insulin 10 units ac supper
- Intermediate-acting (basal) insulin 12 units ac bedtime snack

CASE STUDY 1 QUESTIONS PREVENTION/TREATMENT OF DKA:

1. What were the precipitating factors causing Jason's DKA?
2. What were the signs and symptoms of impending DKA?
3. What would you suggest/review with Jason to prevent reoccurrence?

CASE STUDY 1 ANSWER SHEET:

1. The precipitating factors of Jason's DKA were:

- Missing his bedtime intermediate-acting insulin twice.
- Missing his morning intermediate-acting insulin.
- Inadequate insulin dosage is a major factor in approximately half the cases of DKA.
- Twelve (12) to 24 hours of insulin deficiency can cause profound fluid and electrolyte losses.
- Emotional stress - trying to win the game.
- Possible inadequate replacement dose even if he took all of his insulin dose.
- Disruption of usual routine or schedule may lead to insulin omission.

2. Signs and symptoms of DKA were:

- Elevated BG.
- Frequent trips to the bathroom (polyuria).
- Could not stop drinking (polydipsia).
- Hyperventilation.

3. Discussion should include:

- Review of present diabetes self-care practices and re-inforcement of good diabetes self-management.
- Checking for ketones when BG is > 14.0 mmol/L.
- Importance of basal insulin.
- Strategies to help him remember to take his insulin even with busy university life.
- Guidelines for supplemental insulin/sick day management.
- When to call the diabetes HCT.
- Switching to long-acting insulin analogue once a day if he has been missing intermediate-acting insulin doses on a regular basis.

CASE STUDY 2: ILLNESS

NARRATIVE:

Lilly is a 24-year-old child-care worker who was diagnosed with type 1 diabetes at age 20. She and her husband, Dave, moved into their new home just before Christmas. Lilly has been feeling exhausted and finding it difficult to control her BG over the last few days. She calls this morning to cancel her appointment stating that she has been ill with the flu for the last two days and does not feel well enough to come in. She has had a slight temperature, is nauseated, and vomited once yesterday.

PHYSICAL AND LABORATORY FINDINGS:

- Present weight is 61 kg
- BMI is 23
- A1C is 8.0%

CURRENT DIABETES MEDICATION:

- Rapid-acting (bolus) insulin 5 units ac breakfast
- Rapid-acting (bolus) insulin 5 units ac lunch
- Rapid-acting (bolus) insulin 6 units ac supper
- Long-acting (basal) insulin analogue 20 units ac bedtime snack

RECENT SMBG RESULTS:

DATE	BLOOD GLUCOSE					INSULIN				COMMENTS
	ac bkfst (ketones)	ac lunch (ketones)	ac supper (ketones)	hs bed (ketones)	Other	B	L	S	hs bed	
Day 1	13.4 (Negative)	12.2 (Negative)	18.5 (Positive)	21.2 (Negative)		RA 5 units	RA 5 units	RA 6 units	LA 20 units	Nauseated but not vomiting. Elevated BG and Ketones present
Day 2	12.1 (Negative)	19.8 (Positive)	16.3 (Positive)	17.2 (Positive)						Elevated BG and Ketones present
Day 3	15.1 (Negative)	17.7 (Negative)	12.9 (Negative)	13.5 (Negative)						Elevated BG and ketones present

CASE STUDY 2 ILLNESS QUESTIONS:

1. What sick day guidelines would you review with Lilly?
2. When do you want Lilly to call you again?
3. How much extra insulin should Lilly have taken for each of her BG results?

CASE STUDY 2 ANSWER SHEET:

1. **Ask Lilly if she has been following sick day guidelines.**
   - Monitoring and recording BG every two to four hours around the clock while elevated and/or until symptoms subside.
   - Checking ketones every four hours.
   - Taking her full dose of insulin. Ask if she has been taking extra insulin and ensure her calculations (based on the TDD rule) have been correct.
   - Taking extra fluids to prevent dehydration and facilitate excretion of ketones (8 oz [250 ml] of calorie-free liquid every hour while awake). Ask about her food intake.

2. **You may want Lilly to call you at a specific time, or you may review the general rules that she should follow regarding communication on sick days. Contact the diabetes HCT when:**
   - Vomiting more than once in four hours (or twice in one hour).
   - Experiencing diarrhea more than five times in one day.
   - There is persistent hyperglycemia without ketones.
   - There is persistent hyperglycemia (> 17 mmol/L) and ketonuria/ketonemia in spite of extra insulin doses.
   - There are signs and symptoms of DKA.
   - Unable to eat or drink for more than four hours.
   - Experiencing hypoglycemia.
   - Illness lasts longer than 24 hours, is very severe, or worsens.
   - Uncomfortable with sick day management guidelines and has questions or concerns.

3. **Lilly's TDD is rapid-acting 5 units B +5 units L+ 6 units S + long-acting 24 units hs = TDD of 40 units; therefore, her extra doses would have been:**

breakfast	lunch	supper	hs bed	
13.4 (Negative) Usual 5 units	12.2 (Negative) Usual 5 units	18.5 (Positive) 6 + (10% TDD=4) = 10 units	21.2 (Negative) 10% TDD = 4 units	***Check at 2400 & 0300 hours***
12.1 (Negative) Usual 5 units	19.8 (Positive) 5 + (10% TDD=4) = 9 units	16.3 (Positive) 6 + (10% TDD=4) = 10 units	17.2 (Positive) 10% TDD = 4 units	***Check at 2400 hours***
15.1 (Negative) Usual 5 units	17.7 (Negative) Usual 5 units	12.9 (Negative) Usual 6 units	13.5 (Negative) No extra insulin	

INSULIN ADJUSTMENT FOR PHYSICAL ACTIVITY/EXERCISE

KEY POINTS

- The benefits of exercise include reduced cardiovascular risk factors, increased sense of well-being, improved glycemic control, decreased insulin resistance, increased muscle strength/endurance, and promotion of weight loss/weight maintenance.[1-2]
- Before beginning an exercise program more vigorous than walking, people with diabetes should be medically assessed.[1] Caution is required for individuals with poor metabolic control. This includes, but is not limited to, recurrent hyperglycemia with ketosis or moderate to severe hypoglycemia.
- When starting moderate/vigorous or new activity, increased frequency of SMBG before, during, and after exercise is recommended to determine individual glucose response and to help make decisions about changes in CHO requirements or insulin dose.
- Exercise at consistent times of the day will facilitate insulin adjustments. If exercise is done on a regular basis, the TDD of insulin may need to be reduced.

Physical activity is defined as any type of bodily movement. It is typically unstructured and can take place in a variety of occupational, household, or leisure time situations (e.g., casual walking, gardening, household chores, etc.).[2]

- Hypoglycemia can occur during, immediately after, or many hours after increased physical activity or exercise. Overnight BG should be checked on several occasions to determine post-exercise insulin requirements.
- Individuals who are less physically fit and start an activity/exercise program are more likely to have low BG and greater need to lower insulin doses.[3]
- Insulin should be injected into a non-exercising site prior to physical activity/exercise in order to decrease the risk of exercise-induced hypoglycemia.
- Exercise in the presence of too little insulin may increase already high levels of glucose and ketones and can precipitate diabetic ketoacidosis (DKA).
- Intense, short-duration anaerobic exercise may raise BG with the potential for hypoglycemia later. Correction boluses may be suggested after a short event of hyperglycemia. Glucose testing and record keeping will aid in this decision.[3,4]
- Hypoglycemia can be prevented by decreasing the insulin that will be peaking during time of exercise; or extra CHO can be consumed before, during, or after exercise.

Exercise is defined as planned, structured, physical activity, performed at a minimum level of intensity and duration with the objective of improving one's fitness (e.g., yoga, jogging, weight training, cross country skiing, etc.).[2]

- Adjusting insulin for exercise versus adding CHO is encouraged for overweight individuals. Some trial and error is necessary to find out what works best for each individual.
- Persons at risk for hypoglycemia (on insulin or specific non-insulin therapy) should always carry a source of CHO such as glucose tablets.
- Mild to moderate hypoglycemia should be treated by the oral ingestion of 15 grams of CHO, preferably as glucose or sucrose tablets or solution.[1]
- Maintain hydration. It is important to drink plenty of fluids before, during, and after exercise.[3,5]

TYPE 1 - ADDITIONAL KEY POINTS

- By using record keeping that includes documentation of insulin doses, glucose results, CHO intake, and length and intensity of exercise; BG response to exercise can be identified and strategies for future exercise developed.
- Avoid physical activity if glucose levels are > 16.7 mmol/L and ketones are present,[2,4,6] and use caution if glucose levels are > 17 mmol/L and no ketones are present.[6]

Insulin adjustments for the high-performance, competitive athlete require advanced guidelines. These individuals should be referred to educators/ specialists with an expertise in this area.

TYPE 2 - ADDITIONAL KEY POINTS

- The benefits of exercise for the person with type 2 diabetes are improved CHO metabolism and insulin sensitivity. The increased sensitivity may occur both during and up to 48 hours after exercise.[6-8]
- Hypoglycemia in clients with type 2 diabetes using insulin therapy tends to be less problematic than in the individual with type 1 diabetes.[7]

INSULIN ADJUSTMENT GUIDELINES FOR AEROBIC EXERCISE (TYPE 1 AND TYPE 2 DIABETES)

- Insulin adjustment for exercise is preferred to increasing CHO, as this may lead to weight gain.
- Insulin adjustment for exercise depends on intensity and duration of the exercise, circulating insulin levels during the time of exercise, type of insulin, and time lapsed since last injection.[3]
  - When activity follows soon after an injection of rapid- or short-acting insulin, a pre-exercise reduction of 20 to 50% for moderate activity and 50% for strenuous activity may be required.[5]
  - Prolonged exercise (~3 hours or more) may require a reduction of up to 80%.[5]
  - Monitoring of BG before and after exercise should be used to determine the appropriate change the next time the exercise is done.[5]
  - If exercise occurs more than 3 hours after the pre-meal bolus of rapid-acting or short-acting insulin, a reduction in the bolus insulin dose may not be required.[4,5]
  - If walking at a moderate pace (< 4 mph for less than one hour) late in the afternoon, individuals taking intermediate-acting insulin (NPH) in the morning may require a 10 to 30% reduction of the morning NPH, as the activity is occurring during peak action of this insulin.[8]
- Insulin doses following prolonged exercise may need to be reduced; for example, the next meal dose may need a decrease of 20 to 50% and the bedtime basal dose by 10 to 30%.[5]

For information about exercise with pump therapy, see the Pump Therapy section, page 163.

EXTRA CARBOHYDRATE (CHO) FOR PHYSICAL ACTIVITY/EXERCISE

- If glucose levels are < 5.5 mmol/L, then 15 to 30 grams CHO should be ingested prior to starting the exercise.[1,2,7]
- While insulin adjustment prior to exercise is generally preferred, not all exercise is planned, so additional CHO may be required. The amount of additional CHO required will be determined by BG results; timing and content of last meal; type of insulin and time of last injection; and type, duration, and intensity of exercise. E.g., moderate-intensity exercise such as swimming, tennis, and cycling may require 15 to 30 grams of CHO for every 30 to 60 minutes of exercise. High intensity activity, such as hockey, soccer and strenuous cycling, will require 30 to 60 grams of CHO every hour.[9]
- It is not necessary to consume all the carbohydrates at once. It is better to divide the carbohydrates so something is being consumed every 20 minutes.[9]
- It is not always necessary to eat additional CHO for exercise. By using BG results, the need for additional CHO following exercise can be determined.[5]
- Exercise has several benefits for general health; however, people with diabetes must be aware of the possible risks. Monitoring BG levels before, during, and after exercise will allow the individual with diabetes to gain the knowledge necessary to make adjustments to insulin and CHO intake to exercise safely to their full potential.

High glycemic index food choices meet carbohydrate demands faster and may be useful to consume right before and during exercise.	**Low glycemic index snacks 1 to 2 hours after activity can protect against delayed hypoglycemia.**
The following examples of **high** glycemic index snacks contain 15 grams of carbs: • 7 plain soda crackers • 2 large or 12 small rice cakes • 1 low fibre granola bar **Other examples of high glycemic index snacks include:** • Diced fruit • Sports drinks/juice	The following examples of **low** glycemic index snacks contain 15 grams of carbs: • 7 plain soda crackers with cheese • ½ whole wheat peanut butter sandwich **Other examples of low glycemic index snacks include:** • A muffin with cheese • Fibre cereal sprinkled on yogurt

Source: Diabetes Care Program of Nova Scotia. *Moving on…with Diabetes: A Youth in Transition Handbook*. Halifax, NS: Author; 2013.

Example A (Exercise and a two injection/day regimen):

Mary has type 2 diabetes and attends an exercise class three times a week from 1000 to 1100 hours. Mary takes the following insulin doses:

Before breakfast	**Intermediate-acting (basal) insulin**	**40 units**
	Short-acting (bolus) insulin	**12 units**
Before bed	**Intermediate-acting (basal) insulin**	**15 units**

The insulin peaking during her exercise class is her short-acting insulin. Mary considers her exercise class to be of moderate intensity. Therefore, she would reduce her morning short-acting insulin by 20 to 50%.

20% of 12 units = 2.4 units (12 units – 2.4 units = 9.6 units or 10 units) **OR** **50% of 12 units = 6 units** (12 units – 6 units = 6 units)

Mary would take 40 units intermediate-acting insulin and 6 to 10 units short-acting insulin before breakfast on the mornings she exercises. SMBG results would help her fine-tune these adjustments.

Example B (Exercise and a four injection/day regimen):

John has type 1 diabetes and decides to go hiking this morning at 0900 hours. He will return by suppertime (1700 hours). John takes the following insulin doses:

ac breakfast	**Rapid-acting (bolus) insulin**	**8 units**
ac lunch	**Rapid-acting (bolus) insulin**	**6 units**
ac supper	**Rapid-acting (bolus) insulin**	**6 units**
hs snack	**Long-acting (basal) insulin**	**18 units**

MDI regimens usually require reduction of rapid-acting insulin. In addition, because of the long duration of the hike, his long-acting insulin at bedtime on the day of the hike may also need to be reduced; he will need to figure that out with time.

Morning of hike: 50% of 8 units = 4 units (8 units - 4 units = 4 units)
John would take 4 units rapid-acting insulin before breakfast.

At lunch: 50% of 6 units = 3 units (6 units - 3 units = 3 units)

John would take 3 units rapid-acting insulin before lunch.

At supper: 50% of 6 units = 3 units (6 units - 3 units = 3 units)

John would take 3 units rapid-acting insulin before supper.

At bedtime: 20% of 18 units = 3.6 units (4 units) (18 units – 4 units = 14 units)

John may need to decrease to 14 units long-acting insulin at bedtime.

John should test BG more frequently over the next 6 to 15 hours (after the hike), as there may be delayed hypoglycemia. He should also test at 0300 hours the night after the hike if this is the first time he has hiked for a full day. If he experiences hypoglycemia through the night, next time he should decrease by a larger percentage (25 to 50%).

REFERENCES:

1. Canadian Diabetes Association Clinical Practice Guidelines Expert Committee. Canadian Diabetes Association 2013 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. *Can J Diabetes*. 2013;37(suppl 1):S1-S212.
2. Fowles J, Shields C, Murphy R, Durant M. *Building Competency in Diabetes Education: Physical Activity and Exercise* Toronto, ON: Canadian Diabetes Association; 2012
3. Walsh J, Roberts R. *Pumping Insulin: Everything You Need for Success on an Insulin Pump + a new chapter on CGMs, 5th edition*. San Diego, CA: Torrey Pines Press; 2013.
4. Riddell MC, Perkins BA. Type 1 diabetes and vigorous exercise. *Canadian Journal of Diabetes*. 2006;30(1):63-71.
5. Canadian Diabetes Association. *Building Competency in Diabetes Education: The Essentials 4th edition*. Toronto, ON: Author; 2013.
6. Plotnikoff RC. Physical activity in the management of diabetes: Population based perspectives and strategies. *Canadian Journal of Diabetes*. 2006;30(1):52-62.
7. American Diabetes Association. Physical activity/exercise and diabetes. *Diabetes Care*. 2004;27(suppl 1):S58-S62.
8. Editorial Review Board. *Strategies for Managing Special Situations in the Patient with Type 2 Diabetes*. Hopewell, NJ: Scherer Clinical Communication; 2007. Available at: www.schererclin.com/documents/scherer_spec_sit_print.pdf. Accessed December 2015.
9. Diabetes Care Program of Nova Scotia. *Moving on… with Diabetes A Youth in Transition Handbook*. 2013. Halifax, NS: Author; 2013.

RECOMMENDED READINGS:

- Perkins BA, Riddell MC. Type 1 diabetes and exercise: using the insulin pump to maximum advantage. *Canadian Journal of Diabetes*. 2006;30(1):72-79.

CASE STUDIES - PHYSICAL ACTIVITY/EXERCISE

- In preparation for writing the DMF certification exam and using these guidelines in daily practice, the following case studies should be reviewed and discussed with your Medical Advisor or his/her designate.
- For each case study, read through the narrative and case study questions.
- To answer the questions, draw on your own knowledge and experience, see related section(s) in the manual, and see references and recommended readings.
- Read through the case study answer sheet, compare/contrast your answers, and review/discuss with your Medical Advisor or designate.

CASE STUDY 1: PHYSICAL ACTIVITY/EXERCISE

NARRATIVE:

Joan is a 42-year-old woman who has had type 2 diabetes for 8 years. She was originally on non-insulin therapy but was started on insulin about a year ago. She has put on weight over the last year and has recently decided to start an exercise/physical activity program. She swims three (3) times a week from 1000 to 1100 hours. She has had a few low BG readings lately before lunch on these days, and she tells you that she thinks she will have to give up the swimming.

PHYSICAL AND LABORATORY FINDINGS:

- Present weight is 80 kg
- BMI is 30
- A1C is 8.5%

CURRENT DIABETES MEDICATION:

- Intermediate-acting (basal) insulin 30 units and short-acting (bolus) insulin 10 units ac breakfast
- Short-acting (bolus) insulin 8 units ac supper
- Intermediate-acting (basal) insulin 10 units ac bedtime snack

RECENT SMBG RESULTS:

DATE	BLOOD GLUCOSE					INSULIN				COMMENTS
	ac bkfst	ac lunch	ac supper	hs bed	other	B	L	S	hs bed	
Sun.	8.6	13.7	8.8 (2-hour pc)			IA 30 units SA 10 units		SA 8 units	IA 10 units	
Mon.	9.0	3.5		8.5						Swimming 1000 to 1100 hrs.
Tues.	9.2	9.0	8.5							
Wed.	8.2	3.2	14.7							Swimming 1000 to 1100 hrs; overate at lunch.

CASE STUDY 1 PHYSICAL ACTIVITY/EXERCISE QUESTIONS:

1. What are some benefits of physical activity/exercise that you would discuss with Joan?
2. What about Joan's concern regarding hypoglycemia? How would you address this?
3. How much insulin should Joan take on the days she swims? Which insulin should be adjusted?
4. Before Joan goes swimming, her fasting BG is 12.6 mmol/L. What recommendations would you make?

CASE STUDY 1 ANSWER SHEET:

1. The benefits of physical activity/exercise include:

- Improves glycemic control.
- Helps with weight loss.
- Helps reduce blood pressure.
- Decreases insulin resistance.

2. To address the problems of hypoglycemia, discussion would include:

- Benefits of swimming. Reassure her that the benefits outweigh the problems and that you will assist her in learning how to adjust her insulin to prevent the hypoglycemia.
- Insulin adjustments for exercise/physical activity for Joan.
- Encourage Joan to adjust her insulin versus adding food. As you want to encourage weight loss and improved glycemic control, it is better for Joan to adjust her insulin dose.
- Appropriate treatment of hypoglycemia. Stress the importance of having the necessary supplies within reach at all times.

3. Insulin adjustment:

- It is her short-acting (breakfast) insulin that is peaking when she swims.
- She should decrease her short-acting (breakfast) insulin by 20 to 50% on days she swims.
- She has had two hypoglycemic episodes on swimming day. Recommend she start by reducing her short-acting insulin by 50% (5 units) ac breakfast on swimming days.
- If she continued to have hypoglycemia, she may need to reduce the breakfast intermediate-acting insulin as well.

4. Recommendations:

- Do not make any additional changes other than those recommended above (reduction of short-acting insulin dose ac breakfast on swim days).
- Increase SMBG on swim days, both before and after swimming, as well as later in the day to check the results of the adjustment/exercise/physical activity. This would help her fine-tune the dose adjustments for subsequent exercise/physical activity.
- Tighter BG control should be addressed with her as she becomes less fearful of hypoglycemia. If her fasting BG is consistently above target, then bedtime intermediate-acting insulin should be increased.

CASE STUDY 2: PHYSICAL ACTIVITY/EXERCISE

NARRATIVE:

Bill is a 19-year-old man who has had type 1 diabetes for 7 years. On the weekend, he hikes from 0900 to 1700 hours. He eats breakfast at 0630 hours.

PHYSICAL AND LABORATORY FINDINGS:

- Present weight is 84 kg
- BMI is 24
- A1C is 7.2%
- Fasting BG is 4.3 mmol/L

CURRENT DIABETES MEDICATION:

- Rapid-acting (bolus) insulin 13 units ac breakfast
- Rapid-acting (bolus) insulin 10 units ac lunch
- Rapid-acting (bolus) insulin 15 units ac supper
- Long-acting (basal) insulin 25 units at bedtime snack

RECENT SMBG RESULTS:

DATE	BLOOD GLUCOSE					INSULIN				COMMENTS
	ac bkfst	ac lunch	ac supper	hs bed	other	B	L	S	hs bed	
Tues.	4.3	12.0	7.1	5.4		RA 13 units	RA 10 units	RA 15 units	LA 25 units	
Wed.	8.1	9.0	15.6	8.5						Afternoon meeting; extra food.
Thurs.	6.0	4.2	10.5	3.3						Jogging after supper.
Fri.	5.7	3.0	6.4	7.2						

CASE STUDY 2 PHYSICAL ACTIVITY/EXERCISE QUESTIONS:

1. What are the issues Bill would need to consider for his weekend hikes?
2. What insulin adjustments would you recommend Bill make on the days he hikes?
3. Before Bill starts his hike at 0900 hours, his BG is 5.1 mmol/L. What should he do?
4. What should he do at noon?
5. Should he do anything in the afternoon?
6. Should he do anything else during the evening?

CASE STUDY 2 ANSWER SHEET:

1. Things to consider:

- Possible low BG during or after the hike, during the night following the hike, or even the following day.
- This is physical activity/exercise of long duration; therefore, Bill may need to make several adjustments to his insulin dose as well as carry extra food and supplies for preventing and/or treating low BG.
- If he hikes alone or with friends.
- Probably best to avoid injecting into his legs on day of the hike.
- Adequate fluid intake to avoid dehydration (carry enough).

2. Bill is on a MDI regimen and eats breakfast at 0630 hours. Recommendations include:

- Taking his usual breakfast dose as he is not going hiking until 0900 hours.
- Depending on SMBG results, reduce his lunch and supper doses by up to 50%.
- Depending on SMBG results and experience, reduce bedtime long-acting insulin (10 to 30%). Because of the long duration of the hike, there is potential for delayed hypoglycemia.
- Checking BG more often on the day of the hike would be advisable. Additional tests at 2300 and 0300 hours to determine his later response to the exercise.

3. Bill may need to eat 15 to 30 grams of CHO for every hour of exercise.

4. At noon, Bill should:

- Test his BG.
- Based on the BG readings, he may need to reduce his lunch insulin dose and/or eat extra CHO.

5. During the afternoon, Bill should:

- Test his BG.
- Based on the BG readings, eat extra CHO if < 5.5 mmol/L.
- Ensure adequate fluid intake during hike.

6. In the evening, Bill should:

- Test his BG ac supper and ac bedtime. He may need to decrease rapid-acting insulin at supper or eat extra CHO.
- Bill may need to consider reducing his bedtime long-acting insulin even further than the calculation (previous page) because his SMBG readings ac breakfast are already very good.
- Check his BG at 0300 hours.
- Be alert to any hypoglycemia on the following day and reduce insulin if necessary, as he may have delayed hypoglycemia.

INSULIN ADJUSTMENT FOR TRAVEL

KEY POINTS

- When travelling by car and long distances, the client needs to have ample supplies of medication and food. Blood glucose (BG) values should be assessed frequently when driving/travelling. Remember to pack enough food and hypoglycemia treatment for the trip, and keep these food supplies within reach at all times.
  - Land or sea travel usually allows the client to gradually adjust insulin/mealtimes to accommodate different time zones.
  - Air travel often results in multiple time zone changes in a brief period of time requiring adjustment to insulin doses/mealtimes.
  - There are several different formulas to use for adjusting insulin dose for time zone change.
  - Determine whether or not the destination observes daylight savings time. For example, Saskatchewan, Arizona, and Hawaii do not observe daylight savings time and, as a result, the time difference may not be as great.
  - The goal is to switch to the new time zone as soon as possible.

Passengers with diabetes carrying insulin pens/ syringes and other diabetes-related materials are required to carry a doctor's letter describing the medications and medical devices in their possession. The letter and medications must be presented at security screening points.

- If there is a disruption in the client's regular sleep pattern (circadian rhythm) there may be a change in BG results (insulin resistance increases).[1] Depending on the time zone changes, it may take a few days to adjust to the change; therefore, keep CHO ratios consistent to assist with insulin adjustments.
- Insulin adjustment for travel should be planned ahead, individualized, and as simple as possible.
- Frequent self-monitoring of BG (SMBG) is recommended while travelling to help detect/prevent problems. Check SMBG often and react accordingly.
- The lower the A1C, the greater the risk for hypoglycemia when making insulin adjustments for travel.
- If the A1C is higher and BG values are above target there will be less of a chance of hypoglycemia with travel. Less than optimal control for a 24-hour period is acceptable; i.e., err on the side of hyperglycemia.
- North or south air travel usually involves minimal time difference and, therefore, requires no insulin dose adjustment to the intermediate-acting or long-acting insulin analogues.
- East or west air travel involving time zone differences of two hours or less usually requires no insulin dose adjustment for the intermediate- and long-acting insulins.
- East or west air travel involving more than two time zones requires the preparation of meals and an insulin schedule. Each plan must be worked out individually.[2]
- It is important to gather the necessary information well in advance of the trip so that adjustment guidelines can be worked out, and a written copy of recommended adjustments for travel can be provided to the client.
- Travelling to high altitudes may alter meter readings and reduce appetite. Snacks and sources of glucose should be with the traveller at all times.[3]

- Information helpful in developing a travel plan includes the following:
  - Flight times
  - When meals/snacks will occur
  - Number of hours gained or lost
  - Usual insulin dose/regimen
  - Usual meal/snack times
  - Logbook of recent BG readings
  - Flight connections; time between connections
  - Time of arrival at destination and planned activity or more activity than normal; i.e., sleep, meal, sightseeing, etc.
- The use of basal, long-acting insulin analogues has made crossing time zones less difficult. The injection time can remain on the same schedule as the individual's original time zone.[3]
- The mealtime bolus, rapid-acting insulin, can easily change to match the mealtime of the new destination.[3] This is easier if the individual knows how to carb count.

PUMP CONSIDERATIONS WITH TRAVEL

- When individuals using an insulin pump arrive at their destination, they must change the time on the pump to correspond with the new time zone. They may need to adjust the timing of their nighttime basal rate based on when they sleep in the new time zone.[3]
- Clients can be reminded to change the time/clock on their pump as they travel across different time zones.
- In the case of a pump malfunction when travelling, it is important for insulin pump users to obtain instruction regarding off-pump doses of injected insulin prior to travel and to carry their insulin, regimen, and supplies with them.[4] Most companies will provide a loaner pump for travel as a backup. Call customer service to inquire at least one week in advance of travel.

EASTWARD TRAVEL

- When flying east, the day will be shorter; therefore, less intermediate-acting insulin or long-acting insulin analogue will be required on the day of travel.
- When flying east, decrease the intermediate-acting insulin or long-acting insulin analogue by hours lost in the day using the following formula:

$$\textbf{Usual dose*} - \left(\frac{\textbf{usual dose} \times \textbf{\# hours lost}}{\textbf{24}}\right) = \textbf{New dose}$$

***Usual dose of intermediate-acting insulin or long-acting insulin analogue.**

If two injections of intermediate-acting insulin are taken per day, each dose of intermediate-acting insulin may need to be reduced for that day.

Eastward travel example:

John is travelling from Vancouver to Halifax (4-hour time difference). His flight leaves at 0900 hours Vancouver time. John takes the following:

Morning	**Intermediate-acting (basal) insulin**	**36 units**
	Short-acting (bolus) insulin	**8 units**
Supper	**Short-acting (bolus) insulin**	**6 units**
Bedtime	**Intermediate-acting (basal) insulin**	**20 units**
		TDD 70 units

To determine the insulin adjustment for his travel day:

$$\textbf{Usual morning intermediate-acting insulin dose} - \left(\frac{\textbf{usual dose} \times \textbf{\# hours lost}}{\textbf{24}}\right) = \textbf{New dose}$$

$$\textbf{36} - \left(\frac{\textbf{36} \times \textbf{4}}{\textbf{24}}\right) = \textbf{36} - \textbf{6} = \textbf{30 units}$$

John would take 30 units intermediate-acting insulin and 8 units short-acting insulin before breakfast on the day he flies from Vancouver to Halifax. He would take his usual supper dose, but the bedtime dose may need to be reduced depending on SMBG results. He would resume his usual morning dose the next morning.

WESTWARD TRAVEL - IF YOU GAIN MORE THAN 2 HOURS

- When travelling westward, the day will be longer and more intermediate-acting insulin or long-acting insulin analogue may be required (time zone differences of two or more hours).
- Depending on the flight schedule, duration, and time of arrival, an extra meal or snack may be part of the travel day.
- There are several different formulas to use for adjusting insulin dose for a westward time zone change.

Travel Plan A

- When flying west, increase the morning intermediate-acting insulin or the long-acting insulin analogue by the hours gained in the day by using the following formula:

$$\text{Usual dose*} + \frac{(\text{usual dose} \times \text{\# hours gained})}{24} = \text{New dose}$$

***Usual dose of intermediate-acting insulin or long-acting insulin analogue.**

OR

Travel Plan B

Usual morning or evening dose of intermediate-acting insulin or long-acting insulin analogue

- A catch-up dose of rapid- or short-acting insulin may also be required, depending on SMBG results and extra meals/snacks on the travel day.
- If the SMBG result is > 11 mmol/L, 10% of the total daily dose (TDD) as extra rapid- or short-acting insulin is taken prior to the extra meal.
- If the SMBG results < 11 mmol/L, no extra insulin is taken.

OR

Travel Plan C

Usual morning or evening dose of intermediate-acting insulin or long-acting insulin analogue

- If carbohydrate (CHO) counting and an extra meal or snack is eaten on the travel day, an extra bolus is required.
- Use client's insulin-to-CHO ratio to determine the rapid- or short-acting insulin to cover the extra meal or snack.

Westward travel example:

John is planning to return to Vancouver. His return flight from Halifax to Vancouver leaves at 1000 hours Halifax time. He arrives in Vancouver at 1630 hours. To determine the insulin adjustment for his travel day:

Using Travel Plan A

Usual morning intermediate-acting insulin dose + $\frac{(\text{usual dose} \times \text{\# hours gained})}{24}$ = New dose

$36 + \frac{(36 \times 4)}{24} = 36 + 6 = 42$ units

John would take 42 units intermediate-acting insulin and 8 units short-acting insulin before breakfast on the morning of the flight to cover the longer day.

OR ALTERNATIVELY

John could take his usual morning doses and use Travel Plan B or C method.

REFERENCES:

1. Reutrakul S, Van Cauter E. *Interactions between sleep, circadian function, and glucose metabolism: implications for risk and severity of diabetes*. Annals of the New York Academy. 2014. Ann. N.Y. Acad.Sci. 1311(2014) 151-173, 2014 New York Academy of Sciences.

2. Canadian Diabetes Association. *Travel Tips for People with Diabetes*. Available at: http://www.diabetes.ca/diabetes-and-you/healthy-living-resources/general-tips/travel-tips-for-people-with-diabetes. Accessed December 2015.

3. Childs B, Cypress M, Spollett G, eds. *Complete Nurses Guide to Diabetes Care*. Alexandria, VA: American Diabetes Association; 2005:70-71.

4. Joslin Diabetes Center. *The Joslin Guide to Diabetes: A Program for Managing Your Treatment*. Rockefeller Center, NY: Author; 2005.

RECOMMENDED READING:

- Chandran M, Edelman S. Have insulin, will fly: diabetes management during air travel and time zone adjustment strategies. *Clinical Diabetes*. 2003;21(2):82-85.

- Hernandez C. Traveling with diabetes. http://www.diabetesselfmanagement.com/about-diabetes/general-diabetes-information/traveling-with-diabetes/ Published December 2009. Updated November 2014. Accessed December 2015.

- Canadian Diabetes Association. *Building Competency in Diabetes Education: The Essentials, 4th Edition*. Toronto, ON: Author; 2013.

CASE STUDIES - TRAVEL

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- Read through the case study answer sheet, compare/contrast your answers, and review/discuss with your Medical Advisor or designate.

CASE STUDY 1: TRAVEL

NARRATIVE:

Tammy is a 21 year old who has had type 1 diabetes since age 8. She has been placed on rapid-acting (bolus) insulin and intermediate-acting (basal) insulin before breakfast; rapid-acting (bolus) insulin before lunch and supper; and intermediate-acting (basal) insulin at bedtime. She follows her 1800-calorie diabetes meal plan fairly well, and has an A1C of 7.2%. She has been smoking half a package of cigarettes a day, and has made a considerable effort to quit by joining a support group. She recently had a job opportunity in Calgary, Alberta and came to the Diabetes Centre (DC) for advice about adjusting her insulin for travelling to Alberta. Tammy will leave the Sydney, Nova Scotia airport at 1100 hours and will arrive in Calgary at 1530 hours. There will be a meal available on the flight from Sydney to Toronto and again from Toronto to Calgary.

PHYSICAL AND LABORATORY FINDINGS:

- Present weight is 63.2 kg
- A1C is 7.2%
- Blood pressure is 120/70 mm/Hg
- Urine protein is negative
- TSH, cholesterol and kidney functions are in the recommended target range

CURRENT DIABETES MEDICATION:

- Rapid-acting (bolus) insulin 10 units before (ac) breakfast
- Intermediate-acting (basal) insulin 36 units ac breakfast
- Rapid-acting (bolus) insulin 6 units ac lunch
- Rapid-acting (bolus) insulin 8 units ac supper
- Intermediate-acting (basal) insulin 26 units at bedtime

RECENT SMBG RESULTS:

DATE	BLOOD GLUCOSE (BG)					INSULIN				COMMENTS
	ac bkfst	ac lunch	ac supper	hs bed	Other	B	L	S	hs bed	
Jan.19	4.0	10.0	8.0	7.0		IA 36 units RA 10 units	RA 6 units	RA 8 units	IA 26 units	
Jan. 20	9.0	7.0	5.0	12.0						Out for dinner
Jan. 21	6.0	11.5	9.5	5.0						
Jan. 22	12.0	7.0	5.0	8.0						

CASE STUDY 1 TRAVEL QUESTIONS:

1. What information should Tammy bring with her to the DC about her planned trip?
2. What specific advice would you give about her insulin adjustment when travelling to Calgary?
3. What general advice would you give her about travelling?
4. What would Tammy's insulin adjustment be if she decides to return from Calgary to Sydney?

CASE STUDY 1 ANSWER SHEET:

1. The information Tammy would need to bring to her appointment to help plan for her travel day would include:

- Flight times.
- When meals/snacks will occur.
- Number of hours gained or lost.
- Usual insulin dose/regimen.
- Usual meal/snack times.
- Plans for eating an extra meal or snack during her longer travel day.
- Flight connections; time between connections.
- Time sitting on a plane (i.e., consider what her normally daily activity is like.)
- Time of arrival at destination and planned activity; i.e., sleep, meal, sight seeing, etc. Does she plan to do an activity, other than the interview, that could impact her BG levels?
- Log book with recent BG results.

2. <u>Flying westward</u>: The day will be longer and more intermediate-acting insulin will be required.

<u>Using Travel Plan A</u>

- Increase morning intermediate-acting insulin by the hours-gained formula. Tammy will gain 3 hours flying to Calgary.
- Her usual morning dose is 36 units intermediate-acting insulin and 10 units rapid-acting insulin before breakfast.

$$\text{Intermediate-acting insulin dose} + \frac{\text{usual dose} \times \text{\# hours gained}}{24} = \text{New dose}$$

$$36 + \frac{36 \times 3}{24} = 36 + 4.5 = 40.5 = 40 \text{ units}$$

- Tammy would take 40 units intermediate-acting insulin and 10 units rapid-acting insulin before breakfast on the morning of her flight to cover the longer day *(see Travel Plan A)*.
- Tammy would take her lunchtime dose to cover the meal provided during the Toronto to Calgary flight.
- Supper and evening doses could continue as usual on Calgary time.
- The next morning in Calgary her insulin dose would return to 36 units intermediate-acting insulin and 10 units rapid-acting insulin before breakfast.

3. General advice about travelling would include:

- Plan ahead for insulin adjustment when travelling.
- Try to obtain good glycemic control prior to travel.
- Keep your travel bag with you at all times. Put your diabetes supplies in your carry-on bag. She may want to have some extra supplies in a separate set of luggage.
- Carry plenty of food provisions in case of hypoglycemia or a delayed meal (e.g., dried or fresh fruit, juice, nuts, packets of peanut butter or cheese and crackers, etc.). Keep these within reach at all times.
- Always wear diabetes identification.
- If travelling over several time zones, the insulin dose may have to be adjusted during the time of actual travel. Therefore, travel plans should be discussed with the physician/diabetes health care team.
- Carry a letter from your physician describing your medical condition, medications, and necessary medical supplies. Having an extra prescription for supplies may be helpful.
- Ensure all medications have an identifying pharmacy label on them.
- Use an insulin storage container to protect insulin and test strips.
- Pack twice as many test strips and syringes or needle tips as well as twice as much insulin as needed. It might be a good suggestion to not pack all of her extra supplies together in case some luggage is lost.

4. If Tammy decided to return to Sydney, she would be flying eastward; the days are shorter.

- If Tammy decided to return home from Calgary and was still on the same insulin dose, she would take:

  Usual morning intermediate-acting insulin dose – $\frac{\text{(usual dose x \# hours lost)}}{24}$ = new dose

  $36 - \frac{(36 \times 3)}{24} = 36 - 4.5 = 31.5 = 31$ units

- Tammy would take 31 units intermediate-acting insulin and 10 units rapid-acting insulin before breakfast on the day she flies home.
- She would take her usual supper insulin.
- Her bedtime dose of intermediate-acting insulin may also need to be reduced on the travel day depending on her SMBG results.
- She would resume her usual dose the next day.

Travel Plan

Tammy's Travel Plan – Sydney to Calgary

Usual Insulin Dosages: **Bkfst**: RA 10 units **Lunch**: RA 6 units **Supper:** RA 8 units
Bkfst: IA 36 units **hs**: IA 26units

Date	Cities	Times	Suggested Insulin Dose	Comments
TRAVEL PLAN A				
Jan 24	**Sydney (*ATZ)**	0700 hours	IA 40 units RA 10 units	SMBG Take ac breakfast at home
		1100 hours		Depart Sydney to Toronto
		1130 hours	RA 6 units	SMBG Lunch on flight
	Toronto (*ETZ)	1220 hours		Arrive in Toronto
		1315 hours		Depart Toronto to Calgary
		1400 hours		SMBG Evening snack equivalent
	Calgary (*MTZ)	1520 hours (Calgary time)		Arrive in Calgary
		1700 hours	RA 8 units	SMBG – take catch-up dose if needed Supper
		2200 hours	IA 26 units	SMBG Bedtime snack
Jan 25	**Calgary (*MTZ)**	0700 hours (Calgary time)	IA 36 units RA 10 units	SMBG Resume usual doses

Adapted from: Calgary Regional Health Authority Diabetes Education Centres 2010 year

*** VARIOUS TIME ZONES**
ATZ= ATLANTIC TIME ZONE
ETZ= EASTERN TIME ZONE
MTZ= MOUNTAIN TIME ZONE

CASE STUDY 2: TRAVEL

NARRATIVE:

Sonny is a 62-year-old man with type 2 diabetes for 20 years. In the past, he did not adhere to his management plan and had sustained a myocardial infarction (MI) in 1998. Since then, he has been following his meal plan and has lost 30 lbs. He now keeps regular appointments, walks after breakfast, and incorporates stress management practices into daily routine. He is on a combination of short-acting (bolus) insulin and intermediate-acting (basal) insulin twice a day with Glucophage® BID. His A1C is down from 9.5% to 7.8%. For his 40th wedding anniversary, he is taking his wife on a three-week trip to England and has come to the DC for assistance with insulin adjustment for the trip. The flight leaves Sydney, Nova Scotia at 1800 hours, Montreal at 2000 hours, and arrives in London at 0730 hours (0230 Montreal time). The return flight leaves London at 1515 hours and arrives in Montreal at 1810 hours (2310 hours London time), and Sydney, Nova Scotia at 0100 hours.

PHYSICAL AND LABORATORY FINDINGS:

- Present weight is 89 kg
- A1C is 8.3%
- Blood pressure is 140/86 mm/Hg

CURRENT DIABETES MEDICATION:

- Short-acting (bolus) insulin 9 units ac breakfast
- Intermediate-acting (basal) insulin 17 units ac breakfast
- Short-acting (bolus) insulin 5 units ac supper
- Intermediate-acting (basal) insulin 9 units ac supper
- Glucophage® 500 mg BID

RECENT SMBG RESULTS:

DATE	BLOOD GLUCOSE					INSULIN				COMMENTS
	ac bkfst	ac lunch	ac supper	hs bed	other	B	L	S	hs bed	
Sept. 14	10.0	4.8	17.0	7.0		IA 17 units SA 9 units		IA 9 units SA 5 units		
Sept. 15	6.0	3.2	20.0	17.0						
Sept. 16	7.0	3.0	15.0	8.0						
Sept. 17	5.0	3.8	10.0	6.0						

CASE STUDY 2 TRAVEL QUESTIONS:

1. What advice would you give Sonny about his diabetes management prior to advice about insulin adjustment during travel?
2. What advice would you give Sonny about travelling from Sydney to London?
3. What advice would you give him about his insulin for the return trip home?

CASE STUDY 2 ANSWER SHEET:

1. Sonny should be informed that:

- His lows at lunch probably result from his exercise (walking) after breakfast, and the highs before supper may be a result of over-treating lows and/or overeating at lunch because of the lows.
- He could use a mid-morning snack to prevent lows, but this could cause a weight gain; so better advice would be for him to reduce his morning short-acting insulin to prevent the noon lows. Recommend this first and ask him to see how it works.
- Review prevention and treatment of hypoglycemia. He will be doing extra walking in England while sightseeing and this may increase his chances of having a hypoglycemic event. Discuss extra exercise and insulin adjustments or extra snacks to prevent hypoglycemia.

2. **The flight from Sydney to Montreal (1 hour time change) does not require a dose change, but a dose adjustment is required for the flight from Montreal to London (5 hours).**

Note: Remember to take into consideration extra exercise/activity and a change in their regular meal plan.

Flying eastward: When flying eastward, the day will be shorter. The time difference between Montreal and London is five hours. Sonny will require less intermediate-acting insulin at suppertime on the day he travels.

$$\text{Usual suppertime intermediate-acting insulin dosage} - \frac{(\text{usual dose} \times \#\ \text{hours lost})}{24} = \text{New dose}$$

$$9 - \frac{(9 \times 5)}{24} = 9 - 2 = 7 \text{ units}$$

Sonny would take 7 units intermediate-acting insulin and 5 units short-acting insulin before supper prior to flight from Sydney to Montreal. On the flight from Montreal to London, breakfast will be served at 0600 hours on the plane, and he will arrive in London at 0730 hours. He plans to do some sightseeing after checking into his hotel (i.e., extra walking); therefore, he would also possibly need to reduce his usual morning dose of intermediate-acting insulin and short-acting insulin (using the same formula) before breakfast on the plane. He can split the dose reduction between intermediate-acting insulin and short-acting insulin, as we are not sure how soon he will do the extra walking (e.g., 14 units intermediate-acting insulin and 7 units short-acting insulin). He would resume his usual doses at suppertime in London.

3. **For the return flight, the time difference is five hours, and the day will be longer.** Sonny will leave London at 1515 hours and arrive in Montreal at 1810 hours (2310 London time) and in Sydney at 0100 hours. Supper will be served on the flight and Sonny will also have an extra meal after arriving in Montreal and before he flies to Sydney.

Travel Plan A:

Sonny's usual suppertime dose is 9 units intermediate-acting insulin and 5 units short-acting insulin before supper.

Usual suppertime intermediate-acting insulin dose + ($\frac{\text{usual dose x \# hours gained}}{24}$) = New dose

$9 + \left(\frac{9 \times 5}{24}\right) = 9 + 2 = 11$ units

Sonny would take 11 units intermediate-acting insulin and 5 units short-acting insulin before supper on the flight from London to Montreal.

OR

Travel Plan B:

Sonny's TDD is 9 + 17 + 5 + 9 = 40 units

Sonny would take his usual supper insulin on the flight from London to Montreal. A catch-up dose of short-acting insulin may be required before he eats his extra meal on the travel day. **If his BG is > 11 mmol/L, he should take 10% of his TDD (10% of 40 = 4.0 units).** Sonny would take 4 units of short-acting insulin before the extra meal.

If Sonny's BG is ≤ 11 mmol/L, he would not take extra insulin.

CASE STUDY 3: TRAVEL

NARRATIVE:

Adam is a 34-year-old computer programmer who was diagnosed with type 1 diabetes at the age of 12. He recently accepted a position as a data analyst with an engineering company in the United States. He is aware that his chosen career will require a lot of travel. He contacted the Diabetes Centre yesterday for advice on how to manage/adjust his insulin through the different time zones on his flight schedule. He states that he will be required to fly from Sydney, Nova Scotia to New York for a three-week training period and from New York to Honolulu for an indefinite period-of-time. He questioned whether his flight from Sydney to New York would require a major insulin adjustment and was concerned about insulin requirements for his flight from New York to Honolulu. Adam is aware that the flight from New York to Honolulu takes 11 hours and passes through several time zones. He informed us that Hawaii does not observe daylight savings time, so there is a time difference of 6 hours. The flight departs New York at 1000 hours. It arrives in Honolulu at 1500 hours Honolulu time, which is 2100 hours New York time.

PHYSICAL AND LABORATORY FINDINGS:

- Present weight is 78 kg
- A1C is 7.2%
- Blood pressure is 120/74

CURRENT DIABETES MEDICATION:

- Rapid-acting insulin 10 units before meals
- Long-acting insulin 24 units at bedtime

RECENT SMBG RESULTS:

DATE	BLOOD GLUCOSE				INSULIN				COMMENTS
	ac bkfst	ac noon	ac supper	hs bed	B	L	S	hs bed	
July 14	10.0	4.8	7.0	8.9	RA 10 units	RA 10 units	RA 10 units	LA 24 units	
July 15	6.0	7.8	11.2	7.0	RA 10 units	RA 10 units	RA 10 units	LA 24 units	
July 16	5.0	6.9	6.2	7.7	RA 10 units	RA 10 units	RA 10 units	LA 24 units	
July 17	7.0	9.0	9.7	17.2	RA 10 units	RA 10 units	RA 10 units	LA 24 units	Office party 1800 hours

Departure time: 1000 hours New York time; 0400 hours Honolulu time
Arrival time: 1500 hours Honolulu time; 2100 hours New York time

CASE 3 STUDY TRAVEL QUESTIONS:

1. What specific advice would you give Adam about his insulin adjustment when travelling from Sydney to New York?
2. What specific advice would you give Adam about his insulin adjustment when travelling from New York to Honolulu?

CASE 3 STUDY ANSWERS:

1. North to south air travel involves a minimal time difference (1 hour) and will require no insulin dose adjustment. It will be important ask about his plans for activity upon arrival at his destination. He has good control of his diabetes and he needs to be aware of the risk for hypoglycaemia with added activity.

2. Adam will be travelling westward with a time zone difference of 6 hours (New York to Honolulu) and, therefore, an insulin dose adjustment will be required.

- **Long-acting insulin dose adjustment:**
  Since he is using long-acting insulin once a day, he should take his usual dose of long-acting insulin (24 units) the night before departure. Twenty-four hours later, which in his case would be just before landing in Honolulu, he can take half of his usual dose of long-acting insulin (12 units). That night at bedtime (Honolulu time), he can take the remaining half of his usual bedtime dose of long-acting insulin (12 units). The 24-hour long-acting insulin requirement would remain the same but splitting the dose helps him adjust to the change in time zones.

  The following night in Honolulu he would continue his usual 24 units long-acting insulin at bedtime.

- **Rapid-acting insulin dose adjustment:**
  Pre-meal rapid-acting insulin would remain the same as usual, and Adam could adjust the pre-meal, rapid-acting insulin dose as required during the travel day using the catch-up dose guidelines outlined in Travel Plan B.
- If he counts carbohydrates, travel and adjustments will be easier.

INSULIN ADJUSTMENT FOR SHIFT WORK

KEY POINTS

It is important to stress that any plan must be individualized and adjusted as necessary.

- Maintaining optimal glucose control while managing shift work requires planning because of changes to meal size/times, sleep, and activity patterns. Individual, flexible plans must be devised and adjusted based on self-monitoring of blood glucose (SMBG) results and personal experience. The aim is to match the action of insulin to the meals and activity on different shifts.[1] Clients working rotating shifts must be especially vigilant for hypoglycemia. An appointment with diabetes educators certified in insulin dose adjustment is important for developing a plan.
- Day to evening shifts are not usually a problem and no adjustment is needed other than timing of injections. On evening shift, people often get up later but eat three meals a day as usual. Insulin can be delayed up to one to two hours without significantly affecting BG control. All meals and insulin actions are delayed for the rest of the day.[1]
- For clients who work frequent rotating shifts including nights, the night shift presents the most challenge. If the individual is willing to monitor his/her BG frequently and learn how to adjust his/her short- or rapid-acting insulin for the size of the meal, a multiple daily injection (MDI) regimen or pump therapy offers the most flexibility.[1]
- A once-a-day, long-acting insulin analogue given at the same time each day with rapid-acting insulin given before meals may create more stability with BG control.
- Long-acting insulin analogues, which release more slowly than intermediate-acting insulin and have little to no peak time action, can help prevent swings in BG that can happen during sleep as a result of the time-action of the intermediate-acting insulin.

TWO (2) INJECTIONS/DAY REGIMEN OF INTERMEDIATE-ACTING

- Some clients do not want to inject or monitor their BG frequently and choose to continue with a twice/day regimen. For these clients, Belton and Carr[1] have developed a shift-work plan to accommodate both days at work and days off, which has worked well for them. This can be used as a starting point.

Morning Dose = B Evening Dose = hs

Work Shift	Morning	Evening
Days	B	hs
Evenings	B	hs*
Going on Nights	B	B
Nights	hs**	B
Going off Nights	hs***	hs

* *If the supper break is early; i.e., 1630 or 1700 hours, the dose could be split: rapid-acting insulin at supper and intermediate-acting insulin at 2200 or 2300 hours, if client is willing.*

** *May need less insulin depending on how active the night shift is at work.*

*** *May need to reduce intermediate-acting dose if getting up at noon to start the day.*

Example:

Morning dose = B 20 units	Evening dose = hs 30 units	
Work Shift	**Morning**	**Evening**
Days	B 20 units	hs 30 units
Evenings	B 20 units	hs* 30 units
Going on nights	B 20 units	B 20 units
Nights	hs** 30 units	B 20 units
Going off nights	hs*** 30 units	hs 20 units

THREE TO FIVE (3 TO 5) INJECTIONS/DAY REGIMEN OF RAPID-ACTING AND INTERMEDIATE/LONG-ACTING

- MDI regimens, especially four injections/day, offer the most flexibility for shift work.
- The morning and/or evening doses of intermediate-acting insulin can be switched for night shift.
- When transitioning off the night shift, the client may need to decrease the morning intermediate-acting dose if getting up at noon to avoid hypoglycemia.

Example using intermediate-acting and rapid-acting insulin:

IA = Intermediate-acting
IA Breakfast = IA (B); IA Bedtime = IA (hs)

RA = Rapid-acting
RA Breakfast = RA (B); RA Lunch = RA (L); RA Supper = RA (S)

Example: Day shift and evening shift:

0600	0700	0900	1200	1430	1730	1900	2200
Check BG IA (B) RA (B)	Shift starts	Check BG Break	Check BG RA (L)	Break	Check BG RA (S)	Off shift	Check BG IA (hs)

Example: Going on night shift

0800	1200	1500	1730	1900	0000	0300	0800
Check BG IA (B) RA (B)	Check BG RA (L)	Sleep	Check BG RA (S)	Shift starts	Check BG IA (B) Meal RA	Check BG Snack	Check BG IA (hs)* RA (B)

Example: Night shift

0800	1200	1500	1730	1900	0000	0300	0800
Check BG IA (hs)* RA (B)	Sleep	Check BG RA (L)	Check BG Snack	Shift starts	Check BG IA (B) Meal RA (S)	Check BG Snack	Check BG IA (hs) RA (B)

Example: Going off night shift

0800	1200	1400	1730	1930	2200
Check BG IA (B)* RA (B)	Check BG Get Up RA (L)	Check BG	Check BG RA (S)	Check BG	Check BG IA (hs)

Breakfast	Noon	Supper	hs	0300 hours
Days	RA & IA	RA	RA	IA
Evenings	RA &IA	RA	RA	IA
*Going on Nights	RA & IA	RA	RA	IA
*Nights	± RA &IA	RA	RA	± RA&IA (RA if there is a meal)
*Going off Nights	± RA &IA	RA	RA	IA

Example using long-acting and rapid-acting insulin: LA = Long-acting RA = Rapid-acting

	Breakfast	Noon	Supper	hs	0300 hours
Days	RA	RA	RA	LA**	
Evenings	RA	RA	RA	LA**	
*Nights	± RA		RA	LA** (± RA)	RA
*Going on Nights	RA	RA	RA	LA** (± RA)	RA
*Going off Nights	±RA	RA	RA	LA**	

Example of days, evenings and nights with rapid-acting and long-acting insulin analogue:

0800	1200	1500	1730	1900	0000	0300	0800
Check BG RA (B)	Check BG RA (L)		Check BG RA (S)		Check BG LA ** Meal RA	Check BG	Check BG RA (B)

* *It may be necessary to have a smaller amount of long-acting insulin on the days the person is sleeping.*

* *When going on or off nights, the use of rapid-acting insulin is optional, depending upon SMBG results and if/when the person is eating a meal.*

** *Long-acting insulin may be taken at supper or bedtime. Although there can be flexibility in time of once daily dose, it is important to ensure consistency in time of dose.*

REFERENCES:

1. Belton A, Carr D. Shifty business. *Diabetes Dialogue*. 2000;47(2):6-16.

RECOMMENDED READING:

- D'Arrigot. The shift-work shuffle. *Diabetes Forecast*. 2007;June:51-52.
- Canadian Diabetes Association. *Diabetes & Shiftwork*. Available at: http://www.diabetes.ca/diabetes-and-you/healthy-living-resources/general-tips/diabetes-shift-work. Accessed December 2015.

CASE STUDIES - SHIFT WORK

- In preparation for writing the DMF certification exam and using these guidelines in daily practice, the following case studies should be reviewed and discussed with your Medical Advisor or his/her designate.
- For each case study, read through the narrative and case study questions.
- To answer the questions, draw on your own knowledge and experience, see related section(s) in the manual, and see references and recommended readings.
- Read through the case study answer sheet, compare/contrast your answers, and review/discuss with your Medical Advisor or designate.

CASE STUDY 1: SHIFT WORK

NARRATIVE:

Sam is a 56-year-old man with type 1 diabetes. He works rotating 12-hour shifts at the local paper mill. He counts carbohydrates (CHO). His activity at work varies - sometimes it is quiet, and other times it is very busy. He counts his CHO based on a meal plan to accommodate his night shift, day shift, and days off but now also wants to know how to adjust his insulin for the various shifts.

PHYSICAL AND LABORATORY FINDINGS:

- Present weight is 92.8 kg
- BMI is 29.5
- A1C is 7.8%

CURRENT DIABETES MEDICATION:

- Rapid-acting (bolus) insulin 4 units ac breakfast; 6 units ac lunch; 6 units ac supper
- Long-acting (basal) insulin analogue 32 units at bed

RECENT SMBG RESULTS:

DATE	BLOOD GLUCOSE					INSULIN				COMMENTS
	ac bkfst	ac lunch	ac supper	hs bed	other	B	L	S	hs bed	
Sept. 20	8.0	6.3	7.2	7.6		RA 4 units	RA 6 units	RA 6 units	LA 32 units	Day shift.
Sept. 21	7.8	6.9	8.2	9.4		RA 4 units	RA 6 units	RA 6 units	LA 32 units	Day shift.
Sept. 22	8.2	5.4	6.1	5.2		RA 4 units	RA 6 units	RA 6 units	LA 32 units	Day off (splitting wood after supper).
Sept. 23	8.6	4.2	7.3	6.2		RA 4 units	RA 6 units	RA 6 units	LA 32 units	Day off.

CASE STUDY 1 SHIFT WORK QUESTIONS:

1. What information do you need to know about his work schedule?
2. What are your concerns regarding safety issues when Sam is at work?
3. What recommendations would you make around safety issues?
4. Why are rapid-acting and long-acting insulin a good choice for shift work?
5. Develop a plan for his insulin doses/times for each of his shifts.

CASE STUDY 1 ANSWER SHEET:

1. You would need to know the following:

- Work schedule (2 day shifts, 2 night shifts, 4 days off).
- Meal plan for days, nights, and transition days and accuracy of his CHO counting.
- Routine at home for various shifts.
- SMBG at home and at work.
- Overtime work or call-in.

2. Safety concerns could be:

- Factory work (machinery).
- Potential hypoglycemia from increased activity if there is no time to eat when shift gets very busy.
- Availability of glucose and food supply. How far is the lunchroom? Does he carry a fast-acting glucose supply at all times?
- Does he work alone or with other people?

3. Recommendations and discussion of the following will address safety issues:

- Supplies for treating hypoglycemia at work.
- Information for co-workers (teach others how to help if needed).
- Diabetes identification.
- Delayed hypoglycemia from increased activity.
- Importance of SMBG.
- Adjustment of insulin for increased activity.
- Glucagon administration (Is there a co-worker he could tell?)

4. Sam's insulin regimen:

- With the use of rapid-acting insulin before meals, there is less chance of hypoglycemia because of the shorter duration of action. It also makes it easier to adjust insulin. Review Sam's insulin-to-CHO ratios, (15 grams CHO to be used with breakfast, lunch, and supper). Schedule a follow-up visit to adjust ratios as necessary. Ask Sam to provide 2-hour postprandial BG readings to help guide these changes. At the follow-up visit, he could also be given an algorithm to correct readings that fall out of range.
- There is up to 24-hour basal coverage and virtually no peak with long-acting insulin, but if there is a significant increase in physical activity on some shifts, he needs to be more vigilant for the possibility of hypoglycemia and delayed hypoglycemia.

5. Plan for Sam's insulin dose adjustment with various work schedules:

Work schedule:

Day shift (starts work at 0700 hours):

0600	**1000**	**1200**	**1630**	**1800**	**2200**
Check BG	Check BG	Check BG	Check BG	Check BG	Check BG
Breakfast	Snack	Lunch	Snack	Supper	Snack
RA 1 unit:15 grams CHO		RA 1unit:15 grams CHO		RA 1 unit:15 grams CHO	LA 32 units

0630 Breakfast	**1000** AM Snack	**1200** Lunch	**1430** PM Snack	**1800** Supper	**2200** Bedtime Snack
RA 1 unit:15 grams CHO		RA 1 unit:15 grams CHO		RA 1 unit:15 grams CHO	LA 32 units

Days off are the same as day shift except that breakfast is later (0730 to 0830 hours).

Night shift (going to nights - starts work at 1900 hours):

0800 Breakfast	**1500** Snack	**1700** Lunch	**2200** Snack	**0100** Supper	**0330** Snack
RA 1 unit:15 grams CHO*		RA 1 unit:15 grams CHO	LA 32 units	RA 1 unit:15 grams CHO	± RA with a snack

*Eats breakfast before sleeping. He sleeps 0800 to 1500 hours.

CASE STUDY 2: SHIFT WORK

NARRATIVE:

Tom is a 31-year-old shift worker with type 2 diabetes. He works rotating 8-hour shifts at the local plant. He is married with two young, school-aged children. His wife is supportive and wants to help him with his diabetes management. They had a session with the dietitian who worked out the amount of CHO to have at each meal to accommodate his various shifts. His activity at work is usually consistent. He is concerned that his weight is increasing. He used to be more active playing team sports, such as hockey, but is now too busy with work and the children's activities. He is also afraid of experiencing hypoglycemia at work or when he is sleeping. He is not adjusting his insulin.

PHYSICAL AND LABORATORY FINDINGS:

- Present weight is 90.6 kg
- BMI is 28
- A1C is 8.2%

CURRENT DIABETES MEDICATION:

- Short-acting (bolus) insulin 10 units ac breakfast
- Short-acting (bolus) insulin 12 units ac lunch
- Short-acting (bolus) insulin 14 units ac supper
- Intermediate-acting (basal) insulin 20 units at breakfast
- Intermediate-acting (basal) insulin 30 units at bed

RECENT SMBG RESULTS:

DATE	BLOOD GLUCOSE					INSULIN				COMMENTS
	ac bkfst	ac lunch	ac supper	hs bed	other	B	L	S	hs bed	
Day 1	8.1	5.2	6.3	7.2		SA 10 units IA 20 units	SA 12 units	SA 14 units	IA 30 units	Day shift 0730-1530
Day 2	9.2	6.9	12.0	5.2		SA 10 units IA 20 units	SA 12 units	SA 14 units	IA 30 units	Day shift 0730-1530
Day 3	8.6	7.4	6.3	8.0		SA 10 units IA 20 units	SA 12 units	SA 14 units	IA 30 units	Evening shift 1530-2330
Day 4	10.4	10.1	13.4	11.4		SA 10 units IA 20 units	SA 12 units	SA 14 units	IA 30 units	Evening 1530-2330

CASE STUDY 2 SHIFT WORK QUESTIONS:

1. What areas of concern would you identify with Tom when discussing his diabetes management?
2. How would you help him with his fear of hypoglycemia? What strategies would you recommend to help him feel safe?
3. When Tom is ready, what would you discuss and teach regarding adjusting his insulin? Why would this be important for Tom?
4. Develop a plan for Tom's insulin doses/times for each of his shifts, including transition days. What things would you need to know?
5. Would a change to rapid-acting insulin and long-acting insulin analogue work as well? What would be the advantages?

CASE STUDY ANSWER SHEET:

1. The following should be discussed with Tom:

- Improved overall control as determined by SMBG and A1C.
- Fear of hypoglycemia.
- Weight gain and desirable BMI.

2. Discussion of the following should start towards addressing his fears about hypoglycemia:

- Meals – importance of spacing and CHO content.
- Advantages of learning to adjust insulin to prevent hypoglycemia versus extra food, which would contribute to weight gain.
- SMBG – importance of frequent testing ac and 2-hour pc meals; before, during, and after activity/ exercise; before going to sleep.
- Informing friends, family, and coworkers of how to help with lows if needed.
- Availability of fast-acting glucose supply at all times (at work and at bedside).
- Glucagon administration (review with wife).

3. Discuss/review the following in regards to insulin dose adjustment:

- Insulin action, peak times, and site rotation. Injecting over exercising muscles.
- Importance of SMBG ac and 2-hours pc meals, record keeping, and observing patterns.
- Setting target goals.
- Problem solving - using his SMBG results. (Provide an algorithm to give direction; then help him fine-tune).
- Importance of self-adjustment for tighter control and safety.
- Aiming for decreased A1C (approximately 7.0%).

4. Information needed to develop a plan for Tom would include:

- His work schedule and meal plan/times for each shift.
- Activity levels for each shift; e.g., when on evenings, does he sleep later; when on nights, does he eat before going to sleep; how long does he sleep?

- Activity/meals on transition days, SMBG frequency, and willingness to test at work.
- Is he interested in learning to count CHO?
- Making sure he has written instructions to follow and arrangements for follow-up for revisions as necessary.
- His interest/willingness to switch to a long-acting insulin analogue and rapid-acting insulin at meal times. If this is not an option he may need to reduce his IA insulin when he is working night shifts.

5. Rapid-acting insulin would work very well because of the shorter duration of action. There would be less worry about hypoglycemia if Tom were able to learn how to adjust for decreased food intake or increased activity. Using a long-acting insulin analogue could help alleviate Tom's fear of hypoglycemia while sleeping. Prior to walking or driving home, Tom should check his BG and eat a snack before leaving work if indicated.

Tom's shift work schedule and dose adjustments for each shift:

Day shift (0730 to 1530 hours):

0630 Breakfast	**0930** Snack	**1200** Lunch	**1500** Snack	**1800** Supper	**2300** Snack
SA 10 units IA 20 units		SA 12 units		SA 14 units	IA 30 units

Evening shift (1530 to 2330 hours):

0800 Breakfast	**1000** Snack	**1200 - 1300** Lunch	**1500** Snack	**1830** Supper	**Midnight** Snack
SA 10 units IA 20 units		SA 12 units		SA 14 units	IA 30 units

Transition day (going on nights, usually naps 1800 to 2100 hours):

0800 Breakfast	**1000** Snack	**1200** Lunch	**1500** Snack	**1700** Supper	**2300** Snack
SA 10 units IA 20 units		SA 12 units		SA 14 units	IA 20 units*

** May need to be reduced depending on SMBG results and anticipated activity level during night shift. If he eats a meal during his night shift he may need some SA to cover the meal.*

Night shift (2330 to 0730 hours) – usually sleeps 0800 to 1500 hours:

0800 Breakfast	**1500** Snack	**1700** Lunch	**2200** Supper	**0100** Snack	**0300** Snack
*IA 30 units		SA 12 units	SA 14 units IA 20 units		± SA 8 to 10 units*

** May require smaller dose or no short-acting insulin if BG is low or within target. Night shift short-acting insulin may need to be adjusted according to SMBG results and CHO content of meals/snacks or activity level. Be careful about insulin dose before going to bed.*

Transition day (going off nights, usually sleeps 0800 to 1200 hours):

0800 Breakfast	**1200 - 1400** Lunch	**1600** Snack	**1800** Supper	**2300** Snack
±SA 10 units* IA 20 units	SA 12 units		SA 14 units	IA 30 units

** Many people like to get up at noon and start their day.* ***Be especially vigilant for hypoglycemia on transition days.***

SECTION 3

SPECIALTY AREAS

INSULIN DOSE ADJUSTMENT FOR PREGNANCY

KEY POINTS

- Diabetes mellitus during pregnancy can have a significant effect on maternal and fetal health. Optimal blood glucose (BG) control reduces the risk of diabetes-related complications in pregnancy.[1-3]
- Ideally, women with pre-existing* diabetes should strive for optimal glycemic control prior to attempting to conceive. Optimal control is defined as A1C < 7%.[1-3]
- Most women with pre-existing type 2 diabetes should stop non-insulin therapy** and be started on insulin pre-conceptually.[1-2] While known to cross the placenta, metformin has been shown to be safe for use in the presence of type 2 diabetes and polycystic ovary syndrome (PCOS) for ovulation induction.[1] Also, the continued use of metformin and/or glyburide until insulin can be initiated has been recommended to prevent severe hyperglycemia, which is known to be teratogenic.[1-3]
- Hypoglycemia is more common during pregnancy due to the level of glycemic control recommended for optimal pregnancy outcomes as well as the blunting of counter-regulatory hormone response.[1-3]
- Women should be educated about hypoglycemia unawareness and asymptomatic nocturnal hypoglycemia.[1-3]

Not all women will be able to safely achieve optimal control; aim for the best possible control, while avoiding frequent or significant hypoglycemia.[1]

- Insulin adjustments are guided by regular meal/snack times; consistency in CHO (timing and amounts); routine/regular physical activity/exercise; and self-monitoring of blood glucose (SMBG).
- Frequent SMBG (4 to 8 times a day) is essential to identify glycemic patterns to guide treatments and to prevent or reduce occurrences of hypoglycemia.[1-3] Clients should be advised about the proper treatment of hypoglycemia and to carry a source of fast-acting glucose at all times.[2]
- Continuous glucose monitoring (CGM), or sensor-augmented therapy for pump users, may be useful to identify periods of glucose variability.[1]
- Ketone testing in pregnancy is beneficial to rule out starvation ketosis in clients experiencing weight loss. Ketone testing may also be helpful during illness or periods of hyperglycemia.[2,3]
- Diabetic Ketoacidosis (DKA) may develop at lower levels of hyperglycemia during pregnancy in women with pre-existing diabetes and is potentially fatal to the fetus.[2] Home ketone-testing methods using urine and blood are available.
- Ketone testing is recommended during illness or when BG exceeds levels of 14.0 mmol/L.
- Breastfeeding should be considered a form of physical activity and addressed accordingly. More frequent breastfeeding will lower BG and less frequent breastfeeding will cause BG to rise.

*Pre-existing/pre-gestational = The presence of diagnosed type 1 or type 2 diabetes prior to pregnancy.
**Non-insulin therapies = oral antihyperglycemic agents or injectable incretin-based therapies.

TARGET BLOOD GLUCOSE LEVELS FOR PREGNANCY

- Target BG values for pre-conception planning and during pregnancy are lower than non-pregnant values.[3]

Table 3-1 Recommended Glycemic Targets Preconception and During Pregnancy[1,3]

Pre-pregnancy A1C	< 7.0%
Fasting and preprandial plasma glucose (PG)	< 5.3 mmol/L (3.8 – 5.2 mmol/L)
1-hour postprandial PG	< 7.8 mmol/L (5.5 – 7.7 mmol/L)
2-hour postprandial PG	< 6.7 mmol/L (5.0 – 6.6 mmol/L)

SELF-MONITORING OF BLOOD GLUCOSE (SMBG)

- The frequency and timing of SMBG should be individualized – it is recommended at least four times a day for women taking insulin, planning a pregnancy, and during pregnancy. However, consideration should be given to cost, ability, glycemic control, etc.
- A combination of ac (before meal) and pc (after meal) SMBG is recommended. Evidence suggests that 1-hour postprandial tests are superior to 2-hour pc tests to reduce macrosomia and preeclampsia.[1-3]
- Due to the increased risk of nocturnal hypoglycemia with any intensive insulin therapy, it is recommended that some overnight (0300 hours) tests also be included to assess for nocturnal hyperglycemia and hypoglycemia.[1]
- Use of alternate sites for capillary SMBG is not recommended during pregnancy, as they might not identify the rapid change in glucose common during pregnancy.[2-3]

Achieving the glycemic goals of therapy during pregnancy is very important. Therefore, frequent insulin dose adjustment and close follow-up are recommended.

INSULIN THERAPY FOR PREGNANCY

If the diabetes educator has limited or infrequent experience with pregnant women with type 1 diabetes, insulin requiring type 2 diabetes, or GDM, it is recommended that she/he be in contact with or mentored by a diabetes educator or physician with an expertise in this area.

- Intensive insulin therapy is necessary to achieve optimal glucose control.
- The principles of insulin dose adjustment are used as outlined in the Pattern Management section on page 45.
- Initial insulin doses for pregnancy are determined according to individual glycemic assessment. Women with gestational diabetes mellitus (GDM) not well managed with nutrition and physical activity therapies should start with 6 to 10 units of basal insulin in early pregnancy (usually at bedtime). The starting dose will depend on the level of dysglycemia and current weight. Check BG, titrate, and introduce prandial (bolus) insulin as required.[3]
- It is common practice to switch women from long-acting insulin analogues to intermediate-acting (NPH® or Humulin® N) insulin for pregnancy.[3] The decision as to which type of insulin is used should be made after a discussion regarding the benefits and risks of each insulin.
- Detemir appears safe for pregnancy use with similar perinatal outcomes as compared to NPH® in pregnancy; however, the study was not powered to show differences in perinatal outcomes.[1] There is less data on use of glargine in pregnancy but no adverse effects have been found in fetal or maternal outcomes.[1]
- Rapid-acting insulins (aspart and lispro) are safe for use in pregnancy[1-3] and may result in better postprandial control and fewer hypoglycemic episodes than short-acting insulins.[1,2] To date, there is no information on the use of insulin analogue glulisine in pregnancy.[1]
- Premixed insulin is not recommended during pregnancy, as it does not allow individual insulin dose adjustment as required.
- Insulin pump therapy may be useful in pregnancy due to the availability of multiple basal rates.[1-3] Women must be educated about the increased risk of hyperglycemia and DKA as they relate to technical issues such as pump failure, kinking of the infusion set, air bubbles, or prolonged use of an insertion site.[1-3] Insertion sites may need to be changed more frequently (e.g., every 2 days) due to the high doses infused. Hyperglycemia is more common as the site becomes less effective. Adjustments in pump settings are more aggressive than for non-pregnant clients.
- Insulin requirements can be anticipated to decline by 10 to 20% during the first trimester, leading to increased episodes of hypoglycemia especially in those women having optimal glucose control.[3] Insulin requirements increase during the second and third trimesters to double or even triple the total needed prior to pregnancy, often peaking by 35 to 36 weeks gestation.[2,3] Declining insulin requirements during the third trimester should not be interpreted as placental deterioration, but do indicate a need for close monitoring of fetal well-being.[3]
- There is a significant decrease in insulin requirements postpartum.[2,3] Initial postpartum doses may be started at one-third to one-half pre-delivery doses.[3]
- Postpartum insulin requirements are often lower in women who breastfeed, and episodes of hypoglycemia are common. SMBG is used to guide management.[2,3]
- Women with GDM requiring insulin during pregnancy rarely require insulin postpartum. SMBG should be used for 24 to 48 hours to help identify women with previously undiagnosed type 1 or 2 diabetes.[3] It is recommended that testing for diabetes be done at approximately 6 weeks postpartum for those with GDM.

PATTERN MANAGEMENT

- The same principles for basic pattern management for dose adjustment are followed as for those of the non-pregnant adult.
  - Dose adjustments may need to be more aggressive and/or more frequent due to increased insulin resistance during pregnancy and need for tighter glucose control. Motivated women can be instructed to make insulin self-adjustments at home.[2-3]
  - It is advised that adjustments be made according to pattern management rather than ongoing supplemental corrections to correct BG readings that fall out of range.[2,3]
  - Daily adjustments may be necessary for persistent hyperglycemia.

INSULIN ADJUSTMENT FOR SICK DAYS DURING PREGNANCY

- First, rule out obstetrical complications as the cause of sick day symptoms:
  - Hyperemesis
  - Gestational hypertension
  - Urinary tract infection
  - Labour
  - Other potential medical conditions; e.g., appendicitis, renal colic, etc.

See the DCPNS Pregnancy and Diabetes Guidelines: Approaches to Practice 2014.[3]

- The same principles of insulin adjustment for sick day management are followed as those for the non-pregnant adult with the exception that target BG levels remain tighter; i.e., < 8 mmol/L even during sick days. *See Section 2 - Insulin Adjustment for Illness and Prevention/Treatment of DKA, page 67.*

OTHER SITUATIONS

- Insulin adjustment for other situations - travel, exercise, and pump therapy - are the same as for the non-pregnant adult with the exception that BG target goals for pregnancy remain more stringent. *For physical activity/exercise, see page 77; for travel, see page 90; and for pump therapy, see page 155.*

EXAMPLE:

Audrey, age 31, Gravida 2 Para 1, was diagnosed with GDM at 26 weeks gestation. Her pre-pregnancy BMI is 29. She was started on a nutrition plan and taught SMBG. At the second appointment, her diet was appropriate; and she was walking 30 minutes daily after supper.

Her SMBG results were ranging:

ac breakfast	4.7 to 5.1 mmol/L
1-hour pc breakfast	7.0 to 7.6 mmol/L
ac supper	6.3 to 7.9 mmol/L
ac bedtime snack	5.9 to 6.9 mmol/L

She was instructed on insulin administration and prescribed intermediate-acting insulin 10 units ac breakfast.

At the follow-up appointment 3 days later, her SMBG results were:

	Day 1	**Day 2**
ac breakfast	4.8 mmol/L	5.1 mmol/L
1-hour pc breakfast	7.0 mmol/L	7.3 mmol/L
ac supper	5.6 mmol/L	5.7 mmol/L
ac bedtime snack	5.9 mmol/L	5.6 mmol/L

She was advised to increase her intermediate-acting insulin to 12 units ac breakfast to improve supper glucose levels.

On telephone follow-up 2 days later, her SMBG results were:

	Day 1	**Day 2**
ac breakfast	4.8 mmol/L	4.9 mmol/L
1-hour pc breakfast	6.9 mmol/L	7.6 mmol/L
ac supper	5.2 mmol/L	4.8 mmol/L
ac bedtime snack	5.2 mmol/L	5.0 mmol/L

Audrey was advised to continue with her intermediate-acting insulin 12 units ac breakfast and to include SMBG ac and pc lunch and 1-hour pc supper. She was advised re: self-adjustment guidelines and given a follow-up appointment.

REFERENCES:

1. Canadian Diabetes Association Clinical Practice Guidelines Expert Committee. Canadian Diabetes Association 2013 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. *Canadian Journal of Diabetes*. 2013;37(suppl 1):S1-212.
2. Kitzmiller J. *Managing Preexisting Diabetes and Pregnancy Technical Reviews and Consensus Recommendations for Care*. Alexandria, VA: American Diabetes Association; 2008.
3. Diabetes Care Program of Nova Scotia. *Pregnancy and Diabetes Guidelines: Approaches to Practice (2014)*. Halifax, NS: Author; 2014.

RECOMMENDED READING:

- The Canadian Forum for Injection Technique (FIT) Board. *FIT Forum for Injection Technique Canada: Recommendations for Best Practice in Injection Technique*. Canadian Diabetes Association, BD, and Diabetes Quebec; 2012. Available at: https://www.bd.com/resource.aspx?IDX=25063. Accessed December 2015.

- American Diabetes Association. Coustan D, ed. *Medical Management of Pregnancy Complicated by Diabetes, Fifth Edition*. Alexandria, VA: Author; 2013.

CASE STUDIES - PREGNANCY

- In preparation for writing the DMF certification exam and using these guidelines in daily practice, the following case studies should be reviewed and discussed with your Medical Advisor or his/her designate.
- For each case study, read through the narrative and case study questions.
- To answer the questions, draw on your own knowledge and experience, see related section(s) in the manual, and see references and recommended readings.
- Read through the case study answer sheet, compare/contrast your answers, and review/discuss with your Medical Advisor or designate.

CASE STUDY 1: PREGNANCY

NARRATIVE:

Mrs. M. is a 35-year-old, non-smoker who is pregnant. This is her first pregnancy. There is a family history of diabetes (grandfather with type 2 diabetes). She was referred to the DC at 30 weeks gestation with GDM and started on an 1800-calorie nutrition plan. She was also instructed on SMBG and asked to do SMBG ac and 1-hour pc meals.

Based on her SMBG results ac supper, it was decided on November 12 that Mrs. M needed to start on 8 units of intermediate-acting insulin at breakfast. As values remained above target ac breakfast, 10 units of intermediate-acting insulin were added at bedtime on November 15.

PHYSICAL AND LABORATORY FINDINGS:

- 50 gram glucose challenge test result 10.8 mmol/L at 24 weeks gestation
- At 25 weeks gestation, sent for 75 g Oral Glucose Tolerance Test (OGTT). Positive diagnosis: fasting, 5.6 mmol/L; 1-hour, 9.3 mmol/L; 2-hour, 9.0 mmol/L
- Pre-pregnancy BMI = 32

CURRENT DIABETES MEDICATION:

- Intermediate-acting insulin at breakfast and bedtime.

SMBG RESULTS (AFTER STARTING NUTRITION PLAN):

DATE	BLOOD GLUCOSE					INSULIN				COMMENTS
	ac bkfst	ac lunch	ac supper	hs bed	other	B	L	S	hs bed	
	1-hour pc		1-hour pc							
Nov. 10	5.1	5.2	6.6	5.6						
	7.1		8.4							
Nov. 11	5.3	4.6	5.8	5.3						
	7.1		7.9							
Nov. 12	5.5	4.7	6.1	5.5						
	8.2		8.3							
Nov. 13	5.4	5.4	5.6	5.4		IA 8 units				Start intermediate-acting insulin 8 units ac breakfast
	7.3		8.6							
Nov. 14	5.8	4.5	5.6	5.7		IA 8 units				
	8.1		8.8							
Nov. 15	5.9	5.0	5.5	5.5		IA 8 units			IA 10 units	Start intermediate-acting insulin 10 units at bedtime
	8.4		8.3							

CASE STUDY 1 PREGNANCY QUESTIONS:

1. What are the indications for starting insulin in the pregnant population; and when initiating insulin, what time of day is best?
2. On November 15 follow-up, how would you advise her about the morning dose of insulin?
3. What would you advise about her fasting values?
4. How would you manage her high glucose values pc breakfast and supper?

CASE STUDY 1 ANSWERS:

1. Consider that:

- Target BG levels for pregnancy are much lower than non-pregnant values (preprandial < 5.3 mmol/L; 1 hour, < 7.8 mmol/L; 2 hour, < 6.7 mmol/L). Initiation of insulin is indicated based on BG values above target.
- When initiating insulin, the dose should be guided by the results of SMBG.
- In this case, the results are slightly higher ac supper than earlier in the day; therefore, insulin was started ac breakfast to affect the late afternoon/supper results.
- Once the supper results improved, insulin was added at bedtime to improve morning results.

2. As BG ac supper is still above target, advise her to increase her morning insulin by 2 units every 1 to 2 days until she has readings < 5.3 mmol/L ac supper.

3. Consider the following:

- With an improvement in the ac supper values, add bedtime insulin to improve the fasting values.
- The bedtime insulin dose of 10 units is appropriate based on her degree of dysglycemia, weight, and response to the earlier insulin resistance.
- An alternative might be a small dose of rapid-acting (or short-acting) insulin ac supper and a small dose of intermediate-acting insulin at bedtime.
- As the pregnancy and insulin resistance progresses, increasing doses or adding a second dose can be done fairly aggressively.
- Waiting too long may cause a situation whereby you are always trying to "catch up."
- Doses can be increased or added after a pattern of two to three days indicates the need.
- Remember long-acting insulin analogues are not routinely used in pregnancy.

4. Consider the following:

- Aim for BG readings ac breakfast and ac supper slightly lower into the target range (i.e., 4.0 to 5.0 mmol/L) to prevent or delay the need to add rapid-acting insulin.
- Inform Mrs. M. that the rapid-acting insulin may need to be added at a later date.
- A small dose (e.g., 2 to 4 units) of rapid-acting insulin can be added ac breakfast and ac supper.

CASE STUDY 2: PREGNANCY

NARRATIVE:

Mrs. B. is a 23-year-old woman who has had type 1 diabetes for 6 years. Mrs. B. was referred to the multidisciplinary team at the Pregnancy & Diabetes Clinic for pre-conception counseling. Mrs. B. would like to have children but has fears regarding miscarriage, fetal deformities, and the impact of pregnancy on her own health.

PHYSICAL AND LABORATORY FINDINGS:

- Height 5' 3"
- Present weight is 65 kg
- BMI is 26
- BP is 128/76 mm/Hg
- A1C is 8.6%
- No proteinuria; no neuropathy
- Annual eye exams show no retinopathy
- 2200-calorie nutrition plan
- No exercise/physical activity routine
- Smoker - 1 pack/day

CURRENT DIABETES MEDICATION:

- Intermediate-acting (basal) insulin 15 units ac breakfast
- Short-acting (bolus) insulin 8 units ac breakfast
- Short-acting (bolus) insulin 8 units ac lunch
- Intermediate-acting (basal) insulin 8 units ac supper
- Short-acting (bolus) insulin 8 units ac supper

RECENT SMBG RESULTS:

DATE	BLOOD GLUCOSE					INSULIN				COMMENTS
	ac breakfast	ac lunch	ac supper	hs bed	other	Breakfast	Lunch	Supper	hs bed	
June 4	10.7		2.9 (1500 hours)	9.6		IA 15 units SA 8 units	SA 8 units	IA 8 units SA 8 units		Same insulin daily
June 5	9.6	7.6	2.1 (1445 hours)	11.4						Over treated low, and ate more at supper
June 6	8.7	7.8	4.8	10.2						
June 7	11.2		1.9 (1515 hours)	9.4						

CASE STUDY 2 PREGNANCY QUESTIONS:

1. What issues need to be addressed to improve Mrs. B's chances of a healthy pregnancy?
2. What issues need to be assessed to improve her glycemic control?
3. What might be some of the insulin adjustments that she can expect during her pregnancy?

CASE STUDY 2 ANSWERS:

1. The issues that need to be considered for a healthy pregnancy include:

- Improve glycemic control to reduce the risk of fetal anomalies and miscarriage.
- Begin folic acid supplement.
- Prevent pregnancy until diabetes is better managed; ensure she is using reliable contraception. Preconception care and pregnancy planning are essential for improved maternal and fetal outcomes.
- Educate regarding pregnancy and diabetes.
- Smoking cessation.
- CHO counting.

2. Improved glycemic control would involve a discussion on the following:

- Nutrition Plan. A thorough review of her nutrition plan, consistency of carbohydrate intake, and carbohydrate counting instruction.
- Exercise/physical activity. Choose an activity that is enjoyable and suits her lifestyle.
- Insulin:

  Adjustments are needed. The two areas that need immediate attention are mid-afternoon hypoglycemia and fasting hyperglycemia. Discuss adjustments to correct hypoglycemia first.

  A: Introduce a four injections a day schedule and doses.
  B: Reduce morning intermediate-acting insulin and
  C: Change to rapid-acting insulin in place of short-acting insulin.
  D: Move supper intermediate-acting insulin to bedtime.

  B and C should reduce the mid-afternoon hypoglycemia; C should give her more flexibility; A and D should improve her fasting hyperglycemia; A to D should improve her A1C prior to conception. For example:

ac breakfast	**ac lunch**	**ac supper**	**hs bed**
IA 12 units RA 8 units	RA 6 units	RA 8 units	IA 8 units

  - Teach insulin self-management and guide her as necessary.
  - Review site rotation.
  - Ensure appropriate treatment for hypoglycemia.
  - Increase number of SMBG tests a day (ac and pc tid and ac and hs snack), and test at 0300 hours before adjusting bedtime intermediate-acting insulin.

3. Review the following expectations for pregnancy.

- Insulin requirements often are lower in the first trimester increasing the risk of hypoglycemia. Insulin doses would need to be lowered according to SMBG results.
- Insulin requirements may double or triple from pre-pregnant doses during the 2nd and 3rd trimester of pregnancy. Frequent SMBG and dose adjustment is crucial.
- Frequent contact is recommended (in person or by phone, e-mail, etc.) to assess progress and provide guidance and reassurance.

CASE STUDY 3: PREGNANCY

NARRATIVE:

Mrs. P. has type 2 diabetes and presents with an unplanned pregnancy. It is confirmed with an ultrasound that she has a viable pregnancy at 7 weeks gestation. She wishes to continue the pregnancy.

PHYSICAL AND LABORATORY FINDINGS:

- Height 5' 4"
- No neuropathy; no retinopathy
- Present weight is 95 kg
- Present daily intake is ~2200 calories
- BMI is 36
- Attends water aerobics once a week
- BP is normal
- Non-smoker; no alcohol
- A1C is 9.6%

CURRENT DIABETES MEDICATION:

- Janumet® 50/1000 mg BID

RECENT SMBG RESULTS:

DATE	BLOOD GLUCOSE	
	ac breakfast	2-hour pc supper
Day 1	8.6	
Day 2	7.8	9.6
Day 3	9.1	11.3

CASE STUDY 3 PREGNANCY QUESTIONS:

1. What issues need to be discussed regarding her glycemic control?
2. What issues need to be addressed regarding her diabetes medication?
3. What factors need to be considered when starting her on insulin?

CASE STUDY 3 ANSWERS:

1. The following issues need to be discussed:

- Target glucose values for pregnancy are: ac meals < 5.3 mmol/L; 1-hour pc meals < 7.8 mmol/L; 2-hour pc meals < 6.7 mmol/L in order to reduce the risk of miscarriage and fetal anomalies.
- One-hour pc testing is preferred over 2-hour pc testing. Attaining the 1-hr pc target of < 7.8 mmol/L will help to reduce the risk of fetal macrosomia and the development of maternal gestational hypertension.
- SMBG should be increased; e.g., ac and 1-hour pc tid. There is need for increased BG testing in pregnancy; including more pc tests. This helps to identify patterns of BG (above or below target) thus allowing more timely intervention to achieve the required tight glycemic control required in pregnancy.
- Aggressive BG control may affect the presence of retinopathy. An eye exam is recommended. Screening for other microvascular complications is also recommended.

2. The following issues regarding her diabetes medication need to be addressed:

- Januvia® (Sitagliptin) is not recommended in pregnancy– (*See Section 4, Table 1B, page 179.)*
- Insulin therapy is required to improve her glycemic control for pregnancy. All recorded BG values are above the targets for pregnancy. These values indicate a need for intermediate-acting insulin at bedtime to reduce her fasting BG. The high values pc supper indicate a need for rapid-acting insulin at supper. Further testing is needed to assess her need for intermediate-acting insulin at breakfast and for rapid-acting insulin at breakfast and/or lunch.
- Glucophage® should be continued at 1000 mg bid until insulin initiation and glycemic targets achieved. Glucophage® has been shown to be safe in early pregnancy and will help to prevent severe hyperglycemia, which is teratogenic.

3. Consider the following:

- Nutrition plan adjustments
- Weekly water aerobics
- Increased BMI
- Significantly elevated glucose readings
- Stopping her non-insulin therapy
- Her understanding of the need for multiple daily injections as the pregnancy progresses
- Hypoglycemia at any point and the increased possibility as she nears targets
- Frequent insulin adjustments
- Teaching insulin self-adjustments
- SMBG frequency will change. If on basal only insulin testing 2 times a day is recommended (alternate times, e.g., ac/pc B and S one day; ac/pc L and hs the next, etc. If moved to meal time insulin, will require ac/pc testing with all meals.
- She needs an ophthalmology assessment as soon as possible given her unplanned pregnancy and anticipated aggressive glycemic improvement.
- Screening for other microvascular complications
- Close follow-up

INSULIN DOSE ADJUSTMENT FOR CHILDREN/ADOLESCENTS

KEY POINTS

Some young children may be quite sensitive to rapid-/short-acting insulin and require little or none at all.

- Children and adolescents require sufficient insulin to support healthy growth and development and prevent long-term complications.
- Insulin is required for children with type 2 diabetes with severe metabolic decompensation at diagnosis (e.g., DKA, A1C > 9.0%, symptoms of severe hyperglycemia).[1]
- Rapid-, short-, intermediate-, or long-acting insulins are appropriate for use in children and adolescents. Long-acting insulin analogues (basal insulin) are approved for individuals older than 6 years of age but are used with physician prescription in children under 6 years of age.
- Insulin dosage should be individualized based on the child/adolescent's body weight and BG levels. The units of insulin/kg required in a 24-hour period should be monitored on a regular basis.[2]
- The starting dose of insulin is usually 0.5 to 0.6 units/kg of body weight/day, but must be individualized. During the first week of therapy, an average of 1 unit/kg of body weight/day may be required because the child/adolescent is initially insulin resistant.[1,2]
- Insulin requirements may decrease to as little as 0.1 to 0.3 units/kg of body weight/day during the partial remission or honeymoon phase. Continuation of insulin (at a reduced dose) is recommended during this period.[1,2]
- Any of the insulin regimens may be used, but the current recommendation is that a three or four injections a day regimen be the starting schedule for all children and adolescents with type 1 diabetes.
- The average dose of insulin required depends on the child/adolescent's activity and metabolic requirements; however, it is usually under 1 unit/kg of body weight/day in the prepubertal child.[2]
- During a teenage growth spurt, insulin requirements may reach 1.5 units/kg of body weight/day or more.[2]

TARGETS FOR CHILDREN/ADOLESCENTS WITH TYPE 1 DIABETES [1,2]

The targets are intended as guidelines (Table 3-1). Targets should be graduated to the child's age.[1] There is little scientific evidence for age-related glucose targets. Each child should have their targets individually determined with the goal of achieving a value as close to normal as possible while avoiding severe hypoglycemia, as well as frequent mild to moderate hypoglycemia.[2]

Table 3-1: Target Blood Glucose for Children/Adolescents with Type 1 Diabetes

Age Groups	A1C%	ac meals	2-hours pc meals	Bedtime/nocturnal
Under 6 years of age	< 8.0%[1]	6.0 to 10.0 mmol/L[1]	individualize	individualize
6 to 12 years of age	< 7.5%[1]	4.0 to 10.0 mmol/L[1]	5.0 to 10.0 mmol/L[2]	6.7 to 10.0 mmol/L[2]
13 to 18 years of age	< 7.5%[2]	4.0 to 7.0 mmol/L[1]	5.0 to 10.0 mmol/L[1]	6.7 to 10.0 mmol/L[2]

SELF-MONITORING OF BLOOD GLUCOSE (SMBG)

- Routine SMBG ac meals and bedtime snack.
- When short-acting or rapid-acting analogue is used, postprandial (2-hour pc) BG monitoring will help fine-tune mealtime insulin dose or bolus (if on pump or MDI).
- Extra testing at 2300 and 0300 hours is recommended when first diagnosed. These tests may be discontinued once SMBG results are stable.
- 2300 and/or 0300 hour readings are indicated if:
  - There is a concern of possible nocturnal hypoglycemia.
  - At time of illness.
  - Evening insulin has been changed.
  - The child has had a more active day than usual and/or there is a history of post-exercise hypoglycemia.
  - There is persistent fasting hyperglycemia (rule out dawn phenomenon).
  - As necessary, as directed by the diabetes HCT or parental judgment.
- Continuous glucose monitoring (CGM), or sensor-augmented therapy for pump users, may be helpful to identify periods of glucose variability.[1]
- There are stand-alone CGM units that can be used without pump therapy.

PATTERN MANAGEMENT

- The same principles for basic pattern management for dose adjustment are followed for children and adolescents as those for adults.
- Assess patterns or trends of BG results over two to three days.
- Identify other factors that may cause BG variability; e.g., food intake, CHO counting skills, activity level, presence of illness/infection, etc., prior to making insulin dose adjustment.
- Identify insulin action that influences a particular pattern.
- Adjust insulin by 1 to 3 units (maximum 10% of time of day dose). For toddlers, the adjustment may be 0.5 units changes.[1]
- Leave the changes for three to four days, then reassess.
- Hypoglycemia must be corrected more aggressively. The cause of hypoglycemia should be determined and attempts made to prevent it if the cause is identified. This may include insulin dose adjustment.
- Severe hypoglycemia with loss of consciousness requires medical assessment and assistance with immediate insulin dose adjustment.
- All families and adolescents should be instructed in insulin dose adjustment. Assessment of readiness to assume responsibility for self-insulin dose adjustment is ongoing. A staged approach to transferring this responsibility from the HCT to the family works best. The child/adolescent/family should know that assistance is always available for situations in which they feel uncomfortable.[1]

If the diabetes educator (nurse or dietitian) has limited and/or infrequent experience with diabetes in children, it is recommended that she/he be in contact with or mentored by a diabetes educator or MD with expertise in this area.

SUPPLEMENTAL DOSE ADJUSTMENT

- Most children/adolescents should be provided with an individually designed variable dose algorithm to adjust rapid-acting insulin.
- The purpose of the algorithm is to provide guidelines for adjusting the dose of insulin based on BG level, food intake, and/or anticipated activity.
- The algorithm is developed by the diabetes HCT together with the child/adolescent/family and should be reassessed on a regular basis.
- Adjustments to the variable dose algorithm are very individualized.

Use of algorithms for adjustments should be individualized depending on the regimen and motivation of the child/adolescent/ family.

- Adjust algorithm by 5% of the TDD if BG is 15 to 17 mmol/L or use ISF (Insulin Sensitivity Factor, Section 2 – Supplemental Dose Adjustment) to determine adjustment needed.
- Adjust algorithm by 10% of the TDD if BG is > 20 mmol/L or use the ISF to determine adjustment needed. Also, if moderate to large urine or blood ketones are present, follow management guidelines for sick days. (*See Table 3-2 for sick day adjustments, page 138.*)[1]

SAMPLE FORMAT FOR ALGORITHM

IA = Intermediate-acting RA = Rapid-acting LA = Long-acting

Circle appropriate Insulin(s)

BG (mmol/L)	Basal Insulin	Rapid/Short-Acting (Bolus Insulin)				Basal Insulin
		Breakfast	Lunch	Supper	hs/bed	
≤						
Target	**IA/LA (AM)**	**RA**	**RA**	**RA**	**RA***	**IA/LA (Supper/hs)**

**Use of rapid-acting insulin at bedtime is used cautiously because of the risk of nocturnal hypoglycemia. A conservative supplement for excessively elevated BG readings at bedtime is sometimes used. For children/adolescents on MDI, a conservative dose for the bedtime snack may be used.*

SICK DAY MANAGEMENT

- Acute illness usually upsets BG levels and increases insulin requirements; however, low BG levels (plus decreased insulin requirements) are also possible. Good judgment and close monitoring are required.[2]
- Illness can be managed at home if there is careful attention to sick day guidelines and DKA prevention, and 24-hour access to the diabetes HCT.
- BG and ketones should be tested every two to four hours while the child is sick.
- Supplemental rapid-/short-acting insulin may be given based on SMBG results and the presence or absence of urine or blood ketones. The use of rapid-acting insulin is advised. (*See Table 3-2 below*.)
- Supplemental rapid-/short-acting insulin is calculated as a percentage of the TDD using the 5-10-15% rule.
- Take 10 to 15 grams CHO as liquid hourly if unable to eat solids.
- Take extra sugar-free fluids to prevent dehydration.
- Record BG and ketone results.
- Call diabetes HCT for assistance as needed.
- Medical assessment is required if the child/adolescent:
  - Has vomited more than once in four hours.
  - BG is < 4 mmol/L and unable to keep BG above 4 mmol/L with hourly fluids and glucose tablets and decreased insulin.
  - There is no improvement in BG after two extra doses of insulin two hours apart and no improvement in ketones.
  - Is showing signs of DKA.
  - **NOTE:** Ketones may be elevated with normal or low BG as a normal response to low caloric intake during illness and do not require extra insulin.

Table 3-2: Insulin Adjustment Guidelines for Sick Days

Ketones		BG (mmol/L)	Extra Insulin Required (rapid-acting)
Blood	Urine		
		< 6.0	Reduce usual dose 5 to 10%
< 1.5	Negative/ Small	6 to 20	Usual doses and at usual times with corrections
1.5 to 3.0	Positive/ Moderate	≥ 14	10% of your TDD in addition to usual dose. If this doesn't work within 2 to 3 hours, try 10 - 15% of your TDD or, if on an insulin pump, use 1.5 times usual correction and seek medical attention.
< 1.5	Negative/ Small	> 20	10% of your TDD in addition to usual dose. If this doesn't work within 2 to 3 hours, try 10 - 15% of your TDD or if on an insulin pump, use 1.5 times usual correction and seek medical attention.
> 3.0	Positive/ Large	> 20	15% of your TDD in addition to usual dose and/or consult with your HCT. If not improving, seek medical help.

Source: Diabetes Care Program of Nova Scotia. *Moving on…with Diabetes: A Youth in Transition Handbook*. Halifax, NS: Author; 2013.

EXERCISE/PHYSICAL ACTIVITY

- All children should be involved in regular exercise/physical activity for good health.
- Increased frequency of SMBG before, during, and after exercise/physical activity is essential to determine individual response to exercise/physical activity.[1]
- Exercise/physical activity may enhance the effect of exogenous insulin by increasing glucose uptake by muscle cells and intracellular glucose metabolism. Depletion of glycogen stores may occur with moderate to intense or prolonged exercise/physical activity.
- If excessive hyperglycemia is present, insulin levels may be too low; and glucose cannot be adequately utilized by the muscles. Also, with the rise of counter-regulatory hormones during exercise/physical activity, glucose and free fatty acid metabolism continue to increase plasma glucose and ketone levels. This can lead to progressive hyperglycemia and even ketosis.
- Exercise/physical activity should be avoided when BG is elevated (greater than 14 mmol/L) and ketones are present. Do not exercise with BG greater than 14 mmol/L and small ketones in urine or > 0.5 mmol/L in blood.[2]
- Young children often need extra food because activities are often unplanned.
- As activity becomes more organized/planned, adjusting insulin is preferred.
- Adjusting insulin (versus adding food) is recommended for adolescents (> 13 years) and younger children when possible.
- Hypoglycemia can be prevented by decreasing insulin dose or adding food.
- Always carry a source of fast-acting glucose when exercising; e.g., glucose tablets.[2]
- Glucose tablets are now the recommended treatment of hypoglycemia for children/adolescents able to use them (i.e., infants cannot).
- Hypoglycemia can occur during or after exercise/physical activity. Delayed hypoglycemia can occur up to 36 hours post exercise.[1]
- Vigorous activity, day-long activity, or those with a history of delayed hypoglycemia may need to adjust intermediate-acting or long-acting insulin analogue doses or pump basal rates by 30 to 50%. The reduction may be needed the night before, the day of, and/or the night following the activity.[2] *See Insulin Adjustment for Pump Therapy (CSII) page 155*.
- An insulin pump may be disconnected during exercise for 1 to 2 hours. BG should be checked before disconnecting the pump and upon reconnecting .[2,3] *See Insulin Adjustment for Pump Therapy (CSII) page 155*.

INSULIN ADJUSTMENT GUIDELINES FOR PLANNED ACTIVITY/EXERCISE

- Insulin adjustment for activity must be accompanied by BG measurements before, during and after the activity to evaluate effectiveness (records of previous experiences can be used as a guide).[1]
- These are guidelines only, specific modifications to insulin depends on the type, intensity, and duration of activity, as well as the individual's prior response to that particular activity.
- Additional quick/fast CHO must be available to treat hypoglycemia even if modifications in insulin have been made.
- If adjusting insulin for activity, adjust the insulin that is peaking at the time of the activity.
- Delay activity if BG is less than target or if over 14 mmol/L with ketones present.
- When someone has already administered their insulin but still plans to exercise, they will need to eat extra CHO to help prevent hypoglycemia. The amount and timing will depend on the duration of the activity as well as the intensity of the activity. Always check BG prior to starting the activity.

Table 3-3: Insulin Adjustment Guidelines for Planned Activity (*Those on small doses of rapid-acting insulin may require greater reductions.)*

Type of Activity	Duration	Insulin Reduction (Peaking Insulin)
Low Intensity (walking; bowling)	• If less than 30 minutes • If greater than 30 minutes	• No adjustment may be necessary • 10% reduction
Moderate Intensity (tennis; swimming; biking)		• 20% reduction
High Intensity (running; soccer; hockey)		• 30-50% reduction
Prolonged Intensity	• Lasting throughout the day	• 50% or greater reduction

Adapted from: IWK Children and Adolescents Diabetes Program. *Activity and Diabetes*. IWK Health Centre, Halifax, NS; 2013.

Table 3-4: Extra CHO Required for Unplanned Activity

Type of Activity	Duration	Extra CHO
Low Intensity	• If less than 30 minutes • If greater than 30 minutes	• No extra CHO required • 10 to 15 grams/hour of exercise
Moderate Intensity		1 gram CHO/kg of body weight/hour of exercise (ideally given every 20 minutes during the hour).
High Intensity		1.5 grams CHO/kg of body weight/hour of exercise (ideally given every 20 minutes during the exercise).

Adapted from: IWK Children and Adolescents Diabetes Program. *Activity and Diabetes*. IWK Health Centre, Halifax, NS; 2013.

REFERENCES:

1. Canadian Diabetes Association Clinical Practice Guidelines Expert Committee. Canadian Diabetes Association 2013 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. *Canadian Journal of Diabetes*. 2013;37(suppl 1):S1-212. Available at: http://www.diabetes.ca/clinical-practice-education/clinical-practice-guidelines. Accessed December 2015.
2. International Society for Pediatric and Adolescent Diabetes (ISPAD). ISPAD Clinical Practice Consensus Guidelines 2014. *Pediatric Diabetes*. 2014;15(Suppl. 20):10-290. Available at: http://www.ispad.org/?page=ISPADClinicalPract. Accessed December 2015.
3. Walsh J, Roberts R. *Pumping Insulin: Everything You Need for Success on an Insulin Pump + a new chapter on CGMs, 5th edition*. San Diego, CA: Torrey Pines Press; 2013.

RECOMMENDED READING:

- Brink S, Joel D, Laffel L, et al. Sick day management in children and adolescents with diabetes. *Pediatric Diabetes*. 2014;15(suppl 20):193-202.
- Colberg S. *Diabetic Athlete's Handbook: Your Guide to Peak Performance*. Champaign, IL: Human Kinetics; 2009.
- Danne T, Bangstad H-J, Deeb L, et al. Insulin treatment in children and adolescents with diabetes. *Pediatric Diabetes*. 2014;15(suppl 20):115-134.
- Robertson K, Riddell MC, Guinhouya BC, Adolfsson P, Hanas R. Exercise in children and adolescents with diabetes. *Pediatric Diabetes*. 2014;15(suppl 20):203-223.

CASE STUDIES - CHILDREN/ADOLESCENTS

- In preparation for writing the DMF certification exam and using these guidelines in daily practice, the following case studies should be reviewed and discussed with your Medical Advisor or his/her designate.
- For each case study, read through the narrative and case study questions.
- To answer the questions, draw on your own knowledge and experience, see related section(s) in the manual, and see references and recommended readings.
- Read through the case study answer sheet, compare/contrast your answers, and review/discuss with your Medical Advisor or designate.

CASE STUDY 1: CHILDREN/ADOLESCENTS

NARRATIVE:

Matthew is a 10-year-old boy diagnosed with type 1 diabetes one week ago. At diagnosis, he presented with a casual BG of 29.6 mmol/L and large ketones, but no DKA. Teaching was completed over three days. This week he has resumed normal activities – school, and soccer on Tuesdays from 1900 to 2000 hours. His mother calls to discuss Matthew's insulin dose and to review what to do when planning for soccer. She is also wondering how much longer the 0300 hours test is needed.

PHYSICAL AND LABORATORY FINDINGS:

- Present weight is 36 kg
- A1C at diagnosis is 11.4%

CURRENT DIABETES MEDICATION:

- Intermediate-acting (basal) insulin 16 units ac breakfast
- Rapid-acting (bolus) insulin 7 units ac breakfast
- Rapid-acting (bolus) insulin 5 units ac supper
- Intermediate-acting (basal) insulin 8 units at hs bed

RECENT SMBG RESULTS:

DATE	BLOOD GLUCOSE						INSULIN				COMMENTS
	ac bkfst	ac lunch	ac supper	hs bed	2300	0300	B	L	S	hs bed	
Friday	7.4	3.4	8.9	17.6	18.9	10.4	IA 16 units RA 7 units		RA 5 units	IA 8 units	
Saturday	8.4	4.0	9.2	16.8	15.9	9.6					
Sunday	6.8	3.6	8.7	15.2	13.6	9.4					

CASE STUDY 1 CHILDREN/ADOLESCENTS QUESTIONS:

1. What information do you need to know before making dose changes?
2. What insulin changes would you suggest?
3. How would you advise the mother to manage soccer?

CASE STUDY 1 ANSWER SHEET:

1. Review the following:

- Food intake/activity level in the morning. Explore possible causes of hypoglycemia.
- Treatment for hypoglycemia.
- Food choices at supper/evening snack.
- Explore possible causes of hyperglycemia at hs bed/2300.

2. If no food/activity causes found, suggest the following:

- Decrease the morning rapid-acting insulin by 1 to 2 units because of hypoglycemia before lunch.
- Increase supper rapid-acting insulin by 1 to 2 units to correct hyperglycemia at hs bed.

3. Instructions for managing soccer or any planned exercise/physical activity would include:

- Review that response to exercise/physical activity is very individual and extra SMBG is needed to help decide on action needed.
- Soccer is a moderate to high intensity sport; therefore, Matthew would require 1.5 grams/kg of CHO to cover each hour of exercise. Matthew's mother would give him 1.0-1.5 x 36 kg = 36 to 54 grams of CHO before his soccer game.
- Test BG before, during, and post game. A 0300 hours test would also be recommended that night to determine if he has delayed hypoglycemia. This can help with planning for future activities/sports.
- If delayed hypoglycemia does occur, a decrease in the bedtime intermediate-acting insulin could be recommended for future activity along with extra BG checks.
- Insulin adjustment can be used as an alternative to an activity snack.
- If low BG levels develop despite activity snack, a decrease in insulin before the activity may also be required.
- If the BG level rises during the game but falls after the game, give the snack after the game. Or some before and some after.
- If the 0300 hours BG has been stable for three nights, and there is no change in his bedtime intermediate-acting insulin, and no extra evening physical activity, the 0300 hours BG can be omitted.

CASE STUDY 2: CHILDREN/ADOLESCENTS

NARRATIVE:

Kirsten is a 2-year-old with type 1 diabetes. She was diagnosed at age 18 months. Her mother calls worried about low BG levels and decreased appetite. When asked when the hypoglycemia was happening, the mother reported hypoglycemia almost every morning around 1000 hours. Kirsten has insulin and then breakfast at 0800 hours. Lately, however, her mother has had difficulty getting Kirsten to eat all of her breakfast.

PHYSICAL AND LABORATORY FINDINGS:

- Present weight is 12 kg

CURRENT DIABETES MEDICATION:

- Intermediate-acting (basal) insulin 1 unit ac breakfast
- Rapid-acting (bolus) insulin 0.5 units ac breakfast
- Rapid-acting (bolus) insulin 0.5 units ac supper

RECENT SMBG RESULTS:

DATE	BLOOD GLUCOSE						INSULIN				COMMENTS
	ac bkfst	ac lunch	ac supper	hs bed	2300	0300	B	L	S	hs bed	
Nov 5	8.4	15.8	10.9	9.8	13.6		IA 1.0 units RA 0.5 units		RA 0.5 units		Low between bkfst and lunch.
Nov 6	8.7	13.6	9.2	8.8	14.2						Low between bkfst and lunch.
Nov 7	12.6	9.2	8.4	8.9	17.6						
Nov 8	7.6	8.7	8.9	9.2	15.6						Low between bkfst and lunch.

CASE STUDY 2 CHILDREN/ADOLESCENTS QUESTIONS:

1. What are the BG goals for this age group?
2. What can the mother do to decrease the chance of hypoglycemia mid-morning?
3. What changes would you make in the insulin/meal plan?
4. What if no rapid-acting insulin is given with 0700 am breakfast, she eats the morning snack at 1000, and is 20.0 mmol/L before lunch at 1200 noon?

CASE STUDY 2 ANSWER SHEET:

1. BG goals are more relaxed for toddlers (6.0 to 10.0 mmol/L at a meal; and individualized at bedtime). It is very important to prevent recurrent, severe hypoglycemia in young children.

2. Suggest the following:

- Give insulin after breakfast.
- If BG is < 10 mmol/L, she may not need any rapid-acting insulin. This should decrease the chance of a mid-morning low.
- If BG is > 10 mmol/L, she probably needs 0.5 units rapid-acting insulin and could give it before or after the meal.

3. Suggest the following changes:

- Give insulin after breakfast. If the BG is > 10 mmol/L and she eats at least half her breakfast, give the usual amount of rapid-acting insulin (0.5 units). If the BG is < 10 mmol/L and she eats only half or less of her breakfast, then try without rapid-acting insulin.
- May need to use an insulin-to-CHO ratio. Or may need to review the CHO amount at breakfast and reduce if appropriate.
- Look at the readings. Although only a few, the BG readings appear to increase at lunch.
- The high ac lunch may be related to treating the mid-morning low. Once the mid-morning lows are corrected, the ac lunch readings may improve and not require further insulin adjustment.
- As the hs BG readings are in range, it is probably necessary, for the time being (in this age group), to ignore the relatively high 2300 hours BG readings.
- Consider discussion of insulin pump therapy (CSII) to allow delivery of smaller doses of insulin.

4. Suggest the following:

- Consider adding some rapid-acting insulin at lunch to correct high BG if necessary.
- If giving rapid-acting insulin ac lunch, the BG should be 20 mmol/L and no extra activity should be planned. Suggest rapid-acting insulin 0.5 units and retest in two hours.

CASE STUDY 3: CHILDREN/ADOLESCENTS

NARRATIVE:

Marcus is a 14-year-old boy with type 1 diabetes. He was diagnosed at age 10. Diabetes management has been very good. Lately, his parents have noticed very high BG levels at suppertime. They have been increasing the morning intermediate-acting insulin with no change in the supper BG levels. They wonder what else they can do.

PHYSICAL AND LABORATORY FINDINGS:

- Present weight is 45 kg
- Recent A1C is 8.2%

CURRENT DIABETES MEDICATION:

- Intermediate-acting (basal) insulin 24 units ac breakfast
- Rapid-acting (bolus) insulin 10 units ac breakfast
- Rapid-acting (bolus) insulin 6 units ac supper
- Intermediate-acting (basal) insulin 11 units at hs bed
- An algorithm from last visit

RECENT SMBG RESULTS:

DATE	BLOOD GLUCOSE						INSULIN				COMMENTS
	ac bkfst	ac lunch	ac supper	hs bed	2300	0300	B	L	S	hs bed	
Sept. 4	7.8	8.4	13.4	8.4	10.2		IA 24 units RA 10 units		RA 6 units	IA 11 units	
Sept. 5	8.2	10.6	15.8	8.7	9.4		IA 24 units RA 10 units		RA 6 units	IA 11 units	
Sept. 6	6.9	7.4	16.2	11.0	12.0		IA 24 units RA 10 units		RA 6 units	IA 11 units	
Sept. 7	6.2	7.8	14.6	6.4	9.2		IA 24 units RA 10 units		RA 6 units	IA 11 units	

CASE STUDY 3 CHILDREN/ADOLESCENTS QUESTIONS:

1. What other things do you need to know?
2. How would you determine what insulin adjustments to make?
3. Construct an algorithm for Marcus. What information would you use?

CASE STUDY 3 ANSWER SHEET:

1. Additional information that would be helpful includes:

- Find out if there are any lows in the afternoon with the increase in intermediate-acting insulin in the morning.
- Ask Marcus to check his BG after school; before his afternoon snack.
- Check the size of the afternoon snack. If it is a large snack, is it because of the lows or is he just hungry?
- Check the time between the afternoon snack and supper. If BG levels are OK after school but high at supper, it may be related to the snack.
- Is he using his algorithm?

2. Determine appropriate adjustments.

- Adjustments would depend on information gathered (see above).
- If high BG levels at supper are related to the afternoon snack, he may need to space the afternoon snack so it is two hours before supper. If this is not possible, he may need rapid-acting insulin with his afternoon snack if he is willing.
- If lows are occurring before the afternoon snack, he will require a reduction in the morning intermediate-acting insulin.
- He is 14 years old; so discussion regarding more intensive therapy should be considered (i.e., four injections a day) – adding rapid-acting insulin at lunch and possibly switching to long-acting insulin analogue to provide 24-hour basal coverage.
- Consider teaching use of an insulin-to-CHO ratio as he may benefit from this.

3. To construct an algorithm, you could:

- Determine his ISF by using the ISF formula.
- **TDD = 51 units**
- **ISF = $\frac{100}{51}$ = 1.9 (2)**

  1 unit of rapid-acting insulin will lower his BG by 2 mmol/L.

OR

- Use his previous experience/response to insulin. Marcus and his parents have found that 1 unit of rapid-acting insulin can lower his BG by 3 to 4 mmol/L.
- In this case, you would use his previous response to insulin as your guide. His algorithm would then be as follows:

Blood Glucose (mmol/L)	Basal Insulin	Rapid/Short-Acting (Bolus Insulin)				Basal Insulin
		Bkfst	Lunch	Supper	hs bed	
4-7	IA 24 units	RA 10 units		RA 6 units		IA 11 units (hs)
7.1-10.0		0		0		
10.1-14.0		+1		+1		
14.1-18.0		+2		+2		
>18		+3		+3		

CASE STUDY 4: CHILDREN/ADOLESCENTS

NARRATIVE:

Mary is a 13-year-old diagnosed with type 1 diabetes one year ago. She was started on MDI, using a long-acting insulin analogue at bedtime and an insulin-to-CHO ratio with breakfast, lunch, and supper. Most nights Mary eats just a small bedtime snack and does not give insulin with this.

PHYSICAL AND LABORATORY FINDINGS:

- Present weight is 44 kg
- Recent A1C is 8.3%

CURRENT DIABETES MEDICATION:

- Mealtime ratios: breakfast: 1:10; lunch and supper: 1:15
- Long-acting insulin 16 units at bedtime

RECENT SMBG RESULTS:

DATE	BLOOD GLUCOSE					COMMENTS
	ac breakfast	ac lunch	ac supper	hs bed	2300 hours	
March 1	7.4	15.4	8.2	3.6	18.4	
March 2	6.8	13.2	6.5	3.4	20.9	
March 3	10.2	16.8	5.8	4.4	17.6	
March 4	7.6	12.5	7.9	3.8	22.8	

CASE STUDY 4 CHILDREN/ADOLESCENTS QUESTIONS:

1. Looking at her recent SMBG results, identify where adjustments need to be made first. What would be the impact of this correction?
2. What additional issues need to be addressed and what supporting information do you need?

CASE STUDY 4 ANSWER SHEET:

1. The low glucose readings at bedtime (hs) should be corrected first, probably related to too much insulin at supper or increased activity. Lower the supper insulin. The present ratio is 1:15, so consider changing to 1:20. Ask Mary to test this new ratio.

The high readings at 2300 may be related to overtreatment of lows at bedtime. Once the bedtime BG readings are within target, review these again. If the glucose at 2300 hours continues to be elevated, Mary will need to add rapid-acting insulin with the bedtime snack. Usually at bedtime you would start with a less aggressive ratio, so start with 1:25 or 1:30. Ask Mary to monitor this and adjust as needed.

2. The BG readings at lunch are elevated. Presently, Mary does not take insulin for snacks. You will need to determine if she is eating a morning snack. Ask her to test before the snack or 2 hours after breakfast to determine if the insulin-to-carb ratio is working. If she has a reading in within target at 2 hours pc and high at lunch, she may need rapid-acting insulin for her morning snack. Check to see if she still needs her morning snack.

INSULIN ADJUSTMENT FOR PUMP THERAPY (CSII)

KEY POINTS

It is recommended that a prerequisite to doing insulin adjustments with CSII is that the diabetes educator (nurse or dietitian) is a certified pump trainer as well as being certified in insulin dose adjustment. This section does not include information learned through certification for pump training.

- Insulin pumps deliver insulin via continuous subcutaneous infusion in increments as small as 0.025 to 0.1 units/hour depending on the pump.
- Insulin pumps are programmed to deliver calculated basal rates as a continuous subcutaneous infusion of insulin (CSII) over a 24-hour period.
- Rapid-acting insulin U100 (100 units/ml) is the recommended insulin for pump therapy.
- Insulin boluses are given to cover carbohydrates (CHO) for meals/snacks. The bolus dose is generally calculated using an insulin-to-CHO ratio (grams or choices). Fixed meal doses for known CHO content can be used as an alternative.
- It is important that the client is able to calculate CHO accurately. Often a refresher is required before pump therapy is implemented.
- It is helpful to keep CHO intake and activity levels reasonably consistent at the start of pump therapy until BG levels are in the target range. This is to allow basal doses to be established. Omission of snacks and avoidance of alcohol during the adjustment period (learning) is also helpful.
- Frequent, accurate BG monitoring (a minimum of four to six tests a day) is an essential component of pump therapy. BG tests before (ac) meals, bedtime, 2400 hours, and 0300 hours are necessary to fine-tune initial basal rates.
- BG tests ac and 2-hr after (pc) meals are necessary to establish/confirm appropriate bolus doses and individual insulin-to-CHO ratios.
- Continuous glucose monitoring (CGM), or sensor-augmented therapy for pump users, may be helpful to identify periods of glucose variability[1] and improve glycemic control.
- Once the initial basal and bolus doses are calculated (formulas for determining these are found in pump therapy manuals), it is important to fine-tune basal and bolus doses; and develop a correction formula or Insulin Sensitivity Factor (ISF) that is client-specific (much like individual algorithms).
- Speed of development of diabetic ketoacidosis (DKA) is quicker with pump use - usually, it is caused by pump infusion site problems or other issues including a displaced catheter, empty reservoir, kinked tubing, or a pump mechanical issue. Frequent testing of BG and appropriate management of hyperglycemia, including ketone testing, will decrease the risk of DKA.
- It is important to change infusion set/reservoirs as well as infusion sites every two (48 hours) to three days (72 hours) to ensure adequate insulin delivery and prevent infection.
- Clients/families/caregivers should be encouraged to:
  - use the bolus calculator for all types of boluses
  - download regularly and review results for patterns
  - keep records of current pump settings (including basal rates and bolus doses)
- When travelling with a pump, see *Pump Considerations for Travel, page 91* for further information. Most pump companies will offer loaner pumps when travelling outside of Canada.

INDICATIONS AND ADVANTAGES OF PUMP THERAPY

Indications:[2,3]

- Individuals with insulin-treated diabetes who have met established criteria for insulin pump therapy must be motivated and interested in optimizing glycemic control. People with the following issues may find increased benefit from insulin pump therapy:
  - Frequent hypoglycemia, nocturnal hypoglycemia, hypoglycemia unawareness, and exercise-induced hypoglycemia
  - Dawn phenomenon (early morning rise in glucose caused by release of counter-regulatory hormones and cortisol)
  - Pregnancy or planning conception
  - Varied lifestyle/schedules
  - Wide fluctuations in BG levels
  - Gastroparesis
  - Recurrent diabetes-related hospitalizations
  - Lower insulin needs (marked insulin sensitivity)
  - Infants and toddlers
  - Client/family choice

Advantages:[2,3,4]

- Currently the most precise way to mimic normal insulin secretion, with the potential to achieve improved glycemic control and also reduce glucose variability.
- Individualized basal rates can help reduce nocturnal hypoglycemia and counteract the dawn phenomenon.
- The severity and frequency of hypoglycemia may be decreased.
- Temporary basal rates better match short-term physiological needs, e.g., during short-term illness. These can also be used to reduce the possibility of exercise-induced hypoglycemia.
- An insulin delivery system to assist with travel, work schedules, and challenging lifestyle events that also offers increased flexibility and perhaps an improved quality of life.
- Far fewer needles a day (i.e., reduced to one every 3 days for the site change).

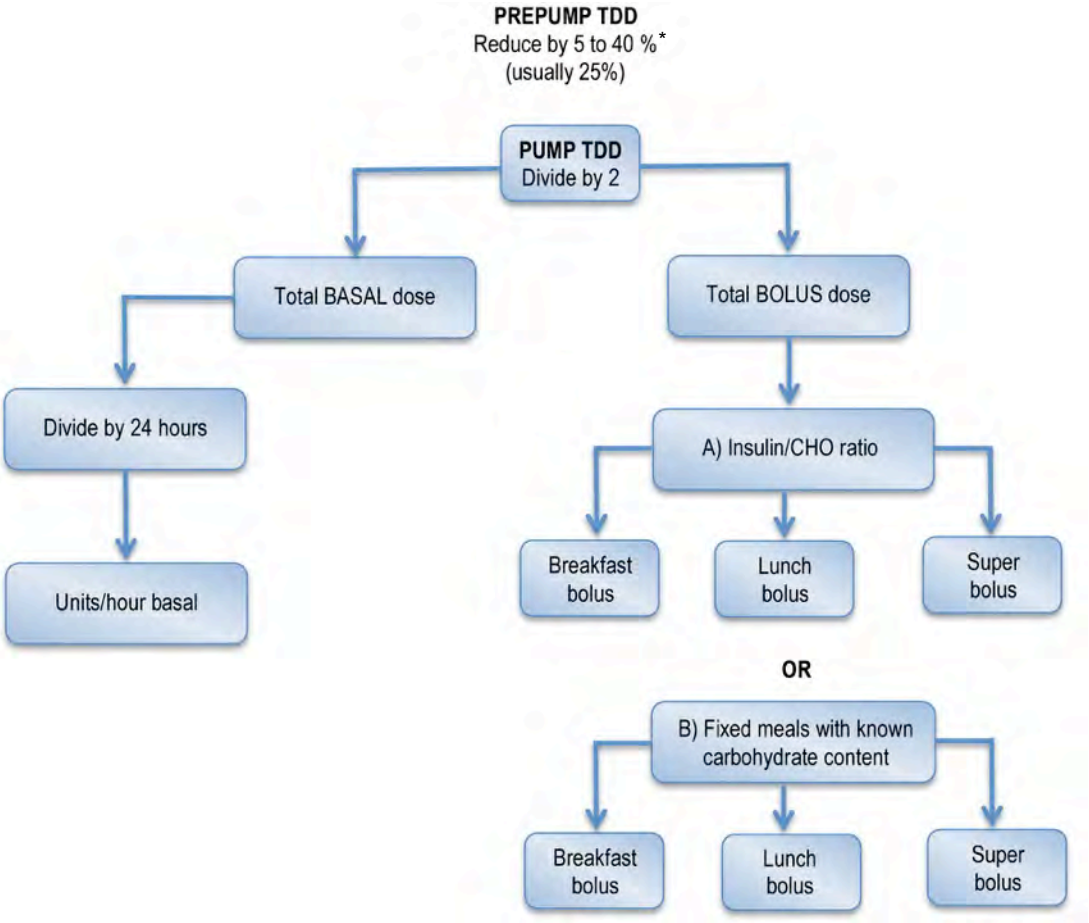
CALCULATING BASAL AND BOLUS REQUIREMENTS FOR PUMP THERAPY

- Start below the requirement and titrate up safely.
- Pre-pump total daily dose (TDD) is usually reduced when starting pump therapy. Generally, there is an average reduction of 25% from pre-pump TDD.[2] It may range from a 5 to 40% reduction.[3]
- Client age and puberty stage may need to be considered.
- An alternative method for determining the starting insulin pump TDD is based on body weight. The TDD is determined by using the client weight in kilograms (kg). For adults it would be times 0.53 units/ kg of body weight and for children prior to puberty, 0.44 units per kilogram.[3]
- A combination of the two methods using the weight method formula and the current TDD via injections reduced by 25% could be considered. An average of these two values is then taken.[2]

PREPARATION FOR THE PUMP START DAY

- The last dose of intermediate-acting insulin is taken the evening before the pump start and then discontinued. It may be suggested to take this last dose at least 12 hours before the actual start time of pump therapy. Lowering of the bedtime dose may not be required unless recent nocturnal hypoglycemia has been problematic.
- If long-acting analogues are used, reduce the supper or bedtime dose (previous to the pump start day) by approximately 50% the evening before the pump start.[5]
- If the long-acting analogue is only taken once a day in the morning, then the last full dose will be discontinued 24 hours before the pump start.
- Corrective doses with rapid-acting insulin may be necessary to counteract the elevated BG prior to the pump start.
- Dietitian review should be considered to ensure accurate carbohydrate counting skills prior to the pump start day.

Examples of Pump Therapy Dose Calculation



* For example, if the A1C is elevated and no hypoglycemia, reduce by less insulin (i.e., 5%). If the A1C is lower with frequent hypoglycemic events, then reduce by more than 25%. This could be as high as 40% to prevent the risk of hypoglycemia.

INSULIN DOSE ADJUSTMENT FOR PUMPS (BASAL/BOLUS)

Basal Dose Adjustment

- If daytime BG is within target on initiation of pump therapy, start with only one basal rate for daytime and a lower rate the first night.
- Adjust basal rate based on the 2400, 0300, and ac meal SMBG results.
- For elevated BG, adjust the basal rate prior to the time you are aiming to correct (i.e., 2 to 6 hours before).
- The goal is for the fasting BG to remain within 1.7 mmol/L of the target BG range. It is best to start in target.

For specific populations, increases or decreases in basal adjustments may differ.

- Temporary basal rate may be used or needed, as directed by the health care team (HCT), to help determine the true insulin requirements.
- Adjust the basal rate by 10 to 20% for BG out of target range.
  - Raise basal rate by 10 to 20% (0.05 to 0.2 units/hour) if BG is higher than target for two to three days in a row, depending on total fine-tuning of daily dose.
  - Lower basal rate by 10 to 20% (0.05 to 0.2 units/hour) if BG is lower than target for two days (change after one low when initiating pump therapy).
  - For very young children, the basal rate may have to be adjusted more finely; e.g., 0.025 units/hour.
- When adding a second basal rate, increase or decrease by 0.05 to 0.20 units/hour increments from the starting basal rate.[1]
- In pregnancy, basal rate adjustments are usually made by 0.1 to 0.2 units/hour.
- When an adjustment in the basal rate is made, close monitoring is important to ensure that the glucose levels have corrected to target range. Consider total change of units in that period of time. i.e., 0.2 units/hr x 5 hours = 1 unit.
- By skipping a meal and recording BG every two hours, basal rates can be assessed. For example, test ac breakfast and skip breakfast bolus dose, breakfast and morning snack. Test BG in two hours and ac lunch. If the basal is correct, the BG should not deviate more than 1.7 mmol/L when meals are skipped. Note: This should be done on a day when fasting BG level is within target.
- Due to tighter glycemic control in pregnancy and the increased risk of hypoglycemia, it is recommended that meals and/or snacks not be skipped.
- Unique patterns of basal infusions may be needed by some clients, but most clients' circadian insulin requirements are met with two or three basal rates a day.[4] Children may need more than two or three basal rates a day.

Insulin-to-CHO ratio can vary between individuals and differ from meal to meal in the same individual.

Meal Bolus Dose Adjustments

- Adjust bolus dose(s) based on the pc BG result.
- The goal is for the BG not to increase more than 2.8 mmol/L from the preprandial level 2-hours pc meal,[2] and to end up no more than 1.7 mmol/L above preprandial levels 4 to 5 hours pc meal.[3]
- Adjust pre-meal bolus dose by 10% or adjust the insulin-to-CHO ratio by 2 grams at a time or consider the typical CHO eaten and calculate the difference in dose. People on a low dose may require higher changes (e.g., 3 to 5 grams to make a dose difference of 10%).

- It is important to start the meal in BG target range when determining what the insulin-to-CHO ratio should be. *See Calculating the Insulin-to-CHO Ratio section, page 51*.
- Continue to SMBG two hours and four hours pc meals for the next two to three days to confirm appropriate adjustment.
- If unsure whether it is the basal or bolus dose that requires adjusting, consider which SMBG results are out of range. For example, if the 2-hour pc BG is out of target, the dose that needs adjusting is, most likely, the meal bolus (provided meal CHO content and insulin-to-CHO ratio calculations are appropriate). If BG results are out of target range ac meals or more than 2 hours pc, it is most likely the basal dose that needs adjusting.
- All pumps have the ability to estimate active insulin (insulin on board [IOB]) and are capable of having an effect on the BG). Pumps have a bolus calculator where the insulin-to-CHO ratio can be set; and if the number of grams of CHO are entered, the pump calculates the bolus. The bolus calculator does not account for physical activity.
- Certain features on insulin pumps may provide the ability to extend meal bolus delivery over time. This is useful for clients with gastroparesis as well as challenges with meals with higher fat content and/or protein content causing a delay in glucose absorption.

Calculating Correction Dose[3] **(***See Calculating the Insulin Sensitivity Factor (ISF) or Correction Dose, page 49)*

- Pumps will calculate the correction dose using the programmed ISF once the target glucose is set. This is helpful as it will subtract insulin still calculated to be active (IOB) from a previous bolus and help to avoid hypoglycemia from stacking boluses.

Example:

Jane is 11 years old and on pump therapy. She is just entering puberty. Her present insulin dose is:

Basal rate: **0.7 units/hour**
Pre-meal boluses: **6.0 units ac breakfast** **4.0 units ac lunch** **6.0 units ac supper**

Jane's TDD is: **17 + 6 + 4 + 6 = 33 units**

Jane's ISF is: $\frac{100}{33}$ **= 3.0 mmol/L**

Jane's SMBG before breakfast this morning is 12.6 mmol/L. Her target BG ac meals is: 4.0 to 10.0 mmol/L. Therefore, her correction dose for this morning would be:

$$\frac{\text{BG} - \text{Target}}{\text{ISF}} = \text{Correction Dose}$$

$$\frac{12.6 - 10.0}{3} = 0.87 \text{ units (0.9 units)}$$

Jane would take her usual 6 units breakfast bolus plus a correction bolus (0.9 units); i.e., 6.9 units before breakfast as recommended by the pump.

Hyperglycemia (Correction Bolus) Dose Adjustment

- Correcting elevated BG is an important element of pump therapy. As the insulin pump only uses rapid-acting insulin, there is a greater risk of developing DKA if insulin delivery is interrupted. This will present as hyperglycemia and ketones.
- If BG is > 14 mmol/L, ketones must be checked as outlined below.

Table 3-5: Hyperglycemia Dose Adjustment

Blood glucose over 14 mmol/L **with low or no ketones** (urine ketones small or blood ketones lower than 0.6)	Blood glucose over 14 mmol/L w**ith ketones** (urine ketones moderate or large or blood ketones higher than 0.6)
• Determine insulin correction using ISF or Correction Factor. • Use the Ez bolus (Animas), Bolus Wizard (Medtronic), Bolus Calculator (Omnipod), or Bolus Advice (Accucheck) to determine the correction dose. • Give insulin using a pump. • Re-test blood glucose and ketones after 2 hours. If blood glucose has not decreased by at least 3.0 points on the meter or ketones are present or have increased, follow the steps for blood glucose over 14mmol/L with moderate or large urine ketones. *Note: When blood glucose is over 14 mmol/L with ketones (urine ketones moderate or large or blood ketones higher than 0.6) see right hand side of this table.*	• **Extra insulin must be given using INSULIN SYRINGE OR PEN.** • Determine insulin dose using ISF or Correction Factor. • Use the Ez bolus (Animas), Bolus Wizard (Medtronic), Bolus Calculator (Omnipod), or Bolus Advice (Accucheck) to determine the correction dose. • Give **1.5** times the usual correction dose using an insulin syringe or pen. **Example**: Blood glucose target of 7 mmol/L. Correction factor is 2.0, blood glucose is 21.0 mmol/L, and blood ketones are 2.0 21 – 7 = 14 14 ÷ 2 = 7 units 7 x 1.5 = 10.5 units (if a ½ unit pen/syringe is not available, give either 10 or 11 units) • Once the insulin has been given by pen or syringe, change the pump site. • Continue testing for ketones and giving insulin as above every 2 hours until ketones are negative. • Call the Diabetes Centre if ketones do not improve. If unable to contact the Diabetes Centre, seek medical attention and go to the local Emergency Room.

Source: Diabetes Care Program of Nova Scotia. *Insulin Pump Initiation for Young Adults/Adults in Nova Scotia Diabetes Centres: Standardized Process with Patient and Provider Tools*. Halifax, NS: Author; 2013.[6]

See Section 2 – Supplemental Dose Adjustment, Calculating the Insulin Sensitivity Factor (ISF) or Correction Dose, page 49.

SICK DAY MANAGEMENT ON AN INSULIN PUMP*

- Test BG every two to four hours during the day when feeling ill and at least once in the middle of the night.[2] Always check the BG before going to bed, especially when feeling unwell.
- Check for ketones if BG is over 14.0 mmol/L.
- Take a correction bolus dose of rapid-acting insulin by syringe/pen if the BG > 14 mmol/L on two consecutive occasions; or if ketones are present when ill (*see Table 3-5, page 161*). If BG is not improving, check the expiry date on the insulin vial.
- If ketones are present, give 1.5 times the usual insulin dose (as the correction bolus) using insulin syringe or pen (*see Table 3-5, page 161*). Remember that the active insulin or insulin on board should **not** be subtracted from the correction bolus.
- Continue to use insulin by syringe/pen until blood ketones are below 0.6 in the blood or trace in urine.
- Always change the infusion site/set and insulin reservoir before resuming the insulin pump.
- If a new site does not alleviate hyperglycemia, than troubleshoot other possibilities i.e., tubing not primed, insulin has expired, poor site choice, menstruation, and illness.
- Consider raising the basal (temporary basal) if the BG continues to remain elevated (after ruling out site/pump technical issues). This will be in conjunction with corrective bolus doses. Basal rates may need to be increased for the duration of the illness.
- If not eating at all but not vomiting, drink 6 to 8 oz of fluid every hour (amounts may be smaller for young children). It is suggested to switch back and forth between fluids that contain sugar, such as soft drinks and juice and sports drinks for one hour, and fluids that do not contain sugar, such as diet pop, tea, and/or water for the other hour. It is important to also choose some liquids that contain salt such as soups or bouillon or electrolyte solutions such as sports drinks or Pedialyte.
- Check BG frequently during time of illness and correct as needed.

DKA MANAGEMENT ON AN INSULIN PUMP*

- In the presence of ketones (*see Table 3-5, page 161*) or if BG > 14 mmol/L on two consecutive occasions, take a correction bolus dose of rapid-acting insulin by syringe/pen. If BG is not improving, a new vial of insulin may be needed.
- If ketones are present, give 1.5 times the usual insulin dose (as the correction bolus) using insulin syringe or pen (*see Table 3-5, page 161*). Remember that the active insulin or insulin on board should not be subtracted from the correction bolus.
- Continue to inject insulin using a syringe/pen until blood ketones are below 0.6 in the blood or trace in urine.
- Always change the infusion set/insulin reservoir and infusion site before resuming the insulin pump.
- Consider troubleshooting possibilities as to why DKA happened, (i.e., pump/site failure, forgetting to bolus, expired insulin, unprimed tubing, empty reservoir, change in routine, etc.) and teach accordingly.

**For additional information, see Section 2 – Insulin Adjustment for Illness and Prevention/Treatment of DKA, page 67.*

EXERCISE WITH PUMP THERAPY*

Activity Considerations

- Pumps may be continued, suspended or disconnected for exercise. Some clients prefer, and certain activities require, the pump to be disconnected (removed) for practical reasons (to protect the pump from damage or water).[3]
- Different types of exercise can affect BG differently. Extra glucose checks and keeping good records can help individualize the approach to exercise.
- Introduction of moderate or strenuous activity should be restricted until initial basal rates are established.
- Exercise that is prolonged or intense causes depletion of muscle glycogen stores and an increase in muscle sensitivity to insulin. This can cause BG to drop several hours after exercise has been completed as the body replenishes the glycogen stores. This is known as delayed onset hypoglycemia.[7]
- Insulin sensitivity can remain elevated for up to 24 hours post-activity. Peak insulin sensitivity can occur up to 7 to 11 hours post exercise.[8,9]
- When activity lasts for longer than 30 minutes, there typically needs to be adjustments with carbohydrates, insulin or both.[9]
- A general rule of thumb for most moderate-intensity exercise (e.g., tennis, swimming, cycling) is to have 15 to 30 grams of carbohydrates for every 30 to 60 minutes of exercise. High intensity activity, such as hockey, soccer and strenuous cycling, will require 30 to 60 grams of carbohydrates every hour.[6]
- The symptoms of hypoglycemia and hyperglycemia can be masked by exercise, it is important to check BG levels often when starting a new exercise.[9]
- Monitor BG before the activity, every 30 minutes during the activity, after the activity, and before bed. Overnight checks may also be required.[9]
- Exercising with ketones can lead to higher glucose and ketone levels. More ketones may precipitate ketosis/DKA. It is important to check for ketones when glucose levels are elevated before beginning the activity.[9]
- Refrain from exercising if fasting glucose is $\geq$ 14 mmol/L and ketones are present.[8] Also, be cautious if glucose levels are 16.7 mmol/L and no ketones are present.[10] Check BG often and react accordingly.

BASAL RATE CONSIDERATIONS FOR EXERCISE

Using Temporary Basal Rates

- A reduced temporary basal rate can be started 60 to 90 minutes before an activity. This decreases the level of circulating insulin during exercise .[8]
- Reduced temporary basal rates should be encouraged before, during, and/or after exercise. Basal rates may need to be decreased by 20 to 80% depending on the duration and intensity of the activity.[9]
- For all-day activities, a temporary basal rate may need to run at 10 to 20% reduction or more overnight the day before the activity and the evening of the event to help prevent hypoglycemia. This requires more BG monitoring.[8,9]

Pump Suspend/Disconnect

- The pump can be disconnected 60 to 90 minutes before an activity. This decreases the level of circulating insulin during exercise.[8]
- If the pump is disconnected or suspended for more than 90 minutes, this may cause hyperglycemia and ketosis may develop quickly.[3] Monitor BG regularly to assess for this.
- To prevent hyperglycemia, clients can re-connect regularly (e.g. 60 minutes but at least every 120 minutes) and give a portion of the missed basal rate as a bolus (typically 50%).[7]
- When the client is not exercising at a level that requires complete elimination of the basal rate, a portion of the missed basal dose (30 to 50%) may be given as a bolus when the client disconnects the pump. Or part way through the activity, if there is a consistent pattern of hyperglycemia after exercise based on the clients prior experience.
- BG monitoring is necessary before disconnecting and upon reconnection of the pump.[3]

BOLUS CONSIDERATIONS FOR EXERCISE

- To avoid hypoglycemia, bolus reductions should be made depending on the time between the before-activity meal and the duration and intensity of the activity:
  - If the meal is more than an hour and up to 2 hours prior to the activity, reduce the bolus by 25 to 75% (reduction depends on the intensity and duration of the activity).[9]
  - It is often helpful to reduce a pre-activity bolus by 50% for carbohydrate intake 30 to 60 minutes prior to exercising.[7]
- Intense, short-duration anaerobic exercise may raise BG with the potential for hypoglycemia later. Correction boluses may be suggested to manage post-exercise hyperglycemia but often should be reduced to avoid later hypoglycemia. Glucose testing and record keeping will aid in this decision.[3]
- Extra carbohydrates post activity is often the best choice to prevent post-exercise hypoglycemia for short duration or high intensity anaerobic activities.[8]

For additional information, see Section 2 – Insulin Adjustment for Exercise/Physical Activity, page 77.

REFERENCES

1. Canadian Diabetes Association Clinical Practice Guidelines Expert Committee. Canadian Diabetes Association 2013 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. *Canadian Journal of Diabetes*. 2013;37(suppl 1):S1-212.
2. Consensus Statement by the American Association of Clinical Endocrinologists/American College of Endocrinology Insulin Pump Management Task Force. *Endocrine Practice*. 2014;20(5):463-489.
3. Walsh J, Roberts R. *Pumping Insulin: Everything You Need for Success on an Insulin Pump + a new chapter on CGMs, 5th edition*. San Diego, CA: Torrey Pines Press; 2013.
4. American Diabetes Association. *Medical Management of Type 1 Diabetes*. Alexandria, VA: Author; 2008.
5. Wolpert H. *Smart Pumping for People with Diabetes*. Alexandria, VA: American Diabetes Association; 2002.
6. Diabetes Care Program of Nova Scotia. *Moving on…with Diabetes: A Youth in Transition Handbook*. Halifax, NS: Author;2013.
7. Bolderman KM. *Putting Your Patients on the Pump*. Alexandria, VA: American Diabetes Association; 2013
8. ISPAD Clinical Practice Consensus Guidelines 2014 Compendium. Exercise in children and adolescents with diabetes. Robertson K, Riddell MC, Guinhouya BC, Adolfsson P, Hanas R. *Pediatric Diabetes.* 2014;15 (Suppl. 20):203-223.
9. Galassetti P, Riddell MC. Exercise and Type 1 Diabetes (TIDM). *Compr Physiol*. 2013 Jul;3(3):1309-36. Doi:10.1002/cphy.c110040.Review. ubed PMID: 23897688.
10. Colberg S. *Diabetic Athlete's Handbook: Your Guide to Peak Performance*. Champaign, IL: Human Kinetics; 2009.

RECOMMENDED READING:

- American Association of Diabetes Educators. *Continuous Subcutaneous Insulin Infusion (CSII)*. Chicago, IL: Author; June, 2014. White Paper.
- Bode B. *Atlanta Diabetes Associates Pumping Protocol: A Physician's Guide to Insulin Pump Therapy Initiation*. Atlanta, GA: MiniMed Inc.; 2008.
- Chamberlain J, Dopita D, Gilgen E. Persistence of continuous glucose monitoring use in a community setting 1 year after purchase. *Clinical Diabetes*. 2013;31(3):106-109.
- Diabetes Care Program of Nova Scotia. *Insulin Pump Initiation for Young Adults/Adults in Nova Scotia Diabetes Centres: Standardized Process with Patient and Provider Tools*. Halifax, NS: Author; 2013
- Diabetes UK. *Insulin Pump Therapy: Also Known as Continuous Subcutaneous Insulin Infusion (CSII)*. London: Author; 2011. Position Statement.
- Frontino G, Bonfanti R, Scaramuzza A, et al. Sensor-augmented pump therapy in very young children with type 1 diabetes: an efficacy and feasibility observational study. *Diabetes Technology & Therapeutics*. 2012;14(9):762-764.
- Jones H, Cleave B, Fredericks C, et al. *Building Competency in Diabetes Education: Advancing Practice*. Toronto, ON: Canadian Diabetes Association and Mount Sinai Hospital; 2013.
- Peppe C. Yikes! The next patient in clinic has a pump. *The Diabetes Communicator*. 2010; Autumn:13-15.
- Walsh J, Roberts R, Varma C, Bailey T. *Using Insulin: Everything You Need for Success with Insulin*. San Diego, CA: Torrey Pines Press; 2003.

CASE STUDIES
INSULIN DOSE ADJUSTMENT FOR PUMP THERAPY

- In preparation for writing the DMF certification exam and using these guidelines in daily practice, the following case studies should be reviewed and discussed with your Medical Advisor or his/her designate.
- For each case study, read through the narrative and case study questions.
- To answer the questions, draw on your own knowledge and experience, see related section(s) in the manual, and see references and recommended readings.
- Read through the case study answer sheet, compare/contrast your answers, and review/discuss with your Medical Advisor or designate.

CASE STUDY 1: INSULIN DOSE ADJUSTMENT FOR PUMP THERAPY – ILLNESS

NARRATIVE:

Mary is a 56-year-old retired teacher who has had type 1 diabetes for 30 years. Mary and her husband love to travel, and they recently drove to New York to visit Mary's sister who also has type 1 diabetes. Both Mary and her sister use the insulin pump as their preferred delivery system and have both indicated that they have been able to improve their A1C since pump therapy was introduced.

Upon arrival in New York, Mary noticed that her blood glucose (BG) was a bit higher than usual. The following evening, Mary felt unwell – abnormally thirsty with slight nausea and abdominal discomfort. She felt like she had a stomach flu. She had already given herself a bolus of 15.2 units for supper with a correction 2 hours earlier. Her sister urged her to test for blood ketones as well as her BG. Mary was surprised to discover that her BG was 25 mmol/L with 1.8 mmol/L blood ketones present. (*See Sick Day Guidelines, Hyperglycemia Dose Adjustment Table 3-5, page 161*).

PHYSICAL AND LABORATORY FINDINGS:

- Present weight is 68.1kg
- BMI is 28
- A1C is 7.6%

CURRENT DIABETES MEDICATION:

- Basal:
  - 2400 hours 0.80 units/hour
  - 0430 hours 0.95 units/hour
  - 1000 hours 0.85 units/hour

- Bolus (Insulin-to-CHO ratio):
  - Breakfast = 1:8 (usual dose 3 units)
  - Lunch = 1:7 (usual dose 9 units)
  - Supper = 1:7 (usual dose 10 units)

- ISF: 2.3 units (24 hours)
- Targets: 5-7 mmol/L
- Active insulin: 4 hours
- IOB: 7.6 units

RECENT SMBG RESULTS:

DATE	BLOOD GLUCOSE								COMMENTS
	ac bkfst	pc bkfst	ac noon	pc noon	ac supper	pc supper	hs bed	0300 hours	
June 20	7.0	7.8	6.2	7.2	7.3	7.9	6.9	-	
June 21	6.0	7.8	5.2	7.0	5.0	6.9	7.0	-	
June 22	8.2	9.2	10.0	11.0	12.0	13.8	11.9	-	Site change
June 23	12.5	13.7	13.9	17.2	19.0	25.0 + 1.8 ketone	16.0 +1.4 ketone	15.0 + 0.6 ketone	Fewer ketones *BG lower*

CASE STUDY 1 ILLNESS QUESTIONS:

1. What immediate sick day management action should be carried out to reverse ketone levels and correct hyperglycemia?
2. What are some practical points that Mary can use when troubleshooting hyperglycemia in insulin pump therapy? Please list any 10 points.

CASE STUDY 1 ANSWER SHEET:

1. **Since the BG > 14 mmol/L and the blood ketone level is already 1.8, the insulin dose requirement should be taken by syringe or pen**. Mary needs to inject extra insulin. Mary will be required to take 1.5 times the usual insulin dose (as a bolus correction dose) of rapid-acting insulin according to the insulin adjustment guidelines for diabetic ketoacidosis (DKA) prevention when on an insulin pump. She must check her BG and blood ketones every one to two hours and should continue to use the insulin syringe/pen until ketones have cleared. Once she has confirmed that the pump is working and the infusion set/reservoir, infusion site, and insulin vial have been changed prior to resuming usage of the pump. If the BG remains high, the basal rate should be raised on a temporary basis. The basal rate should be increased to keep the pre-meal and overnight BG level within 1.7 mmol/L of the baseline level. If the pump has malfunctioned, she should call the 1-800 number on the back of her pump for a replacement. Mary will need to be prepared to revert to her former long-acting insulin for her basal insulin and her rapid-acting insulin for her meal boluses until the new pump arrives.

   Mary still has some active insulin on board (IOB) she will need to add the IOB to her correction bolus as she may not have received this correction properly in the first pump bolus. Remind Mary not to subtract the IOB if she is using her bolus calculator to help figure out her dose.

2. **Mary should follow a trouble shooting approach for her pump and must be aware that even partial interruption of insulin flow can result in hyperglycemia, and complete interruption can result in ketosis or ketoacidosis within a few short hours**.

   - Any of these can occur even if the infusion site/set has been recently changed:
     - Red, tender, and swollen catheter site
     - Leakage, breakage, or kinking of tubing
     - Battery failure
     - Empty reservoir or cartridge
     - Improper positioning of reservoir or piston rod
     - Improper basal rate programming
     - Air in tubing
     - Illness
     - DKA
     - Menstrual cycle fluctuations
     - Omitted bolus, missed bolus, or improper amount given
     - Crimped catheter or needle not penetrating skin
     - Change in usual routine (prolonged sitting with travel)
     - Suspect site not absorbing insulin (site inserted in hypertrophied area)
     - Forgetting insulin dose or no basal delivery

   - Mary should check pump history for insulin delivery (basal/bolus).

CASE STUDY 2: PEDIATRIC INSULIN DOSE ADJUSTMENT FOR PUMP THERAPY & ACTIVITY/EXERCISE

NARRATIVE:

Andrew is a 12-year-old boy who has been on pump therapy for one year. He is joining a soccer team this summer and has practices Monday and Thursday from 1800 to 2000 hours, with games every Saturday from 1600 to 1800 hours. His games are going to be more intense than his practices. His basal dose is 50% of his total daily dose.

PHYSICAL AND LABORATORY FINDINGS:

- Present weight is 45 kg
- Recent A1C is 8.5%

CURRENT INSULIN:

- Basal:
  - 2400 to 0800 0.6 units/hour
  - 0800 to 1200 0.8 units/hour
  - 1200 to 2000 0.7 units/hour
  - 2000 to 2400 0.9 units/hour

- Bolus (Insulin-to-Carbohydrate [CHO] ratio):
  - Meals = 1:10
  - Snacks = 1:15

- ISF: 4
- Targets: 7.0 mmol/L
- Active Insulin: 4 hours
- IOB: none

RECENT SMBG RESULTS:

BLOOD GLUCOSE (BG)			
ac Breakfast	ac Lunch	ac Supper	hs (Evening/Bedtime)
9.8	8.2	7.7	10.1
7.4	9.2	6.5	9.5
8.1	8.5	7.9	8.6
6.4	8.0	7.3	9.3

CASE STUDY 2 PEDIATRIC INSULIN DOSE ADJUSTMENT FOR PUMP THERAPY & ACTIVITY/EXERCISE QUESTIONS:

1. What time of day are his activities?
2. What insulin changes would you suggest for these times (before and after supper)?
3. How would you assess effectiveness of activity insulin adjustment?
4. What about delayed hypoglycemia?
5. What instructions would you give that are pump-specific?

CASE STUDY 2 ANSWERS:

1. The exercise times change. Practice is after supper and games are before supper. All events last for 2 hours.

2. *For practice **after** supper:*

There are different approaches that could work and tracking the approach and recording the result is the best way to work this out. Insulin adjustment is preferred over adding extra CHO for planned activity.

A. CHO bolus considerations for practice *after* supper: This would be the best place to start. As the activity is after the meal, lower the CHO bolus to help reduce insulin levels. He can bolus less insulin for the supper meal on practice days, as this meal is two hours before his game.

He should start with 25%-50% less of the mealtime bolus prior to the soccer practice. (He may need to reduce even more based on his post-activity BG results.)

If the BG is high before disconnection and there has not been a correction bolus in the last two hours, he should consider giving half of the usual BG correction.

OR

B. Basal considerations (off pump procedure) for practice *after* supper: If the pump is to be removed for the practice (two hours), then it may be necessary to replace some of the basal that will be missed. It is likely best to try just disconnecting with no replacement the first time. Then, if he is running high during or immediately post practice, 30 to 50% of the missed basal could be given as a bolus prior to removal of the pump.

For example, 0.7 units/hour x 2 hours = 1.4 units. Fifty percent (50%) would be 0.7 units, or 30% would be 0.4 units. Therefore, he would take 0.4 units to 0.7 units bolus before removing the pump. He can also do this one hour at a time by reconnecting hourly to do this. BG monitoring is necessary before disconnecting and upon reconnecting.

*For games **before** supper: His games are usually much more intense than his practice times. Insulin adjustment is preferred over adding extra CHO for planned activity.*

NOTE: Referees usually require that the pump be removed.

A. Bolus adjustment (off pump procedure) for games *before* supper: He should have his afternoon snack but omit the bolus. Disconnect the pump and check BG half-way through the game. Reconnect and bolus 50% of missed basal if BG rising. BG monitoring is necessary before disconnecting and upon reconnecting. If the BG is high before disconnection and there has not been a correction bolus in the last two hours, he should consider giving a half of the usual BG correction.

OR

B. Basal adjustment for games *before* supper: Leave the pump on and use a temporary basal of minus 30 to 50%. This may need to start 60-90 minutes before the activity and continue until the game is over. The basal rate may need to continue at the lowered basal rate after the game as well.

3. All insulin adjustments for exercise are assessed by doing frequent BG monitoring before, during, and after the exercise.

4. To prevent delayed hypoglycemia, there will be a need for extra BG testing, especially overnight. A temporary basal pattern can be programmed using an insulin reduction of 20 to 30% overnight. The 0300 hour BG test will determine if there is a need to continue with the reduced basal until morning.

5. For pump therapy, it is important to protect the pump from damage during exercise involving physical contact. In these situations, the pump should be removed for a period no longer than two hours without testing and reconnecting to bolus as required. Exercise should be delayed if the BG is over 14 mmol/L with ketones present until ketones are negative.

It will be important for Andrew to check with his coach to make sure he can wear his pump while playing soccer.

SECTION 4

TABLES

- Table 1A: Formulary Coverage of Insulin Therapies & Indications for Use in Various Populations (Updated July 2017)

- Table 1B: Formulary Coverage of Non-Insulin Therapies (oral and injectable) and Indications for Use in Various Populations (Updated July 2017)

- Table 2A: Non-Insulin Therapies and Insulin – Considerations for Use (Updated July 2017)

Provincial formulary links

- **Nova Scotia**
  http://novascotia.ca/dhw/pharmacare/formulary.asp

- **New Brunswick**
  http://www.gnb.ca/0212/pdf/nbpdp_formulary-e.pdf

- **Newfoundland & Labrador**
  http://www.health.gov.nl.ca/health/prescription/newformulary.asp

- **Prince Edward Island**
  http://www.gov.pe.ca/photos/original/hpei_formulary.pdf

TABLE 1A : Formulary Coverage of Insulin Therapies & Indications for Use in Various Populations

	Formulary Coverage				Indication for use with:		
INSULIN THERAPY	**NS**	**NB**	**NL**	**PE**	ADULTS×	PEDIATRICS×	PREGNANCY¥
BOLUS (Prandial/Meal Time) Insulins							
Rapid-acting Insulin Analogues (clear)							
• Insulin Aspart 100u/ml (NovoRapid®)	●	●	●	●	✔	✔	✔
• Insulin Aspart 100u/ml (Fiasp®)	○	○	○	○	✔	No data < 18yrs	No data available for use in pregnancy
• Insulin Glulisine 100 u/ml (Apidra®)	●	●	●	●	✔	✔No data < 6yrs	No data available for use in pregnancy
• Insulin Lispro 100 u/ml (Humalog®)	◖[1]	◖[2]	◖[3]	●	✔	✔ No data < 3yrs	✔
• Insulin Lispro 200 u/ml (Humalog®)	○	○	○	○	✔	✔ No data < 3yrs	✔
Short-acting Insulins (clear)							
• Insulin Regular 100 u/ml (Humulin® -R)	●	●	●	●	✔	✔	✔
• Insulin Regular 100 u/ml (Novolin® ge Toronto)	●	●	●	●	✔	✔	✔
• Insulin Regular 500 u/ml (Entuzity®)	○	○	○	○	✔	No data < 18yrs	No data available for use in pregnancy
BASAL Insulins							
Intermediate-acting (cloudy)							
• Insulin NPH 100 u/ml (Humulin® - N)	●	●	●	●	✔	✔	✔
• Insulin NPH 100 u/ml (Novolin® ge NPH)	●	●	●	●	✔	✔	✔
Long-acting Insulin Analogues (clear)							Not indicated for use in pregnancy. The decision to continue this type of insulin in pregnancy should be made in discussion with the specialist physician. There is no evidence to suggest harm; however, high-grade safety data is lacking.
• Insulin Detemir 100 u/ml (Levemir®)	◖[4]	◖[4]	◖[4]	◖[4]	✔	✔	
• Insulin Glargine 100 u/ml (Lantus®)	◖[4]	◖[4]	◖[4]	◖[4]	✔	✔	
• Insulin Glargine 100 u/ml (Basaglar™)	●	●	●	●	✔	✔ For type I > 6yrs	
• Insulin Glargine 300 u/ml (Toujeo™ SoloSTARr®)	○	○	○	○	✔	No data <18yrs	
• Insulin Degludec 100 u/ml & 200 u/ml (Tresiba®)	○	○	○	○	✔	No data <18yrs	
PREMIXED Insulins							
Premixed Regular and NPH							Not recommended in pregnancy. These do not allow for precise dosing as required to attain and maintain blood glucose targets.
• Humulin® 30/70	●	●	●	●	✔	✔	
• Novolin® ge 30/70, 40/60, 50/50	●	●	●	●	✔	✔	
Premixed Insulin Analogues							
• Biphasic insulin Aspart (NovoMix® 30)	○	○	○	○	✔	✔ No data <16yrs	
• Insulin Lispro/Lispro protamine (Humalog® Mix 25 and Mix 50)	○	○	○	○	✔	✔ No data < 3yrs	

◖= Exception Status; ●=Full Benefit; ○=Not a benefit

× Reference: Product monograph

¥ Reference: Briggs GG, Freeman RK, Yaffe SJ. *Drugs in Pregnancy and Lactation. Ninth edition*. 2011

TABLE 1A: Continued

◖[1] = ES[1]

Full benefit for children 18 years and younger, under Community Services, Family Pharmacare and Diabetes Assistance Programs

For the management of Type I and Type II diabetes mellitus in patients (>18 years old), who are:
- undergoing intensive therapy, i.e., administering three or more injections of insulin per day including basal insulin, and
- testing blood glucose levels 4-6 times per day

◖[2] = ES[2]

For management of Type I or II diabetes in adult patients (>18 years old) who:
- have experienced frequent episodes of postprandial hypoglycemia,
- have unpredictable mealtimes,
- have insulin resistance, or
- are using continuous subcutaneous insulin infusion.

Claim Notes:
- Prescriptions written by New Brunswick endocrinologists and internists do not require special authorization.
- Subsequent refills ordered by other practitioners will not require special authorization.

◖[3] = ES[3]

For patients with insulin-dependent diabetes on multiple insulin dosing (≥ 3 injections of regular insulin per day) and who are experiencing frequent hypoglycemia or poor glycemic control on their current regimen.

For patients with insulin-dependent diabetes who are using an insulin pump.

For patients with insulin-dependent diabetes who, for convenience purposes, wish to use this insulin and are willing to pay the difference in price from traditional regular insulin (i.e., NLPDP, will pay the cost normally reimbursed for regular insulin (Novolin® ge Toronto) and the patient would be responsible for the difference).

◖[4] = ES[4]

For the treatment of patients who have been diagnosed with Type I or Type II diabetes requiring insulin and have previously taken insulin NPH and/or pre-mix daily at optimal dosing, and:
- have experienced unexplained nocturnal hypoglycemia at least once a month despite optimal management, or
- have documented severe or continuing systemic or local allergic reaction to existing insulin(s).

NOTE: TABLE 1A WAS UPDATED FEBRUARY 12, 2018

TABLE 1B: Formulary Coverage of Non-Insulin Therapies (oral and injectable) and Indications for Use in Various Populations

Table 1B: Formulary Coverage of Non-Insulin Therapies (oral and injectable) and Indications for Use in Various Populations

NON-INSULIN THERAPIES	Formulary Coverage				Indication for use with:			Other Therapeutic Considerations
	NS	NB	NL	PE	ADULTS[x]	PEDIATRICS[x]	PREGNANCY	LACTATION[€]	
ORAL ANTIHYPERGLYCEMIC AGENTS									
Alpha-glucosidase inhibitor									
• Acarbose (Glucobay®)	●	●	◖[1]	●	Type 2	Not for use < 18	Safety not established.[¥]	No data, probably compatible	
Insulin Secretagogues									
Sulfonylureas:									
• Gliclazide (Diamicron®, Diamicron® MR)	●	●	●	●			Safety not established.[§]	No data	**Glyburide may be considered** through the first trimester (under care of a specialist) until insulin is initiated - Diabetes Care Program Nova Scotia (DCPNS)
• Glimepiride (Amaryl®)	○	●	●	●	Type 2	Not for use <18	Safety not established.[¥]	No data, probably hazardous	
• Glyburide (Diabeta®, Euglucon®)	●	●	●	●			**Human data suggest low risk[¥]**	No data, probably compatible	
• Chlorpropamide	○	●	●	●	Type 2	Safety, efficacy not established	Human data suggest risk in 3rd trimester. [¥]	No data, probably compatible	
• Tolbutamide	●	●	●	●	Type 2	Safety, efficacy not established	Human data suggest risk in 3rd trimester. [¥]	Limited data, probably compatible	
Meglitinides:									
• Repaglinide (Gluconorm®)	○	◖[2]	◖[3]	○	Type 2	Not for use <18	Safety not established[¥]	No data, probably hazardous	
Biguanides									
• Metformin (generics Glucophage®)	●	●	●	●	Type 2	Safety & efficacy not established	**Human data suggest low risk[¥]**	**Limited data, compatible**	Use in Polycystic Ovarian Syndrome (PCOS). Use in the first trimester until insulin initiated. Increasing use in GDM and type 2 DM in pregnancy.
• Metformin once daily formulation (Glumetza®)	○	○	○	○					
DPP-4 Inhibitor									
• Sitagliptin (Januvia®)	◖[4]	◖[5]	◖[4]	◖[4]	Type 2	Not for use <18	Safety not established [¥]	No data, probably compatible	
• Saxagliptin (Onglyza®)	◖[4]	◖[4]	◖[4]	◖[4]			Safety not established [¥]	No data	
• Linagliptin (Trajenta®)	◖[4]	◖[4]	◖[4]	◖[4]			Safety not established [¥]	No data, probably compatible	
• Alogliptin (Nesina®)	○	○	○	○			Safety not established [¥]	No data	

◖= Exception Status; ●=Full Benefit; ○=Not a benefit

NOTE: TABLE 1B was updated February 12, 2018

TABLE 1B: Continued

ORAL ANTIHYPERGLYCEMIC AGENTS (CONT)	NS	NB	NL	PE	ADULTS[×]	PEDIATRICS[×]	PREGNANCY	LACTATION[€]	
Thiazolidinedione									
• Pioglitazone (Actos®)	◖[6]	◖[7]	◖[7]	◖[6]	Type 2	Not for use < 18	Safety not established[¥]	No data, probably compatible	
• Rosiglitazone (Avandia®)	○	○	○	○					
Sodium Glucose co-transporter (SGLT2) Inhibitors									
• Canagliflozin (Invokana®)	◖[4]	◖[4]	◖[4]	◖[4]	Type 2	Not for use < 18	Safety not established[¥]	No data	
• Dapagliflozin (Forxiga®)	◖[4]	◖[4]	◖[4]	◖[4]					
• Empagliflozin (Jardiance®)	◖[4]	◖[4]	◖[4]	◖[4]					
Combined formulations									
• Metformin + Rosiglitazone (Avandamet ®)	○	○	○	○	Type 2	Not for use < 18	See recommendations for individual agents, page 1	See recommendations for individual agents, page 1	
• Metformin + Sitagliptin (Janumet®)	◖[8]	◖[8]	◖[8]	◖[8]					
• Metformin + Sitagliptin (Janumet® XR)	◖[8]	◖[8]	◖[8]	◖[8]					
• Metformin + Linagliptin (Jentadueto®)	◖[9]	◖[9]	◖[9]	◖[9]					
• Metformin + Saxagliptin (Komboglyze®)	◖[10]	◖[10]	◖[10]	◖[10]					
• Metformin + Alogliptin (Kazano®)	○	○	○	○					
• Metformin + Canagliflozin (Invokamet®)	○	○	○	○	Type 2	Not for use < 18	See recommendations for individual agents, page 1	See recommendations for individual agents, page 1	
• Metformin + Dapagliflozin (Xigduo®)	◖[11]	◖[11]	○	○					
• Metformin + Empagliflozin (Synjardy®)	○	○	○	○					
• Linagliptin + Empagliflozin (Glyxambi®)	○	○	○	○					
INJECTABLE ANTIHYPERGLYCEMIC THERAPY									
GLP-1 Receptor Agonists:									
• Exenatide (Byetta®)	○	○	○	○	Type 2	Not for use <18	Safety not established[¥]	No data, probably compatible	
• Exenatide extended release (Bydureon®)	○	○	○	○					
• Liraglutide (Victoza®)	○	○	○	○	Type 2	Not for use <18	Safety not established[¥]	No data	
• Dulaglutide (Trulicity ™)	○	○	○	○					
WEIGHT LOSS AGENTS									
• Orlistat (Xenical®)	○	○	○	○	Weight loss	Not for use < 12	Safety not established[¥]	No data, probably compatible	
• Liraglutide (Saxenda®)	○	○	○	○		Not for use < 18	Safety not established[x]		

◖= Exception Status; ●=Full Benefit; ○=Not a benefit

× Product monograph

¥ Reference: Briggs GG, Freeman RK, Yaffe SJ. *Drugs in Pregnancy and Lactation. Ninth edition*; With the exception of orlistat, all product monographs recommend no use in pregnancy.

§ Reference: Micromedex Healthcare Series. *Thomson Micromedex*. Available at: http://www.thomson hc.com. Accessed: 2012 May 15

€ Reference: Hale TW and Rowe HE. *Medications and Mothers Milk*. Plano, TX: Hale Publishing; 2014.

NOTE: TABLE 1B was updated February 12, 2018

TABLE 1B: TABLE KEY

◖ = ES	Exception Status Criteria, Key Interpretations
◖1	For patients who are not controlled satisfactorily, despite maximum doses of a biguanide and sulfonlyurea, or in whom these agents are contraindicated.
◖2	For patients with type 2 diabetes who are not adequately controlled by diet and exercise and glyburide and/or metformin or who have frequent or severe hypoglycemic episodes despite dosage adjustment of glyburide.
◖3	For patients who have failed to respond to or have experienced hypoglycemia from sulfonylureas.
◖4	For the treatment of type 2 diabetes in addition to metformin and a sulfonylurea in patients who have inadequate glycemic control or intolerance to metformin or a sulfonylurea **AND** in whom insulin is not an option.
◖5	For the treatment of Type 2 diabetes mellitus in patients for whom NPH insulin is not an option **AND**: • who have inadequate glycemic control while on optimal doses of metformin and a sulfonylurea when added as a third agent; **OR** • In combination with metformin when a sulfonylurea is not suitable due to contraindications or intolerance; **OR** • As monotherapy when metformin and sulfonylurea are not suitable due to contraindications or intolerance
◖6	For treatment of Type 2 diabetes in patients who have: • inadequate glycemic control on optimal doses of sulfonylurea and metformin; **OR** • demonstrated intolerance or contraindication to metformin and are on optimal doses of sulfonylurea; **OR** • demonstrated intolerance or contraindication to sulfonylurea and are on optimal doses of metformin
◖7	For patients with type 2 diabetes who are not adequately controlled by diet, exercise, and drug therapy. Drug therapy should include a trial of a sulfonylurea and metformin, alone and in combination, unless one of these agents is not tolerated or is contraindicated.
◖8	For the treatment of type 2 diabetes in patients for whom insulin is not an option **AND** who are already stabilized on therapy with metformin, a sulfonylurea and sitagliptin, to replace the individual components of sitagliptin and metformin in these patients.
◖9	For the treatment of patients with type II diabetes for whom insulin is not an option **AND** who are already stabilized on therapy with metformin, a sulfonylurea and linagliptin, to replace the individual components of linagliptin and metformin for these patients.
◖10	For the treatment of patients with type II diabetes for whom insulin is not an option **AND** who are already stabilized on therapy with metformin, a sulfonylurea and saxagliptin, to replace the individual components of saxagliptin and metformin for these patients.
◖11	For the treatment of patients with type II diabetes for whom insulin is not an option **AND** who are already stabilized on therapy with metformin and dapagliflozin, to replace the individual components of metformin and dapagliflozin for these patients.

NOTE: TABLE 1B was updated February 12, 2018

Table 2A: Non-Insulin Therapies and Insulin - Considerations for Use

The recommendations in the following table are made based on varying levels of evidence, ranging from randomized controlled trial (RCT) data to existing clinical practice. Each agent is referenced to indicate the rationale for the recommendations made regarding their use with insulin. Recommendations may change as evidence evolves.

NON-INSULIN THERAPIES Use with Insulin (in combination)	BOLUS INSULIN	Rapid-acting IA	Short-acting (Regular insulin)	BASAL INSULIN	Intermediate-acting (NPH or Humulin N)	Long-acting IA • Detemir	Long-acting IA • Glargine	Ultra-long-acting IA • Degludec	PREMIXED	Premixed Reg and NPH	Premixed IAs
ORAL ANTIHYPERGLYCEMIC AGENTS											
Biguanides • Metformin[1] (Generics, Glucophage®, Glumetza® once-daily formulation)		✓	✓		✓	✓	✓	✓		✓	✓
INSULIN SECRETAGOGUES[2]											
• Sulfonylureas (Gliclazide®, Glimepiride®, Glyburide®, chlorpropamide and tolbutamide)		X	X		✓	✓	✓	✓		X	X
• Meglitinides: Repaglinide (Gluconorm®)		X	X		✓	✓	✓	✓		X	X
DPP-4 INHIBITOR											
• Sitagliptin[3] (Januvia®)		✓	✓		✓	✓	✓	✓		✓	✓
• Saxagliptin[3] (Onglyza®)		✓	✓		✓	✓	✓	✓		✓	✓
• Alogliptin[3] (Nesina®)		✓	✓		✓	✓	✓	✓		✓	✓
• Linagliptin (Trajenta®)		✓	✓		✓	✓	✓	✓		✓	✓
THIAZOLIDINEDIONE											
• Pioglitazone (Actos®)		X	X		X	X	X	X		X	X
• Rosiglitazone (Avandia®)		X	X		X	X	X	X		X	X
SODIUM GLUCOSE CO-TRANSPORTER (SGLT2) INHIBITORS											
• Canagliflozin (Invokana®)[3]		✓	✓		✓	✓	✓	✓		✓	✓
• Dapagliflozin (Forxiga®)[3]		✓	✓		✓	✓	✓	✓		✓	✓
• Empagliflozin (Jardiance®)[3]		✓	✓		✓	✓	✓	✓		✓	✓
ALPHA-GLYCOSIDASE INHIBITOR											
• Acarbose (Glucobay®)[3]		✓	✓		✓	✓	✓	✓		✓	✓
COMBINED FORMULATIONS											
• Metformin + Rosiglitazone (Avandamet ®)		X	X		X	X	X	X		X	X
• Metformin + Sitagliptin (Janumet®)		✓	✓		✓	✓	✓	✓		✓	✓
• Metformin + Sitagliptin (Janumet®XR)		✓	✓		✓	✓	✓	✓		✓	✓
• Metformin + Linagliptin (Jentadueto®)		X	X		X	X	X	X		X	X
• Metformin + Saxagliptin (Komboglyze®)		✓	✓		✓	✓	✓	✓		✓	✓
• Metformin + alogliptin (Kazano®)		✓	✓		✓	✓	✓	✓		✓	✓
• Metformin + Canagliflozin (Invokamet®)		✓	✓		✓	✓	✓	✓		✓	✓
• Metformin + Dapagliflozin (Xigduo®)		✓	✓		✓	✓	✓	✓		✓	✓
• Metformin + Empagliflozin (Synjardy®)		✓	✓		✓	✓	✓	✓		✓	✓
• Linagliptin + Empagliflozin (Glyxambi®)		X	X		X	X	X	X		X	X
INJECTABLE ANTIHYPERGLYCEMIC THERAPY: GLP-1 RECEPTOR AGONIST											
• Exenatide (Byetta®)[4]		X	X		✓	✓	✓	✓		X	X
• Exenatide extended release (Bydureon®)		X	X		✓	✓	✓	✓		X	X
• Liraglutide (Victoza®)[5]		X	X		✓	✓	✓	✓		X	X
• Dulaglutide (Trulicity™)[5]		X	X		✓	✓	✓	✓		X	X
WEIGHT LOSS AGENTS											
• Orlistat (Xenical®)		✓	✓		✓	✓	✓	✓		✓	✓
• Liraglutide (Saxenda®)		X	X		✓	✓	✓	✓		X	X

IA - insulin analogue; **X** - Not recommended for use with insulin - either due to lack of data or proof of harm; ✓- Used with insulin in clinical practice

NOTE: TABLE 2A was updated February 12, 2018

TABLE 2A: Continued

Footnotes:

1. RCT data supports metformin as the standard of care in combination with insulin in T2DM.

2. Existing clinical practice: Insulin secretagogues may be continued while taking basal insulin to limit initial deterioration of glycemic control and because of their insulin-sparing effect, but the combination should be avoided later if hypoglycemia occurs and/or when bolus insulin regimens are added. RCT data to inform the secretagogues optimal place in therapy with insulin are lacking.

3. Monograph states: Indicated as add-on combination therapy with insulin.

4. Monograph states: Indicated as add-on combination therapy with glargine insulin [based on RCT data]. Exenatide is combined with detemir and intermediate-acting insulin in clinical practice despite a lack of RCT data examining these combinations [existing/emerging clinical practice]. The combination of exenatide and bolus insulin has not been studied.

5. Monograph states: Indicated as add-on combination therapy with basal insulin. The combination of liraglutide and bolus insulin has not been studied.

NOTE:

Several studies have compared the effects of oral antidiabetic agents (OADs) added to insulin compared with insulin monotherapy; however, there are no studies that have directly compared OADs in combination with insulin to help understand their relative effectiveness and tolerability in this context.

- A common limitation of currently available data on the use of OAD agents in combination with insulin is that most studies were designed to fulfill drug licensing requirements.

- Study design is influenced by when drugs are brought to market. Newer agents such as the SGLT2 inhibitors have been specifically studied in patients poorly controlled on high insulin doses plus OADs. The older oral agents were not studied in this way as practice patterns were very different at the time they came to market. Therefore, the relative efficacy and safety of the available oral agents in combination with insulin is largely unknown.

- Studies have either not evaluated the efficacy and tolerability of the addition of an OAD agent to insulin or, if evaluated, the comparator was placebo not other OAD agents plus insulin in combination (i.e., metformin + insulin).

- Study patients are not necessarily using basal insulin exclusively. Also, full details on insulin regimens are not always provided.

- The bulk of trial data are only partially reflective of T2DM treatment with insulin as it exists in current clinical practice.

NOTE: TABLE 2A was updated Februay 12, 2018

SECTION 5

DOCUMENTATION FORMS

- Insulin Start Order Form
- Insulin Start Instruction Education Checklist

INSULIN START ORDER FORM

Please complete, and forward to the local Diabetes Centre

Addressograph Area

Current Diabetes Non-Insulin Therapies (oral and Injectables)

Medication Name	Dose/ Frequency	Continue	If continued, New Dose/Frequency	Discontinue	Date to Discontinue
		☐		☐	
		☐		☐	
		☐		☐	
		☐		☐	

Insulin (type, dosage, frequency, and time):

_____

_____

_____

Special Instructions:

_____

_____

_____

Authorization for Dose Adjustment: ☐ Yes ☐ No

Endocrinologist/Internist consult: ☐ Yes ☐ No If yes, to whom? _____

Consult already forwarded: ☐ Yes ☐ No

Prescription for Insulin and Supplies:

☐ Provided to patient Comment: _____

☐ Will be provided following insulin start appointment.

_____ _____

Date Physician Signature

Addressograph Area

INSULIN START INSTRUCTION EDUCATION CHECKLIST

DIABETES CENTRE

INSTRUCTIONS:

Instruction Use columns under this heading to indicate the first time the topic was taught.
Reinforcement Use columns under this heading to indicate review of specific topics.
Date & Initial Record the date. Initial if required.
C Check (√) when comprehension is adequate and reinforcement of topic is not required.
H Check (√) if handouts/materials were given.
F Check (√) if family/others were present for instruction.
G Check (√) if topic was instructed in a group.

TOPIC	Instruction					Reinforcement					Reinforcement				
	Date & Initial	C	H	F	G	Date & Initial	C	H	F	G	Date & Initial	C	H	F	G
Insulin															
• name/type/time action															
• measurement (units)															
• storage/expiry dates															
• delivery devices ❑ pen ❑ syringe															
• preparation															
• site selection/rotation (exercise)															
• starting dose/expected dose adjustment															
• injection times															
Sharps Disposal															
Infection Control															
• single use needles															
Meal Timing/Snacks															
Hypoglycemia															
• causes															
• treatment/glucagon															
SMBG															
• times/frequency															
• target ranges/goals															
Non-insulin therapy (oral)															
• discontinue or continue															
Non-insulin therapy (injectables)															
• discontinue or continue															
Prescription(s)															
• supplies															
Follow-up Routine															
Other:															
• special aids															
• adjustment															

Demonstration—Preparation and Administration

Insulin	Demonstration (Date)	Return Demonstration (Date)	Return Demonstration (Date)	Comments
Preparation Single Dose ❑ Pen ❑ Syringe				
Mixed Dose				
Administration ❑ Pen Needle tip size ____				
❑ Syringe				

Overall Comments:

Follow-up Plan:

Signature	Initials	Signature	Initials
Signature	Initials	Signature	Initials

SECTION 6

GLOSSARY OF TERMS AND ABBREVIATIONS

GLOSSARY OF TERMS

ALGORITHM:	An insulin dose scale that provides a guide for making insulin dose adjustments to correct for immediate high or low blood glucose.
ANTICIPATORY DOSE ADJUSTMENT:	Adjustment in advance of planned physical activity or food intake.
BASAL INSULIN DOSE:	Background insulin from a long-acting insulin analogue or intermediate-acting insulin to match background insulin need. In continuous subcutaneous insulin infusion (pump), is a continuous 24-hour delivery of insulin. When one or more basal insulin doses are correctly set to deliver 50% of the TDD, the blood glucose does not rise or fall during periods in which no eating occurs.
BOLUS INSULIN:	Delivery of rapid- or short-acting insulin to match carbohydrates in an upcoming meal or snack.
CERTIFIED DIABETES EDUCATOR:	A health care professional who is trained, experienced, and competent in diabetes education and has passed a certification exam provided by the Canadian Diabetes Educator Certification Board.
CARBOHYDRATE COUNTING:	Counting the grams of carbohydrates in any food eaten and matching these grams with appropriate insulin doses; focuses on total amount of carbohydrates at each meal and snack.
CERTIFICATION:	Process to qualify the healthcare provider for safe, competent practice of an advanced skill.
COMBINATION THERAPY:	Use of both insulin and non-insulin therapy (oral agents and/or injectables.)
COMPENSATORY DOSE ADJUSTMENT:	An adjustment to the rapid-/short-acting insulin dose to compensate for hypoglycemia or hyperglycemia.
CORRECTION BOLUS:	Insulin delivered to bring a high blood glucose back to target goals.
DAWN PHENOMENON:	An early morning rise in blood glucose levels caused largely by the normal release of growth hormone that blocks the effect of insulin during the early morning hours.
DESIGNATE (for exam purposes):	A diabetes educator previously certified in insulin dose adjustment with demonstrated competency and confidence who is formally (in writing) appointed by the Diabetes Centre Medical Advisor/Director to oversee the preparation and examination for insulin dose adjustment.
FLEXIBLE INSULIN THERAPY:	Therapy that uses predetermined blood glucose targets and A1C values as goals. Insulin doses are adjusted according to blood glucose levels, food intake, and/or physical activity.
GLUCAGON:	A hormone produced by the alpha cells of the pancreatic islet of Langerhans and a counter-regulatory hormone to insulin. It is injected during severe hypoglycemia to raise the blood glucose quickly by releasing glucose stored in the liver.
GLYCOGEN:	The form in which the liver and muscles store glucose. It may be broken down to active blood glucose during an insulin reaction, a fast, or exercise.

GLOSSARY OF TERMS (CONT)

GRAVIDA:	Woman who is or has been pregnant regardless of outcome.
HONEYMOON PHASE:	A remission phase that can happen within weeks of diagnosis of type 1 diabetes. This phase is characterized by a temporary recovery of beta-cell function during which time insulin requirements may decline.
INSULIN SENSITIVITY FACTOR:	Estimates point drop in mmol/L with a unit of rapid-/short-acting insulin.
INSULIN-TO-CARBOHYDRATE RATIO:	The amount of insulin required to cover a known amount of carbohydrate, keeping blood glucose levels within target two hours after the meal/snack.
INTENSIVE DIABETES THERAPY:	The intensity of the effort an individual makes using self-management strategies to meet diabetes-related goals.
INTENSIVE INSULIN THERAPY:	Insulin regimens that are designed to mimic physiologic insulin aimed at achieving normal or near normal blood glucose levels.
INTERCURRENT ILLNESS:	An illness that is superimposed on diabetes.
INTERMEDIATE-ACTING INSULIN:	Insulin that starts to work in 1 to 3 hours, peaks in 5 to 8 hours, and lasts approximately 18 hours (up to 24 hours in children).
LONG-ACTING INSULIN ANALOGUE:	Insulin analogue that provides basal 24-hour coverage.
MEAL PERIOD:	Includes a meal plus any snacks before the next meal.
MULTIPLE DAILY INJECTIONS:	Insulin regimens involving three or more insulin injections a day.
NON-INSULIN THERAPY:	Term used to describe non-insulin therapies used with diabetes. Includes oral antiglycemic agents (OAAs) such as secretagogues, biguanides etc, and injectable therapy such as GLP-1 receptor agonists.
PARA (PARITY):	Number of pregnancies reaching viability; not number of fetuses delivered.
PATTERN MANAGEMENT:	Changes made to usual insulin dose based on blood glucose patterns.
RAPID-ACTING INSULIN:	An insulin analogue that starts to work in 10 to 15 minutes, peaks at 1.0 to 1.5 hours, and lasts approximately 3.0 to 5.0 hours.
SENSOR-AUGMENTED THERAPY:	Combines the technology of an insulin pump with the continuous glucose sensor. The user has access to continuous, real-time glucose readings, enhancing the ability to make decisions around food, exercise, sick day/DKA management, etc.
SHORT-ACTING INSULIN:	Insulin that starts to work in 30 minutes, peaks at 2 to 3 hours, and lasts approximately 6.5 hours.
SUPPLEMENTAL DOSE ADJUSTMENT:	Temporary insulin adjustments to the rapid-/short-acting insulin dose to compensate for hyperglycemia or hypoglycemia. Supplements can be additional insulin added to the usual dose or a "negative supplement" (i.e., a decrease in the usual dose).
TERATOGEN	An agent or influence that causes physical defects in the developing embryo.

ABBREVIATIONS:

ac	before meals
AcAc	acetoacetate
BID	twice a day
BMI	Body Mass Index
CDA	Canadian Diabetes Association
CDE®	certified diabetes educator
CGMS	continuous glucose monitoring system
CHO	carbohydrate
CSII	continuous subcutaneous insulin infusion (pump)
DC	Diabetes Centre
DCPNS	Diabetes Care Program of Nova Scotia
DKA	diabetic ketoacidosis
DMF	delegated medical function
ER	Emergency Room
GDM	gestational diabetes
A1C	hemoglobin A_{1c}
HB	3 beta-hydroxybutyrate
HDL	high-density lipoprotein
hs	evening or at bedtime (for the purpose of this resource)
IA	intermediate-acting insulin
ICU	Intensive Care Unit
ISF	insulin sensitivity factor

ABBREVIATIONS (CONT):

LA	long-acting insulin analogues
LDL	low density lipoprotein
MDI	multiple daily injections
mg	milligrams
mmol/L	millimoles per litre
OAA	oral antihyperglycemic agents
OGTT	oral glucose tolerance test
pc	after meals
PCOS	polycystic ovarian syndrome
PMA	premixed insulin analogues
PMR	premixed regular insulin
QID	four times a day
RA	rapid-acting insulin analogues
SA	short-acting insulin
SMBG	self-monitoring of blood glucose
TDD	total daily dose
TID	three times a day
TSH	thyroid stimulating hormone
UKPDS	United Kingdom Prospective Diabetes Study